AMS-12

The Twelfth International Conference on Accelerator Mass Spectrometry

20 – 25 March 2011

Museum of New Zealand Te Papa Tongarewa
Wellington, New Zealand

Programme and Abstracts Handbook

Conference Convenors

Albert Zondervan
Frank Bruhn

National Isotope Centre
GNS Science

Delivering Expertise

GNS Science

New Zealand's leading provider of Earth, geoscience and isotope research and consultancy services. We apply our scientific knowledge from the atomic to the planetary scale to create wealth, protect the environment, and improve the safety of people.

Energy & Resources

Sustainable energy development and wealth creation.

- Geological Mapping
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- Minerals
- Oceans
- Oil & Gas

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- Extremophiles
- Environmental change
- Paleontology
- Water
- Ice Core

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- Earthquakes
- Landslides
- Tsunami
- Volcanoes

Materials & Forensics

Innovative problem solving, authentication and materials fabrication.

- Geoforensics & authentication
- Ion beam physics
- Nanotechnology
- Non-invasive scanning

We are proud to host AMS-12 and welcome all delegates to Wellington, New Zealand.

GNS SCIENCE
TE PŪ AO

Scientific Advisory Panel

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Lucio Calcagnile
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Local Organising Committee

Albert Zondervan
Frank Bruhn
Christine Prior
Chris Purcell
Susanne Schaff-Ede
Mike Sim
Anne Williamson

Conference Manager

Janet Simes (Absolutely Organised Ltd)

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Welcome to AMS-12 – Welcome to Wellington!

A warm welcome to the 12th International Conference on Accelerator Mass Spectrometry (AMS-12) in Wellington, New Zealand! We have chosen the National Museum of New Zealand, Te Papa Tongarewa, as the conference site, as in addition to being an excellent conference venue it provides a unique opportunity to explore New Zealand's nature, art, history, and cultural heritage.

AMS-12 continues the tradition of previous conferences to be the major forum for discussing recent developments of technical and applied aspects of AMS. For the second time, the conference is being held in the Southern hemisphere. During this five day conference you will have the opportunity to hear over 200 scientists present their latest work in their respective disciplines. There will be two concurrent sessions each day – so some choices will have to be made. Posters will be available for viewing each day in Oceania where teas and lunches will be served. We have about 240 registrants so we encourage you each day to talk to someone you haven't met before.

We thank the sponsors and exhibitors:

- GNS Science
- Australian Nuclear Science and Technology Organisation (ANSTO)
- National Electrostatics Corp. (NEC)
- High Voltage Engineering Europa B.V. (HVE)
- John Morris Scientific
- Danfysik A/S

without whose help we could not have run the conference at Te Papa. Please take the time to visit their displays in Oceania.

Members of the Scientific Advisory Panel did a tremendous job of reviewing the abstracts and putting the scientific programme together. We also thank the Local Organising Committee and all our staff here at the National Isotope Centre, and in particular Christine Prior, Chris Purcell, Susanne Schaff-Ede, Mike Sim and Anne Williamson for helping to get the conference together. Our conference organizer, Janet Simes, did an excellent job making sure everything happened on time in the lead up to the conference.

On Monday afternoon, we will be opening all our laboratories at GNS Science's National Isotope Centre and we invite as many as you who can make it to come and visit our facilities, talk to our people and enjoy the views during afternoon tea.

Wellington, our capital city, is a great place to live and a great place to visit. We hope you can all take the opportunity to enjoy the many things it has to offer. The city centre is very compact, and there are many eateries, bars, theatres and museums within easy walking distance. If you feel the teas and lunches at Te Papa are getting too much for you - take a walk along Oriental Parade or, for the energetic amongst you, a walk to the top of Mount Victoria. This will reward you with fantastic views and possibly a close encounter with that Wellington wind!

Albert Zondervan
Frank Bruhn
AMS-12 Convenors

General Information

Registration and Information Desk

The registration and information desk will be located in Oceania on Level 3 from 16.00 to 18.30 on Sunday 20 March and from 8.00 to 15.30 each day thereafter.

Coats and Luggage

There will be a coat rack located in Oceania. On Friday there will also be a luggage storage area available for registrants in Oceania.

Name Badges

Please wear your name badges at all times so that Te Papa hosts know you are with the conference and the catering staff know to serve you. The museum will be open to the general public during the conference, so admission to Oceania, the TelstraClear Centre and Soundings Theatre will be restricted to conference participants wearing name badges.

Teas and Lunches

Morning teas, lunches and afternoon teas will be served in Oceania. The caterer has been advised of any special dietary requirements. If you requested a special diet in advance this will be available for you. Please see the conference registration staff or make yourself known to the catering staff to obtain your special requirements.

Internet

Free WI-FI is available in Oceania and in many areas of Te Papa. One computer kiosk with internet access will be available for conference participants who do not bring their own computers.

Messages and Phones

Messages received for registrants will be placed on the notice board near the registration and information desk. There are pay phones on the ground floor of Te Papa. Please keep your mobile phones and pagers turned off during conference sessions.

Presenters

Please report to the Technician in the room in which you are presenting during a break well in advance of your presentation.

Parking

The two closest car parks are the Te Papa and Barnett Street car parks. Other nearby car parking is available at the James Smith car park adjacent to the Amora Hotel, and Queens Wharf Event Centre car park. Normal car parking fees apply to all parks.

Room Locations

If you have any difficulty finding the room you wish to go to, please do not hesitate to ask any of the Te Papa hosts or the conference registration staff.

All papers will be presented in either Soundings Theatre (level 2) or Rangimarie in the TelstraClear Centre on Level 3.

All catering, registrations, exhibits, and posters are located in Oceania on Level 3.

Toilets are located on each level of Te Papa and are clearly marked.

Manuscript Submission

Following tradition, presenters at AMS-12 have the opportunity to publish their work in a NIM-B proceedings volume. The terms under which this is possible have been discussed with the journal's Editor and a contract with this journal's publisher, Elsevier, has been put in place. The guest editors are Albert Zondervan, Christine Prior and Frank Bruhn. Many tasks lie ahead for them, the Corresponding Editors and reviewers, in order to make publication of the proceedings by May 2012 possible.

For now, it suffices to mention the key points for presenters and/or first/submitting authors of proceedings papers:

- Elsevier's Editorial System (EES) has been chosen as the tool for the whole of the process. It is web-based and comprehensive. More importantly, technical support is available in a variety of ways.
- The website: http://ees.elsevier.com/nimb_proceedings is the starting point for authors, editors, and reviewers. On this site, Elsevier provides the EES customized to NIM-B proceedings. It will be accessible for authors to submit their proceedings paper by the time the conference commences.
- The deadline for submission of proceedings papers is 1 June 2011.
- The deadline for review of proceedings papers is 15 August 2011.
- You can direct all your questions about this process to ams12@gns.cri.nz .

Compact Carbon AMS

National Electrostatics Corp. offers a wide variety of compact, low voltage AMS systems for carbon radio isotope ratio measurement*. All NEC systems provide high precision and low background. They can be equipped with the high throughput, multi-sample ion source or dual ion source injector for added versatility.

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Throughput of 400 samples/day to 2% precision for modern carbon with the 134 sample source

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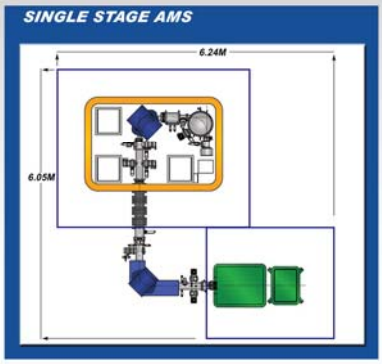
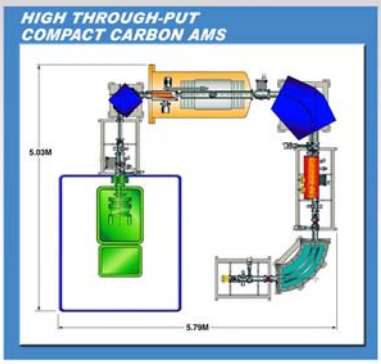
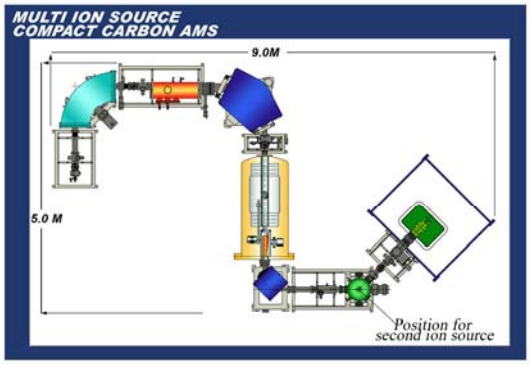
Automated Data Collection and Analysis







* NEC also provides complete AMS systems up to 25MV for radio isotope measurement through the actinides.

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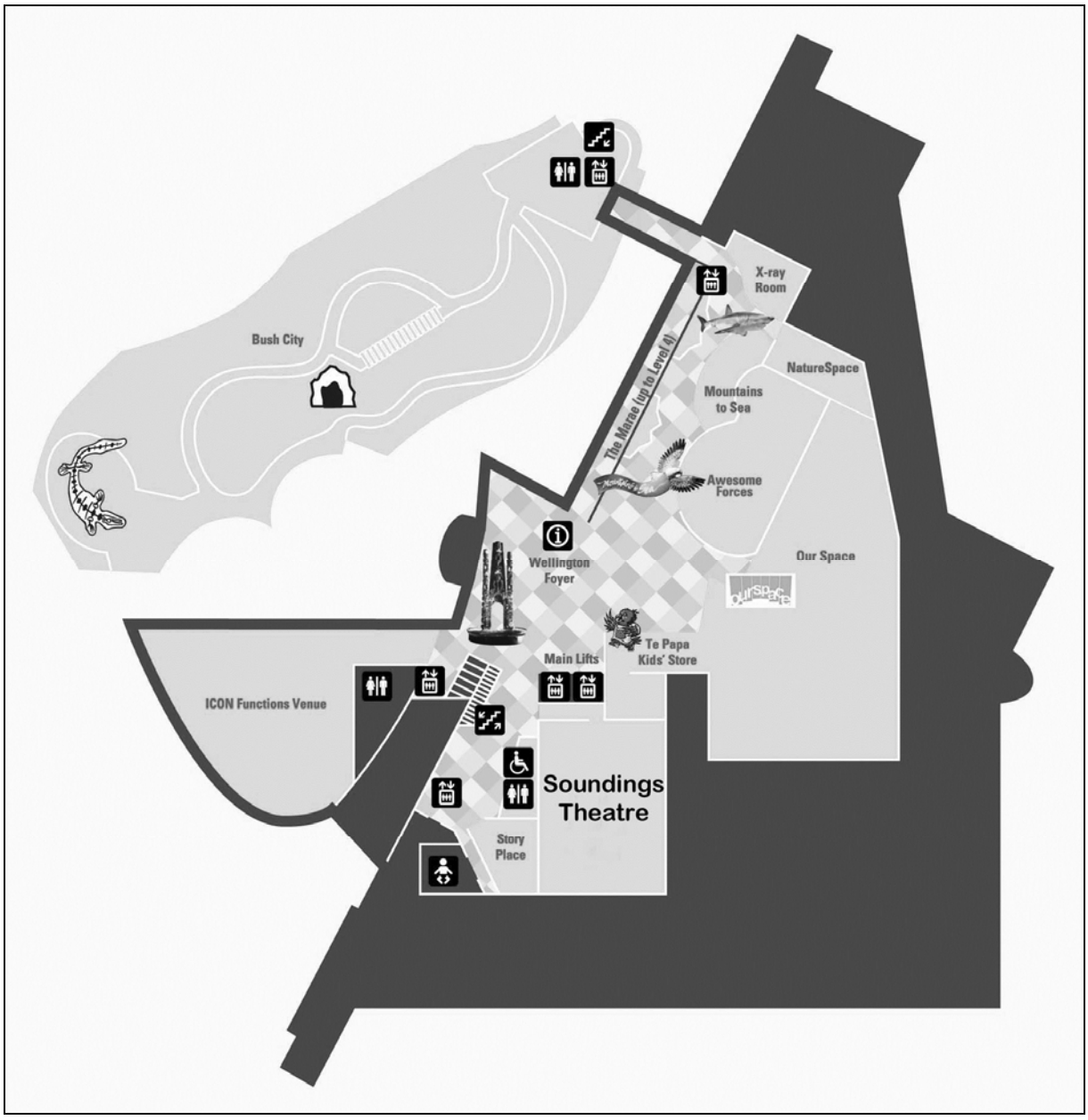
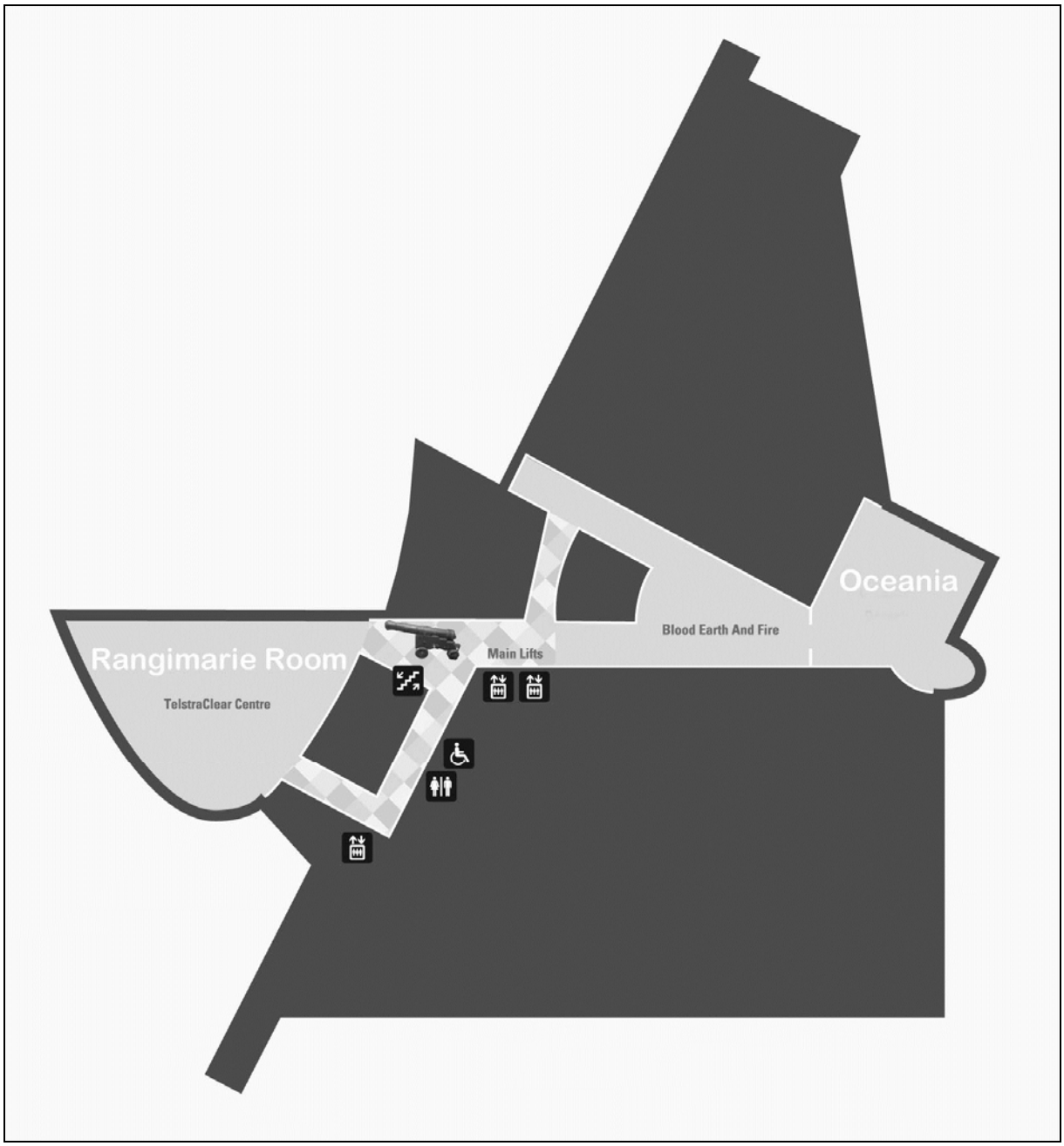
7540 Graber Rd. P.O. Box 620310 Middleton, WI 53562
Tel: 608-831-7600 Fax: 608-831-9591 Email: nec@pelletron.com Web: www.pelletron.com

Te Papa Floor Plan

Level 2



Level 3


Oceania
Blood Earth And Fire
Rangimarie Room
TelstraClear Centre
Main Lifts

Sponsors

We are grateful for the support of the following sponsors

We are also pleased to welcome the following exhibitors

Quick Guide Programme

Monday 21-Mar

start	stop	session / presentation	
		session 1	
9:00	9:30	opening	
9:30	10:15	FOR#1	
10:15	11:00	GLO#1	
11:00	11:30	break	
		session 2A	**session 2B**
11:30	11:50	EAR#1	TEC#1
11:50	12:10	EAR#2	TEC#2
12:10	12:30	EAR#3	TEC#3
12:30	12:50	EAR#4	TEC#4
12:50	14:00	lunch	
		session 3a	**session 3b**
14:00	14:20	EAR#5	TEC#5
14:20	14:40	EAR#6	TEC#6
14:40	15:00	EAR#7	TEC#7
15:00	15:20	EAR#8	TEC#8
15:20	15:40	EAR#9	TEC#9
15:40	16:00	into bus / no break	
16:00	18:00	NIC lab visit	

Tuesday 22-Mar

start	stop	session / presentation	
		session 4	
9:00	9:20	EAR#10	
9:20	9:40	GLO#2	
9:40	10:00	EAR#11	
10:00	10:20	GLO#3	
10:20	10:40	GLO#4	
10:40	11:10	break	
		session 5a	**session 5b**
11:10	11:30	GLO#5	TEC#10
11:30	11:50	GLO#6	TEC#11
11:50	12:10	GLO#7	TEC#12
12:10	12:30	GLO#8	TEC#13
12:30	12:50	GLO#9	REP#1
12:50	14:00	lunch	
		poster session 1	
14:00	15:40	EAR#P101-P124 + TEC#P101-P122 + GLO#P101-P122 + REP#P101-P119	
15:40	16:00	break	
		session 6a	**session 6b**
16:00	16:20	GLO#10	REP#2
16:20	16:40	GLO#11	REP#3
16:40	17:00	EAR#12	REP#4
17:00	17:20	EAR#13	REP#5
17:20	17:40	EAR#14	REP#6

Wednesday 23-Mar

start	stop	session / presentation	
		session 7	
9:00	9:20	TEC#14	
9:20	9:40	TEC#15	
9:40	10:00	TEC#16	
10:00	10:20	EAR#15	
10:20	10:40	EAR#16	
10:40	11:10	break	
		session 8a	**session 8b**
11:10	11:30	EAR#17	REP#7
11:30	11:50	EAR#18	REP#8
11:50	12:10	EAR#19	REP#9
12:10	12:30	EAR#20	SAM#1
12:30	12:50	EAR#21	SAM#2
12:50	14:00	lunch	
		session 9a	**session 9b**
14:00	14:20	GLO#12	SAM#3
14:20	14:40	GLO#13	SAM#4
14:40	15:00	GLO#14	SAM#5
15:00	15:20	GLO#15	SAM#6
15:20	15:40	GLO#16	SAM#7
15:40	16:00	into bus / break	
16:00	18:00	excursion to Zealandia	

Thursday 24-Mar

start	stop	session / presentation	
		session 10	
9:00	9:20	TEC#17	
9:20	9:40	REP#10	
9:40	10:00	REP#11	
10:00	10:20	REP#12	
10:20	10:40	LIF#1	
10:40	11:10	break	
		session 11a	**session 11b**
11:10	11:30	LIF#2	AST#1
11:30	11:50	LIF#3	AST#2
11:50	12:10	ARC#1	AST#3
12:10	12:30	ARC#2	AST#4
12:30	12:50	ARC#3	AST#5
12:50	14:00	lunch	
		poster session 2	
14:00	15:40	REP#P120-P128 + AST#P101-P107 + FOR#P101-P106 + SAM#P101-P142 + CAL#P101-P106 + ARC#P101-P112 + LIF#P101-P104	
15:40	16:00	into bus / no break	
16:00	23:00	coastal tour & dinner	

Friday 25-Mar

start	stop	session / presentation	
		session 12	
9:00	9:20	SAM#8	
9:20	9:40	ARC#4	
9:40	10:00	ARC#5	
10:00	10:20	CAL#7	
10:20	10:40	AST#6	
10:40	11:10	break	
		session 13a	**session 13b**
11:10	11:30	FOR#2	CAL#2
11:30	11:50	FOR#3	CAL#3
11:50	12:10	FOR#4	CAL#4
12:10	12:30	FOR#5	CAL#5
12:30	12:50	FOR#6	CAL#6
12:50	14:00	lunch	
		session 14	
14:00	14:20	AST#7	
14:20	14:40	FOR#7	
14:40	15:40	summary	
15:40	16:00	break	
		session 15	
16:00	16:30	business	
16:30	17:00	AMS-13 bids	
17:00	17:30	closing	

Soundings Theatre | **Rangimarie** | **Oceania**

code	theme
EAR	EARth and environmental sciences
TEC	TEChnical advances, non-standard AMS isotopes
GLO	GLObal change
REP	status REPorts: accelerator facilities, sample-preparation labs
AST	ASTrophysics, cosmochemistry
FOR	FORensics, nuclear safeguards
SAM	SAMple preparation
CAL	standards, CALibration, data analysis
ARC	ARChaeology
LIF	LIFe sciences

(Please refer to Lookup Table on page 256)

> **The Institute for Environmental Research** conducts research on Quaternary climates, water management, atmospheric processes and aerosol characterisation through the application of isotopic and analytical facilities.

Capabilities include:

> **Accelerator Mass Spectrometry**
- Radiocarbon dating
- Cosmogenic isotope dating (^{10}Be, ^{26}Al)
- ^{129}I, U and Pu isotope analysis

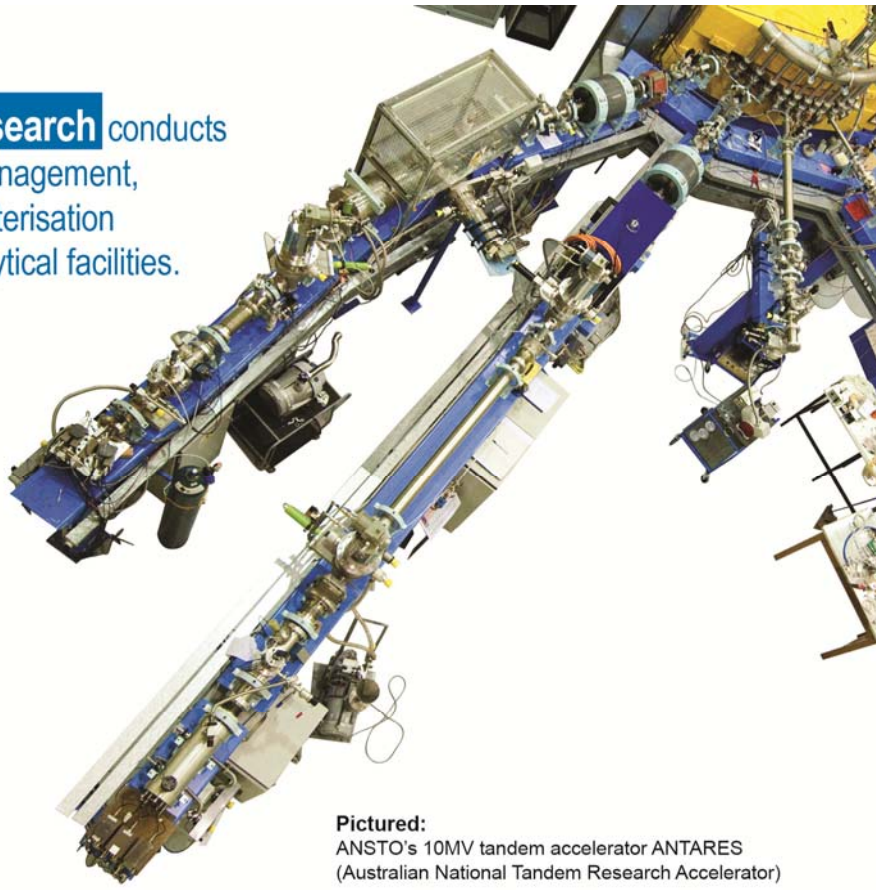
> **Stable Isotope Analysis for**
- δ^{13}C, δ^{15}N, δ^{18}O, δ^{32}S and δD analysis

> **^{210}Pb/^{137}Cs Dating**

> **Tritium Analysis**

> **Ion Beam Analysis**
- PIXE / PIGE
- RBS and RToF
- Heavy Ion Microprobe

> **ITRAX Core Scanner**



Pictured:
ANSTO's 10MV tandem accelerator ANTARES
(Australian National Tandem Research Accelerator)

> **Contact information**

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Email: John.Dodson@ansto.gov.au
Learn more about us at www.ansto.gov.au/environment

Australian Government

ansto
Nuclear-based science benefiting all Australians

Social Programme

Welcome Icebreaker – **Sunday, 20 March, 16.00-18.30**

The welcome function will be held in conjunction with registration at Te Papa on the evening of Sunday 20 March before the full conference starts. This will be your first experience of Te Papa and an opportunity to meet up with old friends and colleagues and set the scene for the conference. The cost is included in the registration fee and all are welcome to attend. Pick up your registration materials in advance of Monday and put up your poster.

Lab visit – **Monday, 21 March, departure from Te Papa 16.00**

A visit to the laboratories of GNS Science's National Isotope Centre is included in the registration fee and will take place on Monday 21 March from 16.00. You will need to sign up for this tour at the conference registration desk on Sunday 20 March or Monday 21 March by midday. Buses will transport the participants from Te Papa to the laboratories (approximately 30 minutes' bus ride). Afternoon tea will be available on arrival and a tour around the laboratories will take place in small groups. Please note, all computing gear should be left at NIC reception, to be collected prior to boarding for the return trip.

Excursion – **Wednesday, 23 March, departure from Te Papa 16.00**

A two-hour guided tour of ZEALANDIA is available as an optional midweek excursion.

Buses will take conference attendees to ZEALANDIA, a unique eco-attraction. Established in 1995, ZEALANDIA is the world's first fully-fenced urban wildlife sanctuary to provide a haven for some of New Zealand's most endangered native animals. Attendees will experience a 90-minute guided tour of the sanctuary valley, followed by 30 minutes in the ZEALANDIA exhibition before being returned by bus to Te Papa.

Coastal tour and Conference dinner – **Thursday, 24 March, departure from Te Papa 16.00**

The Conference Dinner is to be held at a rustic, wild and unique location close to Wellington, on a 800 hectare coastal sheep and cattle farm. Situated at the Harbour entrance with views of the Kaikoura ranges in the South Island, Pencarrow Lodge is 45 minutes from Wellington and dinner attendees will enjoy the additional experience of a scenic coach ride to the property.

The lodge has timber floors, large open fireplaces, deep comfortable sofas and a large viewing deck. It has panoramic views of Wellington's south coast, so bring your camera!

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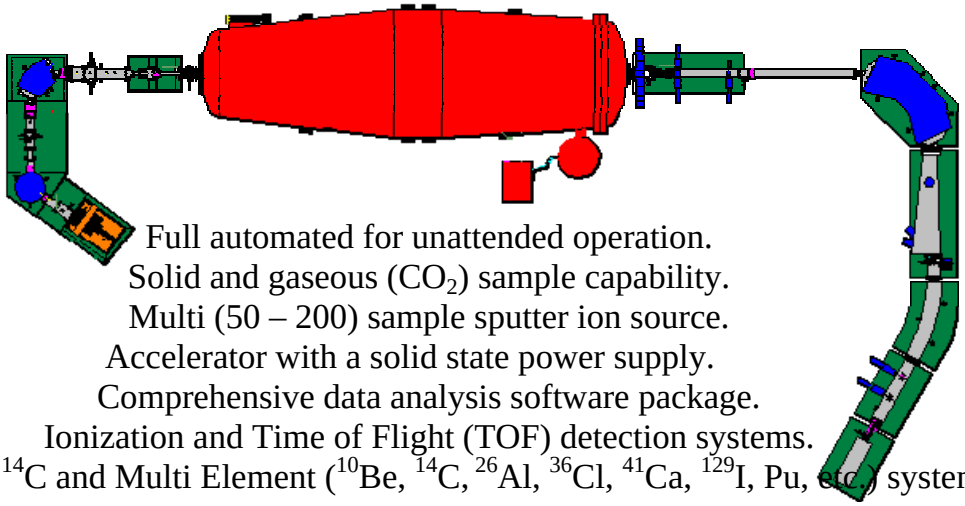

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E-mail: info@highvolteng.com – Web: www.highvolteng.com

Oral Programme

	Monday 21 March 2011	
	Session 1 – Soundings Theatre	
09:00	Opening	
09:30	FOR#1 Mayer: Can Minor Constituents Tell a Major Story in Nuclear Forensics?	
10:15	GLO#1 Manning: ^{14}CO: The key indicator for atmospheric chemistry and climate change	
11:00 - 11:30	Break	
	Session 2A – Rangimarie	**Session 2B – Soundings Theatre**
11:30	EAR#1 Argento: Utilizing MCNPX and excitation functions to investigate boundary effects and shielding corrections for cosmogenic nuclide production rates	TEC#1 Wallner: New exotic and non-standard radionuclides in AMS
11:50	EAR#2 Braucher: Why are depth profiles promising?	TEC#2 Galindo-Uribarri: Pushing the detection limits of rare isotopes
12:10	EAR#3 De Pascale: Preliminary erosion rates and characterisation of Quaternary faults using field mapping and cosmogenic dating techniques in the Dry Valleys, Antarctica	TEC#3 Vockenhuber: The potential of He stripping in heavy ion AMS
12:30	EAR#4 Granger: Isochron burial dating of fluvial gravel deposits	TEC#4 Hotchkis: Investigation of gas stripping at 4MV for high mass negative ions
12:50 – 14:00	Lunch	
	Session 3A – Rangimarie	**Session 3B – Soundings Theatre**
14:00	EAR#5 Hua: Variations in Marine Reservoir Corrections for The Great Barrier Reef during The Last 7000 years	TEC#5 Ognibene: Implementation of on-line interface for AMS
14:20	EAR#6 Nakanishi: Radiocarbon reservoir effect from shell and plant pairs in the Holocene sediments around the Yeongsan River, Korea	TEC#6 Longworth: Rapid AMS Analysis of Carbonates by Direct Sputtering
14:40	EAR#7 Bräuer: Carbon Dynamics under Paddy Management	TEC#7 Smith: A new capability for ANTARES: 7Be by AMS
15:00	EAR#8 Sakaguchi: Feasibility using ^{236}U to reconstruct close-in fallout deposition from the Hiroshima Atomic Bomb	TEC#8 Martschini: AMS of ^{36}Cl with the VERA 3 MV Tandem Accelerator
15:20	EAR#9 Sugiyama: Chemical speciation of metal elements in ferromanganese crusts	TEC#9 Murnick: Advances in Radiocarbon ICOGS Systems
15:40	Into bus / No break	
16:00 – 18:00	NIC lab visit	

	Tuesday 22 March 2011	
	Session 4 – Soundings Theatre	
09:00	EAR#10 Tims: Plutonium isotope measurements from across continental Australia	
09:20	GLO#2 Winkler: Measurement of $^{236}U/^{238}U$ in corals as a proxy for anthropogenic and pre-anthropogenic ^{236}U in ocean waters	
9:40	EAR#11 Szidat: Compound-specific ^{14}C analysis of acidic aerosol components	
10:00	GLO#3 Quigley: Cosmogenic dating of the oldest landscapes on Earth: tectonic, climatic, and biological implications	
10:20	GLO#4 Fink: Constraints on ice volume changes of the West Antarctic Ice Sheet and Ross Ice Shelf since the LGM based on cosmogenic exposure ages	
10:40 - 11:10	Break	
	Session 5A – Rangimarie	**Session 5B – Soundings Theatre**
11:10	GLO#5 Baisden: Using 50 Years of Soil Radiocarbon Data to Identify Optimal Approaches for Estimating Soil Carbon Residence Times	TEC#10 Lachner: AMS of ^{236}U at low energies: Highly efficient performance and first detection of UH3+ and ThH3+ molecules
11:30	GLO#6 Zhou: Turnover of organic carbon in temperate grassland soil profiles from Northern China	TEC#11 Fifield: Recent developments in the AMS measurement of ^{236}U and ^{36}Cl at the Australian National University
11:50	GLO#7 Uchida: Radiocarbon Based Organic Carbon Source Identification of Soil Respired CO_2 under Soil Warming in a Cultivated Andisol	TEC#12 Vogel: Absolute carbon isotope ratios by AMS
12:10	GLO#8 Xu: Potential Use of Chia Plant As An Alternative Sampling Method for Atmospheric $^{14}CO_2$	TEC#13 Jiang: An absolute AMS method for determination of 79Se half-life
12:30	GLO#9 Levchenko: NEEM, North West Greenland firn air timescale calibration with the $^{14}CO_2$ bomb-pulse	REP#1 Klein: A novel 3 MV multi-element AMS system
12:50 – 14:00	Lunch	
14:00 – 15:40	**Poster Session 1 – Oceania**	
15:40 - 16:00	Break	
	Session 6A – Rangimarie	**Session 6B – Soundings Theatre**
16:00	GLO#10 Rakowski: Radiocarbon method in environmental monitoring of CO_2 emission	REP#2 Akhmadaliev: The new 6 MV-AMS-facility DREAMS at Dresden, Germany
16:20	GLO#11 Hou: Speciation Analysis for ^{129}I and ^{127}I in Air and its Tracer Application in Geochemical Cycle of Stable Iodine	REP#3 Chopra: A New AMS Facility at Inter University Accelerator Centre, NewDelhi, India
16:40	EAR#12 Buchholz: Anomalous Elevated Radiocarbon Measurements of PM2.5	REP#4 Zondervan: One year of operation with XCAMS, the 0.5 MV Pelletron Compact ^{14}C AMS eXtended for ^{10}Be and ^{26}Al at New Zealand's National Isotope Centre
17:00	EAR#13 Kretschmer: Investigation of the Origin of Environmental Compounds from Indoor Air Samples via AMS	REP#5 Korschinek: Accelerator mass spectrometry at the Munich Tandem accelerator
17:20 – 17:40	EAR#14 Oinonen: AMS biocarbon measurements - from liquid fuels to flue gases	REP#6 Caffee: Accelerator Mass Spectrometry at Purdue University PRIME Lab

	Wednesday 23 March 2011	
	Session 7 – Soundings Theatre	
09:00	TEC#14 Suter: Including scattering and molecular dissociation in ion optics calculation for AMS	
09:20	TEC#15 Synal: Reducing Size and Complexity of Radiocarbon Detection Systems	
9:40	TEC#16 Zhao: Preliminary Studies of Pu Measurement by AMS using PuF4-	
10:00	EAR#15 Lal: A catchment level study of soil erosion and soil formation rates using 239Pu and ^{10}Be, in the wet-dry tropics of northern Australia	
10:20	EAR#16 Li: AMS radiocarbon dating on the Taal Lake cores of central Philippines	
10:40 - 11:10	Break	
	Session 8A – Rangimarie	**Session 8B – Soundings Theatre**
11:10	EAR#17 Herod: The dispersion of ^{129}I in the northwest Canadian Arctic and southern Canada	REP#7 Dewald: CologneAMS, a dedicated Centre for Accelerator Mass Spectrometry in Germany
11:30	EAR#18 Matsuzaki: Study for natural iodine isotope system: - Implication from ^{129}I/^{127}I depth profiles of Indian ocean	REP#8 Wilcken: SUERC ^{36}Cl AMS
11:50	EAR#19 Mahara: Pore-water mobility: distribution of delta^{37}Cl, ^{36}Cl/Cl ratio and dissolved ^{4}He concentration in the core drilled in the Mobara Gas Field, Japan	REP#9 Jiang: Major Programs of AMS laboratory at CIAE in recent 12 years
12:10	EAR#20 Kadokura: Distribution of ^{236}U in Japan Sea: Feasibility of ^{236}U as a tracer of water masses in ocean	SAM#1 Merchel: The role of chemistry in setting-up a new AMS facility
12:30	EAR#21 Muramatsu: Determinations of iodine and ^{129}I/^{127}I ratios in hot springs around the Kusatsu-Shirane hydrothermal systems, Japan	SAM#2 Jiang: Progress in measurement of 182Hf with AMS at CIAE
12:50 – 14:00	Lunch	
	Session 9A – Rangimarie	**Session 9B – Soundings Theatre**
14:00	GLO#12 Caffee: Evaluating cosmogenic exposure ages of boulders from glacial deposits	SAM#3 Hou: Separation of microgram carrier free iodine from geological and environmental samples for AMS determination of ultra low level ^{129}I
14:20	GLO#13 Norton: Quantifying geomorphic process rates in Alpine landscapes with cosmogenic nuclides	SAM#4 Fernandes: Screening criteria for the radiocarbon dating of bone apatite
14:40	GLO#14 Kim: Plaeoclimate and environmental change of the Potrok Aike, Argentina using beryllium isotopes	SAM#5 Boudin: Development of a nanofiltration method for bone collagen dating
15:00	GLO#15 Fink: Overturned mega boulders on coastal cliff-tops and in bedrock river channels : can cosmogenic nuclides constrain tsunami and palaeo-flood events in Australia?	SAM#6 Rebollo: Influence of pH changes on graphitic components in Archaeological Charcoal
15:20	GLO#16 Joy: In-situ cosmogenic exposure dating in the Meirs and Garwood Valleys, Denton Hills, Antarctica	SAM#7 Culp: Compound Specific Radiocarbon Content of Lignin Oxidation Products from the Altamaha River and Coastal Georgia
15:40 – 16:00	Into bus - Break	
16:00 – 18:00	Excursion to Zealandia	

	Thursday 24 March 2011	
	Session 10 – Sounding Theatre	
09:00	TEC#17 Kieser: On-line Ion Chemistry for the AMS Analysis of 90Sr and 135,137Cs	
09:20	REP#10 Smith: Strange bedfellows: the curious case of STAR and MOATA	
09:40	REP#11 Wacker: A versatile gas interface for routine radiocarbon analyses with a gas ion source	
10:00	REP#12 Zoppi: Can biomedical and traditional applications of radiocarbon dating co-exist at the same AMS facility?	
10:20	LIF#1 Buchholz: Bomb-Pulse Biology	
10:40 - 11:10	Break	
	Session 11A – Rangimarie	**Session 11B – Soundings Theatre**
11:10	LIF#2 Salehpour: Biological Accelerator Mass Spectrometry at Uppsala University	AST#1 Masarik: Numerical Simulation of Particle Fluxes and Cosmogenic Nuclide Production Rates
11:30	LIF#3 Liebl: ^{14}C bomb peak dating of human DNA samples at the microgram level	AST#2 Reedy: Cosmogenic-Nuclide Production Rates: Reaction Cross Section Update
11:50	ARC#1 Terrasi: Accelerator Mass Spectrometry ^{14}C Dating of Lime Mortars: Methodological Aspects and Field Study Application at CIRCE (Italy)	AST#3 Collon: Re-measuring the half-life of 60Fe
12:10	ARC#2 Kim: The Radiocarbon Ages of Sorori Ancient Rice of Korea	AST#4 Paul: New AMS Method to Measure the Atom Ratio 146Sm/147Sm for a Halflife Determination of 146Sm
12:30	ARC#3 Nakamura: Duration period of shell midden estimated by radiocarbon dates: two examples at Higashimyo site, southern Japan and Kime site, southern Korea	AST#5 Robertson: Measuring the astrophysically important 40Ca(a,g)44Ti reaction with AMS
12:50 – 14:00	Lunch	
14:00 – 15:40	**Poster Session 2 – Oceania**	
15:40 - 16:00	Into bus / No break	
16:00 – 23:00	Coastal tour & dinner	

	Friday 25 March 2011	
	Session 12 – Soundings Theatre	
09:00	SAM#8 Molnár: ^{14}C analysis of groundwater down to the milliliter level	
09:20	ARC#4 Calcagnile: Ion Beam Analysis and AMS ^{14}C dating as complementary tools in cultural heritage diagnostics	
09:40	ARC#5 Luis: Measurement of lead isotopic ratios using Micro-AMS	
10:00	CAL#7 Nadeau: Calculation of the compounded uncertainty of ^{14}C AMS measurements	
10:20	AST#6 Nishiizumi: Measurements of high-energy neutron cross sections for cosmogenic nuclides	
10:40 - 11:10	Break	
	Session 13A – Rangimarie	**Session 13B – Sounding Theatre**
11:10	FOR#2 Hodgins: Dating photographs using the bomb-spike	CAL#2 Jull: The CRONUS-Earth inter-comparison for cosmogenic isotope analysis
11:30	FOR#3 Kromer: Bomb ^{14}C in forensic anthropology	CAL#3 Rood: Performance and uncertainties of ^{10}Be measurements at CAMS
11:50	FOR#4 Steier: AMS of the Minor Plutonium Isotopes	CAL#4 Grootes: Organic Backgrounds: Are they material dependent?
12:10	FOR#5 Child: Plutonium and uranium contamination in soils from the former nuclear weapon tests in Australia	CAL#5 Hong: Calibration Curve from 1249 AD - 1650 AD by Tree-ring Measurement Grown in Korean Peninsula
12:30	FOR#6 Whitehead: A nuclear forensics use of ^{10}Be at Dolon, Semipalatinsk	CAL#6 Southon: A Record of Deglacial Atmospheric ^{14}C from Hulu Cave Speleothem H82
12:50 – 14:00	Lunch	
	Session 14 – Soundings Theatre	
14:00	AST#7 Kutschera: Pushing the Limits in Searches for Superheavy Elements in Nature	
14:20	FOR#7 Wallner: A novel approach for neutron-capture studies of ^{235}U and ^{238}U	
14:40	Summary	
15:40 - 16:00	Break	
	Session 15 – Soundings Theatre	
16:00	Business	
16:30	AMS-13 bids	
17:00 – 17:30	Closing	

List of Posters

Poster Session 1 – Oceania Room		
Tuesday 22 March 2011, 14:00 – 15:40		
EAR#P101	Berggren	Tracing water masses in the Baltic Sea by iodine speciation
EAR#P102	Calcagnile	Application of ^{14}C AMS measurements for the determination of the Bio-Based content in polymers and industrial flue gases
EAR#P103	Christl	First data of Uranium-236 in the Atlantic Ocean
EAR#P104	Fallon	Bomb Radiocarbon at the Source: Coral $\Delta^{14}C$ from Enewetak Atoll during the 1950s
EAR#P105	Fernández Niello	^{129}I concentration measurements in animal thyroid from Argentina
EAR#P106	Gomez Guzman	AMS measurements of ^{129}I in seawater around Iceland and Irminger Sea
EAR#P107	Heinemeier	Reservoir age variations and stable isotope values of bulk sediment in a core from the Limfjord, Denmark
EAR#P108	Jiang	Methodological study on exposure date of Tiankeng by means of measurement of in-situ produced cosmogenic ^{36}Cl
EAR#P109	Kim	Dating of aeolian sand deposits in Korea using OSL and ^{10}Be
EAR#P110	Kim	Investigation of Dashgil mud volcano using Beryllium-10
EAR#P111	Kim	Investigation of ^{7}Be anad ^{3}H in the rainwater of Korea
EAR#P112	Kitagawa	Intercomparison study with radionuclides ^{129}I, ^{36}Cl, and ^{137}Cs in soils
EAR#P113	Kumata	Compound Class Specific Radiocarbon Analysis (CCSRA) of PAHs from Highly Contaminated Kolkata Canal Sediments
EAR#P114	Miyata	Reconstruction of carbon cycle induced from apparent radiocarbon age difference from middle to late Holocene at Lake Biwa, Japan: freshwater reservoir effect estimated from archaeological and biological samples
EAR#P115	Murayama	Sedimentation rate and deposition processes of organic materials from surface cores off Shikoku, western north Pacific
EAR#P116	Nagai	Distribution of ^{7}Be and ^{10}Be in the Pacific and Southern Oceans
EAR#P117	Okuno	AMS radiocarbon dating of wood trunks buried by the Kikai-Akahoya eruption in Yakushima Island, SW Japan
EAR#P118	Park	Distributions of Fossil fuel origin CO_2 in the five Metropolis (Seoul, Busan, Daegu, Daejeon, Gwangju)
EAR#P119	Santos	A study of the Suess effect using a raised peat bog as historical archive
EAR#P120	Sueki	Isotope ratios of $^{36}Cl/Cl$ in surface soils at the equal-latitude in Japan
EAR#P121	Toyama	Studies on the secular variation of $^{129}I/^{127}I$ ratios in atmospheric fallout in Tokyo and Akita using AMS
EAR#P122	Watanabe	Measurement of isotope ratios $^{129}I/^{127}I$ of Hokkaido hot springs water
EAR#P123	Zhou	A Case Study of Radioisotope ^{129}I Environmental Tracing Using Xi'an Accelerator Mass Spectrometry
EAR#P124	Shinozaki	Radiocarbon dating of peat archives using plant cellulose for the reconstruction of past environmental changes
TEC#P101	Calcagnile	Design features of the new multi isotope AMS beamline at CEDAD
TEC#P102	Daniel	Development of a Commercial Laser-Induced Combustion Interface to a CO_2 Ion Source for AMS
TEC#P103	Finkel	Improved ^{36}Cl Performance at the ASTER HVE 5 MV Accelerator Mass Spectrometer Facility
TEC#P104	Garwan	AMS Study of the Lanthanides
TEC#P105	Guilderson	3-4‰ AMS Radiocarbon Measurements Using Low Energy $^{12}C-$ Normalization: A Case for a "Simpler" (Accelerator) Mass Spectrometer
TEC#P106	He	AMS measurement of ^{32}Si at CIAE

Poster Session 1 – Oceania Room

Tuesday 22 March 2011, 14:00 – 15:40

TEC#P107	He	A method for ^{36}Cl measurement with high sensitivity
TEC#P108	Jiang	The measurement of ^{92g}Nb with Accelerator Mass Spectrometry at CIAE
TEC#P109	Klein	A 1 MV multi-element AMS system for biomedical applications
TEC#P110	Klein	A low background upgrade for the HVE 1 MV multi-element AMS system
TEC#P111	Korschinek	Search for Superheavy Elements in Nature
TEC#P112	Korschinek	Charge state distribution studies of SrF_3, MnF_3 and CaF_3 molecules using single and double stripper in a Tandem Accelerator
TEC#P113	Nottoli	The physics behind the isobar separation of ^{36}Cl and ^{10}Be at the AMS facility ASTER
TEC#P114	Pardo	Laser Ablation Accelerator Mass Spectrometry of Actinides with an ECRIS and Linear Acceleration
TEC#P115	Salazar	Optimization of Direct Ionization of CO_2 by Controlling the Gas flow inside of a Beam-Target.
TEC#P116	Szidat	Improving and understanding a gas ion source for ^{14}C AMS
TEC#P117	Tikkanen	Fast isotope switching and ion beam diagnostics
TEC#P118	Tumey	The feasibility of isobaric suppression of 26Mg via post-accelerator foil stripping for the measurement of ^{26}Al.
TEC#P119	Vockenhuber	A new 2D sensitive detector setup for ^{36}Cl AMS at ETH Zürich
TEC#P120	Wacker	Direct coupling of a laser ablation cell to an AMS
TEC#P121	Wilcken	Further studies of a bi-polar single-stage accelerator mass spectrometer
TEC#P122	Zhao	Partial Fragmentation of CaF_3^- at Low Tandem Energies and its Potential Use for ^{41}Ca Measurement
GLO#P101	Berggren	A comparison of annually resolved varved lake sediment and ice core ^{10}Be and sunspot data
GLO#P102	Berggren	Global distribution of ^{129}I in the marine waters
GLO#P103	Berggren	Variability of ^{10}Be and $\delta^{18}O$ in snow in Greenland and Antarctica
GLO#P104	Caffee	^{10}Be depth profile in top 575 m of the West Antarctic Ice Sheet Divide core
GLO#P105	Caffee	Cosmic-Ray Produced Nuclide Systematics on Earth Project
GLO#P106	Horiuchi	^{10}Be and ^{26}Al records of the past 3 kyr from Dome Fuji (Antarctica) ice core
GLO#P107	Inoue	Studies on annual variation of $^{14}C/^{12}C$ ratios in plant samples by AMS
GLO#P108	Ise	Constructing a Depth-Stratified Model for Soil Organic Carbon: a Brand-new, Integrated Ecosystem Model with Radiocarbon Tracking
GLO#P109	Kondo	Radiocarbon constraints for soil carbon accumulation and carbon release of arctic and boreal soil in Alaska
GLO#P110	Kumamoto	Radiocarbon from repeat hydrography along WOCE lines in the Pacific Ocean during the 2000s
GLO#P111	Kurosumi	A fluctuation of ^{36}Cl depositional flux recorded around 11 ka in an Antarctic ice core: implication to the enhanced cosmic-ray intensity around 11 ka
GLO#P112	Piotrowska	Modelling of calendar timescales for laminated lake sediments in Northern Poland
GLO#P113	Povinec	Iodine-129 and ^{14}C as world-wide tracers of water masses in the Ocean
GLO#P114	Sagawa	Intermediate ventilation change and its relation to the surface environmental change from the last glacial maximum in the western North Pacific
GLO#P115	Sasa	^{36}Cl profiles in the Dome Fuji ice core during the last deglaciation
GLO#P116	Suganuma	Deglaciation history of Sor Rondane Mountains in Dronning Maud Land, East Antarctica

Poster Session 1 – Oceania Room

Tuesday 22 March 2011, 14:00 – 15:40

GLO#P117	Suzuki	Concentrations of iodine-129 at the subarctic and subtropical circulations in the Japan Sea
GLO#P118	Uchida	Northwest Pacific mid-depth ventilation changes during the Holocene and their link to global climate changes
GLO#P119	Wagai	Carbon pools of contrasting ^{14}C age within a Japanese volcanic-ash soil
GLO#P120	Watanabe	A chronology of PY608E sediment core (Lake Pumoyum Co, south Tibetan plateau) on the basis of radiocarbon dating of total organic carbon
GLO#P121	Xi	DELTA^{14}C Level of Annual Plants and Fossil Fuel Derived CO_2 Distribution in Different Regions of China
GLO#P122	Yamagata	Decadal variations of the atmospheric concentrations of 7Be and ^{10}Be : as tracers for stratosphere-troposphere exchange intensity
REP#P101	Arnold	Status of the French accelerator mass spectrometry facility ASTER after 4 years
REP#P102	Barešić	Status report on target preparation for ^{14}C AMS dating in the Zagreb Radiocarbon Laboratory
REP#P103	Brown	Current Status and Ion Source and Beamline Developments at LLNL's Center for Accelerator Mass Spectrometry
REP#P104	Choe	A study of thermal ionization for the HVEE 846 ion source
REP#P105	Culp	A Decade of AMS at the University of Georgia
REP#P106	Guettler	Accelerator-SIMS for isotopic analysis of trace elements
REP#P107	Heinze	A new BPM-TOF system for CologneAMS
REP#P108	James	When size really does matter; measurement of ultra-small samples at the ANU Radiocarbon Dating Laboratory
REP#P109	Kokubu	Current status and future plans for the AMS facility at the Tono Geoscience Center of Japan Atomic Energy Agency
REP#P110	Kromer	Status report : The Mannheim AMS facility (MAMS)
REP#P111	Kubik	Performance parameters and standard reference materials at the ETH AMS facilities
REP#P112	Longworth	Status and Plans for the National Ocean Sciences AMS (NOSAMS) Facility
REP#P113	Minami	A first step toward small-mass AMS radiocarbon analysis at Nagoya University
REP#P114	Moreau	ARTEMIS : ^{14}C AMS Facility – Status report
REP#P115	Priller	Refining the performance of VERA for actinide AMS
REP#P116	Rethemeyer	Sample preparation facilities for ^{14}C analysis at the new CologneAMS center
REP#P117	Roberts	A gas-accepting ion source for Accelerator Mass Spectrometry: Progress and Applications
REP#P118	Xu	^{10}Be and 26Al measurements at the SUERC 5MV AMS
REP#P119	Tokanai	A new AMS facility at Yamagata University

Poster Session 2 – Oceania Room

Thursday 24 March 2011, 14:00 – 15:40

REP#P120	Guettler	High precision ^{14}C AMS-analysis of oak tree rings - Can we observe a modulation of the ^{14}C content according to the 11 years solar cycle?
REP#P121	Matsuzaki	Summary of current AMS system and research projects at MALT, The University of Tokyo
REP#P122	Ognibene	Installation of hybrid ion source on the 1-MV LLNL BioAMS spectrometer
REP#P123	Park	Status of the 1MV AMS facility at KIGAM
REP#P124	Piotrowska	Status report of AMS preparation laboratory at GADAM Centre, Gliwice, Poland
REP#P125	Sasa	Progress on ^{36}Cl AMS with the 12UD Pelletron tandem accelerator at the University of Tsukuba
REP#P126	Fallon	Three years on: an update on the ANU SSAMS
REP#P127	Uchida	Recent advances of radiocarbon measurements at NIES TERRA
REP#P128	Meigikos dos Anjos	A new ^{14}C-AMS facility at UFF, Niterói, Brazil
AST#P101	Bowers	^{36}Cl Cross Section Measurement for In-situ Production in the Early Solar System
AST#P102	Lu	93Zr beam development for AMS measurement
AST#P103	Luis	Determination of the detection limits for the ^{36}Cl/^{35}Cl isotopic ratio in AgCl pellets in the micro AMS system at ITN.
AST#P104	Paul	High-Sensitivity Detection of ^{244}Pu via Electron-Cyclotron Resonance Ionization and Linear Acceleration
AST#P105	Sekimoto	Measurements of light nuclides production cross sections for Cu and Y with 300 MeV proton
AST#P106	Wallner	Nuclear astrophysics and nuclear physics programme at VERA
AST#P107	Wallner	Stable Isotope Measurements in Presolar Grains
FOR#P101	dos Santos	Can we blame discrepancies of year-of-birth ^{14}C determination on Mom? Preliminary isotope results of fingernails of breastfed mother-infant pairs
FOR#P102	Lopez-Gutierrez	Long-lived radionuclides in residues from nuclear power plants operation and decommissioning
FOR#P103	Jiang	The AMS measurements of fission products at CIAE
FOR#P104	De Cesare	Actinides AMS at CIRCE and ^{236}U, xPu measurements at the Garigliano Nuclear Power Plant
FOR#P105	Chamizo	Measurement of Pu and U isotopes on the 1 MV AMS system at the Centro Nacional de Aceleradores
FOR#P106	Stan-Sion	AMS applied in the research for the first fusion reactor
SAM#P101	Granger	Preparation of aluminum metal targets for AMS analysis
SAM#P102	Christl	New Be-cathode preparation method for the ETH 6 MV Tandem
SAM#P103	Horiuchi	^{10}Be measurements at MALT for reduced size samples of bulk sediments
SAM#P104	Lachner	Carrier-free ^{10}Be/^{9}Be measurements with low energy AMS: Determination of sedimentation rates in the Arctic Ocean
SAM#P105	Simon	Reprocessing of ^{10}B-contaminated ^{10}Be AMS targets
SAM#P106	Child	A new method for separation and purification of beryllium and aluminium using the Eichrom DIPEX® resin
SAM#P107	Fink	Extraction and purification of quartz using phosphoric acid
SAM#P108	Fink	Improving the accuracy of aluminium assay in purified quartz for in situ cosmogenic exposure dating
SAM#P109	Haack	3H BioAMS Sample Preparation at LLNL Using Septa Sealed Vials
SAM#P110	Ohta	Separation of ^{129}I and ^{127}I in pre-nuclear-era marine algae with ultra low ^{129}I/^{127}I isotopic ratios

Poster Session 2 – Oceania Room

Thursday 24 March 2011, 14:00 – 15:40

SAM#P111	Baisden	Automated Combustion Interface for Routine Rafter Radiocarbon Samples on EA-CF-IRMS
SAM#P112	Calzolai	The sample preparation line for radiocarbon measurements on atmospheric aerosol at INFN-LABEC (Florence, Italy)
SAM#P113	Cherkinsky	AMS measurement of samples smaller than 300 microgram at Center for Applied Isotope Studies, University of Georgia.
SAM#P114	Czernik	Effect of HF leaching on ^{14}C dates of pottery
SAM#P115	D'Elia	The processing line for the extraction of dissolved inorganic carbon in seawater samples at CEDAD
SAM#P116	Fallon	An automated graphite preparation line for hydrogen or zinc reduced graphite
SAM#P117	Hajdas	Treatment for carbonate samples for radiocarbon dating
SAM#P118	Jacobsen	Radiocarbon Dating of linen from an Egyptian Mummy
SAM#P119	James	Lose 5,000 radiocarbon years in just one hour; improved backgrounds using zinc reduction for graphite target preparation
SAM#P120	Minami	Radiocarbon dating of VIRI bone samples using ultrafiltration method
SAM#P121	Miyata	Reproducibility in radiocarbon dating of carbonized materials adhering to pottery
SAM#P122	Moreau	Preparation and measurement of microgram samples with the ARTEMIS AMS facility in Saclay, France
SAM#P123	Nagasawa	Newly developed automatic graphitization system for AMS ^{14}C measurements
SAM#P124	Nawrocka	Preparation and AMS dating of charcoal samples from northern Poland
SAM#P125	Nishimoto	The detection of PEG using GC/MS for AMS radiocarbon dating of preserved wood
SAM#P126	Palonen	A modular sampling system for atmospheric and soil CO_2 samples
SAM#P127	Palonen	HASE - The Helsinki adaptive sample preparation line
SAM#P128	Pesonen	Elemental Analyzer combustion of liquid fuel samples for AMS biocarbon measurements
SAM#P129	Prior	Testing the effect of Sodium Polytungstate on pollen concentrate sample preparation procedures for AMS ^{14}C dating
SAM#P130	Rinyu	Optimization of sealed tube graphitization method for environmental ^{14}C studies using MICADAS
SAM#P131	Smith	Early results from the ANSTO/NIWA ^{14}C of atmospheric methane program
SAM#P132	Szidat	Radiocarbon measurements of carbonaceous aerosols: the new sample preparation line at University of Bern
SAM#P133	Takayanagi	CO_2-laser decomposition method of carbonate for AMS ^{14}C measurements
SAM#P134	Tani	High-yield recovery of contamination-free organic matters from plant remains for AMS ^{14}C measurements
SAM#P135	Varley	Development and Characterisation of a Small Mass H2/Fe Graphitisation Line
SAM#P136	Wacker	A novel approach to process carbonate samples for radiocarbon measurement
SAM#P137	Wacker	Cosmogenic in-situ ^{14}C analysis at ETH Zürich
SAM#P138	Wacker	Towards single-foraminifera-dating with a gas ion source
SAM#P139	Wood	Testing the ABOx-SC pretreatment protocol: Radiocarbon dating charcoal below the Campanian Ignimbrite tephra
SAM#P140	Wood	A comparison of ultrafilter membranes used in bone collagen pretreatment for radiocarbon dating
SAM#P141	Yang	A cold finger cooling system for the efficient graphitisation of microgram-sized carbon samples
SAM#P142	Zermeño	Natural Radiocarbon Sample Preparation at LLNL/CAMS

Poster Session 2 – Oceania Room

Thursday 24 March 2011, 14:00 – 15:40

CAL#P101	Baisden	Managing the Transition to ^{14}C AMS Operations and Calculations at Routine ≤0.2% Precision
CAL#P102	Cherkinsky	Offset from SH calibration curve based on Chilean Fitzroya cupressoides tree ring dating in the range 1500-1950AD.
CAL#P103	Fedi	May ^{14}C be used to date Contemporary Art?
CAL#P104	Sakamoto	Wiggle-matching of wooden coffins of Kofun Period: supporting regional offsets on Japanese tree-ring from IntCal
CAL#P105	Taylor	Reviewing the Mid-First Millennium BC ^{14}C 'Warp' Using Decadal ^{14}C/Bristlecone Pine Data
CAL#P106	Xu	Homogeneity Evaluation of Chinese Sugar Carbon (CSC) Standard for AMS ^{14}C Measurement
ARC#P101	Ding	Investigation of Mi-deer fossil age in Qingdun site, Jiangsu Province, China
ARC#P102	Ding	Radiocarbon dating of lacustrine sediment from an impact crater in northeastern China
ARC#P103	Fernandes	Mussels with Meat
ARC#P104	Grootes	Edit Regine Cineres hic Sarcophagus Habet: Confirming the Identity of Queen Editha, Wife of Otto, the First German Emperor
ARC#P105	Guan	Radiocarbon dating of tomb in Hepu, China
ARC#P106	Hua	Reliable AMS Ages for Mayan Caches at Copán, Honduras based on Spondylus sp. Marine Shells
ARC#P107	Kretschmer	Historical and Climatological Research in the Himalaya Region by ^{14}C AMS Dating of Wooden Drill Cores from Historic Buildings.
ARC#P108	Kunikita	Age determination of Neolithic cultural change and dietary reconstruction in the Amur River basin
ARC#P109	Lee	C^{14} AMS dating Yongcheon cave
ARC#P110	Oda	Radiocarbon dating of ancient calligraphy attributed to Fujiwara Teika: The genuine handwritings, copies, and counterfeits of the famous calligraphist
ARC#P111	Zhu	The Research of Environmental Change, Archaeology and ^{14}C Chronology in Donglongshan, Shaanxi Province, China
ARC#P112	Zoppi	The dating of the Seattle Art Museum's Italian room
LIF#P101	Jiang	Study on bone resorption behavior of osteoclast under drug effect using ^{41}Ca tracing
LIF#P102	Kim	Tracing oil spilled environment, Taean, Korea using radiocarbon and stable isotopes
LIF#P103	Patrut	AMS radiocarbon investigation of the African baobab
LIF#P104	Patrut	Old ages of historic Romanian trees assessed by AMS radiocarbon dating

Oral Abstracts – Sessions 1–5b

(in order of presentation)

FOR#1 **SESSION 1** **Monday 21st March, 0900 – 1100**

Can Minor Constituents Tell a Major Story in Nuclear Forensics?

Mayer K [1], Wallenius M [1], Varga Z [1], Srncik M [2], Steier P [2], Fifield K [3], Tims S [3]
[1] European Commission - Joint Research Centre Institute for Transuranium Elements,
[2] Department of Inorganic Chemistry, University of Vienna,
[3] Australian National University, Canberra, Australia

The Nuclear Security Summit of April 2010 strongly underlined the need for international cooperation for addressing the threat of nuclear terrorism. The three main pillars related to nuclear security are prevention, detection and response. If prevention fails and nuclear material is detected (through measurement systems or by intelligence), an appropriate response has to be initiated. An essential element of the response process is nuclear forensics. Also the need to develop national capabilities in nuclear forensics was explicitly mentioned in the Communiqué of the Nuclear Security Summit.

Nuclear forensics is a highly specialized discipline in science, at the interface between physics, chemistry, and material science on the one hand, and between law enforcement and non-proliferation on the other. It aims at providing clues on the history of nuclear material which was intercepting from illicit trafficking. To this end, nuclear forensic investigations include the measurement of parameters that help determining the age, the intended use, the production process or the geographic origin of the material. Parameters that are typically measured include the isotopic composition of nuclear material, the concentration of chemical impurities, products of radioactive decay, and the isotopic composition of minor constituents and of selected trace elements.

In the present paper we will provide an overview of nuclear forensics methodologies and focus on the relevance of minor constituents in nuclear forensics interpretation. Minor constituents may include trace elements but also minor abundant isotopes. Using the example of natural uranium, we will illustrate the usefulness and limitations of using such measurement results in nuclear forensics.

GLO#1 **SESSION 1** **Monday 21st March, 0900 – 1100**

^{14}CO: The Key Indicator for Atmospheric Chemistry and Climate Change

Manning M [1], Moss R [2], Lowe D [3], Mak J [4], Brailsford G [2]
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Although it is not widely recognised, atmospheric oxidation is the most important mechanism for limiting increases in the greenhouse effect due human activities. Furthermore, the degree of stability and potential trends that may affect this critical process are still not very well understood. Accelerator mass spectrometry was developed in New Zealand as a way of measuring atmospheric ^{14}CO which is the intermediate species occurring between the formation of ^{14}C by cosmic radiation and the production of $^{14}CO_2$. The wide distribution and short atmospheric lifetime for this species make it an ideal tracer for changes in atmospheric oxidation rates and it has provided clear evidence for significant large scale variations that are closely linked with a volcanic eruption and with biomass burning. This paper will give an overview of the strategic importance of understanding atmospheric oxidation rates; an update on the status of ^{14}CO measurements and analysis so far; and present the case for these needing to be used more widely.

EAR#1 **SESSION 2A** **Monday 21st March, 1130 - 1250**

Utilizing MCNPX and excitation functions to investigate boundary effects and shielding corrections for cosmogenic nuclide production rates

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Cosmogenic nuclides have been used to develop a set of tools critical to the quantification of a wide range of geomorphic and climatic processes and events. There are still numerous aspects of both uncertainties and novel applications to develop. Physics based scaling schemes are currently evolving to encapsulate more physics and greater spatial detail (Masarik & Beer 2009, Masarik & Reedy 1995, Lifton 2005). Refinement of these models allows greater characterization of the radiation field responsible for nuclide production, thereby reducing the uncertainties associated with using cosmogenic nuclides for geomorphic studies (Gosse & Phillips 2001).

We will present results from our physics based radiation transport model where we investigate aspects of the cosmic radiation cascade in the atmosphere and boundary effects at the air-bedrock interface. Using the MCNPX radiation transport code we simulate the cosmic radiation cascade through the atmosphere and into a variety of lithologies. Simulation results indicate a transition in the nucleonic flux in the upper ~100 g/cm2 of bedrock, in the energy range of MeV, as the radiation field transitions from the multiplicity of air to the multiplicity of the bedrock. The depth of the region and the energy range of the transition region is lithology dependent.

Nucleonic flux model results are folded with excitation functions (energy dependent cross sections) for the spallation of target nuclei to provide individual nuclide production rates with depth. Each production excitation function has different energy thresholds and energy dependencies. We find that nuclide production rates have boundary effects in the depth profile, such that the production rate is suppressed below the expected exponential profile found in the lower profile. This effect can account for up to a 10% disparity in surface production rate from the expected exponential profile in granite. Models of other lithologies are under development and will be presented.

EAR#2 **SESSION 2A** **Monday 21st March, 1130 – 1250**

Why are depth profiles promising?

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Cosmonuclide concentrations in surface samples are function of both duration of exposure to cosmic radiation and surface stability. From the measurement of a single cosmonuclide concentration in a single surface sample, it is thus impossible to quantify simultaneously the exposure duration and the denudation rate affecting the studied object. In the case of a simple exposure history, measurements of two cosmonuclide concentrations within the same surface sample may however theoretically be used to estimate both unknowns.

A more constraining approach to accurately quantify both exposure time and denudation rate is to take advantage of the fact that the effective production attenuation length of neutrons is significantly shorter than that of muons. The neutron-induced cosmonuclide concentrations reach steady-state with respect to denudational loss much more rapidly than the muon induced ones. Consequently, the near-surface cosmonuclide concentrations mainly resulting from interactions with neutrons might be used to estimate the denudation rates while the several meters depth concentrations mainly resulting from interactions with muons might be used to estimate the exposure duration. A unique well constrained depth profile permits determination of both the exposure time and the denudation rate. In the case of abandoned material, inheritance due to previous exposition to cosmic rays can be revealed.

Multi-nuclide depth profiles are also excellent tools for better deducing the physical parameters of the particles involved in the production of these cosmogenic radionuclides. This approach has been applied twice: 1.) ^{10}Be and ^{26}Al along a 25 meters pure quartz core from Galicia, Spain, and 2.) ^{10}Be, ^{26}Al and ^{36}Cl along a ~11 meters carbonate and quartzose conglomerates core from La Ciotat, S.E. France). Both projects confirm that the density of the material is one of the most sensitive parameters. The latter study also allows to precise the still debatable spallation production rate of ^{36}Cl from Ca.

EAR#3 **SESSION 2A** **Monday 21st March, 1130 – 1250**

Preliminary erosion rates and characterisation of Quaternary faults using field mapping and cosmogenic dating techniques in the Dry Valleys, Antarctica

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The southern Dry Valleys of Antarctica are the driest and coldest places on the planet - with very low erosion rates, and are an important location for tracking landscape changes and neotectonics over long time scales (>1Ma). Using a combination of LiDAR and field mapping, combined with cosmogenic sampling, we present preliminary results documenting normal faults with vertical sense of slip are active at Quaternary time scales. Offset moraines, fluvial evidence of fault response coupled with cosmogenic dating of surfaces help constrain timing of deformation. Secondly, we present the preliminary results of the application of cosmogenic dating for eroding bedrock outcrops and implications for hillslope erosion rates. This research is important as this is the first documentation of recent uplift along the Transantarctic first via active normal faults in the Quaternary as well as implications of slow hillslope erosion rates for landscape development.

EAR#4 **SESSION 2A** **Monday 21st March, 1130 – 1250**

Isochron burial dating of fluvial gravel deposits

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Burial dating with ^{26}Al and ^{10}Be has become increasingly useful for dating quartz sediment over the past 5 million years, both in geomorphology and in human evolution. The method has been successfully used to date cave sediments and deeply buried river sediments in a variety of settings. However, it is limited to sites that are buried deeply enough to shield sediment from secondary cosmic ray muons, which continue to produce ^{26}Al and ^{10}Be after burial. Typically this requires burial depths of tens of meters, which is impractical for many geological deposits.

A major advance in burial dating has been the development of isochron methods[1]. Our version is based on the measurement of ^{26}Al and ^{10}Be in individual clasts, where postburial production is identical among the clasts and can be treated as a constant. A plot of ^{26}Al vs. ^{10}Be yields a gentle curve whose slope depends only on the burial age, and whose intercept depends on postburial production. The isochron method can be solved iteratively, by linearizing the data, or by direct fitting of a curve in a Bayesian analysis. Because the isochron method explicitly accounts for postburial production, it allows burial dating of deposits only a few meters thick, and in natural exposures. In addition it allows identification of individual clasts with complex burial histories, which can then be excluded from the fit.

We will discuss a suite of isochron burial ages from a flight of fluvial terraces on the Sundays River in South Africa, with ages ranging from 0.1 to 4 million years. These data illustrate many of the strengths and weaknesses of the isochron method. We will also compare ages and uncertainties determined using both the iterative and Bayesian approaches.

[1]Balco, G., and Rovey, C. W. II, 2008, Am. J. Sci., 308:1083-1114.

TEC#1 **SESSION 2B** **Monday 21st March, 1130 – 1250**

New exotic and non-standard radionuclides in AMS

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Isobaric interference represents one of the major limitations in mass spectrometry. In the very few cases in AMS where nature allows isobaric-free measurements, lowest background levels are accessible. Such conditions are given, if the isobar does not form stable negative ions either as atomic ion, or by choosing a suitable molecular species; well-known examples are e.g. $^{14}C^-$, $^{26}Al^-$, $^{129}I^-$, or $^{41}CaH_3^-$, respectively, and also for the unstable isotopes in the mass range above Bi.

In this work, we will present a few additional cases where isobaric interference is completely excluded, among them ^{55}Fe, ^{68}Ge and ^{202}Pb. Applications will be discussed where the exceptional sensitivity of AMS offers important insights to such different fields like nuclear astrophysics, nuclear physics and general physics issues.

VERA, a dedicated AMS facility, based on a 3-MV tandem, featuring high mass resolution in combination with efficient background suppression and an automated measurement procedure, allows to transport all nuclides from hydrogen to the actinides through the system up to the detector stations. Such a facility is well suited for developing the tuning and measurement procedures for new and non-standard isotopes.

We will demonstrate the actual measurement limits of such radionuclides for the VERA facility and results for selected applications. In order to generate final values AMS usually relies on the parallel measurement of reference materials. We will discuss the production of such materials for these non-standard AMS nuclides.

TEC#2 **SESSION 2B** **Monday 21st March, 1130 – 1250**

Pushing the detection limits of rare isotopes

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Research on the occurrence, transfer and distribution of radioactivity in natural systems will benefit from further exploring the detection limits of Accelerator Mass Spectrometry (AMS). With the aid of the 25MV tandem accelerator (the highest voltage accelerator in the world) we have pushed the limits of AMS in measuring the isotopic ratio of ^{36}Cl/Cl in seawater [1]. In that paper we reported results from seawater samples taken a a depth of 4000m in the Atlantic ocean near the island of Madeira and 6m in the Pacific ocean together with a reference sample from the Great Artesian Basin in Australia and a blank from a halite sample within the Salina Formation in Ontario.

Here, we report on ^{36}Cl/Cl values for seawater samples obtained from the Arctic Ocean and the Barents sea and compare them with those reported in [1] and with those reported by ANU on the Pacific Ocean [2]. We will discuss apparent discrepancies and the importance of further exploring reliable and efficient methods for measuring ^{36}Cl in seawater, such as photodetachment of negative ions to isolate the isobars of interest [3]. This work is done within the science program of the Holifield Radioactive Ion Beam Facility (HRIBF) at Oak Ridge National Laboratory, a national user facility for research with radioactive ion beams (RIB). HRIBF has demonstrated the ability to accelerate approximately 200 short-lived radioactive isotopes with tandem energies and high-beam quality for nuclear structure and reaction studies, astrophysics research, and interdisciplinary applications. I will discuss how these two frontier fields of research – AMS and RIB science – share some common challenges and complement each other in techniques. I will give a brief description of some of the experimental tools and specialized techniques developed, which will broaden the range of radionuclides that can be detected at ultra-low levels. Finally, I will describe the on-going research activities at the HRIBF highlighting current approaches aimed at the studies of environmental radioactivity (oceanography, rock erosion, climatic events and fuel cycles).

[1] A. Galindo-Uribarri *et al.*, Nucl. Instr. Meth. B 259 (2007)123.

[2] D.C. Argento *et al.*, Nucl. Instr. Meth. B 268 (2010) 1226.

[3] A. Galindo-Uribarri *et al.*, Nucl. Instr. Meth. B 268 (2010) 834.

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TEC#3 **SESSION 2B** **Monday 21st March, 1130 – 1250**

The potential of He stripping in heavy ion AMS

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The measurement sensitivity in Accelerator Mass Spectrometry (AMS) is often limited by the low overall efficiency for detecting the rare isotopes. This is mainly determined by the negative ion formation and extraction efficiency in the ion source, but also losses due to the selection of an unfavourable charge state and losses in the beam transport can be significant. The mismatch of the most probable charge states and the accepting charge states (which are determined by bending strengths of the analyzing components) is particularly worse for the heaviest ions at facilities operating at high energies. Thus the transmission for e.g. the actinides is often well below 10%.

With the development of small AMS systems with terminal voltages around 0.5 MV low charge states (≤ 3+) are employed. At these low energies the mean charge state can be significantly increased by using He as a stripper gas. In many cases, this allows bending the most probable charge state which directly results in a considerably increased transmission.

On the example of the 0.5 MV TANDY AMS system at ETH Zurich we will show how the use of He increases the transmission for many nuclides. Transmissions of up to 40% can be reached for the actinides in charge state 3+. Likewise the transmission for iodine ions in charge state 2+ is >40%. Ions in the medium mass range (e.g. calcium) also benefit from He stripping, allowing to employ the charge states 1+ and 2+. Moreover, because of the low nuclear charge of He and the stripping kinematics, losses due to small angle scattering are reduced. This is particularly important for low charge states, where the stripper gas thickness has to be high enough in order to sufficiently destroy molecules by multiple collisions.

TEC#4 **SESSION 2B** **Monday 21st March, 1130 – 1250**

Investigation of gas stripping at 4MV for high mass negative ions

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ANSTO

For AMS analysis of actinides using the ANTARES tandem accelerator, we currently achieve an accelerator transmission of 4-5%, when injecting UO^- ions and analysing the 5+ charge state at a terminal voltage of 4MV with argon stripper gas. The present study was undertaken to better understand the stripping process for such heavy ions and, if possible, find a means to achieve higher transmission and therefore improved overall efficiency. We have measured charge state distributions at 4MV terminal voltage using negative ions ranging from carbon to uranium oxide. The stripper gas density was varied over a wide range to observe the onset of equilibrium stripping conditions. Using a 12º electrostatic deflector after the accelerator, charge states from 1+ to 8+ have been measured. The results show several interesting features: (i) for heavy ions such as iodine, uranium and thorium, there is a high probability of multiple electron loss in a single collision with the argon gas, leading to the mean charge state for I, Th and U ions being greater than 2.5 even at very low gas stripper pressure; (ii) with increased stripper pressure, scattering losses dominate before equilibrium stripping conditions are achieved. Further experiments are underway using helium and xenon stripper gases. Helium is of particular interest, as in earlier studies [1] performed externally to an accelerator, helium was shown to give the highest equilibrium charge state for uranium at low energy.

[1] A.B. Wittkower and H.D. Betz, Phys. Rev A 7 (1973) 159.

EAR#5 **SESSION 3A** **Monday 21st March, 1400 - 1540**

Variations in Marine Reservoir corrections for the Great Barrier Reef during the last 7000 years

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For calibration of marine ^{14}C ages, marine reservoir correction value (ΔR) of a given location is generally assumed to be constant with time. However, variations in the marine reservoir effect of several hundred to a couple of thousand years have been observed for various regions in the Pacific, Atlantic and Mediterranean during the Late-glacial and Holocene. These variations result from changes in ocean circulation and the carbon cycle associated with climate change. Here we present a new data set of ΔR for the Great Barrier Reef (GBR) in south-western Pacific Ocean during the last 7000 years for the investigation of possible variability in the marine reservoir effect of this area and for improving radiocarbon dating of marine samples. Coral samples used in this study were from shallow cores and storm derived blocks collected on Heron Reef in southern GBR at 23º26'S, 151º55'E. Fifteen unaltered coral samples (based on SEM screening, $\delta^{234}U$ and initial $^{230}Th/^{232}Th$ ratios) were analysed for $^{230}Th/U$ and ^{14}C. ^{230}Th dates were determined by TIMS U-series in the Radiogenic Isotope Laboratory at the University of Queensland with a precision better than 0.5% (2σ). Aliquots of these dated corals were then taken for radiocarbon analysis. The samples were cut by diamond saw, cleaned in deionised water, oven dried, and homogenised in a mortar and pestle prior to ^{14}C analysis using the STAR AMS facility at ANSTO. A typical precision for ^{14}C analysis is <0.4% (1σ). The results of this investigation will be compared with those of previous studies for the Pacific, and variations in ΔR for the GBR for the mid- to late Holocene and their possible mechanisms will be then discussed.

This work was supported by AINSE grant 09/056.

EAR#6 **SESSION 3A** **Monday 21st March, 1400 - 1540**

Radiocarbon reservoir effect from shell and plant pairs in the Holocene sediments around the Yeongsan River, Korea

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Calibration of radiocarbon ages from coastal calcareous samples is difficult problem because the reservoir effect is complicated process, which is associated by circulation of brine and freshwater. In order to measure reservoir effect, radiocarbon ages of shell and plant pairs from same horizons of a sediment core were measured by the AMS facility of KIGAM. Approximately 20 m depth of the Holocene sediment was analyzed around an axis of an incised valley, which had been formed after the last glacial maximum around Yeongsan River in south-western area of Korea. Based on our core analysis, these sediments would be consisted by the three sedimentary systems: fluvial, estuary and delta from the bottom to the top. The paleoenvironmental change is mainly associated by the sea-level change in deglacial period and the sediment discharge from Yeongsan River. This change is clearly recorded as the sedimentary facies, mollusc assemblages, and sedimentary ages. Molluscs are containing into the sediments of estuary and delta systems. These sediments seem to be formed near tidal flat, because the most of molluscs are consisted by Pacific oysters. The radiocarbon age offsets of oysters and the other molluscs which have different habitats would indicate reworking of old samples. These reworking might have been occurred by the large tidal range of this area. On the other hand, the age offsets between shells and plants were interpreted as radiocarbon reservoir effect of this area. The change of the values would be associated by the paleogeographical evolution of this tide-dominated coastal area.

EAR#7 **SESSION 3A** **Monday 21st March, 1400 - 1540**

Carbon Dynamics under Paddy Management

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Paddy and non-paddy soils from a chronosequence of 50 to 2000 years of agricultural use, developed on former estuarine sediments of the Yangtze River, were sampled near Cixi, Zhejiang Province, China, in the framework of the Research Unit "Biogeochemistry of paddy soil evolution" of the German Research Foundation (DFG). In addition samples of Yangtze River estuarine sediments were obtained.

The parent estuarine sediment shows a fairly homogeneous composition with ca. 0.4 % TOC and a ^{14}C concentration of ca. 50 pMC. After being diked-in, gradients in soil organic carbon and ^{14}C concentration develop under the influence of vegetation.

In the non-paddy soil, a ^{14}C gradient with ^{14}C concentrations decreasing from modern (>100 pMC) with increasing depth to original sediment values around 50 pMC has already become established after 50 years and can also be observed in the older sites.

In contrast, the 50 years old paddy shows organic carbon and ^{14}C enrichment only in the A-horizon and a nearly constant TOC and ^{14}C stock of original sediment below the plough pan. After 100 years of paddy management, paddy and non-paddy sites show, however, quite similar ^{14}C depth profiles.

Paddy rice cultivation quickly leads to a dense plough pan, which seriously reduces, but not totally prevents, downward transport of organic matter. With time, the effect of the initial disturbance caused by paddy management is decreasing and the ^{14}C and TOC depth profiles of paddy sites converge to those of non-paddy sites. The equilibrium times for TOC and ^{14}C concentrations in paddy soil profiles are short (decades) in the top soil and in the order of centuries in the subsoil, underlining the dynamic character of soil organic carbon.

EAR#8 **SESSION 3A** **Monday 21st March, 1400 - 1540**

Feasibility using ^{236}U to reconstruct close-in fallout deposition from the Hiroshima Atomic Bomb

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First results on the feasibility of using ^{236}U to reconstruct level and spatial distribution of close-in fallout deposition from the Hiroshima A-bomb are reported, coupled with the use of ^{137}Cs and $^{239+240}Pu$. The results for global fallout ^{236}U in soil samples (0-30 cm) from Japan showed that the deposition density of ^{236}U from global fallout can be accurately evaluated using AMS. Substantially, all deposited ^{236}U, ^{137}Cs and $^{239+240}Pu$ appeared to have been recovered using 30-cm cores. It was also noted from the depth profiles for $^{236}U/^{239+240}Pu$ and $^{236}U/^{137}Cs$ ratios that the downward behavior of ^{236}U in the soil was apparently similar to that of $^{239+240}Pu$, while the ^{137}Cs was more liable to be retained in upper layers. The accumulated levels were 1.78×10^{13} atoms/m^2 for ^{236}U, 4,340 Bq/m^2 for ^{137}Cs and 141 Bq/m^2 for $^{239+240}Pu$. The ratios of $^{236}U/^{137}Cs$ and $^{236}U/^{239+240}Pu$ were $(4.10\pm0.12)\times10^{9}$ and $(1.26\pm0.04)\times10^{11}$ atoms/Bq, respectively. Results of ^{236}U, ^{137}Cs and $^{239+240}Pu$ measurements for the seven soil cores (0-30 cm) from Hiroshima are discussed on the basis of ratios of $^{236}U/^{137}Cs$ and $^{236}U/^{239+240}Pu$, by comparison with soil from a background area in Ishikawa. Apparently, global fallout dominates the current level of ^{236}U accumulated in soil in the black rain area around Hiroshima after the Hiroshima bomb, and the contribution of the close-in fallout ^{236}U produced by the Hiroshima A-bomb seems difficult to be observed.

Now we are trying to analyze ^{236}U, ^{137}Cs and $^{239+240}Pu$ in soil samples which were collected 1) from underthe floor of a house built in 1945 to 1950, 2) around the hypocentre immediately after the explosion of the Hiroshima A-bomb by the Nishina research group, and 3) in residues form Black-rain on the walls of a house. The results will be discussed in the presentation.

EAR#9 **SESSION 3A** **Monday 21st March, 1400 - 1540**

Chemical speciation of metal elements in ferromanganese crusts

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Marine ferromanganese crusts consist of iron hydroxides and manganese oxides with various minor and trace metal elements. The crusts grow at a rate of a few millimetres per million years, and often occur at slopes and tops of seamounts. Thus they are potential archives of paleoceanic and geological environment and events. In previous studies, however, the samples were obtained randomly from various regions of ocean using dredge-type sampling method without confirming the growing environment of the crust. And discussion on the paleoceanic environment was made from concentrations of elements without considering the incorporation mechanism of elements into the crust. In this study, we attempted to get information on speciation and enrichment mechanism of elements to serve as an aid to reconstruct the paleoceanic environment using the samples obtained from Takuyo-Daigo seamount collected in 2009 with hyper-dolphin (remotely operated vehicle) equipped with live video camera and manipulators. The very surface less than 1mm thickness collected from 950m to 3000m water depth at the seamount were analyzed. Mineralogy of crust and concentration of elements was analyzed with XRD, XAFS, ICP-AES and ICP-MS. Furthermore, chemical species of some elements and their micro-scale distributions in the crust (collected at 2209 m water depth) were also analyzed by XAFS, EPMA and LA-ICP-MS. The growth rate of this crust was determined by ^{10}Be dating method using AMS. Mineralogy of manganese oxides shows no significant variation over the water depth ranges between 3000-900m. The depth profile pattern of element concentration was classified into several groups based on the types of the variation. The major mineral is vernadite and indicate no significant variation in area and in depth. In the presentation, the species and enrichment mechanism of growth dependence elements such as Co will be discussed together with the results of ^{10}Be dating.

TEC#5 **SESSION 3B** **Monday 21st March, 1400 – 1540**

Implementation of on-line interface for AMS

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Currently, all biochemical samples for ^{14}C-AMS analysis at LLNL are converted to graphite through a multistep, time consuming and labor intensive process. This procedure necessitates significant human handling and suffers from long turnaround times. A solution to this sample handling limitation is to combust and directly analyze the samples as CO_2, thus eliminating the need to reduce the samples to graphite. We have installed a CO_2 gas-accepting ion source onto our 1-MV BioAMS spectrometer and have coupled an on-line combustion interface to provide for the direct analysis of nonvolatile carbonaceous samples. Our interface is based on the moving wire technique and allows for both flow injection analysis of discrete small samples, as well as for continous flow applications to directly measure the output of a coupled HPLC. Our system is designed to send 100% of the combusted sample to the ion source, thus minimizing the release of ^{14}C-elevated CO_2 to the atmosphere from the interface. Overall system efficiencies (interface and ion source) of a few percent have been measured for sub-microgram samples. Preliminary data indicate that we are able to measure samples containing contemporary levels of ^{14}C and 500 ng carbon to a precision of a few percent.

Work performed (partially) at the Research Resource for Biomedical AMS which is operated at LLNL under the auspices of the U.S. Department of Energy under contract DE-AC52-07NA27344. The Research Resource is supported by the National Institutes of Health, National Center for Research Resources, Biomedical Technology Program grant #P41 RR13461.

TEC#6 **SESSION 3B** **Monday 21st March, 1400 – 1540**

Rapid AMS Analysis of Carbonates by Direct Sputtering

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We developed a technique for direct AMS analysis of carbonate samples using the caesium sputter source. By analyzing carbonate material without conversion to graphite, the time and expense of graphite preparation are eliminated. The method involves mixing clean, powdered carbonate with titanium powder and pressing the mixture into sputter target cartridges. Beam currents for optimally sized carbonate targets (1-2mg $CaCO_3$) are typically 5-15% of those produced by graphite targets. Normalized ratios of carbonates match well with those of the same material prepared as graphite, and the overall measurement precision is 1-2%. Targets with 0.2-1mg carbonate give 5-10% of graphite current and values within 3% of samples run as graphite. In its current state, direct sputtering is best applied to problems where low precision provides useful answers and a large number of analyses would be precluded by the time and cost of traditional hydrolysis and graphitization. These applications could include age surveys of deep-sea corals for determination of population dynamics, pinpointing interesting samples for high precision analysis, and for growth rate studies of animals forming carbonate skeletons.

TEC#7 **SESSION 3B** **Monday 21st March, 1400 – 1540**

A new capability for ANTARES: ^{7}Be by AMS

Smith A, Mokhber-Shahin L, Simon K
ANSTO

ANSTO, in collaboration with the Australian Antarctic Division, has compiled a quasi-monthly record of the concentration of ^{10}Be ($t_{½}$ = 1.36 × 10^{6} years) in firn near the summit of Law Dome, Antarctica. This record spans December 1999 to January 2010 and is comprised of overlapping ice cores and snow pits from this high-accumulation site (~640 kg/m^2/a). Since the 2008/2009 season, summer field work has retrieved multiple 3–5 m ice cores and 100 mm (~monthly) thick samples from 0.5–1.0 m snow pits. Each ice core overlaps an earlier record and a further expedition is planned for January 2011. Sample chronology has been established through measurement of δ^{18}O, permitting re-sampling to even monthly spacing and the production of a composite ^{10}Be record. All samples were processed and measured for ^{10}Be by accelerator mass spectrometry (AMS) at ANSTO's ANTARES facility.

Snow pit samples have also been measured for ^{7}Be ($t_{½}$ = 53.4 days) as this isotope has the potential to give further insight into the transport and deposition of cosmogenic beryllium to Law Dome. Early measurements have been made applying gamma-ray spectrometry with the sample concentrated to 10g in a LSC vial and typical counting times of 3 days. In 2010 we developed the capability for ^{7}Be/^{9}Be, using carbon foil post-stripping of $^{7}Be^{3+}$ to $^{7}Be^{4+}$ to eliminate the ^{7}Li isobar. There are a number of advantages in using AMS over gamma-ray spectrometry. Firstly, the sample can be directly processed to BeO and pressed into an AMS target. Secondly, there is no need to perform a ^{9}Be assay to determine the ^{7}Be/^{9}Be ratio. Thirdly, samples are measured rapidly, avoiding the decay of ^{7}Be when queued for gamma-ray spectrometry. Finally, there is no measurement background, permitting very low-level samples to be measured. We describe the status of this program.

TEC#8 **SESSION 3B** **Monday 21st March, 1400 – 1540**

AMS of ^{36}Cl with the VERA 3 MV Tandem Accelerator

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AMS of ^{36}Cl ($t_{1/2}$ = 0.30 Ma) at natural isotopic concentrations requires high particle energies for the separation from the stable isobar ^{36}S, usually provided by tandem accelerators with terminal voltages $\geq$ 5 MV. At VERA we have achieved ^{36}S suppression factors above 10^4 at 3 MV terminal voltage, using terminal foil stripping and a detection setup consisting of a split-anode ionization chamber and a silicon strip detector. To further increase the ^{36}S suppression we investigated energy loss straggling in various counting gases and the effect of "energy focusing" below the maximum of the Bragg curve. Comparison of experimental data with simulations and published data showed how energy loss, energy straggling and angular scattering determine the ^{36}S suppression.

In addition, we improved ion source conditions, target backing materials, and the cathode design with respect to sulfur output and cross contamination. These changes allow higher currents during measurement ($^{35}Cl^-$ current $\approx$ 10 µA) and also increased reproducibility. A thorough investigation of the memory effect of our ion source lead to a better understanding of our blank value. Currently it is $^{36}Cl/Cl \approx 5\times10^{-16}$ if measured together with samples with a ratio of 10^{-12} or below, and $^{36}Cl/Cl \approx 3\times10^{-15}$ when 10^{-11}-samples are used in the same sample wheel. We achieve an injector to detector efficiency for ^{36}Cl-ions of 8%. This comprises 16% stripping yield for the 7+ charge state in the accelerator and about 50% loss in the detection setup. We can now demonstrate that ^{36}Cl measurements at 3 MV terminal voltage are competitive to measurements at larger tandems.

Recently we started to explore the potential of selective laser-optical filtering of sulfur and chlorine by photodetachment directly in the ion source. First results of this study will also be presented.

TEC#9 **SESSION 3B** **Monday 21st March, 1400 – 1540**

Advances in Radiocarbon ICOGS systems

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Intracavity optogalvanic spectroscopy (ICOGS) is a laser-based analytical technique that allows extremely high sensitivity for detection of ^{14}C-labeled carbon dioxide and complements AMS in its ability to measure small samples with relatively high precision. (High Sensitivity Laboratory Based ^{14}C Analysis for Drug Discovery, Erhan Ilkmen and D. E. Murnick, Journal of Labeled Compounds and Radiopharmaceuticals, 53, 304-307 (2010); ^{14}C Analysis via Intracavity Optogalvanic Spectroscopy, Daniel Murnick, Ozgur Dogru and Erhan Ilkmen, Nuclear Instruments and Research in Physics Research, B 268 (2010) 708-711) Whereas AMS is a particle counting technique with precision limited by $\sqrt{N}$ statistics, where N is the number of counts, ICOGS is based on monitoring the impedance of an electrical discharge with precision limited by electrical noise. Using Allen variance plots precision improves with $\sqrt{t}$, t being the averaging time, until about 350 seconds. In principle, ICOGS precision is similar for both high and low (e.g. "dead') radiocarbon content. Unlike AMS, however, ICOGS is not an absolute measurement, with calibration to the AMS standard, being non-linear and dependent on controllable variables related to laser and gas discharge properties. Both AMS and ICOGS are also limited in precision and accuracy by sample preparation methodologies- ICOGS, and AMS both require sample oxidation to carbon dioxide. CO_2 is the analyte for ICOGS measurement; reduction to graphite is now also required for precision AMS studies. Recent studies on instrument properties, sensitivity and precision for small samples, $\leq\sim$100mg, in the dead to 1 Modern radiocarbon concentration range will be reviewed and design of a compact table-top instrument presented.

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EAR#10 **SESSION 4** **Tuesday 22nd March, 0900 - 1040**

Plutonium isotope measurements from across continental Australia

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The Australian National University

Atmospheric nuclear weapons tests in the 1950's and 1960's resulted in plutonium fallout being deposited on the earth's surface. The ^{239}Pu and ^{240}Pu fallout isotopes can be used as artificial tracers of soil erosion and sediment accumulation rates. In practice the low plutonium levels necessitate the use of the ultra-sensitive detection technique of AMS to make studies of large river systems possible [1]. The $^{240}Pu/^{239}Pu$ ratio can also provide useful historical information [2]. In global fallout the ratio is typically in the range 0.17 - 0.19, but the influence of regional nuclear installations or weapons test sites can lead to values outside this range. We report recent measurements on soil samples collected from locations scattered across a significant portion of the Australian mainland, including areas close to weapons testing grounds.

[1] S.E. Everett *et al.*, J. Environ. Radioact. 99, 383 (2008).

[2] S.G.Tims *et al.*, Nucl. Instrum. Meth. B. 268, 1155 (2010).

GLO#2 **SESSION 4** **Tuesday 22nd March, 0900 - 1040**

Measurement of $^{236}U/^{238}U$ in corals as a proxy for anthropogenic and pre-anthropogenic ^{236}U in ocean waters

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Corals build their skeletons by precipitating $CaCO_3$ (aragonite) from sea-water. Depending on species and location these skeletons show annual banding in the form of seasonal density fluctuations. During precipitation trace elements are incorporated into the aragonite, reflecting the conditions of the surrounding sea-water at the time. Using this feature for stable isotopes is a well-established method in the study of climate change and human environmental impacts for ocean waters in the past (e.g. [1], [2]).

Corals co-precipitate uranium at a ratio of about 3ppm. We apply this feature of corals to establish a year-by-year record of $^{236}U/^{238}U$ over the past 100 years for a core [2] from the Caribbean Sea. The selected core was taken in 2006. It has shown well-defined annual banding structure in X-rays and stretches back more than 100 years, and therefore covers the interesting period of global stratospheric fall-out.

Previous studies on soils have shown $^{236}U/^{238}U$ ratios of 10^{-7} to 10^{-8} which were attributed to this source (e.g. [3]). However, these studies lacked reliable temporal resolution, owing to the choice of sample. The coral core allows studying the onset and development of the introduction of anthropogenic ^{236}U into the ocean, which is expected for the early 1960's.

We have used the exceptional sensitivity and ultra-low background for ^{236}U of the Vienna Environmental Research Accelerator's heavy-ion AMS system for this measurement and find a distinct $^{236}U/^{238}U$ signature at the 10^{-9} level and set a limit on the pre-anthropogenic $^{236}U/^{238}U$-ratio in ocean surface waters. The latter is of high interest for potential geophysical application of this isotope. The detailed results will be presented.

1. Tezer M. Esat, Yusuke Yokoyama, Geochimica et Cosmochimica Acta. DOI: 10.1016/j.gca.2010.09.007.

2. Jessica E. Carilli, Nancy G. Prouty, Konrad A. Hughen, Richard D. Norris, Marine Pollution Bulletin. DOI:10.1016/j.marpolbul.2009.07.024.

3. A. Sakaguchi, K. Kawai, P. Steier, F. Quinto, K. Mino, J. Tomita, M. Hoshi, N. Whitehead, M. Yamamoto, Science of The Total Environment. DOI: 10.1016/j.scitotenv.2009.01.058.

EAR#11 **SESSION 4** **Tuesday 22nd March, 0900 - 1040**

Compound-specific ^{14}C analysis of acidic aerosol components

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[2] Paul Scherrer Institut,
[3] Lund University,
[4] Vienna University of Technology,
[5] ETH Zurich

The carbonaceous aerosol as a major constituent of air-borne particulate matter affects climate and human health. However, there is a large uncertainty about detailed apportionment and quantification of its sources due to the vast number of origins and associated chemical compounds. Radiocarbon (^{14}C) measurements have been proved to be a useful isotopic tracer for distinguishing contemporary and non-fossil emissions of carbonaceous aerosols [Szidat, 2009]. Dicarboxylic acids (such as oxalic acid) and other polyacidic components (so-called humic-like substances, HULIS) are important constituents of air-borne particulate matter. In order to quantify the contributions of fossil vs. biogenic and biomass-burning sources, we applied ^{14}C analysis specifically to oxalic acid and HULIS. Oxalic acid and other dicarboxylic acids were isolated from water extracts of quartz fiber filters using 2-D liquid chromatography [Fahrni et al., 2010]. HULIS were separated from an alkaline solution with a strong anion exchange column [Limbeck et al., 2005]. ^{14}C analyses of small samples (<20 µgC) were performed with the AMS system MICADAS, which is equipped with a gas ion source [Ruff et al., 2007]. First results imply biomass burning as the most important source of HULIS and oxalic acid during wintertime as well as a slightly stronger fossil influence during summer.

Fahrni et al., Radiocarbon 52, 752-760 (2010).

Limbeck et al., Analytical Chemistry 77, 7288-7293 (2005).

Ruff et al., Radiocarbon 49, 307-314 (2007).

Szidat, Science 323, 470-471 (2009).

GLO#3 **SESSION 4** **Tuesday 22nd March, 0900 - 1040**

Cosmogenic dating of the oldest landscapes on Earth: tectonic, climatic, and biological implications

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University of Canterbury

Over the last two decades, the AMS measurement of *in-situ* produced cosmogenic radionuclide concentrations in rocks and sediment has provided remarkable insights into how our planet operates. Slowly evolving landscapes such as Australia and Antarctica provide unique opportunities to explore the roles of tectonic (i.e. earthquakes and differential uplift) and climatic processes in controlling long-term landscape evolution, relief production, and biodiversity. In the Australian continent, bedrock landscapes appear to evolve at rates dictated by seismic activity and bedrock composition but show no strong correlation with modern climate or topographic relief. This surprising conclusion is supported by the near identical bedrock denudation rates of 3-5 $mMyr^{-1}$ from similar landscapes in the coldest and wettest (Tasmania), hottest and driest (central Australia), and Mediterranean climates (Western Australia) of the continent. Ongoing research in the tropical north aims to further scrutinize this relationship. In areas affected by Quaternary earthquakes, denudation rates are 1-2 orders of magnitude higher than undeformed areas, implying a first-order tectonic control on bedrock denudation due to co-seismic rock fracturing. Similar relationships may exist in the Dry Valleys of Antarctica, where the importance of understanding spatial variability in denudation is important for influencing the distribution of life in this extreme environment.

GLO#4 **SESSION 4** **Tuesday 22nd March, 0900 - 1040**

Constraints on ice volume changes of the West Antarctic Ice Sheet and Ross Ice Shelf since the LGM based on cosmogenic exposure ages

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At the Last Glacial Maximum (~20 ka), marine evidence indicates that the grounding line of the West Antarctic Ice Sheet (WAIS) advanced northwards into the Ross Ice Shelf (RIS), blocking drainage of outlet glaciers through the Transantarctic Mountains (TM) resulting in significant downstream thickening of glacier profiles. The Darwin and Hatherton Glaciers in the TMs provide geological and pedological records of WAIS fluctuations that are interpreted as evidence for a LGM ice volume at least ~800 m thicker than today. Cosmogenic ^{10}Be and ^{26}Al exposure ages at Lake Wellman and Dubris Valley from ice-sheet contact (850 masl) to mountain peak (600 masl) show a WAIS Pleistocene ice thickness some 800 to 400 meters thicker than today. However a cluster of mid-altitude moraine boulders, previously taken to demarcate the LGM advance, have exposure ages ranging from 30 to 40 ka. This suggests that while WAIS expansion during the early Pleistocene was large, its LGM ice volume was not as large as previously estimated and little different from what is observed today (at most 50 m above current ice surface). A second site further north, Diamond Hill, lies at the confluence of the Darwin Glacier and RIS. Two transects were sampled on Diamond Hill that cover an altitude range of 1100 meters. Preliminary ^{10}Be cosmogenic dates show a similar trend to that seen further up glacier in Lake Wellman. For the case of Diamond Hill, the WAIS was approximately 900 meters thicker than the current Rose Ice Shelf configuration at ~1.5Ma and with only minor advances in the last 10ka. As with Lake Wellman no evidence of large scale LGM advances were found. These results raise serious questions about the implications of a reduced West Antarctic ice Sheet at the LGM, and how the Antarctic ice sheets respond to global warming.

GLO#5 **SESSION 5A** **Tuesday 22nd March, 1110 - 1250**

Using 50 Years of Soil Radiocarbon Data to Identify Optimal Approaches for Estimating Soil Carbon Residence Times

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GNS Science - National Isotope Centre

In 1959, Athol Rafter began a substantial programme of monitoring the flow of ^{14}C produced by atmospheric thermonuclear tests through New Zealand's atmosphere, biosphere and soil. A database of ~500 soil radiocarbon measurements spanning 50 years has now been compiled. These data, which span the 'bomb ^{14}C' spike, have great value in C-cycle studies. Soil plays a major role in the global C budget – storing more C than the atmosphere and biosphere combined. Human activity has major impacts on soil C stocks over decades. Improved quantification of soil C turnover will greatly benefit estimation of greenhouse gas emissions from human land use, at scales ranging from global to national, and down to the embodied emissions associated with agricultural products. We have evaluated our database and identified opportunities to make the calculation of soil C residence times much more routine.

Our database contains over a dozen soil ^{14}C time series that provide unique opportunities to understand how to optimise the calculation of soil carbon residence times, with a focus on the large ~decadal pool stabilised within grassland soils. High-resolution time series, including 10 time-points in the Judgeford surface soil, confirm that the use of ^{14}C effectively separates and mathematically describes the stabilisation and turnover of the commonly modelled pools of soil C under a range of conditions. By comparing time series collected at sites on different soils where other factors are controlled, we can identify a 50–90% increase in stabilised (decadal) soil C residence times in Andisols formed from volcanic materials, when compared to non-Andisols. Calculating residence times across soil depths has presented challenges, but can be solved surprisingly elegantly by combining horizons in our data sets.

Our results confirm the potential of ^{14}C to determine residence times, by estimating the amount of 'bomb ^{14}C' incorporated. High-resolution time series confirm this approach is appropriate, but emphasize that calculations can be carried out routinely with 2 or more time points. Two recent time points separated by as little as 10 years are adequate for useful, routine results. This approach is generally robust to the key assumptions that can create large errors when single time-point ^{14}C measurements are modelled. The 3 most critical assumptions relate to:

1. The proportion of old C ("fraction passive")
2. The lag time between photosynthesis and C entering the modelled pool
3. Changes in the rates of C input (i.e., steady state).

AMS and sample preparation laboratories can play an important role in coordinating the efficient delivery of robust calculated residence times for soil carbon.

GLO#6 **SESSION 5A** **Tuesday 22nd March, 1110 - 1250**

Turnover of organic carbon in temperate grassland soil profiles from Northern China

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Approximately 40% of Earth's land surface area is covered by grassland which contains about 34% of terrestrial carbon. Nearly 90% of the terrestrial C is from soil organic carbon (SOC) and temperate grassland soil is the second largest soil carbon pool. Therefore, the dynamics of grassland SOC and its response to environmental changes may potentially exert great influence on global carbon cycles. Previous studies on the dynamics of SOC in grassland have been largely based on the measurements of soil respiration and the derived turnover time is in the range of decades for SOC in the top soils. Such an approach assumes that the top 10s cm soil carbon stock is responsible for the soil respiration emitted from the whole soil profile. In this study, we report applications of the radiocarbon technique to our recent investigations on the size and turnover time of different carbon pools in the temperate steppe soils of Inner Mongolia, China. Density fractionation was applied to samples from soil profiles in order to obtain SOC from different C pools. Radiocarbon measurements were made to the light density fraction (< 1.6 g cm^{-3}), the medium density fraction (1.6-2.2 g cm^{-3}) and the heavy density fraction (> 2.2 g cm^{-3}) as well as the bulk SOC. Our turnover time estimates for the bulk SOC agree with radiocarbon studies from other regions, but are in contrast with the values derived from the measurements of soil respiration and soil carbon input. There is great variation among the turnover time estimates for the three density fractions as well as for different depths. Our results point to the complex nature of the dynamics of organic carbon in temperate grassland soils and have implications for the study of global carbon cycle involving terrestrial carbon pools.

GLO#7 **SESSION 5A** **Tuesday 22nd March, 1110 - 1250**

Radiocarbon Based Organic Carbon Source Identification of Soil Respired CO_2 under Soil Warming in a Cultivated Andisol

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The Arctic and boreal soil organic-carbon pool is a significant, but poorly constrained carbon store. Some current studies in the Arctic have pointed to the importance of these SOC stores as they are affected by warming temperatures, such as the widespread warming of the upper permafrost in the Arctic, and efflux of up to 80% of the seasonal C flux from tundra soils during the cold season when the organic-carbon-rich sub-soils are the warmest in the soil profile. The fate of carbon in arctic and boreal region is an important consideration for the current and future carbon cycle as soils warm in northern latitudes. In this study, we investigated the soil carbon stores and estimated these residence times in arctic and boreal soil in Alaska. Soils above the permafrost were collected along the Dalton Highway, between Fairbanks and Deadhorse near the Arctic coast. The observation area extends from Tundra in the Arctic coast, mountain area in the Brooksrange, in September 2009, then boreal forests in the south of Brooksrange. We measure C contents of SOC and the radiocarbon age of SOC and ecosystem respiration. Thick moss and detrital layers were found in poorly drained soils. According to ^{14}C data, the thickness of the recent detritus accumulated after 1960s' were from 10cm to 14cm in boreal forests and from 8 cm to 13cm in Tundra ecosystem. Bomb^{14}C contents and TOC down profiles suggested that boreal forests had large amount of SOC above permafrost and high accumulation rates which corresponded to 6.6 – 8.2 kg m^{-2} for past 60 years. We also examined soil $^{14}CO_2$ and discuss origin of soil respired CO_2 in this conference.

GLO#8 **SESSION 5A** **Tuesday 22nd March, 1110 - 1250**

Potential Use of Chia Plant as an Alternative Sampling Method for Atmospheric $^{14}CO_2$

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$\Delta^{14}CO_2$ is a unique tracer for quantifying anthropogenic CO_2 emissions. We have tested the potential use of a chia plant (*Salvia hispanica*) as an alternative way to collect a time-integrated CO_2 sample for radiocarbon analysis. $\Delta^{14}C$ measurements of commercially available chia seeds indicated they were relatively homogeneous in one single batch, and there was no noticeable difference between dark and light color seeds. However, as expected, chia seeds are older, usually with 3-6 years shelf life and thus have higher $\Delta^{14}C$ than the current atmosphere. Our objective was to determine if the chia plant would record the atmospheric $^{14}CO_2$ during its growth. In order to answer this question we have to know if the ^{14}C content of the new growth will be affected by the stored carbon in the seeds. We divided the chia sprouts into several parts, from the leaf, stem to the roots. The results show that $\Delta^{14}C$ of the new growth of chia sprouts longer than four cms, or older than four weeks is consistent with the $\Delta^{14}C$ of air samples collected during the growth period, indicating the new growth has no inherited C from seeds and thus records atmospheric $^{14}CO_2$. Time-integrated air samples and chia sprout samples significantly reduced the noises of $\Delta^{14}CO_2$ in urban environment. $\Delta^{14}C$ of one week integrated UC Irvine air was from 11.4 to 29.4 ‰, with an average of 20±7 ‰ (n=8) from 3/8/10 to 5/4/10, implying a fossil fuel CO_2 component of 5.1±2.5 ppm in Irvine, CA in this period. In summary, this study has shown encouraging result that chia plant can be potentially used as a convenient and inexpensive sampling method for time-integrated atmospheric $^{14}CO_2$. Combined with other annual plants we could map out time-integrated fossil fuel-derived CO_2 in major cities which can provide invaluable information for validating emissions and various climate/transport models.

GLO#9 **SESSION 5A** **Tuesday 22nd March, 1110 - 1250**

NEEM, North West Greenland firn air timescale calibration with the $^{14}CO_2$ bomb-pulse

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Firn is a porous layer of accumulating snow above the impervious ice sheet. Atmospheric air is trapped in voids and channels between ice crystals which increase in tortuosity as the layer compacts. This firn air can span the last century and connects ice core gas measurements to direct atmospheric observations. Knowledge of diffusion in the firn and the bubble-trapping process at the ice transition is crucial to interpreting the age and composition of air in ice. Tracers like $^{14}CO_2$ with significant recent changes are useful for these studies. In 2008, firn air sampling associated with the Greenland NEEM deep drilling project was undertaken at 77.445°N, 51.066°W, 2484 masl, ~1.5 km from the main camp. Along with other samples, a set of 0.5 L glass flasks and 3 L stainless steel cylinders were filled at depths from the surface to the base of the firn at 76 metres.

At CSIRO MAR, 15 CO_2 samples were extracted from the glass flasks, including 4 duplicates for reproducibility checks. Additionally, 6 radiocarbon-free CO_2 samples of matching size were processed for contamination checks. Later three CO_2 samples were extracted from the stainless steel cylinders at depths bracketing the expected $^{14}CO_2$ maximum. Two of these were from the same depths (68 and 72 m) as the glass flasks.

At ANSTO, the CO_2 samples were graphitised and analysed for ^{14}C at the AMS ANTARES facility. Replicates agreed perfectly within experimental errors, giving, together with low blanks, confidence in the entire process from air sampling to AMS analysis. The clearly visible $^{14}CO_2$ bomb pulse in firn air was used for tuning, along with ten other tracers, to constrain the firn air diffusion and trapping model. The age and age spread of CO_2 in firn air for this site were determined for each sampling depth.

TEC#10 **SESSION 5B** **Tuesday 22nd March, 1110 - 1250**

AMS of ^{236}U at low energies: highly efficient performance and first detection of UH_3^+ and ThH_3^+ molecules

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ETH Zurich

With the installation of an additional 130° magnet on the high-energy side of the TANDY AMS facility (0.5 MV) at ETH Zurich the performance for actinide-AMS has been significantly improved. We report on the new feasibility for highly sensitive measurements of $^{236}U/^{238}U$ ratios down to the 10^{-12} range and show the first evidence for molecules in charge state 3+ affecting an AMS measurement.

For AMS measurements of actinides the suppression of isobars and molecules of the same mass is extremely difficult and also the separation of long-lived neighbouring isotopes is challenging because of the small relative mass differences. For most nuclides in AMS the successful approach to destroy molecular background is to select a charge state ≥ 3+ at the high-energy spectrometer. Systematic studies of the possible background for $^{236}U^{3+}$ at the compact TANDY system show that actinide molecules in charge state 3+ do exist, namely $(^{232}Th^{1}H)^{3+}$, $(^{235}U^{1}H)^{3+}$ and $(^{238}U^{1}H)^{3+}$, and can cause a severe background on masses 233, 236, and 239, respectively. The existence of the $(^{232}Th^{1}H)^{3+}$ molecule could be verified unambiguously by analyzing its breakup products. Theoretical calculations confirm a metastable state for this molecule. These actinide hydride molecules can be destroyed efficiently using higher stripper pressures.

The newly installed magnet reduces background from neighbouring masses allowing now $^{236}U/^{238}U$ measurements down to the 10^{-12} level with the ionization chamber only. At an ion energy of 1.2 MeV an overall efficiency of more than 10^{-4} can be achieved. The high efficiency in combination with the low background opens the spectrum of possible applications to both anthropogenic ($^{236}U/^{238}U=10^{-7}$-10^{-9}) and natural samples ($^{236}U/^{238}U<10^{-10}$). As an example of the new activities first results of ^{236}U measurements in ocean water samples will be presented.

TEC#11 **SESSION 5B** **Tuesday 22nd March, 1110 - 1250**

Recent developments in the AMS measurement of ^{236}U and ^{36}Cl at the Australian National University

Fifield K, Tims S
The Australian National University

AMS measurement of ^{236}U requires a time-of-flight (TOF) detection system in order to separate the isotope of interest from background ^{235}U and ^{238}U ions that reach the detector. Such a system has been in operation at the ANU for several years. Recently, we have extended the flight path of our TOF system from 2m to 6m, which has substantially improved the separation of the three isotopes. A magnetic quadrupole doublet lens in the middle of the flight path ensures that the efficiency of the system is essentially the same as it was for the shorter flight path.

For ^{36}Cl measurements at 14MV, the principal limitation on sensitivity arises not from ^{36}S background, but from genuine ^{36}Cl ions due to ion-source memory. In a recent study of the ^{36}Cl/Cl ratio of seawater, where the expected ratio was below 10^{-15}, it was necessary to attain backgrounds below 10^{-16}. Such low ratios were achieved by running only low-level samples for several wheels previously, by using a secondary standard with a ratio of only $100x10^{-15}$ rather than our normal $450x10^{-15}$, by preparing several blanks in parallel with the samples, and by scrupulous attention to cleanliness during sample preparation.

Results from both developments will be presented.

TEC#12 **SESSION 5B** **Tuesday 22nd March, 1110 - 1250**

Absolute carbon isotope ratios by AMS

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Collisional electron removal from negative ions produces positive ions whose equilibrium charge states depend on the collision velocity in a gas target. The fraction of resulting positive ions of neighbor isotopes is equal at a velocity near the maximal transmission of the charge state, at an energy above 560 keV for equal production of 1+ ^{14}C and ^{13}C. If the quantification of the separated isotopic ions is equivalently efficient, a measured positive isotope ratio is equal to the ratio of the accelerated negative ions. Efficient ion sources have minimal isotopic fractionation, independent of surface detail, when sputtered in low electric fields. Equivalent positive transmission of isotopes through gas stripping thus produces absolute isotope ratios for AMS samples within precisions of 1-2%, acceptable for biochemical quantitation. We demonstrate that the +1 charge transmissions of $^{12}C^-$, $^{13}C^-$, and $^{14}C^-$ have predictable ratios at collision energies near 200 keV, providing a lower span of energies at which one isotope's transmission is calculable from another's. Isotope ratios are then quantified without normalization to reference standards, which act as quality control measurements. This mode of operation provides efficient ^{14}C/C measurements as well as stable precision in ^{13}C/^{12}C ratios for isotope dilution quantification of sample masses. Continuous gas samples from directly combusted chemical separations will not need intermittent internal standards for accurate AMS quantification using this method.

TEC#13 **SESSION 5B** **Tuesday 22nd March, 1110 - 1250**

An absolute AMS method for determination of ^{79}Se half-life

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Half-life of ^{79}Se has wide applications in nuclear astrophysics, radioactive waste management, nuclear data, isotope production, neutron activation, etc. However, the half-life of ^{79}Se is so far not precisely known for those correlative studies. Aiming at accurate determination of the half-life for ^{79}Se, an absolute method of AMS measurement for the ratio of ^{79}Se/^{80}Se has been developed at the China Institute of Atomic Energy (CIAE). Key parameters of injection magnet, the terminal voltage, the analyzing magnet and electrostatic analyzer have been systematic study to optimize the conditions for ^{79}Se transmission. The experimental results showed that there is a good linear relationship between measured values and referential values for ^{79}Se series samples. For measuring a sample with a ^{79}Se/Se ratio of about 10^{-9} level, the relative standard deviation for absolute method of about 3% was obtained. This method can be used for accurate determination of ^{79}Se in AMS measurement without reliable laboratory standard samples.

The determination of ^{79}Se half-life was undertaken. The atom number (N) of ^{79}Se was measured by using the established absolute method at the CIAE AMS. The activity of ^{79}Se was measured by a liquid scintillation spectrometer with low background and accurate calibration. A new ^{79}Se half-life value will be obtained.

REP#1 **SESSION 5B** **Tuesday 22nd March, 1110 - 1250**

A novel 3 MV multi-element AMS system

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The University of Ottawa, (Canada), to complement their existing earth science analytical facilities, will install a 3 MV multi-element AMS system manufactured by High Voltage Engineering Europa B.V., The Netherlands. The system is equipped for analysis of tritium, carbon, beryllium, aluminium and iodine samples and is designed so that measurements of other elements up to plutonium can be developed. It features two 200 sample SO110 sputter ion sources, one followed by a high-resolution bouncer type injector with the capability to bend molecular anions up to 340 AMU at full ion source energy. The accelerator terminal is equipped with a differential pumping section to achieve best possible vacuum in the accelerator tubes. The high energy spectrometer utilizes a 350 MeV-AMU magnet for mass analysis and a gas ionization chamber for rare isotope detection. A switching magnet allows the use of different (future) detection systems.

This unique system has been designed to provide services for a broad user community, with emphasis on a number of specialized themes: the exploration for and handling of nuclear fuel materials, including the biological and geological monitoring of nuclear materials from mining to waste storage; Quaternary geology, paleoclimatology and the evolution of landscapes (exposure ages); archaeometry and the analysis of cultural artifacts and the transport and metabolism of chemicals in environmental toxicology, biomedical and pharmaceutical research. In particular, the system is designed to be flexible so that research into new AMS techniques, such as the use of reaction cells for isobar separation and fluoride matrices for enhanced anion production can be carried out, thus continuing the legacy of the IsoTrace Laboratory in Toronto

Poster Abstracts – Session 1

EAR#P101 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Tracing water masses in the Baltic Sea by iodine speciation

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Tracer technology has been used to understand water circulation in the marine systems. Tracer dose is commonly injected into the marine system through controlled experiments, accidental releases or waste discharges. Despite possible pollution problems and disturbance of the ecosystem associated with the tracer releases, they can provide precious information concerning water circulation. The semi-closed Baltic Sea with its rather well defined in- and outflow water budget represents an excellent experimental site for application of tracers. Accurate recognition of water circulation in the Baltic Sea and entrainment of the deepwater into surface currents has direct impact on the delicate ecosystem. The supply of anthropogenic ^{129}I signal through a dominant single source (nuclear fuel reprocessing) facilitates the tracing and modeling of circulation in the Baltic Sea. Accordingly, we here use anthropogenic ^{129}I and its chemical species iodide and iodate as tracers of water circulation. The tracer model we apply incorporates effects of current transport, diffusion processes and release from sediments. The data reveal patterns that partly (with some deviations) confirm earlier studies which used current measurements and modeling approach. The deviations are most common in the deep parts of the Baltic Sea and along the transition zone in the southern Baltic where evidence for intrusion of deep water and North Atlantic water is demonstrated. The transport of water from the deep basins likely happens by cyclonic water upwelling currents breaking through a halocline transition and seems consistent with the Baltic haline conveyor belt. Anomalous ^{129}I values indicate addition of fresh water, particularly along coastal regions, that may enhance surface circulation.

EAR#P102 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Application of ^{14}C AMS measurements for the determination of the Bio-Based content in polymers and industrial flue gases

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Following the need of reducing the carbon dioxide emission into the atmosphere, international protocols have come into force in the last years which aim to promote the use of bio-based products and of renewable energy sources such as those deriving from biomass combustion. The development of fast, accurate and reliable experimental methods for the determination of the biogenic fraction in carbon based industrial products (such as polymers, fuels and flue gases) is thus an active research field. In this paper we present the potentialities of the AMS-^{14}C method for the quantitative determination of the biogenic fraction in polymers and carbon dioxide stack emission in Waste to Energy plants (WTE) and waste combustion stations.

For the analysis of plastic material different resins were analyzed both in the solid and in the liquid forms from different manufacturers and different certified biomass contents. Aim of the study was to set-up the proper sample processing and calculation procedures, to test the reliability of the method to be used as a certification protocols of both the employed raw materials and finished products and estimate the uncertainties associated with the method.

For the analysis of carbon dioxide stack emissions, CO_2 recovered by dissolution in KOH solutions from different type of WTE (Waste to Energy Plants) in Northern Italy were analyzed by AMS. The analyses allowed to refine the sample processing and calculation procedures which presents critical aspects in the definition of the blank correction step and in the estimation of the biogenic fraction starting from the measured ^{14}C concentrations. For both the applications, the used sample processing protocol and the calculation procedures will be presented together with the obtained results indicating the strong potentialities of AMS in this field.

EAR#P103 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

First data of Uranium-236 in the Atlantic Ocean

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Recently $^{236}U/^{238}U$ measurements have been established on the compact (0.6 MV) ETH-AMS system TANDY at background levels below 10^{-11}. The low level of background together with the good overall efficiency enables the precise determination of ^{236}U amounts in the fg (10^{-15} g) range. This not only allows the detection of anthropogenic ^{236}U ($^{236}U/^{238}U \approx 10^{-7}$-$10^{-9}$), it also opens the field of applications using natural occurring ^{236}U ($^{236}U/^{238}U < 10^{-10}$). With the addition of a ^{233}U spike to the samples the $^{236}U/^{238}U$-ratio and the concentration of both ^{236}U and ^{238}U in the sample can be determined during only one AMS-measurement.

The aim of this study is to explore the potential of ^{236}U as a new oceanic tracer by mapping the distribution of both natural and anthropogenic ^{236}U in the Atlantic Ocean. We present the first comprehensive data set showing the ^{236}U distribution in the North Sea as sampled in 2009. Furthermore, two vertical water mass profiles from the Equatorial West Atlantic (sampled in 2010) will be shown representing a snapshot of the ^{236}U-concentration and the $^{236}U/^{238}U$ ratio in the major water masses of the oceanic region.

Box model results indicate that the elevated $^{236}U/^{238}U$ ratios in the North Sea (10^{-9} – 10^{-8}) can be explained quantitatively by the release of irradiated U from the nuclear reprocessing plants Sellafield (GB) and La Hague (F). In the equatorial West Atlantic $^{236}U/^{238}U$ ratios decrease from about 10^{-9} at the surface (in accordance with ^{236}U from global fallout) to about 10^{-10} at a depth of 4000 m. This is still much higher than expected from the sole input of natural sources. A possible explanation for the elevated ratios in the bottom waters is the transport and the subsequent release of particle bound U from the surface waters. The modelling results further indicate that also the advection of water masses from the Island-Shetland region (^{236}U from reprocessing) might have contributed significantly to the elevated ratios observed at a depth of 2500 m.

EAR#P104 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Bomb Radiocarbon at the Source: Coral $\Delta^{14}C$ from Enewetak Atoll during the 1950s

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The seasonal $\Delta^{14}C$ history of surface waters in and around Enewetak Atoll (RMI) in the tropical western Pacific has been reconstructed from radiocarbon measurements on a coral. Enewetak Atoll was a major nuclear test-site during the 1940-50s and this is the first coral-radiocarbon record produced in such proximity to a nuclear test site. We will present $\Delta^{14}C$ data from the pre-bomb (-60‰) to 1960 encompassing the bomb testing period. Individual bomb tests can be differentiated as well as the cumulative of multiple tests. The largest $\Delta^{14}C$ value in the coral came from the 1957 Oak test (34,840‰). The Oak test site was located ~2km west from the coral site. The coral did not display any growth effects from the nuclear bomb tests.

EAR#P105 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

^{129}I Concentration measurements in animal thyroid from Argentina

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Thyroid hormones require iodine for their synthesis and therefore iodine is naturally concentrated in those glands. Thyroids of grazing animals act as sensitive probes to asses the fallout of ^{129}I in environmental studies. In our work, the ^{129}I content and ^{129}I/^{127}I ratio of cow thyroid samples coming from all over Argentina were determined by means of AMS. The concentrations and ratios measured in this work (^{129}I/^{127}I $\approx 7\cdot10^{-11}$ on average) were measured low, similar to those previously found at other places far away from potential sources (nuclear fuel reprocessing plants in France and U.K.) and orders of magnitude lower than observed close to reprocessing plants. Prior to this study, no data were available on the ^{129}I present in Argentina. The very low values found in samples from this region, make them good blanks samples for measurements in the northern hemisphere and may help to establish the worldwide pre-anthropogenic level of ^{129}I.

EAR#P106 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

AMS Measurements of ^{129}I in seawater around Iceland and Irminger Sea

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Large amounts of iodine-129 were, and still are, released to the environment from nuclear facilities, in particular from two reprocessing facilities located at the east coast of the North Atlantic Ocean (Sellafield and La Hague). The main transport path of the releases from the two facilities is through the NAC (North Atlantic Current) and the NCC (Norwegian Coastal Current) to the North Atlantic and Arctic Oceans, respectively. These waters enter the West North Atlantic and Labrador Sea through the DWBC (Deep Western Boundary Current). At CNA we have determined the ^{129}I/^{127}I ratio in seawater samples from three locations at the Iceland and Irminger Basins (61.47N 21.05W, 59.59N, 23.37W and 60.00N 4.60W) at different depths (from surface to 1000 m). The measured ratios ranged from 150×10^{-10} in surface waters to 6×10^{-10} in deepest waters (1000 m), compared to the pre-anthropogenic ratio ^{129}I/^{127}I of $\sim10^{-12}$. These values are in the range expected if there was an anthropogenic contribution, confirming that a ^{129}I release might take place. If a ^{127}I concentration of 60 μg L^{-1} was assumed, ^{129}I concentration in these profiles range from 400×10^{7} at L^{-1} in surface waters to 15×10^{7} at L^{-1} in deepest waters. These values are higher than other published near Labrador Sea before and they might be reflecting the significant increase of liquid discharges from European reprocessing fuel facilities in the last ten years. The measurement of ^{129}I concentrations in these samples is in progress, in order to obtain the complete information of the samples collected.

EAR#P107 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Reservoir age variations and stable isotope values of bulk sediment in a core from the Limfjord, Denmark

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The Limfjord is a sound in Northern Jutland, Denmark, connecting the North Sea with the Kattegat. A multi-proxy approach has been applied to a sediment core from Kilen, a former fjord arm near the town of Struer, to reveal the Limfjord's development in more detail. In this paper, we concentrate on radiocarbon dating of shells and on stable isotope measurements of bulk sediment from 7400 to 1300 cal BP.

Reservoir ages in coastal waters and estuaries can differ considerably from the global model ocean. The seas around Denmark have a reservoir age of *c*. 400 years, while a hardwater effect of a few thousand years is possible for freshwater with a high content of dissolved carbonate. On the other hand, freshwater without a significant content of ^{14}C-dead carbon does not have a reservoir age. In coastal waters, the different water sources mix and produce highly variable reservoir ages.

Due to Holocene relative sea level fluctuations, caused by the interplay of eustatic sea level changes and isostasy, the Limfjord had varying connections to the sea. As the relative proportion of marine and fresh water varied with time, the reservoir age for the Limfjord is also expected to vary. Radiocarbon datings of shells, compared to a terrestrial age model, resulted in reservoir ages with ΔR values between -150 and +320 years.

The δ^{13}C and C/N values of bulk organic matter follow a line which endpoints are the values of terrestrial and marine plants, respectively. The relative contribution of the two sources of organic matter can thus be estimated. The δ^{13}C and C/N inferred salinity can be related to changes in ΔR and other palaeoenvironmental proxies. An increasing marine influence throughout the largest part of the core is followed by large variations around 2000 cal BP.

EAR#P108 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Methodological study on exposure date of Tiankeng by means of measurement of in-situ produced cosmogenic ^{36}Cl

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Tiankeng is a typical Karst relief of Late Quaternary Period. Studies on the exposure ages of Tiankeng are very important to the geographical research, the formation condition, the developing process, and the features of the biological species. ^{36}Cl on the surface layer of the section of Tiankeng is largely produced by cosmogenic high-energy neutron induced reactions ^{39}K(n, α) and ^{40}Ca(n, αp), and accumulated since the formation of the Tiankeng. Low-energy neutron reaction ^{35}Cl(n, γ) contributes a small portion of ^{36}Cl. In this work, the concentration of the cosmogenic ^{36}Cl in rock samples taken from Da Shiwei Tiankeng, Leye County, Guangxi Zhuang Autonomous Region, China, was measured by Accelerator Mass Spectrometry (AMS) both in CIAE and University of Tsukuba in an effort to estimate the formation time (or exposure age) of the Tiankeng. The results show that the exposure time of Da Shiwei Tiankeng is more than 22 ka (the erosion rate will be given by follow-up work). The characteristics, distribution, developing process of the Tiankeng will be introduced briefly; the sampling strategy and procedures, experimental set-up and preliminary results will also be presented in details.

EAR#P109 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Dating of aeolian sand deposits in Korea using OSL and ^{10}Be

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In Korea, a variety of marine terraces are located in both Eastern and Southern parts of the country, but only limited applications of dating techniques have been attempted in the past. In the case of an earlier investigation of a marine terrace in Masanri, Phohang, Korea (36°0N, 129°3E), results shows that the ^{10}Be concentrations of the soil profile of this study are ranged from (0.67±0.45) ~ (1.47±0.47) x 10^8 atoms/g. Our more recent preliminary results of *in situ* ^{10}Be study suggest that the study area might have been covered by wind blown sand deposits which would be expected to be associated with high inherited cosmogenic nuclides.. Such a situation presents a major uncertainty on the interpretation of the ^{10}Be data. We have taken another approach to meet the challenge by determining a marine terrace formation age by means of combined dating techniques. To unravel the geological history of a complicated geological site, combining ^{10}Be dating with OSL dating method is a promising but challenging task. We have selected another site of aeolian sand deposit for our dating application. The location of this site is the western coastal area, Cheonripo (36.5°N, 126.9°E), Taean, Chungcheongnamdo, Korea. The characteristics of wind blown sand grains are very similar in particle size distribution. However, later soil modification seems to be very different. This could be related to soil development and the difference in the age of the soils. Our preliminary dating of the soil for this area ranges from 138±11 to 222±14 kyr for the depths from near surface to 150 cm. This presentation will focus on the discussions of the dating methodology and new results of both OSL and ^{10}Be.

EAR#P110 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Investigation of Dashgil mud volcano using Beryllium-10

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We collected and analyzed 5 sediments from 3 mud volcanoes (MV) and 6 suspended and bottom sediment samples from adjoining river in Dashgil mud volcano in Azerbaijan for ^{10}Be. These 3 MV are among the 190 onshore and > 150 offshore MV found in this region which correspond to the western flank of the South Caspian depression. These MVs overlie the faulted and petroleum-bearing anticlines. The sediment samples were leached with hydroxylamine hydrochloride. The concentrations of ^{10}Be in the mud volcano samples varied between (0.038±0.00) x 10^8 and (0.052±0.00) x 10^8 atoms/g and between (0.23±0.01) x 10^8 and (0.52±0.02) x 10^8 atoms/g in the river sediment samples. The two orders of magnitude higher ^{10}Be concentrations in river sediments indicate large erosional input of surficial soil particles compared to the mud volcano sediments. The ^{10}Be concentration is comparable to the values reported the mud volcanoes in Trinidad Island (Castrec-Roulle et al., 2002). The ^{9}Be concentration in the mud volcano and river sediment samples ranged between (1.40±0.01) and (1.50±0.01) x 10^{16} atoms/g and (1.60±0.02) and (3.50±0.01) x 10^{16} atoms/g. It appears the stable Be concentrations in Azerbaijan rivers are not perturbed by anthropogenic effects and are comparable to the sediments that are much older (mud volcano samples). However, the stable ^{9}Be concentrations in MVs as well as river sediments are distinctly lower than that reported for the mud volcanoes in the Trinidad Islands and this is attributed to the differences in the composition of the minerals between these two regions. The ^{10}Be and ^{9}Be concentrations in our river sediments are compared to the global data set. This study with ^{10}Be and ^{9}Be along with other U-Th-series radiochemical measurements on mud volcanoes will provide a new insight in tectonically driven mud volcanic activities**.**

EAR#P111 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Investigation of ^{7}Be and ^{3}H in the rainwater of Korea

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Recently both Beryllium-7 (^{7}Be) and Tritium (^{3}H) are produced by cosmic ray interactions in upper atmosphere by spallation reactions. We investigated these nuclides in rainwater along with sodium concentration in the region of Daejeon, Korea (36.32°N, 127.41°E). The results of our study demonstrate that ^{7}Be in rainwater is inversely proportional to sodium amount and proportional to the rainwater amounts. Also it was observed that ^{3}H falls down to the ground in about a month later than ^{7}Be. It was found that both ^{7}Be and ^{3}H data have a trend associated with rainwater amount and air mixing of the stratosphere in the spring. Both isotopes show their peaks during fall and spring season. The trend of ^{3}H variation is shifted about a month compared to that of ^{7}Be. This could be due to the different residence time between ^{3}H and ^{7}Be in the atmosphere. The detection efficiency uncorrected ^{7}Be concentrations in Daejeon, Korea show as 0.06 ~14.13 Bq/L which is lower than the reference values of New Zealad as 0.5~4.3 x 10^{7} and Japan (atoms/kg rain). The ^{3}H concentrations of this study ranged from 4.8±0.10 and 18.62±0.27 (TU). This range is well compared to the ^{3}H concentration of the Northern Hemisphere. Also, sodium variation of the rainwater is found to be inversely proportional to ^{7}Be concentrations. This could be associated with air mixing phenomenon involved in salt movement in land of Korea. Elemental variations in rainwater during November and January seem different than other months. This reason is not explained at present. The data of this study will an important data set of rainwater for future studies associated with geological applications using ^{7}Be and ^{10}Be in Korea.

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EAR#P112 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Intercomparison study with radionuclides ^{129}I, ^{36}Cl, and ^{137}Cs in soils

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^{129}I (half-life: 1.57×10^{7} yr), ^{36}Cl (half-life: 3.01×10^{5} yr) and ^{137}Cs (half-life: 30.07 yr) are important radionuclides used as environmental tracers. These radionuclides are produced both naturally and through human nuclear activities. The aims of this investigation are to search environmental contamination in soils by the ratio of the radioisotopes, and to compare these radionuclides on their environmental distributions. Isotopic ratios of $^{129}I/I$ were determined by accelerator mass spectrometry (AMS) at MALT, the University of Tokyo, and concentrations of iodine were determined by ICP-MS. $^{36}Cl/Cl$ ratios were determined by AMS at TAC, the University of Tsukuba. We determined ^{137}Cs concentrations by an HPGe detector and organic matter content in soils by loss on ignition (LOI). We obtained the concentrations of radionuclides in surface soils (0~10 cm) at 13 points and approximately 1 meter depth profiles at 4 points. The measured ^{129}I of surface soil samples were between 0.18 and 0.75 mBq/g. It was showed that the ^{129}I, ^{36}Cl and ^{137}Cs are different distributions in the environment according to the comparison of the depth profiles. The depth profiles showed that the concentration values of radionuclides had higher peak at a shallow point (between 0 - 20 cm) and had flat below 40 cm. ^{129}I concentration peak is most surface, but ^{36}Cl and ^{137}Cs concentration peaks are about 10 cm depth from surface.

EAR#P113 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Compound Class Specific Radiocarbon Analysis (CCSRA) of PAHS from Highly Contaminated Kolkata Canal Sediments

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Polycyclic aromatic hydrocarbons (PAHs) originate mostly from incomplete combustion of carbon-based fuels. Amongst atmospheric contaminants, PAHs account for most (35-82%) of the total mutagenic activity of ambient aerosols. Reduction of air pollution by PAHs is essential for an effective air quality control, which requires reliable source apportionment. Combined processes of atmospheric deposition, runoff, water mixing, and sedimentation make surface sediments an ideally homogenized natural archive of particle-borne pollution which portrays the input over the last few years.

Previously we examined level of PAHs pollution in 174 surface sediments from eight tropical Asian countries and found Kolkata canals with averaged S14-parent PAHs concentration of 15.9±11.6 μg/g (n=12) was the most polluted site among investigated.

Among probable sources of PAHs in Kolkata canal sediments (i.e., combustion of coal in brickyards, wood for cooking, and petroleum in automobiles), petroleum was excluded by source diagnosis using methylated-to parental PAHs ratios of three homologous series, coupled with C_{30}-hopane/SPAHs ratios. However, the relative importance of coal and wood as combustion sources were not solved.

Recently developed preparative capillary GC (PCGC) system and micro-scale AMS-^{14}C analysis enable compound (or compound class) specific radiocarbon analysis (CSRA or CCSRA), to be applied to environmental samples. The 5730 yr half-life of ^{14}C makes it an ideal tracer for identifying combustion products derived from fossil fuels (^{14}C-free) vs. those from modern biomass (contemporary ^{14}C).

Applying this innovative CCSRA to PAHs in two of the Kolkata canal sediments, ^{14}C signature of PAHs with MW of 178, 202 and 228-276 were found nearly dead (i.e., average pMC for two sites=9.5, 7.1 and 8.1% respectively). Combined with molecular fingerprinting approach above mentioned, it indicates that coal combustion is the major source for PAHs (>90%) in Kolkata city.

EAR#P114 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Reconstruction of carbon cycle induced from apparent radiocarbon age difference from middle to late Holocene at Lake Biwa, Japan: freshwater reservoir effect estimated from archaeological and biological samples

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We measured the radiocarbon ages of the samples such as molluscan shells, Phragmites and pine leaves collected after 1966 year at Lake Biwa to examine the possibility of freshwater reservoir effects at Lake Biwa, Japan. The molluscan shells collected after 1990 year, were hardly affected from the nuclear bomb test, showed 330 – 450 ^{14}C yrs older radiocarbon ages than that of the coeval atmosphere. Then, the apparent difference in radiocarbon age between the shell fossils and wood samples (∼300 ^{14}C yrs) excavated from the Awazu submarine shell midden at Lake Biwa suggests that the freshwater reservoir effect existed in middle Holocene (the Middle Jomon period) at Lake Biwa. Because the present-day average residence time of Lake Biwa water is less than a decade, its direct influence on the reservoir effect is little, which suggests that old carbon has been supplied into Lake Biwa. The both age offsets of radiocarbon dating strongly indicate that there were likely to be freshwater reservoir effects at Lake Biwa from middle to late Holocene, which was corresponded to about 5000 years.

A great deal of organic matter has flowed into Lake Biwa. Some very old radiocarbon ages can result from retention of old carbon in peat layers formed by plants such as the ditch reeds that grow along the shore of Lake Biwa. This may have been the result of the inflow of aged subsurface waters that may have dissolved old carbon from the carbonate rocks of Mt. Ibuki and Mt. Ryouzen. Therefore the degree of freshwater reservoir effects at Lake Biwa had a possibility to fluctuate, depending on change of the lake environment such as inflow into the lake and circulation of the lake water.

In this paper, we discuss the relationships between the apparent radiocarbon age offsets and its lake environment to understand carbon cycle from middle to late Holocene at Lake Biwa, Japan.

EAR#P115 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Sedimentation rate and deposition processes of organic materials from surface cores off Shikoku, western north Pacific

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Accelerator mass spectrometry has been well used to measure radiocarbon dating of marine sediments. Radiocarbon ages of planktonic foraminifera and bulk organic carbon in sediments were compared for the surface sediment cores collected from continental shelf, upper and lower slope basins and Shikoku Basin off Shikoku along the 133 to 134 longitudeal line, in Japan. The results indicated the radiocarbon ages of organic carbon were older constantly than those of planktonic foraminifera in the same depths. The age differences of planktonic foraminifera and bulk organic carbon in the sediments are around 870 to 3,820 years. These results indicated the contamination of the "older" terrigenous or marine originated carbon in the sediments, although the $\delta^{13}C$ values of organic carbon showed the marine origin. It is considered that the spatial distribution of ^{14}C and $\delta^{13}C$ values might be reflected by the variations in transport and depositional processes together with erosion and resuspension of sediments.

EAR#P116 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Distribution of ^{7}Be and ^{10}Be in the Pacific and Southern Oceans

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The distribution of cosmogenic ^{7}Be (53.35 d) concentration in the atmosphere and ocean surface has been studied by many investigators, and is known to show characteristic latitudinal distribution [1,2]. On the other hand, there are a few studies for cosmogenic ^{10}Be ($T_{1/2}=1.36\times10^{6}$ y) in the atmosphere and ocean surface. In this study, we present results on distribution of ^{7}Be and ^{10}Be in ocean surface waters of the western Pacific and Southern Oceans. The seawater samples from 6 to 500 m depth at 13 stations and 41 surface water samples were collected during the R/V Hakuho-Maru KH-04-5 cruise (between Japan and Antarctica, 31°N-67°S and 142°E-170°W) from November 2004 to January 2005. Most of the ^{7}Be and ^{10}Be concentrations in the surface waters were 10-50 and 400-1000 atoms cm^{-3}, respectively. The maximum concentrations for ^{7}Be and ^{10}Be were observed in 20-40°S, while the minimum concentrations for ^{7}Be and ^{10}Be were observed in 60-70°S and equator. Using the $^{7}Be/^{10}Be$ ratio in the ocean surface water and atmosphere, the ^{7}Be and ^{10}Be fluxes across the ocean surface are estimated to 0.01-0.04 and 0.01-0.06 atoms cm^{-2} s^{-1}, respectively.

[1] J.A.Young and W.B.Silker, Earth Planet. Sci. Lett., **50**, 92-104 (1980)

[2] H.Nagai, T.Yamagata, C.Saito, T.Saito and H.Matsuzaki, abstract, AMS10 (2005.9, Berkeley, U.S.A.)

EAR#P117 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

AMS radiocarbon dating of wood trunks buried by the Kikai-Akahoya eruption in Yakushima Island, SW Japan

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We found numerous wood trunks from pumiceous deposits along three rivers (Nagata, Isso and Miyanoura) on the northern side of Yakushima Island, 60 km south of Kyushu Island, and conducted radiocarbon dating with AMS. Obtained ^{14}C dates, around 6500 BP, and petrographic characteristics of the pumiceous deposits indicate that all specimens were buried by the Kikai-Akahoya (K-Ah) eruption from Kikai caldera. However, they are not charred, suggesting that these deposits are not pyroclastic flows. Fourteen floras, *Cryptomeria*, *Lagerstroemia*, *Tsuga*, *Quercus* subgen.*Cyclobalanopsis*, *Myrica*, *Symplocos*, *Trochodendron*, *Chamaecyparis*, *Pinus* Subgen. *Diploxylon*, *Myrsine*, *Distylium*, *Castanopsis*, *Castanea* and *Rhododendron*, were identified through anatomical characteristics. They are the first information on a forest in the island before the devastating eruption.

A part of radiocarbon dating in this study was performed under the Common-Use Facility Program of JAEA.

EAR#P118 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Distributions of Fossil fuel origin CO_2 in the five Metropolis (Seoul, Busan, Daegu, Daejeon, Gwangju)

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We have collected a batch of ginkgo leaf samples at main crossroads in five metropolises of Korea (Seoul, Busan, Daegu, Daejeon, Gwangju) for obtaining regional distribution of fossil fuel originated CO_2 ratios to CO_2 in the atmosphere. Regions where were expected to be fossil fuel CO_2 free were selected in Mt. Chiak, Mt. Kyeryong, Mt. Jiri, Anmyeon island, and Jeju island as background areas against the metroplises. After Ginkgo leaf samples were pretreated, $\Delta^{14}C$ values of the samples were measured using an Accelerator Mass Spectrometry (AMS) and distributions of fossil fuel originated CO_2 in the five metropolises were obtained. The average ratio of fossil fuel originated CO_2 in Seoul is higher than that in the other four cities. And the leaves from Sajik tunnel in Seoul recorded the highest $\Delta^{14}C$ value, -112.3‰, as the air flow of neighborhood of Sajik tunnel was blocked.

EAR#P119 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

A study of the Suess effect using a raised peat bog as historical archive

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The radiocarbon content in a peat core from Gävle, Sweden, 61.0 ^{o}N, 17.0 ^{o}E, has been studied. This is a raised peat bog which only receives material from atmospheric deposition. There has been an increased use of fossil fuels by industries and also locally by transports and heating of domestic buildings. There has been fallout of ^{14}C from nuclear tests during the 1950ies and 1960ies and also from the Chernobyl accident in 1986. There is also emission of ^{14}C from nuclear facilities. The $^{14}C/^{12}C$ ratio from the Chernobyl accident is unclear since it was a graphite moderated reactor and the graphite was burning.

The core was sampled in 2008 and was previously dated using the ^{210}Pb method, giving a growth rate of 0.15 mm/yr. The top 21 cm have been analyzed to obtain radiocarbon content by Accelerator Mass Spectrometry (AMS) at the Centro Nacional de Aceleradores (CNA), Seville Spain. Using 0.5 cm samples, information about the last 140 years could be obtained with resolution better than 4 years. Results show a clear depletion of $F^{14}C$ levels in the area, the so called SUESS effect with maximum levels of only $F^{14}C=1.2333\pm0.0043$, and the absence of a clear nuclear tests peak.

EAR#P120 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Isotope ratios of ^{36}Cl/Cl in surface soils at the equal-latitude in Japan

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A long-lived radionuclide, ^{36}Cl, is produced in nature by cosmic-rays interacting with Ar in the atmosphere. However, the ^{36}Cl was produced by nuclear tests between 1952 and 1958. The ^{36}Cl bomb pulse has been used as a good tracer in geoscience. We measured ^{36}Cl/Cl ratios of surface soil samples collected from the Sea of Japan to the Pacific Ocean at the equal-latitude cross-sectional areas (37°20’ N - 37°30’ N) in the south Tohoku, Japan. We developed an improved leaching process that uses diluted HNO_3 as an extractant, activated carbon to remove organic matters without decomposition, and H_2O_2 to remove residual organic matters. This sequential treatment allows us to measure selectively ^{36}Cl/Cl ratios of inorganic chlorine in soil. The isotope ratios ^{36}Cl/Cl of soil samples were determined by accelerator mass spectrometry (AMS) at the Tandem Accelerator Complex, University of Tsukuba. We have collected 34 surface soil samples which were about 0-10 cm in depth from 6 sites at the equal-latitude cross-sectional areas. The measured ^{36}Cl/Cl ratios of these samples were between 0.1×10^{-13} and 4.1×10^{-13}. It was shown that the ^{36}Cl/Cl ratios are lower at both sea sides.

EAR#P121 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Studies on the secular variation of $^{129}I/^{127}I$ ratios in atmospheric fallout in Tokyo and Akita using AMS

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Iodine-129 (half life: 1.57×10^7yr) is one of the most important radionuclides in environmental radioactivity and geochemistry. This nuclide has been analyzed usually by neutron activation analysis (NAA). However, for the analysis of low ^{129}I levels (e.g. background samples, geochemical materials), sensitivity of NAA is not sufficient. In this study, we have developed an appropriate separation procedure of iodine from atmospheric fallout samples for determining $^{129}I/^{127}I$ ratios by accelerator mass spectrometry (AMS). Samples used in this study were collected from Tokyo and Akita from 1963 to 2003 by Meteorological Research Institute.

The analytical results showed that the secular variation of $^{129}I/^{127}I$ ratios in the atmospheric fallout was different from that of ^{90}Sr and ^{137}Cs. This suggested that the variation of $^{129}I/^{127}I$ ratios observed was not due to the nuclear bomb tests. There was also no influence due to Chernobyl accident. High $^{129}I/^{127}I$ ratios (up to 8×10^{-8}) found after 1980 indicate that contribution from the other sources (e.g. possibly from nuclear spent fuel reprocessing plants) might be important to understand the increase of the ratios. It is observed that the pattern of Tokyo (Pacific side) and Akita (Japan-Sea side) is somewhat different. This suggests the possibility that there are different sources (domestic and outside Japan) of ^{129}I to these cities. We are planning to analyze additional samples collected from other regions (Tsukuba and Ishigaki in Japan) and results will be presented at the conference.

EAR#P122 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Measurement of isotope ratios $^{129}I/^{127}I$ of Hokkaido hot springs water

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Due to the strong association between iodine and organic matter, $^{129}I/^{127}I$ isotope system has been expected to be a good tracing and dating tool for the origin and dynamics of organic carbon reservoir such as hydrates and natural gases.

However, iodine isotopic ages in groundwater in several cases are fairly older than the depositional or geologic ages of its host formations.

Such a discrepancy was explained so far as that the groundwater containing the iodine had travelled spatially certain distance from older formation to present place.

In this study, iodine concentrations and isotope ratios $^{129}I/^{127}I$ were measured in various hot springs water collected from Hokkaido, Japan for the detailed examination of the relation between the iodine isotopic ages and host formation ages. The hot springs water in Hokkaido arises from various geological formations reflecting complicate geological history of Hokkaido so that it is appropriate for this study.

As a result, in many hot springs water samples showed considerably lower iodine isotopic ages compared to their geologic ages. The differences between these two ages widely varied but were clearly categorized due to the characteristics of host formations. The samples group that show much older isotopic ages arise from host formation which contains many terrigenous rocks incorporated with its marine depositions by such as a "turbidite".

From these observations, it is inferred that the iodine showing older isotopic age had been isolated in the older era and fixed in the refractory fossil organic matter and re-deposited again at the same age of the deposition of current host formation.

EAR#P123 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

A Case Study of Radioisotope ^{129}I Environmental Tracing Using XI'an Accelerator Mass Spectrometry

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^{129}I has a half life of 15.7 Ma and is naturally formed through reactions of cosmic rays with xenon in the upper atmosphere. ^{129}I has been proven to be an effective tracer for investigation of environmental effects from increasing nuclear activities such as nuclear power industry. The estimated pre-anthropogenic atom ratio of $^{129}I/^{127}I$ in the hydrosphere is 3×10^{-13} ~ 3×10^{-12}. Human nuclear activities have elevated this ratio by at least two orders of magnitude to $>10^{-10}$. The newly established 3MV Accelerator Mass Spectrometry (AMS) facility in Xi'an, with an instrument background of 2×10^{-14} for $^{129}I/^{127}I$ ratio, provides sufficient analytical capability to carry out ^{129}I environmental tracing studies. Here we report preliminary analytical results of ^{129}I in surface soil and water samples collected in China. Samples collected adjacent to a nuclear power plant show $^{129}I/^{127}I$ ratios of $(0.8\text{-}1.1)\times10^{-10}$, not significantly different comparing with those measured in remote areas, reflecting a safe nuclear environment in terms of ^{129}I level. Chemical separation methods of iodine from different type samples have been established in Xi'an AMS Center, including solvent extraction and combustion followed by extraction or coprecipitation depending on sample types. A carrier free method for iodine separation and AMS measurement of low level ^{129}I in samples with low total iodine concentration has been established for development of a ^{129}I dating tool of geological samples, which remains a challenge in this field.

EAR#P124 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Radiocarbon dating of peat archives using plant cellulose for the reconstruction of past environmental changes

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Peat sediments are one of the most important terrestrial archives to reconstruct past climate valiability. We can reconstruct paleoclimate using stable isotopes of peat cellulose with decadal to centennial time resolution. Especially, stable carbon isotope ratio ($\delta^{13}C$) of peat cellulose is used on indicator for past precipitations. However, peat exists in forms of matrices of organic matter such as intact plants, and plant debris with soil mineral. Therefore, it is necessary to consider how influence the existence of various plants for ^{14}C dating and $\delta^{13}C$ values.

In this study, we present radiocarbon dates of intact plants (*Sphagnum*), plant cellulose, and bulk organic matter from the same horizons of a peat core to investigate adequate dating candidates. Results of radiocarbon dates from plant cellulose were compared with those of bulk organic matter and intact plants (*Sphagnum*). In addition, we tried three cellulose extraction methods to decide on the most suitable one; (I) extended Acid-Alkali-Acid procedure, (II) removed lipids using solvent procedure and (III) extended cuprammonium solution (CUAM) procedure. To check their purity, we measured and compared every TOC (%), TON (%), $\delta^{13}C$ (‰) and NMR.

TEC#P101 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Design features of the new multi isotope AMS beamline at CEDAD

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In the frame on an ongoing research project the experimental potentialities of the CEDAD (Centre for Dating and Diagnostics) the AMS-IBA facility of the University of Salento, Lecce, Italy are being further enhanced by the installation of a new high energy mass spectrometry beam line. The new beam line has been designed for the detection of rare isotopes such as ^{10}Be, ^{26}Al, ^{129}I and uranium isotopes. The new high energy spectrometer, designed in collaboration with the AMS group at ETH, Zurich, Switzerland is formed by three dispersive elements: a 60° magnet, a 90° spherical electrostatic analyzer and a 135° magnet. The main design features of the new beam line will be presented in term of ion optics calculations, beam envelope simulations and beam transmission measurements. The design characteristics of the faraday cups for the measurements of stable isotopes currents and of the multi-anode ionization detector for rare isotopes will be presented. The electronic system for the control of the vacuum system and of the diagnostics stations as well as for data acquisition and analysis will be described.

TEC#P102 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Development of a Commercial Laser-Induced Combustion Interface to a CO_2 Ion Source for AMS

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National Electrostatics Corp., Massachusetts Institute of Technology and GlaxoSmithKline collectively have developed a manufacturing prototype of an interface to introduce CO_2 produced by laser combustion of the solutes of a liquid of interest (e.g. from an HPLC) directly into the ion source of an AMS system, thereby bypassing the customary graphitization process. Typically, the liquid is deposited on a CuO substrate contained in stainless-steel mesh wells in a standard format 96-well plate. The interface manipulates the well plate to combust each sample sequentially. The combusted samples can be interlaced with CO_2 standards as well as solid samples in the ion source. The interface can be operated in fully automatic mode when coupled with an NEC AccelNet controlled AMS system. The poster describes the equipment, design, and present performance.

TEC#P103 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Improved ^{36}Cl Performance at the ASTER HVE 5 MV Accelerator Mass Spectrometer Facility

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The HVE 5 MV ASTER AMS facility at CEREGE was accepted in 2007. Since then we have continued to optimize performance for ^{36}Cl. ^{36}Cl analyses use AgCl, a Cs negative ion sputter source, Ar stripping to +5 in the terminal of the Tandetron™ accelerator at 5 MV and a Si_3N_4 post-acceleration stripper foil to enhance suppression of ^{36}S relative to ^{36}Cl. The major challenges to obtaining the desired performance for Earth science applications are ion source memory, mass fractionation effects, ^{36}S isobar suppression and sensitivity. Redesign of the SO110 ion source by HVE to change the size of the aperture and the shape of cathode significantly reduced ion source memory to less than ~0.1%, a level that can be compensated for by matching standards to samples. We observe small systematic drifts in $^{35}Cl/^{37}Cl$ ratios over time, the source of which is not yet determined. Measurement of standards indicates that this effect limits the precision of $^{35}Cl/^{37}Cl$ ratio determination to about 2%. ^{36}S is suppressed in several ways. First, the sample chemistry has been designed to reduce S to very low levels. Second, cathodes are constructed of low-S nickel, enabling direct target loading without the use of AgBr pre-packing. Third, a post-acceleration Si_3N_4 stripper foil differentially absorbs energy from ^{36}Cl and ^{36}S. A subsequent electrostatic deflector is then able to suppress ^{36}S by a factor of $\sim 5 \times 10^{-3}$. Differential energy loss in the detector further suppresses ^{36}S by about 10^{-4}, for an overall suppression of 5×10^{-7}. ^{36}S count rates are typically equivalent to a background $^{36}Cl/Cl$ of $<10^{-15}$. At typical ^{35}Cl currents of 20 mA samples with $^{36}Cl/^{35}Cl$ of 5×10^{-14} can be measured to ± 6% statistical uncertainty with one hour of analysis time. Typical machine blanks have $^{36}Cl/Cl \sim 2 \times 10^{-15}$.

TEC#P104 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

AMS Study of the Lanthanides

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The lanthanide molecular hydride anions from a Cs^+ sputter ion source, including all LnH_n^- with $n \leq 4$, were studied[1] in the early 90s and were found to show differing values of n for the maximum yield. For example the maximum intensity for YbH_n^- was found to be for n = 3 with only about 3% for n = 4 and not n = 4 as expected. This problem was resolved when the hydrides of Yb were later studied again by Middleton who showed indeed that the hydride yield with n = 3 was dominant. Since then a systematic study of the abundances of the molecular fluoride anions of the elements has been made and the lanthanides, including YbF_n^-, found to universally have the strongly dominant form of LnF_4^-. Looking back again at the data from 1993 we notice that there are two other cases where there is some ambiguity of the value of n for the lanthanide hydrides and these are for SmH_n^- and EuH_n^-. In these cases the maximum value of n was 4 from the Cookbook of Middleton but n = 3 from the data from reference one. We suspect that the value of n = 3 is correct and these are two more possible examples of minor errors in what is otherwise a remarkable piece of work by Middleton. The possibility of n = 5 lanthanides was overlooked in the past and quite small intensities of LnF_5^- and LnH_5^- have since been found in a few cases. An explanation for the hydride results will be given and the relevance of this data review to the isobar separation of ^{146}Sm and ^{146}Nd as well as ^{53}Mn and ^{53}Cr using chemical reaction cells will be discussed briefly.

1. Garwan M. A. PhD Thesis, University of Toronto 1993.

TEC#P105 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

3-4‰ AMS Radiocarbon Measurements Using Low Energy $^{12}C^-$ Normalization: A Case for a "Simpler" (Accelerator) Mass Spectrometer

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In the thirty-odd years since the advent of accelerator mass spectrometry, as proposed by Muller in 1977 and the successful experiments at Simon Fraser – McMaster Universities and the University of Rochester, the predominant physical measurement scheme has, in a real sense, remained static. Negative ions (C^- and corresponding molecular isobars) are produced from a graphite or a hybrid CO_2 source, are sequentially or simultaneously injected into an accelerating field, and then stripped of some number of electrons, whereupon the molecular ions are destroyed and the resulting $^{14}C^{+x}$ ions are normalized to similarly stripped "high" energy $^{13}C^{+x}$ and or $^{12}C^{+x}$ ions (*e.g.*, Donahue *et al.*, 1989). Building on the experiments of early pioneers in AMS, we have performed experiments demonstrating that the CAMS FN-based AMS system has sufficient ion-optical and transmission properties to allow for the routine (3-4‰) ^{14}C analysis of modern and near modern materials with $^{14}C^{+4}$ to $^{12}C^-$ normalization. We interpret the somewhat larger scatter in our $^{14}C^{+4}/^{12}C^-$ normalized data relative to our conventional $^{14}C^{+4}/^{13}C^{+4}$ data as reflecting effects of angular scattering of the stripped ions relative to the unstripped $^{12}C^-$ ions.

We hypothesize that one could design a purpose-built simplified system around clean transmission and good ion-optical characteristics which requires only injection of ^{14}C (with normalization to $^{12}C^-$ measured in the low energy end), obviating sequential or simultaneous injection of ^{12}C and ^{13}C. This would reduce the cost of systems used for routine analyses. In addition to the fundamental ion-optical characteristics which are intrinsic to an 'open' and un-constricted system, such a system requires a very precise and well-calibrated current measuring system. Although we have only experimented with thin carbon stripper foils, we anticipate that gas stripping will have a similar simplified system potential, conditional on the possible deleterious effects of angular scattering within the stripper gas itself.

TEC#P106 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

AMS measurement of ^{32}Si at CIAE

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^{32}Si measurement method was developed based on a Q3D magnetic spectrometry in CIAE. One of the major obstacles in ^{32}Si AMS measurement is suppression of isobaric interference ^{32}S. in order to achieve a detection limit of ^{32}Si/Si~10^{-15}, a method was developed to suppress ^{32}S interference. Usually, the gas filled magnet was used to suppress ^{32}S interference. In our case a method name ΔE-Q3D method was developed.The ΔE-Q3D method utilizes a homogeneous absorber with a suitable thickness placed at the entrance of the Q3D magnetic spectrometer to produce different energy loss of isobars. The isobars were separated on the focal plane of the Q3D magnet spectrometer, according to the difference in energy loss between the isobars. A multi-anode ionization chamber was placed at the focal plan in the position collecting events of the nuclides to be measured to further reject the remanent interfering isobars.

For ^{32}Si measurement, SiO_2 mixed with 4 times iron powder (w/w) was used as sample material. Si^- ions were extracted from the AMS ion source and carbon foil was used as the stripper in the accelerator terminal. Ions with charge states of 7^+ and energy of 84.1 MeV were selected by the analyzer magnet and transported to the Q3D beam line. A 3 μm Si_3N_4 foil was used as the absorber at the entrance of the Q3D. Si ions with charge state of 11^+ and an absorber stripping yield of about 41% were then analyzed with the Q3D magnet spectrometer. Our result shown that the position between ^{32}Si and ^{32}S at the focal plane is about 264 mm which cause a ^{32}S suppression factor of about 10^6. A gas ionization chamber was then used for further remove the remaining ^{32}S. It was shown that the ^{32}S and ^{32}Si was clearly identified with the ionization chamber. A sensitivity of 1×10^{-15} (^{32}Si/Si) was obtained.

TEC#P107 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

A method for ^{36}Cl measurement with high sensitivity

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In the case of ^{36}Cl measurement, chemical procedures were inveloved to remove the sulfur, these procedures need strict chemical lab condition,high quality chemical reagent and carefull sample keeping. Also it need long time for sample preparation. Recently a ΔE-Q3D method were developed in CIAE. By utilizing a homogeneous absorber at the entrance of the Q3D magnetic spectrometer to produce different energy loss of isobars. The isobars were separated on the focal plane of the Q3D magnet spectrometer.Based on this method, about 10^4 ^{36}S interference can be removed. This method greatly simply the chemical procedures, also base on the high power for removing ^{36}S interference the sensitivity was improved.

For ^{36}Cl measurement, Cl^- ions were extracted and carbon foil was used as the stripper in the accelerator terminal. Ions with charge states of 8^+ and energy of 99.1 MeV were selected by the analyzer magnet and transported to the Q3D beam line. A 3 μm Si_3N_4 foil was used as the absorber at the entrance of the Q3D. Cl ions with charge state of 14^+ and stripping yield of about 30% were then analyzed with the Q3D magnet spectrometer. The result shown that the position between ^{36}Cl and ^{36}S at the focal plane is 90 mm which cause a ^{36}S suppression factor of about 10^4. A gas ionization chamber was then used for further remove the remaining ^{36}S. It was shown that the sensitivity of 10^{-16} (^{36}Cl/Cl) was obtained.After that, a series geological samples with simple chemical procedures were measured succefully.

TEC#P108 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

The measurement of ^{92g}Nb with Accelerator Mass Spectrometry at CIAE

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^{92g}Nb ($T_{1/2}$=35 Ma) is a shielded "p-only" nuclide. It decays by electron capture to ^{92}Zr. The decay mold has been recognized as one of the four most accurate p-process extinct chronometers. Niobium has been usually used in the construction of nuclear reactor. Existence of ^{92g}Nb that produced in ^{93}Nb (n, 2n) ^{92g}Nb reaction opens up the possibility for dosimetric purposes many years after niobium withdraw from nuclear power plants.

Theoretical and actual use of ^{92g}Nb always arouses requirements for the accurate measurement. But detection for ^{92g}Nb by the activity measurement method is unfeasible due to the very long half-life and sample's overall low activity. AMS is a sensitive analytical technique many orders of magnitude more than conventional Mass Spectrometry. It is one of the most promising methods to detect trace amounts of ^{92g}Nb.

Measurement method for the radionuclide ^{92g}Nb has been established by AMS, at China Institute of Atomic Energy (CIAE). Niobium powder mixed with PbF_2 matrix by the ratio of 1:2 (in mass) was used as target material. Negative ions from Nb^- to NbF_6^- were tested. Charge states of the stripped particles increased from 9^+ to 13^+ were tested. Terminal voltage increased from 8.0 to 11MV were tried, thereby particle energy of 154 MeV was arrived. Substituting Mylar foil, the thin silicon nitride membrane with thickness of 100 nm was used as entrance window to a multi-anode gas ionization chamber. Increment in particle energy and improvement in energy resolution insure a clearer separation for the two isobars ^{92}Zr and ^{92}Mo, by the specific ionization energy loss spectrum analysis. An absolute measurement method was applied in ^{92g}Nb-AMS and the blank sample measurement sensitivity was about 10^{-11} (^{92g}Nb/^{93}Nb). ^{92g}Nb concentration in a niobium neutron flux monitor were measured and the result was about$\sim 10^{-10}$ (^{92g}Nb/ ^{93}Nb).

TEC#P109 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

A 1 MV multi-element AMS system for biomedical applications

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The Netherlands Organization for Applied Scientific Research (TNO) has installed a compact 1 MV multi-element AMS system manufactured by High Voltage Engineering Europa B.V., The Netherlands. TNO performs food and pharma research to obtain early pharmacokinetic data and to provide antiosteoporotic efficacy data of new treatments. The AMS system will analyse carbon, iodine and calcium samples for this purpose. The first measurements on blank samples indicate background levels in the low 10^{-12} for calcium and iodine, making the system well suited for these biomedical applications. Carbon blanks have been measured at low 10^{-16}. For unattended around the clock analysis, the system features the 200 sample version of the SO110 hybrid ion source and a user friendly control software.

TEC#P110 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

A low background upgrade for the HVE 1 MV multi-element AMS system

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It is known that the present performance of the compact HVE 1 MV AMS system on beryllium AMS is limited by charge exchange and scattering of the stable isotope ^{9}Be. A new low background upgrade for the AMS system has been designed to suppress this interference. It features a 30^{o} analyzing magnet that is added after the high-energy side electrostatic analyzer. The gas ionization chamber for identification of the rare isotope that is originally mounted on this position is shifted to behind the magnet. Like the standard 90^{o} high-energy side analyzing magnet, the additional background suppression magnet supports AMS of all isotopes with masses up to plutonium. It is anticipated that the present typical background level for ^{10}Be of 1~3 × 10^{-14} will be reduced to the low 10^{-15} regime, comparable with larger (TV > 3 MV) AMS systems.

TEC#P111 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Search for Superheavy Elements in Nature

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The idea of the existence of another domain of stable or very long living elements, beyond those in the "peninsula of nuclear matter" was at first proposed in the thirties by Glenn T. Seaburg. Since that time several successful approaches have been performed to synthesize nuclei close to the region of stability of so called superheavy elements (SHE), but also not successful approaches to search for them in nature have been done. Because of the large theoretical uncertainties in calculations about the half-lives of SHEs in a region where these nuclei are assumed, we considered it worthwhile to initiate a further search for SHE in nature. The differences to former studies are our extremely sensitive AMS arrangement at the Munich tandem laboratory, the search in dedicated target materials, and also an almost complete scan of the expected mass range for SHEs. Row platinum, which is composed of Os, Ir, Pt, Au, but also their lighter chemical homologues Ru, Rh, Pd, and Ag, has been considered as most promising for a search for these heavy eka-elements. But also antique lead and plain Os have been considered for our search. The results of a complete mass scan from 292 au until 310 au will be shown and discussed in details.

TEC#P112 POSTER SESSION 1 Tuesday 22nd March, 1400 - 1540

Charge state distribution studies of SrF_3, MnF_3 and CaF_3 molecules using single and double stripper in a Tandem Accelerator

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High energy beams of high ion currents from a Tandem Accelerator are a common requirement in Accelerator Mass Spectrometry (AMS). However in many cases, molecular beams are chosen from the ion source to achieve a high yield for the negative ions, or to suppress isobaric interference. For this reason we have studied the use of consecutive stripper foils, double stripper, to increase the ion yield in conjunction with an increased energy of injected molecular beams through a Tandem Accelerator. By this method we could achieve a shift in the yield towards higher charge states. We will show the results for different foil thicknesses, different distances of the stripper foils, but also different energies of the molecular beams. A qualitative explanation of the effect will be discussed.

TEC#P113 POSTER SESSION 1 Tuesday 22nd March, 1400 - 1540

The physics behind the isobar separation of ^{36}Cl and ^{10}Be at the AMS facility ASTER

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The French national AMS facility ASTER, based on a 5 MV Tandetron accelerator, uses a degrader foil installed behind the focal plane of the 90°-high energy magnet for ^{10}Be and ^{36}Cl analyses. Ions passing the 1000 nm silicon nitride degrader foil are analyzed with a 35°-ESA (horizontal plane) and a 30°-magnet (vertical plane). Two quadrupole-doublet lenses are used for beam focussing. The incident beam parameters at the location of the degrader foil affect the transmission as well as the separation of the isobar. To optimize performance, the horizontal beam profiles were measured by closing slits in the focal plane and scanning the beam across these slits by varying the terminal voltage. For 30 MeV Cl ions, we observed a very narrow beam width ($\sigma \cong 0.7$ mm), which is well described by a normal distribution. Corresponding scans of ^{9}Be and ^{10}B at 11.2 MeV, however, revealed much wider beam widths ($\sigma \cong 1.7$ - 2 mm) and showed tails on both sides that could not be described by a normal distribution. These non-normal distributions can be interpreted to result from the coulomb-explosion that occurs during dissociation of the BeO^- or BO^- molecules in the terminal. In an additional experiment, the energy loss in the silicon nitride foil and the associated energy straggling were characterized by scanning the ESA-voltage with narrow slit settings. The results were compared with SRIM and other models. Finally, charge state distributions were determined for ^{36}Cl exiting the degrader foil at 23.9 and 19.8 MeV. These distributions are well described by Gaussian functions and the associated positions and widths agree quit well with published values for carbon foils. Based on these studies, the analysis settings for ^{36}Cl could be modified to produce a 12% increase in transmission yield with the same ^{36}S suppression.

TEC#P114 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Laser Ablation Accelerator Mass Spectrometry of Actinides with an ECRIS and Linear Acceleration

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A project to measure neutron capture cross sections of a number of actinides in a reactor environment using Accelerator Mass Spectrometry (AMS) at the ATLAS facility of Argonne National Laboratory is underway. This project will require the precise and accurate measurement of many samples irradiated in the Advanced Test Reactor at Idaho National Laboratory with neutron fluxes having different energy distributions. The AMS technique at ATLAS is based on production of highly-charged positive ions in an electron cyclotron resonance ion source (ECRIS) followed by acceleration in the ATLAS linac and (m/q) detection at the focus of the Fragment Mass Analyzer. We have chosen to use laser ablation as the best means of feeding the actinide material into the ion source because we believe this technique will have higher efficiency and lower chamber contamination than either the oven or sputtering techniques, thus reducing 'cross talk' between samples. In addition a new multi-sample holder/changer to allow quick change between samples and a computer-controlled routine allowing fast tuning of the accelerator for different beams, are being developed . An initial test run studying backgrounds, detector response, and accelerator scaling precision was conducted in December 2010. The project design, schedule, results of first off-line ablation tests and initial test run will be discussed. This work is supported by the U.S. Department of Energy, Office of Nuclear Physics, under contract No. DE-AC02-06CH11357.

TEC#P115 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Optimization of Direct Ionization of CO_2 by Controlling the Gas flow inside of a Beam-Target

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BioAMS routinely follows a procedure of burning ^{14}C-labeled samples and graphitization of the CO_2. Elimination of the graphitization step by direct ionization of a continuous flow of CO_2 has been demonstrated. In this work, a new Cs^+ beam target, containing a Ti insert, was designed for ionizing CO_2 pulses. An injection system was constructed to introduce controlled small amounts of CO_2 carried in a flow of Helium through a fused silica capillary that could hold the high voltage and low pressure of the "warmed" ion source. A stainless steel tube connected the capillary outside of the source with the back of the target mounted on a sample wheel. The fluidics inside the targets were designed to bring the CO_2 in contact with a Ti insert and with the Cs^+ beam. COMSOL 3.5 was programmed to simulate the gas flow inside the target. The simulations showed that by deflecting the flow towards the Ti, the gas density at the surface, was several orders of magnitude higher than for a non deflected flow. Experimentally, this translated in doubled ionization efficiency. Linearity was kept for the detected charge in the range of 100-900 ng of C however; for the non deflected system, it was 100-500 ng. Careful target positioning maximed sampling from the Cesium sputter beam; increasing the ionization efficiency. As consequence, higher ionization efficiencies were obtained with Ti inserts with higher cross-section. In conclusion, a target was effectively designed and studied for C^- production from CO_2 potentially compatible with on-line interface techniques like GC and combustion-coupled HPLC that produce small amounts of fast-flow CO_2 pulses.

TEC#P116 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Improving and understanding a gas ion source for ^{14}C AMS

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For more than 4 years, gaseous samples of 1 to 50 µg carbon have been routinely measured with the gas ion source of the small AMS (Accelerator Mass Spectrometer) facility MICADAS at ETH Zurich [Ruff et al., 2007; 2010]. The applied measurement technique offers a simple and fast way of ^{14}C measurements without the need of sample graphitization. A major drawback of gaseous ^{14}C measurements, however, is the relatively low negative ion current in comparison to graphitized samples. This results in longer measurement times and lower precision. In December 2009, we installed a new, improved Cs sputter ion source at MICADAS and began to optimize conditions for the measurement of gaseous samples. The $^{12}C^-$ currents from the new source are pushed from initially 3 µA by a factor of ~5 for routine measurements with a doubled negative ion yield. The new measurement settings enable a doubled CO_2 flow, thus substantially reducing measurement times. The achieved performance allows closing the sample size gap between gaseous and solid samples and even makes the gas ion source attractive for dating purposes in the 5 ‰ range.

Ruff et al., Radiocarbon 49, 307-314 (2007).

Ruff et al., Nucl. Instr. Meth. Phys. Res. B 268, 790-794 (2010).

TEC#P117 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Fast isotope switching and ion beam diagnostics

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In a typical AMS measurement, the amount of the rare isotope in the sample is determined by comparing the number of rare isotope ions registered in the detector at the end of the beam line to the collected charge of the stable isotope ion beam. These measurements are done either simultaneously or sequentially, depending on the choice of mass-dispersive ion optics at the injector. The simultaneous injection can be understood as a limiting case of a sequential injection where the isotope switching time approaches zero. In our current approach to the problem of isotope swithing we have desided to design a sequential injection system. The presented system is based on fast and accurate digital control of electrostatic deflection of stable and rare isotope ion beams at the injector, in conjunction with fast digitization of ion current and ion counts at the high-energy end, respectively. The diagnostics of the abundant stable isotope ion beam during the tune-up of the accelerator is facilitated by fast digitization of signals from several beam profile monitors simultaneously.

TEC#P118 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

The feasibility of isobaric suppression of ^{26}Mg via post-accelerator foil stripping for the measurement of ^{26}Al

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Cosmogenically-produced ^{26}Al is widely used in the Earth sciences for exposure and burial age dating. Due to its long half-life (~705,000 yr), AMS is the method of choice for measurement of ^{26}Al at naturally-occurring levels. One normally selects the most intensely produced negative ion associated with the isotope of interest to provide the most efficient AMS measurements. In the case of aluminum oxide, which is the preferred target material for ^{26}Al AMS, AlO^- is by far the most intense negative ion, but has not been traditionally used because of the presence of the ^{26}Mg isobar. Since Mg does not produce stable elemental negative ions, Al^- is typically employed to achieve acceptable isobaric suppression of ^{26}Mg. The beam currents obtained for Al^- are much lower than for AlO^-, typically by a factor of ten to twenty. These lower beam currents limit the overall precision of ^{26}Al AMS measurements. It was recently demonstrated [1,2] that ^{26}Al could be effectively distinguished from ^{26}Mg by exploiting differential energy loss in a gas-filled magnet which enables the use of AlO^- rather than Al^-. However, for many AMS facilities, a gas-filled magnet is not feasible due to logistical (e.g., space) or fiscal concerns. Therefore, we have explored the feasibility of employing isobaric suppression of ^{26}Mg via foil stripping after the accelerator of an AMS system. Here we present the theoretical basis for post-stripping as well as the results of initial experiments to demonstrate its feasibility.

References

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TEC#P119 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

A new 2D sensitive detector setup for ^{36}Cl AMS at ETH Zürich

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The ^{36}Cl AMS measurement setup at the 6 MV EN tandem accelerator of the Laboratory of Ion Beam Physics at ETH Zürich has overcome a major upgrade. A new gas ionization detector was constructed and is now placed between the Faraday cups for the measurements of high-energy currents of ^{35}Cl and ^{37}Cl. This reduces the ion-optical losses of the rare isotope down to a minimum. The anodes of the new gas ionization detector are arranged in a central measurement trapezoid which follow the angular straggling of the 48 MeV ^{36}Cl ions inside the detector gas. For an effective isobaric suppression of ^{36}S the trapezoid is split into five segments, four anodes for energy-loss measurements and the central split-anode for position determination. The position information allows identifying ^{36}S ions which are scattered in the first section of the ionization detector and which mimic ^{36}Cl ions in the other sections. This is enough to reduce the ^{36}S background by a factor of 3. Another factor of 3 in the background reduction is gained by the evaluation of the time-of-flight signal between the first and third energy loss signals. The overall ^{36}S background suppression is 1:150000 or one ^{36}S ion misidentified as ^{36}Cl in 150000 ^{36}S ions that are rejected by the detector system. Hence, the occasional "sulfur problem" of an unlucky AMS user has been greatly reduced. This is a major improvement of the previous ETH ^{36}Cl AMS setup, which had a factor 1:20000 of ^{36}S suppression in routine operation. The improvement comes at the price of increased rare isotope losses due to multiple gating. They amount to 5-10% with the old setup and 20-30% with the new setup.

TEC#P120 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Direct coupling of a laser ablation cell to an AMS

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Only in very rare cases cleaned samples can be directly inserted into a negative ion source of an AMS and still meet the requirements for long-term stable measurements.

We present the coupling of a laser ablation system to an AMS (MICADAS, ETH Zurich) for direct and continuous sample introduction into a gas ion source of an AMS system. Solid carbonate samples like stalagmites or corals are suitable sample materials, which can be ablated and decomposed continuously using a pulse laser focused onto the surface of the solid sample, which is placed in an airtight ablation cell. CO_2 formed after the ablation of the solid is continually flushed with He into the gas ion source of the AMS. The production rate of CO_2 can be adjusted by the laser frequency (1-20 Hz), crater diameter (1 – 150 □m) and the energy (0.2 - 3 mJ/pulse) of the pulsed laser (frequency quintupled Nd:YAG at 213 nm with 5 ns pulse duration).The high energy density of the focused laser beam (up to 15 J/cm^2) allows ablation of practically any solid material with a lateral resolution of 150 µm or less.

The set-up consists of a commercial laser ablation unit (LSX 213, CETAC Technologies, Omaha, USA) equipped with a specially designed laser ablation cell.

First results and figures of merit will be discussed in detail.

TEC#P121 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Further studies of a bi-polar single-stage accelerator mass spectrometer

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A single-stage accelerator mass spectrometer (SSAMS) is a good alternative to conventional spectrometers based on tandem electrostatic accelerators for radiocarbon measurement [1] and permits experimentation with both positive and negative carbon ions [2].

Such ^{14}C-AMS of either polarity ions is limited by an interference with lower ion energy but otherwise inconclusive properties. This has been studied by improvising an additional Wien filter on the SUERC SSAMS deck. The filter is sufficient to split the interference into two discernable species.

In principle ^{14}C-AMS can be improved by removing its dependency on negative-ionisation in a sputter ion source. This requires negative-ionisation of sample atoms elsewhere to suppress the ^{14}N interference, which is accomplished at SUERC by transmitting initially positive ions through a thin membrane. This ionisation process is further characterised.

References

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TEC#P122 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Partial Fragmentation of CaF_3^- at Low Tandem Energies and its Potential Use for ^{41}Ca Measurement

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Partial molecular fragmentation has always been a mixed blessing in mass spectrometry. It is a constant source of interferences on one hand, yet on the other hand it offers opportunities for ion identification of some large masses. In AMS, however, it has so far received little attention of its occasional merit. An exception to this has been found recently that the fragmentation of CaF_3^- and KF_2^- in the terminal is very different at low Ar stripper gas pressures. A partial fragmentation of CaF_3^- into CaF^+ is found to have about 10% yield at around 1.25MV terminal voltage, while only 0.1% is found with KF_2^- into KF^+. Although the presence of KF_3^- as the main source of ^{41}K background is now known, the current of KF_3^- is too low for its KF^+ yield to be directly determined. But it is likely no more than 0.1% as KF_3^- is found to most readily fragment into KF_2^- upon first collision with residual gases in vacuum at tens of keV, as well as at eV energies in a RFQ gas-cell. When CaF_3^- is used for ^{41}Ca measurement with a small AMS system directly, a sensitivity of ^{41}Ca/Ca around 10^{-11} is usually found, depending on the level of impurities in both Cs^+ beams and samples, as well as the clarity of signals in the final energy spectra. It is conceivable that the employment of a second gas stripper after the accelerator, to eliminate $^{60}Ni^+$ and other $[Mass\text{-}60]^+$ interferences, would bring the sensitivity to 10^{-13} or below, a level well suited for medical applications.

GLO#P101 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

A comparison of annually resolved varved lake sediment and ice core ^{10}Be and sunspot data

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To extend the regional cover of annual ^{10}Be archives outside the polar regions, we have analysed ^{10}Be in varved lake sediments from an Eastern Finland lake. The challenge is that deposition of ^{10}Be into a lake is more complex than in a glacial setting, since ^{10}Be can both be retained and released from the lake catchment area, and we examine whether this archive can be used as a proxy for past ^{10}Be production and solar activity. We have focussed on the most recent five centuries to allow for comparison with annual ^{10}Be data from the Greenlandic Dye-3 and NGRIP ice cores and the historic sunspot record.

The examined lake sediment had an average varve thickness of ~0.9 mm, and we used a sampling area of 1.53 cm^2, resulting in samples sizes in the range 6-150 mg dry weight with average ^{10}Be concentrations of 4×10^8 atoms g^{-1}. Based on sediment accumulation rates and catchment and sampling areas, ^{10}Be deposition rates were determined to $0.5\text{-}3.9\times10^6$ atoms cm^{-2} a^{-1}.

In a comparison with sunspot data and ^{10}Be flux derived from NGRIP and Dye-3 ice, we find several similarities but also divergences. We note a higher ^{10}Be flux in the sediments during the Spörer and Maunder minima, while the flux is low during the solar minimum in the first decades of the 19th century and unexpectedly high in the 1840s. There is especially good agreement between sediment and Dye-3 ^{10}Be flux from around 1500 to the mid-1700s, to some extent even on an annual scale.

In glacial archives, deposition rates deviating from the predicted production rate can be explained by variations in air mass circulation and deposition pathways. In the lake sediments, there may be added variations from detention and release of catchment ^{10}Be, possibly related to anthropogenic activity in the immediate vicinity.

GLO#P102 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Global distribution of ^{129}I in the marine waters

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Despite the many reports concerning the occurrence of anthropogenic iodine-129 in the atmosphere, terrestrial and marine environments, there is a lack of a comprehensive collection of data about the distribution of the isotope in the marine waters. The temporal and spatial variability of anthropogenic ^{129}I is strongly linked to the major point sources of nuclear reprocessing facilities located in UK (Sellafield) and France (La Hague), and the global marine spreading pathways are partly outlined from these sources. The temporal evolution is still, however, not well defined when transport and dissipation are considered in the different oceans and ocean compartments. We here summarize available temporal and spatial data about ^{129}I distribution in the marine water. The results show that most of the data published are restricted to the northern hemisphere, especially the North Atlantic and Arctic Oceans, except few data collected in the Bering Sea and Japan Sea in the North Pacific, with strong variability in terms of water depth, time and location. As most ^{129}I input occurred in west Europe, a large deficiency in data from the Pacific, Indian and South Atlantic Oceans demonstrate gaps in the coverage of the isotope spatial extent. In spite of long transport distance from the North Atlantic into other oceans, the limited data acquired from waters of the South Indian Ocean suggest a presence of an anthropogenic ^{129}I signal in the Southern Hemisphere, although this may partly originate from atmospheric-precipitation process. Future data on ^{129}I from recent expeditions in the Southern oceans and geotrace ocean profiling will reveal additional trends in the distribution of the isotope in the global marine waters.

GLO#P103 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Variability of ^{10}Be and δ^{18}O in snow in Greenland and Antarctica

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Temporal and spatial variability of ^{10}Be in glacial ice may result from local and regional transport and deposition processes. To examine the variability, we sampled snow to a depth of 160 cm at the NEEM deep ice core drilling site in Greenland, analysing oxygen isotopes and ^{10}Be content with focus on short term temporal variability. The samples span three years between the summers of 2006 and 2009. Spatial variability of ^{10}Be in Antarctica was explored through collection of surface samples during part of the Swedish-Japanese traverse from Svea to Syowa station during the austral summer in 2007-2008. The samples contained the upper ~5 cm of snow which corresponds to less than one year of accumulation.

In the Greenlandic snow pit, the highest ^{10}Be concentration occurs in the summer of 2007, when δ^{18}O values are also the least negative. Throughout the pit, there is otherwise a lack of correlation between ^{10}Be and δ^{18}O values. While δ^{18}O exhibits a distinct pattern with a clear maximum each summer, this seasonal pattern is not apparent in the ^{10}Be concentrations. For ^{10}Be we observe high and variable values during the middle of the examined period, and low values in the beginning and end of the period. These variations in ^{10}Be concentration cannot be attributed to changes in snow accumulation rate or solar activity variability, but most likely to variable aerosol loading and deposition pathways, possibly in combination with post-depositional processes.

The Antarctic data expose a negative correlation between ^{10}Be and δ^{18}O (Spearman ρ=-0.52, $p<0.0005$), while there are weaker but still significant correlations to altitude and distance to the coast (approximated by the distance to the 70th latitude). These correlations indicate that geographical factors, mainly the proximity to the coast, affect ^{10}Be concentrations in snow in Dronning Maud Land, Antarctica.

GLO#P104 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

^{10}Be depth profile in top 575 m of the West Antarctic Ice Sheet Divide core

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Concentrations of cosmogenic ^{10}Be in ice core vary as a function of changes in solar activity, geomagnetic field strength, atmospheric mixing and snow accumulation rates. Since the observed fluctuations in ^{10}Be in ice cores appear to represent a global signal, the ^{10}Be depth profile provides independent chronological markers to tie Antarctic to Greenland ice cores and to tie Holocene ice cores to the ^{14}C treeing record. We are measuring ^{10}Be concentrations in the West Antarctic Ice Sheet Divide core (WDC) that is expected to reach a depth of 3300 m, corresponding to an age of 100-120 kyr. First, we set up an ice sample processing line at Purdue, similar to the one at UC Berkeley that was used for GISP2 ice core analysis [1]. In an intercomparison study of six 1 meter Antarctic ice core sections, we showed that the two labs yield identical ^{10}Be results within the experimental uncertainties of 2-3%. We measured a continuous ^{10}Be depth profile in the top 575 m of WDC core, using waste melting ice from glacio-chemical analyses at the Desert Research Institute, Reno similar to part of GISP2 project [1]. The samples of 1-2 L generally represent 2-4 m of ice, equivalent to an average temporal resolution of ~12 yr. Be, Al and Cl were separated using ion exchange chromatography procedures [1] and the ^{10}Be concentrations were measured by AMS at PRIME lab. The ^{10}Be concentrations were (8-21) x 10^3 atom/g, with peaks during periods of low solar activity, known as Oort, Wolf, Spörer, Maunder and Dalton minima as expected. We will compare the ^{10}Be depth profile in the WDC with those in other Antarctic as well as Greenland ice cores. [1] Finkel R. C. and Nishiizumi K. (1997) *J. Geophys. Res*. 102, 26,699-26,706. This work is funded by NSF.

GLO#P105 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Cosmic-Ray Produced Nuclide Systematics on Earth Project

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The interaction between cosmic rays and exposed target nuclei on the Earth's surface provides a means of determining important information about the last few million years of Earth history. These interactions produce nuclides, both stable and radioactive. For some of these nuclides, there are production pathways other than "cosmogenic" and for others, this is the only source of these nuclides. The abundance of cosmogenic nuclides in landscapes (e.g., lavas, alluvium, moraines, mountain peaks) enables interpretations about geological processes on or near Earth's surface. The objective of the CRONUS-Earth Project is to simultaneously address the various uncertainties affecting the production and accumulation of in-situ cosmogenic nuclides, with the goal of producing a widely accepted and internally consistent set of parameters that can be used in calculating ages and erosion rates. During the last 6 years investigators from over 20 groups have been participating in the measurement of geologic calibration samples, cross section determinations for cosmogenic nuclide production, inter-laboratory comparisons, assessment of muon production, comparison between and validation by cosmogenic nuclide measurement of scaling functions, and production of calculators for use by the broader scientific community. Results from these lines of investigation have shown that none of the "standard" scaling models for spatial/temporal distribution of production entirely represents the measurements. The underlying reason for this discrepancy may be nonlinearities in the response of neutron monitors whose data were used to construct the scaling relations. A new scaling model based on cosmic-ray simulations provides a better match to the CRONUS-Earth data.

GLO#P106 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

^{10}Be and 26Al records of the past 3 kyr from Dome Fuji (Antarctica) ice core

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We determined the concentrations of ^{10}Be and ^{26}Al in the Dome Fuji (Antarctica) ice core for the past 3 kyr. The analytical procedures followed those of our previous works (Horiuchi et al., 2007, 2008) except for the calibration with the latest nominal value of the ICN ^{10}Be standard (Nishiizumi et al., 2007) we used.

The concentration and flux of ^{10}Be show almost the same fluctuation patterns throughout the last 3ky, implying little meteological influence on the ^{10}Be fluctuations. Moreover, the variations in these ^{10}Be data are in line with those in the ^{14}C production rate but the former lagged slightly the later between 1000 BCE and 500 CE where the ice-core chronology is not robust. Major increasing peaks of the both nuclides are found at around 750 BCE, 350 BCE, 700 CE, and the five famous solar minimums of the last 1 kyr (Oort, Wolf, Spörer, Maunder and Dalton; see Horiuchi et al., 2008), all of which are connected to the solar minimums and considered as strong stratigraphic age-control points.

We found simultaneous fluctuations between ^{10}Be and ^{26}Al in our records although the time resolution for the later nuclide (80 to 160 yr) is approximately ten times lower than the former because of its low concentration in the ice (100 to 200 atoms g^{-1}). The average ^{26}Al/^{10}Be ratio was 1.95×10^{-3} and practically the same as the previous estimation (1.75×10^{-3}; Horiuchi et al., 2007) based on restricted samples and the previous (1.1 times higher) nominal value of the ICN ^{10}Be standard. This is the first time to show empirically covariation among the three cosmogenic nuclides ^{10}Be, ^{14}C, and ^{26}Al with solar-activity changes.

GLO#P107 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Studies on annual variation of $^{14}C/^{12}C$ ratios in plant samples by AMS

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Carbon-14 ($T_{1/2}$; 5730yr) is produced by the reaction of cosmic ray with nitrogen in the upper atmosphere. Therefore, $^{14}C/^{12}C$ ratios in plant materials should provide information on the past atmospheric ^{14}C levels which might be related to the variation of solar activities. The ^{14}C levels in the atmosphere are also affected by the anthropogenic sources such as nuclear weapons testing and accident of nuclear facilities. In this study, we have determined $^{14}C/^{12}C$ ratios by AMS in three different plant materials, i.e. tree rings of Japanese Yaku-ceder, Japanese rice grains and tree rings of pine from Chernobyl area, for assessing the variation of atmospheric ^{14}C.

In order to know the natural variation of ^{14}C, we used tree rings of old Yaku-ceder (1139 year-old) and focused on a period between AC1000-1100. As a result, we found a peak around AC1050. This suggests that the solar activity was weak in this period.

Rice grain data (AC1950~2009) showed that there was the highest peak around 1963 due to nuclear weapons testing and the values decreased gradually. Residence time of the produced ^{14}C was calculated to be about 11 years.

Tree rings of pine collected from the vicinity of Chernobyl NPP was used to assess the release of ^{14}C at the accident, which occurred in late April 1986. A peak of $^{14}C/^{12}C$ ratio clearly observed in the tree ring of 1986. However, the ratio varied widely within the tree ring. This heterogeneous distribution should be due to the short time releases (about 10 days) of ^{14}C during the accident. To examine this, we have separated early and late wood and found that the early wood contained markedly high ^{14}C and the late wood contained low ^{14}C compared to whole ring of the same year.

GLO#P108 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Constructing a Depth-Stratified Model for Soil Organic Carbon: A Brand-new, Integrated Ecosystem Model with Radiocarbon Tracking

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Accumulation and decomposition of soil organic carbon (SOC) have significant impacts on global carbon cycling. Especially, high-latitudinal regions, where a particularly strong warming is expected, currently store large amounts of SOC, and vulnerability against environmental changes are hotly discussed. Due to the expected warming, the SOC in high-latitudinal regions can start to decompose quickly and the resultant carbon dioxide emissions to the atmosphere would further intensify the ongoing climate change. To quantitatively study this land-atmosphere feedback, I developed a depth-stratified SOC model and applied it to a boreal forest site in Alaska. Based on model structure of ED2.0-peat and VISIT, the newly constructed model was designed to reproduce short- (months to several years) and long-term (centuries to millennia) SOC dynamics. Since decomposition rates of SOC are highly sensitive to soil environmental conditions (i.e., temperature and moisture), a physics-based approach to simulate belowground thermal and hydrological conditions is used. Moreover, the model simulates radiocarbon dynamics simultaneously with SOC. Current anthropogenic impacts in radiocarbon concentrations such as the Suess effect (since the industrial revolution) and explosions of thermonuclear weapons (mid-20th century) are tracked. Since delta ^{14}C was highly sensitive to the recent anthropogenic impacts, a direct comparison against field sampling data will enhance the predictive ability of the model by estimating the recent SOC dynamics.

GLO#P109 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Radiocarbon constraints for soil carbon accumulation and carbon release of arctic and boreal soil in Alaska

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The Arctic and boreal soil organic-carbon pool is a significant, but poorly constrained carbon store. Some current studies in the Arctic have pointed to the importance of these SOC stores as they are affected by warming temperatures, such as the widespread warming of the upper permafrost in the Arctic, and efflux of up to 80% of the seasonal C flux from tundra soils during the cold season when the organic-carbon-rich sub-soils are the warmest in the soil profile. The fate of carbon in arctic and boreal region is an important consideration for the current and future carbon cycle as soils warm in northern latitudes. In this study, we investigated the soil carbon stores and estimated these residence times in arctic and boreal soil in Alaska. Soils above the permafrost were collected along the Dalton Highway, between Fairbanks and Deadhorse near the Arctic coast. The observation area extends from Tundra in the Arctic coast, mountain area in the Brooksrange, in September 2009, then boreal forests in the south of Brooksrange. We measure C contents of SOC and the radiocarbon age of SOC and ecosystem respiration. Thick moss and detrital layers were found in poorly drained soils. According to ^{14}C data, the thickness of the recent detritus accumulated after 1960s' were from 10cm to 14cm in boreal forests and from 8 cm to 13cm in Tundra ecosystem. Bomb^{14}C contents and TOC down profiles suggested that boreal forests had large amount of SOC above permafrost and high accumulation rates which corresponded to 6.6 – 8.2 kg m^{-2} for past 60 years. We also examined soil $^{14}CO_2$ and discuss origin of soil respired CO_2 in this conference.

GLO#P110 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Radiocarbon from repeat hydrography along WOCE lines in the Pacific Ocean during the 2000s

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In the 2000s, we collected more than 5500 seawater samples for radiocarbon measurement in dissolved inorganic carbon during our repeat hydrography along the World Ocean Circulation Experiment (WOCE) lines of P01 (2007, approx. 47ºN), P03 (2005, approx. 24ºN), P06 (2003, approx. 30ºS), P10 (2005, approx. 149ºE), P14N/C (2007, approx. 179ºE), P17N (2001, approx. 135ºW), and P21 (2009 approx. 18ºS) conducted in the 1990s in the Pacific Ocean. These were parts of Japanese contribution to the Climate Variability and Predictability (CLIVAR) and Carbon Repeat Hydrography, CCRH. Radiocarbon in the seawater samples were measured in accelerator mass spectrometry (AMS) facilities in Japan. Comparison of radiocarbon data between WOCE in the 1990s and CCRH in the 2000s revealed decadal radiocarbon changes in the Pacific Ocean. In the subtropical region, radiocarbon decreased in upper thermocline from surface to about 500-m depth. In contrast, radiocarbon increased in lower thermocline from about 500-m to 1500-m depths. The two opposing directions in radiocarbon change resulted in total increase of vertical radiocarbon inventory in the subtropical region. The radiocarbon inventory in the equatorial zone has not changed significantly because of a balance between the radiocarbon decrease and increase in the upper and lower thermoclines, respectively. In the subarctic region, concentration of radiocarbon in the upper and lower thermocline has decreased and not changed, respectively, resulting in total decrease in the vertical inventory of radiocarbon. These decadal changes are primarily due to meridional transport of the bomb-produced radiocarbon from high latitude into temperate zone, and suggest that the total inventory of the bomb-radiocarbon in the Pacific Basin has increased slightly during the past decade.

GLO#P111 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

A fluctuation of ^{36}Cl depositional flux recorded around 11 ka in an antarctic ice core: Implication to the enhanced cosmic-ray intensity around 11 ka

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^{36}Cl is a cosmogenic nuclide (half-life: 301 kyr) produced mainly by a reaction of ^{40}Ar (p□□nα) ^{36}Cl in the upper atmosphere. The nuclide falls on the Earth's surface at a rate depending on the nuclide production rates and hence reflecting the cosmic ray intensity. Therefore we can reconstruct fluctuations of cosmic ray intensity, by determining the past ^{36}Cl depositional flux. Such fluctuations of cosmic ray intensity may indicate paleo solar activity and/or variations in the Earth's geomagnetic field.

This paper presents the results of cosmogenic ^{36}Cl measurements around 11 ka in the ice core drilled at the Dome Fuji station, Antarctica (39°42'12" E, 77°19'01" S, 3810 m above sea level) [1]. ^{36}Cl in the ice was measured with the Accelerator Mass Spectrometry (AMS) system on the 12UD Pelletron tandem accelerator at the University of Tsukuba[2]. A peak of ^{36}Cl depositional flux was observed around 11 ka, corresponding to the ^{10}Be enhancement found in the same ice core. At the peak of modulation (4.7×10^4 atoms cm^{-2} yr^{-1}) is about 2.8 times higher than the minimum flux around 11 ka (1.7×10^4 atoms cm^{-2} yr^{-1}). The decadal-to-centennial variation in ^{36}Cl flux shows similar fluctuations with that in ^{10}Be flux reported previously. ^{10}Be /^{36}Cl is estimated to be nearly constant at about 7.2 during 10 – 11 ka for the data obtained here.

References

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GLO#P112 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Modelling of calendar timescales for laminated lake sediments in Northern Poland

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In the framework of NORPOLAR (Northern Polish Lake Research), interdisciplinary research on laminated sediments from four northern Polish lakes is carried out. These paleolimnological studies will provide completely new, high resolution data of climatic and environmental changes in this part of Europe. Preliminary studies confirm that all sediment records retreived covers the time span of entire Holocene up to the present time.

The age-depth models for the investigated lakes will be based on different dating methods, taking into account the assumptions, limitations and uncertainties of each method. Varve counting will be performed for laminated sections of the cores. The isotopic methods ^{210}Pb and ^{137}Cs will provide additional age control for uppermost parts, and radiocarbon dates will supplement and verify the varve chronologies, with special regard to poorly-laminated and homogenous parts.

At present (Dec 2010) we have obtained 21 AMS radiocarbon ages, ^{210}Pb ages and partial varve chronologies. The project "Modelling of calendar timescales for laminated lake sediments in Northern Poland as a basis for high-resolution palaeoenvironmental reconstructions" has been launched, with funding for 50 additional ^{14}C samples and ^{137}Cs measurements. Statistical analysis of all available information related to time will be performed in order to construct robust age-depth models and to calculate the corresponding uncertainties. This presentation will give an overview of the current state of work and provide the first (preliminary) age-depth models.

GLO#P113 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Iodine-129 and ^{14}C as world-wide tracers of water masses in the Ocean

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Fifty years after the main injection of anthropogenic ^{14}C and ^{129}I from nuclear weapons tests on the ocean surface their concentrations in seawater of the World Ocean do not reflect the deposition patterns of global fallout, as they have been influenced by circulation and sequestration processes, as well as by regional sources such as releases from nuclear reprocessing facilities in Europe (Sellafield and Le Hague) and in Japan (Tokai-mura). While their concentrations in the north-eastern Atlantic Ocean clearly show an impact of nuclear reprocessing facilities, in the Indian Ocean the most interesting feature is the transport of water masses carrying elevated radionuclide levels from the subtropical western Pacific via the Indonesian Seas to the Indian Ocean. Higher levels observed in the latitudinal belt of 20-40°S are associated with Subtropical gyre which acts as a reservoir of radionuclides, maintaining their high concentrations on a time scale of several decades. ^{14}C data documents that the southern Indian Ocean is important for sink of anthropogenic carbon. The dominant feature in the radionuclide distributions in the Pacific Ocean is the existence of elevated concentrations in the north-western Pacific Ocean mainly associated with higher deposition due to the combined effect of higher precipitation and higher stratosphere-troposphere exchange of air, as well as due to specific circulation patterns.

GLO#P114 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Intermediate ventilation change and its relation to the surface environmental change from the last glacial maximum in the western North Pacific

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Changes in the overturning circulation at the high-latitude ocean may have a large impact on the atmosphere-ocean gas exchange, which includes greenhouse gas such as carbon dioxide. In the North Pacific, deep water is not formed on the modern condition due to low salinity of surface water, even though sea surface temperature (SST) is lower than the North Atlantic. Instead of deep water, the North Pacific Intermediate Water (NPIW) is formed in the west and spreads to wide area of the North Pacific. It is reported that the modern NPIW is sensitive to the surface environmental changes. However, little is known about the relationship between the long-term NPIW ventilation and surface environment. We reconstructed ventilation change of intermediate water (900-1600 m water depth) during the last 23 kyrs, using radiocarbon age difference between benthic and planktonic foraminifera, and surface environmental change deduced from chemical analysis of planktonic foraminiferal shells. We present new intermediate ventilation data from two sediment cores and compiled published data from the western North Pacific. The intermediate depth ventilation age varied from 400 to 1500 years and corresponded to the millennial-scale climate changes during the last deglaciation. The surface environment also showed the millennial-scale warm-cold oscillation which synchronized with the oxygen isotope record of the Greenland ice core. As a result, small ventilation age corresponded to low SST periods such as Heinrich Event 1 and Younger Dryas, and large ventilation age corresponded to high SST period of Bølling-Allerød. This relationship suggested that the intermediate ventilation in the North Pacific has been strongly affected by surface environmental change that closely related with the North Atlantic climate oscillations.

GLO#P115 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

^{36}Cl profiles in the Dome Fuji ice core during the last deglaciation

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Cosmogenic nuclides in ice cores provide useful information about the history of the cosmic ray flux in the atmosphere, the past solar activity and the past earth environment such as changes in the geomagnetic field. In this presentation, we show preliminary results of the cosmogenic ^{36}Cl ($T_{1/2}$: 301 kyr) profiles during the last deglaciation in an ice core retrieved from the Dome Fuji station, Antarctica (39°42'12''E, 77°19'01''S, 3810 m a.s.l). Ice samples have been extracted from depths corresponding with the late glacial to the early Holocene, with each sample comprising about 150 g for a core length of 0.5 m (~30 - 40 yr resolution). Analyses of ^{36}Cl concentrations by an accelerator mass spectrometry system at the University of Tsukuba were successfully performed within ±10% precision. The background with chemical blanks was about $\sim 1 \times 10^{-15}$ for the ^{36}Cl/Cl ratio. The ^{36}Cl concentrations in the ice ranged from (1.2 - 1.8) $\times 10^4$ atoms g^{-1} at the late glacial to (0.2 - 1.0) $\times 10^4$ atoms g^{-1} at the early Holocene. The changes of ^{36}Cl concentrations became particularly noticeable at around 17 ka. The ^{36}Cl flux is estimated to $1 \sim 4 \times 10^4$ atom cm^{-2} yr^{-1} in inland Antarctica during the last deglaciation.

This work is supported in part by the Grants-in-Aid for Scientific Research Programs of the Ministry of Education, Culture, Sports, Science and Technology, Japan (Nos. 22241003 and 21310004).

GLO#P116 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Deglaciation history of Sor Rondane Mountains in Dronning Maud Land, East Antarctica

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Antarctic ice sheet volume and sea ice extent are driven by Earth's global climatic system and more regional parameters such as albedo, thermohaline circulation, productivity of marine organisms, and erosion or weathering rate of base rock. A reconstruction of Antarctic ice sheet variability is essential to begin to understand their interactions. Previous studies have estimated a significant decrease in ice sheet thickness during the last several million years (e.g., Liu et al, 2010). However, the geographical extent of this decrease and its response and feedback to the global climate remain uncertain and topic of debate.

In this study, we focus on the past change of the ice sheet thickness at Sør Rondane Mountains in Dronning Maud Land, East Antarctica, because little is known about this region's deglaciation history. In 2010, we carried out a field expedition to investigate the past change of the ice sheet elevation based on detailed geomorphologic evidence and precise surface exposure ages using the cosmogenic isotopes ^{10}Be and ^{26}Al. In total, 34 bedrock or erratic samples were collected from ca 1000 – 2500 m a.s.l. at the western and central part of Sør Rondane Mountains. Based on these data, we attempt to reconstruct key changes in glaciation of the Sør Rondane Mountains and we will discuss this in a wider context: connections between East Antarctic ice sheet changes and global climate.

GLO#P117 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Concentrations of iodine-129 at the subarctic and subtropical circulations in the Japan Sea

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The Japan Sea, a small marginal sea in the North Pacific, is known as a sensitive indicator for global climate change. It has subtropical and subarctic circulations on the surface and forms subarctic front around 40 ^{o}N like Kuroshio-Oyashio currents system in the North Pacific. Therefore, knowledge of the dynamics in the Japan Sea is not only for local concern but also for comprehensive understanding of circulation in the Pacific Ocean. In this paper, we discuss the source and transportation mechanism of ^{129}I in the surface seawater of the Japan Sea. Seawater samples were collected during the cruise of the T/S Oshoro-maru in November 2007. Several sampling stations were selected as representative locations of the subarctic and subtropical circulation in the Japan Sea. The averaged concentration of ^{129}I above 100 m in the subarctic circulation was higher than that in the subtropical circulation. The latitudinal gradient of ^{129}I was not consistent with those of bomb-derived artificial radionuclides such as ^{14}C [Kumamoto et. al., 2008] and ^{90}Sr [Ito et al., 2003, Ito et al., 2005] and ^{137}Cs [Ito et al., 2003, Ito et al., 2005]. Taking account of latitudinal location of active reprocessing plants at La Hague (49.50 ^{o}N) in France and Sellafield (54.00 ^{o}N) in England, the discriminating distributional pattern of ^{129}I in the Japan Sea would indicate the significant amount of ^{129}I originating from the active reprocessing plants in EU is supplied to the surface of the sea. Concentrations of ^{129}I and/or combination of other anthropogenic radionuclides would provide us much information on the dynamic of the subarctic front in the Japan Sea as well as in the North Pacific.

GLO#P118 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Northwest Pacific mid-depth ventilation changes during the Holocene and their link to global climate changes

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The oxygen content of North Pacific Intermediate Water (NPIW), a water mass in the subtropical North Pacific that at present extends between 300 and 800 m depth and primarily originates in the Okhotsk Sea, has declined during the last several decades suggesting decreased ventilation, the consequences of which are not well understood. It is therefore of high interest to elucidate the oceanic history of mid-depth waters in the Northwest Pacific, which can be variably influenced by deep waters and NPIW, during the last 11000 years (the Holocene), when climatic boundary conditions were relatively similar to the present. However, such efforts have been hampered so far by the lack of appropriate sediment cores with high Holocene sedimentation rates. Core CK05-04, recovered in 2005 from 1180 m water depth off Shimokita peninsula, Japan, shows sedimentation rates of 80 cm/kyr during the Holocene and therefore presents a good opportunity to reconstruct for the first time the Holocene ventilation history of the Northwest Pacific Ocean. We employ Accelerator Mass Spectroscopy radiocarbon analysis of co-existing benthic and planktonic foraminifera to conclude on the ventilation age and radiocarbon activity of the mid-depth water. A comparison of our results with identical variables from deeper layers suggests considerable NPIW influence during the Mid-Holocene Thermal Maximum, while advection of deep waters was more important during the Neoglaciation. We link these changes to regional and global climate history, atmospheric circulation patterns, and the atmosphere-ocean carbon cycle.

GLO#P119 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Carbon pools of contrasting ^{14}C age within a Japanese volcanic-ash soil

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It has been shown that carbon (C) in Japanese volcanic-ash soils can be quite old (>1000 yr) even at surface horizons. Yet little information is available on how the old C is stabilized in soil matrix. Fractionation of soil according to particle density is an effective approach to distinguish the OM of different degrees of mineral associations and to elucidate SOM stabilization processes. We examined a surface (Ap) horizon of an allophanic Andisol in central Japan by isolating six density fractions (from F1: <1.6 g/cc to F6: >2.5 g/cc). Almost half of total C was distributed to F4 (2.0-2.25 g/cc), 26% of total C to F3 (1.8-2.0 g/cc), 10-12% to F2 (1.6-1.8 g/cc) and F5 (2.25-2.5 g/cc), and 3-4% to F1 and F6, respectively. The concentration of allophane was also highest in F4 then F3, implying that allophane-OM association is the main form of OM present in this soil. ^{14}C age generally increased with particle density from F1 (modern) to F5 (1300 yr libby age) and slightly declined to F6 (1000 yr). The clear exception to this trend was the old C age (1300 yr) of 1.6-1.8 g/cc fraction. Following results suggested the presence of char in this fraction: (i) C:N ratio was the highest, (ii) aromaticity nearly doubled from F1 to F2, and (iii) large numbers of small, dark fragments were microscopically observed along with plant detritus fragments. In contrast to F2, equally-old C in F5 appear to be strongly altered by microbial process and bound to mineral particles. F5 had lower C:N ratio of 9.7 and was more enriched in N-15 (+5 per mill) and C-13 (+2 per mill) compared to F2. The presence of contrasting forms of old C suggests that the pool size and turnover rate of old C may be controlled by different soil processes.

GLO#P120 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

A chronology of PY608E sediment core (Lake Pumoyum Co, south Tibetan plateau) on the basis of radiocarbon dating of total organic carbon

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Lake Pumoyum Co is a freshwater lake on the southern Tibetan plateau formed by fault action (28º34'N, 90º24'E; altitude, ~5020 m asl; lake surface area, 281 km^2; maximum water depth, 65 m). Lake Pumoyum Co, the largest lake in the high-altitude region of the southern Tibetan plateau (>5000 m asl), has a sedimentary sequence at least 40 m thick. The lake sediment cores from the southern Tibetan plateau provide novel and important clues that can reveal variations in both the past environment and biological activities. The new continuous sediment core (PY608E; core length, 3.9 m) for reconstruction of climatic changes in the area was taken with a piston corer from the southeastern part of Pumoyum Co in August 2006. The ^{14}C measurements of total organic carbon in the PY608E were performed with a Tandetron Accelerator Mass Spectrometry system (AMS, Model-4130, HVEE) at the Center for Chronological Research, Nagoya University. The main objective of our study was to evaluate the resulting suite of 14 AMS radiocarbon ages to determine a chronology for the cores. In this study, we propose a new age model for reconstruction of environmental and climate changes in southern Tibetan plateau during the last ca. 10 kyr based on ^{14}C data sets from the sediment core.

GLO#P121 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

DELTA^{14}C Level of Annual Plants and Fossil Fuel Derived CO_2 Distribution in Different Regions of China

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^{14}C levels in annual plants is one of sensitive tracers for monitoring fossil fuel derived CO_2 in the atmosphere. Corn leave samples were selected from different regions of China, including high mountains in Tibetean Plateau, grassland in Inner Mongolian, inland and coastal cities during the summer of 2009 and 2010. The $^{14}C/^{12}C$ ratio of the samples were measured with the NEC compact AMS system at Institute of Heavy Ion Physics, Peking University. The fossil fuel derived CO_2 concentration was obtained by systematically analysing the $\Delta^{14}C$ levels of the samples. The influences of topography, meteorological conditions and carbon cycling processes on the fossil fuel derived CO_2 concentration are considered when interpreting the data. Our results show a clear association of the low $\Delta^{14}C$ values with regions where human activities are intensive.

GLO#P122 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Decadal variations of the atmospheric concentrations of ^{7}Be and ^{10}Be : As tracers for stratosphere-troposphere exchange intensity

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The atmospheric concentrations of ^{7}Be ($T_{1/2}$ = 53.3 days) and ^{10}Be ($T_{1/2}$ = 1.36x10^{6} years) were observed at Tokyo, Hachijo-Island and Dazaifu in Japan, during the period of September 1998 to December 2009. The mean annual ^{7}Be and ^{10}Be concentrations were almost same for the three stations. The maximum values of ^{7}Be and ^{10}Be concentrations and ^{10}Be/^{7}Be ratio appeared in spring (from March to June). The seasonal variations of the ^{10}Be/^{7}Be were similar to that of precipitation in Switzerland [1]. A box model was applied to the observed datasets to estimate the intensity of stratosphere-troposphere exchange (STE) that causes these spring peaks. In this model, ^{7}Be and ^{10}Be concentrations were calculated with fluctuating production rates propotional to the observed neutron flux on earth's surface. Using 1.9 years and 35 days for the mean residence time of stratosphere and troposphere, respectively, the STE intensity was estimated to rises by a factor of 3 from March to June. The estimated STE intensity is consistent with net mass transport model by Appenzeller et al. [2].

[1] Heikkilä et al. (2008) *J. Geophys. Res*, **113**, 11,104 – 11,114.

[2] Appenzeller et al. (1996) *J. Geophys. Res*, **101**, 15,071 – 15,078.

REP#P101 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Status of the French accelerator mass spectrometry facility ASTER after 4 years

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Since the acceptance tests of ASTER in March 2007, routine measurement conditions for the long-lived radionuclides ^{10}Be and ^{26}Al have been established. Sample throughput as high as over 3300 unknowns has been reached for ^{10}Be in 2010. Steady numbers for ^{26}Al within the last three years settle down ~300 real samples.

Unacceptable cross-contamination for volatile elements has been largely solved by an ion source upgrade [1]. Thus, the second frequent nuclide measured at ASTER in 2010 is ^{36}Cl with ~480 sample targets. The enhancement with respect to immediate short-term sample to sample by the new ion source is impressive allowing minimal measurement time losses such as for initial burn-in periods of 5 min for virgin targets and waiting periods between data acquisition of two sample runs of 2 min. However, recent long-term tests using ^{35}Cl/^{37}Cl samples with strongly varying ratios have shown that identical targets lead to different ^{35}Cl/^{37}Cl results at the 2-4% level when being measured after a time gap of 24 hours while the source is running other samples. Reasons for this such as source memory, time dependent mass fractionation, drift of the Faraday-cup measurement system or something else are not yet clear.

Finally, after establishing quality assurance at ASTER by cross-calibration of secondary in-house ^{26}Al and ^{41}Ca standards [1] and taking part in round-robin exercises of ^{10}Be and ^{36}Cl, we performed a two-step cross-calibration of secondary in-house ^{129}I standards. The two ampoules of NIST 3231 containing ^{129}I/^{127}I at 0.981×10^{-6} have been used for step-wise dilution with NaI (MERCK, suprapur, 99.99 %) to get gram-quantities of lower-level standards for every-day use. The material SM-I-9 (~1×10^{-9}) has been measured vs. AgI produced from the two NIST ampoules with $(0.982+0.012) \times 10^{-8}$ solution using minimum chemistry. In a second stage, SM-I-10 and SM-I-11 with ratios of ~1×10^{-10} and ~1×10^{-11}, respectively, have been cross-calibrated against SM-I-9. Individual uncertainties of the traceable secondary standards are around 1.5 %, mainly originating from the given uncertainty of the primary NIST 3231 at 10^{-8}.

References:

[1] M. Arnold et al., NIMB 268 (2010) 1954.

REP#P102 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Status report on target preparation for ^{14}C AMS dating in the Zagreb Radiocarbon Laboratory

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A new rig for graphite target preparation for ^{14}C dating by AMS was implemented in the Zagreb Radiocarbon Laboratory in 2008. Graphites are prepared by oxidation of organic samples with CuO on 850°C or by hydrolization of carbonate samples with acid and then by converting the obtained CO_2 to graphite on iron powder in reaction with Zn on 450°C. The samples in form of graphite-iron powders are sent to the Scottish Universities Environmental Research Centre (SUERC), Glasgow, UK, where they are pressed into aluminium carriers (targets) and measured for ^{14}C on AMS. Technical details and the results from the test and validation series have already been presented [1].

A batch of samples prepared during the further validation phase showed increased background levels probably caused by an inappropriate position of the graphitization rig. Therefore, it was moved into an adapted and isolated "clean" room. The next batch of background and standard samples proved that this location is suitable for producing contamination-free graphite powders for ^{14}C AMS measurements showing age limit detection of 51 000 years BP. Each step in graphite preparation was separately tested using background materials in different forms (borehole CO_2 gas, anthracite, the "Heidelberg wood" and the Carrara marble).

For final validation a set of graphite targets was prepared from various types of samples (linen, collagen, wood, charcoal, dissolved inorganic carbon and shell) of known ^{14}C activities that have already been determined either by liquid scintillation counting (LSC), routinely used in our laboratory, or within the VIRI intercomparison. The comparison of ^{14}C AMS results with the LSC or VIRI values showed a good agreement.

[1] I. Krajcar Bronić, N. Horvatinčić, A. Sironić, B. Obelić, J. Barešić, I. Felja, Nucl. Instrum. Meth. B 268 (2010) 943-946.

REP#P103 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Current Status and Ion Source and Beamline Developments at LLNL's Center for Accelerator Mass Spectrometry

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LLNL's Center for Accelerator Mass Spectrometry has been in operation for more than 20 years. Over those years AMS operations at CAMS have included measurements of ^{3}H, ^{7}Be, ^{10}Be, ^{14}C, ^{26}Al, ^{36}Cl, ^{41}Ca, ^{63}Ni, ^{90}Sr, ^{99}Tc, ^{129}I, $^{233\text{-}238}$U, $^{236\text{-}237}$Np and $^{239\text{-}244}$Pu. The current status of the CAMS facility and routine operations will be described.

Over the past five years CAMS facility projects have included the development/installation of three new ion sources and four new beamlines. One of the ion sources is a commercial NEC 40-sample gas-capable MCGSNICS ion source. The second new ion source is a CAMS -designed 64-sample Cs sputter negative ion source. And, the third new ion source is a commercial NEC TORVIS ion source configured for He^{-} production. The four beamlines include a complete refurbishment of the South 30° beamline used for microprobe-based research utilizing ion beams from our HVEC FN Tandem Van de Graaff accelerator. The second beamline serves to connect our new NEC ion source to our 1 MV NEC Pelletron that is used for BioAMS research. The third beamline serves to connect the new TORVIS and CAMS designed ion sources to the FN accelerator and includes a new injection magnet and high-speed bouncer. The fourth beamline allows the HE transport of energetic ions to a target for implantation, isotope production or other similar experiments. The development/installation and current utilization of these ion sources and beamlines will be discussed.

This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.

REP#P104 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

A study of thermal ionization for the HVEE 846 ion source

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Often after ion source cleaning work, it takes a prolonged time for us to obtain a normal level of the output current. In order to remedy this problem of the ion source operation, and to better understand the HVEE 846 ion source, we have investigated the thermal ionization properties of this source. We have observed Saha-Langmuir equilibrium is not reached at our usual operating temperature of ~1000°C [ionizer current 17A], and the ionization is still monotonically increasing function of the ionizer current. Therefore, higher beam current than the present level may be attainable by pushing up the operating temperature further. However, it seems that the thermo-mechanical durability of the ion source is a limiting factor.

REP#P105 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

A Decade of AMS at the University of Georgia

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Nearly all ^{14}C analysis at the University of Georgia's Center for Applied isotope Studies, for radiocarbon dating, are now measured using accelerator mass spectrometry (AMS). In a span of ten years, the Center has transformed itself from a principally liquid scintillation counting (LSC) laboratory to one conducting thousands of AMS and stable isotope ratio analysis (SIRA) annually. After receiving the first of the NEC compact AMS units in the United States, the Center began to meet the demand for ^{14}C analysis outside the normal realm of most radiocarbon dating laboratories. With industries support, isotope research continued on an already developing natural products program to authenticate materials origin and process of formation. The Center's AMS allowed for the detection of synthetic materials in milligram quantities rather than gram quantities required by LSC and allowed new compound specific SIRA techniques to be directed toward compound specific ^{14}C measurement. By 2005 the Center was one of only a few laboratories accredited to determine bio-base content in industrial fuels and products by both AMS and LSC following ASTM 6866-10.

Since 2000, when our first sample was analyzed both radiocarbon and natural products sample numbers have increased steadily. The advantages of AMS analysis in overall efficiency, cost savings, accuracy and precision, are detailed here in a review of analytical precision for radiocarbon and natural products analyzed over ten years of AMS operation. Comparisons are made between natural products and biobased materials analyzed by both AMS and LSC. Although high precision is not required to authenticate natural products, for the purpose of product comparison with regard to degree of naturalness accurate and precise ^{14}C measurement is shown to be achievable by both methods.

REP#P106 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Accelerator-SIMS for isotopic analysis of trace elements

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Secondary ion mass spectrometry (SIMS) is one of the most extensively used methods to detect impurities and their isotopic signatures in materials. However, especially for heavier trace elements, the sensitivity of SIMS is severely limited by molecular and charge state interferences. This problem can be overcome using accelerator mass spectrometry (AMS).

We introduce a combined SIMS – AMS facility at the ETH-Zurich, Switzerland, where a SIMS sputter source with Cesium ion gun (Atomika CS 431) is attached to the 6 MV EN-Tandem accelerator. Negative ions sputtered from a sample by the Cs beam are injected into the Tandem accelerator, where ion stripping to high charge states at the terminal guarantees the destruction of all molecular ions. At the high-energy side of the accelerator, 40 MeV ions are filtered by an electrostatic/magnetic spectrometer. Final detection of the ions is done with a position-sensitive gas ionization chamber that also measures dE/dx and the residual energy for isobar separation. A fast beam bouncing system and a wide detector entrance window allow for quasi simultaneously detection of multiple isotope.

Within the EuroGENESIS program we are planning to use Accelerator-SIMS to measure isotopic compositions of heavy elements in pre-solar grains. The isotopic signatures in these grains carry the fingerprint of nucleosynthesis and provide valuable astrophysical information. In particular, rare earth elements in nano-diamonds will be studied, where molecular and isobaric interferences severely limit conventional mass spectrometric isotope analysis.

REP#P107 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

A new BPM-TOF system for CologneAMS

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At the center for accelerator mass spectrometry at the university of Cologne (CologneAMS) a complex beam detector consisting of a high resolution Beam Profile Monitor (BPM) and a Time of Flight (TOF) spectrometer with tracking capabilities was developed especially for the needs of the Cologne AMS facility. The complex beam detector assembly is designed to match the beam specifications of the 6MV Tandetron AMS setup and its DAQ system, which is presently in the commissioning phase at the IKP of the University of Cologne. The BPM-TOF system will have a reconfigurable structure, namely: either a very fast TOF subsystem with a small active area or a more complex BPM-TOF detector with beam tracking capabilities and with a large active area. The system aims for background suppression in case of the spectrometry of heavy ions, e.g. U, Cm, Am etc. and could also be used as an additional filter e.g. for the isobar suppression 36S in case of the spectrometry of ^{36}Cl. We will report on details of the design and on first experimental results obtained with some components of the detector system.

REP#P108 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

When size really does matter; measurement of ultra-small samples at the ANU Radiocarbon Dating Laboratory

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The increasing demand for radiocarbon ages from materials and compounds containing less than a few hundred micrograms of carbon, has motivated the development of procedures for handling "ultra-small" samples (20-200ugC) at the Australian National University's Radiocarbon Dating Laboratory. We outline the protocol for producing graphite targets by hydrogen reduction that minimizes fractionation of the sample. Multiple aliquots of CO_2 derived from the primary standard Oxalic Acid I (OX-I) were processed over a range of temperatures, pressures, and iron pre-treatment to monitor reaction rates and yields. Performance by our NEC Single Stage Accelerator Mass Spectrometer was monitored and tuning parameters adjusted to maximize beam intensity over 25-30 runs. Optimized procedures were then applied to a suite of ultra-small standards (modern, dead, 4,500 and 18,000 yrs) and the background contribution of exogenous carbon quantified. In total, more than 250 targets were produced. We present the equations for data correction and appropriate error propagation that were derived from the matrix of experiments, and apply them to a set of our own raw data. By maximizing the precision and accuracy of our measurements we intend to facilitate the application of compound specific radiocarbon in marine biogeochemical research, while providing a commercial service for use by Australia's greater scientific community.

REP#P109 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Current status and future plans for the AMS facility at the Tono Geoscience Center of Japan Atomic Energy Agency

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The Japan Atomic Energy Agency (JAEA) installed the JAEA-AMS-TONO system in 1997 at Tono Geoscience Center. The system has a 15SDH-2 Pelletron accelerator (NEC, US) with a maximum terminal voltage of 5 MV. Since 1998, the system has routinely been used for ^{14}C-AMS. Recently, about 800 samples have been measured per year, mainly for neotectonics and hydrogeology studies in support of research on geosphere stability for long-term isolation of high-level radioactive waste. Under the common-use facility program of JAEA, the system has also been available and used by researchers from universities and other institutes for geoscience and environmental science studies.

In addition, ^{10}Be-AMS has been developed for geochronological studies such as estimation of sedimentation rate and exposure age of basement rocks. A gas ionisation detector was exchanged for one reported by Maden[1]. Because the detector has a gas absorber cell with a larger volume than the previous one, it is possible to remove ^{10}B efficiently and thus is more desirable for ^{10}Be measurement. Test measurements using several standard samples supplied from University of California, Berkeley were performed. Ratios of ^{10}Be/^{9}Be in the samples were comparable to the certified values, indicating that the system is suitable for performance of ^{10}Be-AMS. In the presentation, we will introduce our plans such as improvement of ^{14}C-AMS and ^{10}Be-AMS systems and their application.

[1] C. Maden et al., Nucl. Instr. and Meth. in Phys. Res. B 259 (2007) 131-139.

REP#P110 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Status report: The Mannheim AMS facility (MAMS)

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A new AMS facility has been established at the Curt-Engelhorn Centre for Archaeometry, Mannheim, Germany. It is based on the compact MICADAS system, developed and built at the ETH Zurich, Switzerland. We report on the first year of operation, focusing on high precision studies of atmospheric CO_2, compared to results from CO_2 gas counters at the Heidelberg laboratory. We also explore the ability of this a 200 kV AMS system to date samples close to the limit of the ^{14}C method.

REP#P111 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Performance parameters and standard reference materials at the ETH AMS facilities

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We report here on the current performance parameters of the three AMS systems in operation at the ETH AMS facility, the 6 MV HVEC EN-Tandem, the 0.6 MV NEC Pelletron "TANDY" and the ETH 0.2 MV facility "MICADAS". The radionuclides routinely measured with these systems are ^{10}Be, ^{14}C, ^{26}Al, ^{36}Cl, ^{41}Ca, ^{129}I and actinides. The standard reference materials used for the normalization of the AMS measurements will be described.

REP#P112 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Status and Plans for the National Ocean Sciences AMS (NOSAMS) Facility

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The National Ocean Sciences Accelerator Mass Spectrometry lab (NOSAMS) is dedicated to providing the US ocean sciences community with high precision radiocarbon AMS analyses, improving existing AMS techniques and developing new methods for radiocarbon AMS. Our lab currently processes roughly 6500 unknowns per year, provides precision of 2-5‰, and analyzes samples containing as little as 20 ug C. There are two AMS systems at the lab. The 3 MV tandetron has been used since 1991 for most of the graphite throughput. It uses a 59 sample caesium sputter source and simultaneous injection. The newer 500 kV pelletron is used primarily with a newly developed microwave plasma gas ion source for continuous-flow AMS (CFAMS) development. Our sample preparation lab produced ~9500 graphite targets in the last year from an array of gas samples; organic and inorganic solids; dissolved organic and inorganic carbon (DOC and DIC) in seawater; and compound specific sources. This level of throughput is made possible by recent and ongoing efficiency and method improvements such as an automated acid-base-acid pretreatment system, improvements to seawater DIC stripping, an automated catalyst dispensing system, and online measurement of sample δ^{13}C using cavity ringdown spectroscopy.

REP#P113 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

A first step toward small-mass AMS radiocarbon analysis at Nagoya University

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We have started to establish a small-mass sample preparation system at Nagoya University. In the first step, NIST Ox-II standard samples <0.5 mgC, graphitized using our regular sample preparation protocol, were measured for ^{14}C. The $^{14}C/^{12}C$ ratios of these small-mass samples were affected by the decrease in beam current intensity and incomplete graphitization especially for samples <0.3 mgC.

In the second step, we have designed a compact graphitization system suitable for small-mass samples and compared its performance to that of our regular graphitization system. During the graphitization reaction following our regular protocol, by-product water vapor was incompletely trapped, which resulted in low graphite yield or no graphitization for samples of <0.5 mgC. Meanwhile graphite was successfully produced for samples of 0.2mgC using the new reactor. The SEM images of small-samples using the new reactor show spotted graphite covering the spherical iron particles. No or very little graphite was observed for the samples graphitized using our regular graphitization system. During the graphitization reaction using the sealed tube method, water vapor was incompletely trapped, which resulted in low graphite yield especially for samples of <0.5 mgC. Meanwhile graphite was successfully produced for samples of 0.2mgC using the new reactor. The cold trap at −80°C employed in the new graphitization system was effective in trapping water for small-mass samples. The combination of lower temperature for trapping water and a reduction in reactor volume delivered higher graphitization efficiency for small samples. We are now ready for ^{14}C analysis of samples of around 0.2mgC.

We also report an example of stepwise combustion of samples containing sulfur in a closed tube to produce graphite successfully.

REP#P114 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

ARTEMIS: ^{14}C AMS Facility – Status report

Moreau C, Quiles A, Bavay D, Caffy I, Comby C, Delque-Kolic E, Dumoulin J, Ferkane S, Hain S, Setti V, Souprayen C
CEA LMC14

The AMS facility ARTEMIS is installed since 2003 in Saclay, France. ARTEMIS is a 3MV NEC 9SDH-2 Pelletron and is dedicated to high precision ^{14}C measurements. It routinely measures over 4500 samples a year for the French laboratories. A status report will be done here, showing the measurements of standard, blank and intercomparison samples (FIRI).

The main Research and Development programmes done by the ARTEMIS team will be presented and especially the new project based on beam optic simulation on the ARTEMIS facility carried out to improve the technical factors involved and control the settings of the facility.

REP#P115 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Refining the performance of VERA for actinide AMS

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The detection limits for AMS of actinides, especially for uranium, bismuth, and thorium isotopes, are often imposed by background from ions interacting with residual gas [1]. These ions, which lie close in energy or momentum to the ions of interest can only partially be suppressed; the suppression factor is limited by the energetic width of the beam, which is mainly determined by the stability of the terminal voltage. This raises the demand for a better stability of the terminal voltage of the 9SDH-2 Pelletron accelerator (NEC; WI, USA) used at VERA and for a better vacuum inside the analyzing beam line. This contribution will present our attempts to tackle these challenges and report the experience gained.

We made several approaches to improve the terminal voltage: (a) The control circuit of our accelerator consists of a generating voltmeter (GVM), capacitive pick-offs (CPO), a TPS-6 terminal potential stabilizer (TPS), and a corona probe. We tried to replace the analog TPS regulation by digital filters implemented in LabVIEW (National Instruments, TX, USA). (b) To reduce the bouncing of the charging chains we tested an idler wheel with shock absorber. (c) Frequency inverters controlling the speed of the charging chains allow to avoid resonant modes of the mechanism. (d) The terminal-voltage induced jitter of the beam can partially be compensated by modulating the voltage of the electrostatic analyzer with the CPO signal.

Over the years the base vacuum inside the high-energy analyzing beam line of VERA, also used for several non-AMS experiments, became worse. One reason was that for convenience experimentalists had replaced metal gaskets by neoprene or Viton. Additionally, apparently unclean parts had been mounted at least once. We changed back to metal gaskets and - in order to clean the surfaces from suspected hydrocarbons - applied UV/ozone cleaning [2] to the inside of the most affected beam line sections.

[1] P. Steier et al., Nucl. Instr. and Meth. in Phys. Res. B 268 (2010) 1045-1049.

[2] J.R. Vig, J. Vac. Sci. Technol. A, 3/3 (1985) 127-134.

REP#P116 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

Sample preparation facilities for ^{14}C analysis at the new CologneAMS center

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The new AMS facility at the University of Cologne, Germany (CologneAMS) is based on a 6 MV Tandetron system from High Voltage Engineering that will be used for the analysis of ^{10}Be, ^{14}C, ^{26}Al, ^{36}Cl, ^{41}Ca, ^{129}I, ^{239}U and ^{244}Pu. The AMS is currently being set up at Cologne and acceptance tests will start in February 2011. Parallel to the AMS installation we have started to set up instruments for the preparation of AMS ^{14}C targets. We use an improved version of the automated graphitization equipment (AGE; Wacker et al., 2010) for the conversion of organic samples into AMS graphite targets. The system consists of an elemental analyzer for sample combustion and a graphitization system with a zeolite trap for CO_2 concentration and subsequent release into reactors for reduction with H_2 over iron as catalyst. Our laboratory is also equipped with different systems for the extraction of lipids and for purification and isolation of individual molecules with preparative capillary gas chromatography (PCGC) for compound-specific ^{14}C analysis. We have tested the preparation of organic samples, including acid-alkali-acid treatment and sample conversion to graphite with the AGE. The tests have been performed with reference and standard materials (Ox-II, IAEA C6, selected VIRI samples) and the results are in good agreement with consensus values. The graphitization blank determined with anthracite for normal sized samples (1 mg C) presently is between 45,000 to 50,000 years BP. We have also measured a size series of blanks, starting with a minimal sample size of only 50 µg C to test the limit of the AGE graphitization system. The small blanks are heavily influenced by contamination introduced mainly by the tin containers in which the samples are combusted (1.1 µg C with 65 ± 6 pmC; Ruff et al., 2010). While 350 µg C still yields a reasonable blank value of 0.5 pmC, the results for smaller samples were significantly higher because of the larger effect of the blank uncertainty on smaller samples sizes. Tests of the isolation of individual fatty acids and *n*-alkanes with our new PCGC system, which are performed with old and young standards, are currently in progress and will also be presented.

Ruff, M., Fahrni, S., Gäggeler, H .W., Hajdas, I., Suter, M., Synal, H.-A., Szidat, S., Wacker, L., 2010. On-line radiocarbon measurements of small samples using elemental analyzer and MICADAS gas ion source. Radicarbon 52 (4), 1645-1656.

Wacker, L., Němec, M., Bourquin, J., 2010. A revolutionary graphitisation system: Fully automated, compact and simple, Nuclear Inst. and Methods in Physics Research, B 268 (7-8), 931-934.

REP#P117 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

A gas-accepting ion source for Accelerator Mass Spectrometry: Progress and Applications

Roberts M, von Reden K, Burton J, McIntyre C, Beaupre S
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The National Ocean Sciences Accelerator Mass Spectrometry facility at the Woods Hole Oceanographic Institution has developed an Accelerator Mass Spectrometry system designed specifically for the analysis of ^{14}C in a continuously flowing stream of carrier gas. A key part of the system is a gas-accepting microwave ion source. Recently, substantial progress has been made in the development of this source, having achieved ion currents rivaling that of a traditional graphite source. Details and current performance of the gas source will be given. Additionally, representative results obtained from coupling the source to both a gas chromatograph and gas bench will be presented.

REP#P118 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

^{10}Be and 26Al measurements at the SUERC 5MV AMS

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Scottish Universities Environmental Research Centre

^{10}Be and ^{26}Al AMS measurements using the 134-cathode NEC MC-SNICS ion source in the SUERC AMS system have been routinely carried out over the last 5 years. Stable and reproducible BeO^- and Al^- currents up to 10 μA and 1 μA can be achieved respectively and efficiently transmitted through our 5 MV spectrometer. Using silicon nitride membrane detector windows low energy 16 MeV $^{26}Al^{3+}$ ions can be separated from interferences. ^{10}Be vs ^{10}B separation has been compared by B stopping in a single Havar detector window and the conventional combination of absorber cell and detector. In order to check the quality of measurements at low ^{10}Be and ^{26}Al concentrations, we have investigated and presented the linearity of $^{10}Be/^{9}Be$ and $^{26}Al/^{27}Al$.

REP#P119 **POSTER SESSION 1** **Tuesday 22nd March, 1400 - 1540**

A new AMS facility at Yamagata University

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Yamagata University

A new compact accelerator mass spectrometry (AMS) system and fully automated 20-reactor graphite lines were installed at Yamagata University (YU) in the middle of March 2010. The performance tests of the YU-AMS system were carried out at the end of March 2010, by measuring the C series standard samples (C1 – C9) and HOxII provided by IAEA and NIST, respectively. The results show that the YU-AMS enables precise measurement of ^{14}C concentration. The graphitization system has been automated employing an elemental analyzer (EA), a stable isotope ratio mass spectrometer (IRMS), and an automatic cryogenic CO_2 trapping system. The system is capable of producing 20 graphite samples per day. The collection efficiency of the CO_2 trapping system is approximately 90%. This AMS system is the first AMS system installed in a university in the Tohoku-Hokkaido region in Japan. The facility provides radiocarbon dating for samples from other universities, institutes and public organizations. Moreover, we are planning to apply the system in medical and pharmaceutical areas, particularly to microdosing studies to predict the pharmacokinetics of new drugs by labelling them with ^{14}C and administrating them to human volunteers. In this conference, we present the performance and status of the new compact AMS system, as well as of the fully automated 20-reactor graphite lines equipped at the research institute.

Oral Abstracts – Sessions 6a–11b

(in order of presentation)

GLO#10 **SESSION 6A** **Tuesday 21st March, 1600 – 1740**

Radiocarbon method in environmental monitoring of CO_2 emission

Rakowski A [1], Nadeau M-J [2], Nakamura T [3], Pazdur A [2], Pawełczyk S [2], Piotrowska N [2]
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[2] Radiocarbon Laboratory, Silesian University of Technology, Gliwice, Poland,
[3] Center for Chronological Research, Nagoya University, Japan

New $\Delta^{14}C$ and $\delta^{13}C$ data, representing the isotopic composition of carbon in "clean air", were obtained from the annual rings of a pine tree (*Pinus sylvestris*) from the area of Niepołomice, 25 km east from the city of Kraków. α-cellulose were extracted from all samples. Radiocarbon concentration in each annual ring was measured using AMS and stable isotopic composition of carbon was determinate using IR-MS. The dataset covers a growth period between 1960 and 2003. These data will be compared with results presented in Rakowski et al. 2004a from the city of Kraków, where local decrease of ^{14}C concentration were observed due to local CO_2 emission from fossil fuel use. The differences in observed ^{14}C concentrations between those two places will be used to estimate a magnitude of local Suess effect in the city area. Based on mass balance calculations for CO_2 concentrations, stable isotopic composition of carbon, and ^{14}C concentration (Levin et al. 2003), it was possible to calculate CO_2 concentration associated with fossil fuel emission (c_{foss}) into the atmosphere.

Rakowski A, Kuc T, Nakamura T, Pazdur A. 2004. Radiocarbon 46(2): 911 – 916.

Levin I, Kromer B, Schmidt M, Sartorius H. 2003. Geopysical Research Letters 30, No 23, 2194.

GLO#11 **SESSION 6A** **Tuesday 22nd March, 1600 - 1740**

Speciation Analysis for ^{129}I and ^{127}I in Air and its Tracer Application in Geochemical Cycle of Stable Iodine

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[5] Department og Geogology, United Arab Emirates University, Al-Ain, UAE

A method for the collection and separation of different species of iodine in air was developed. Particle associated iodine, inorganic gaseous iodine and organic gaseous iodine were collected by pumping the air through air sampler with sequential air filters, a glass fibre filter, cellulous filter impregnated in NaOH/glycerol and a active charcoal column impregnated with TEDA. The collected different species of iodine were then separated by a combustion method and trapped in an alkali solution. ^{127}I in the trap solution is measured by ICP-MS. Iodine remained solution was further separated by solvent extraction and AgI precipitation for AMS measurement of ^{129}I.

Total 45 air samples at 8 locations with different distance to the North Sea (0, 5, 50, 100, 250, 500, 1000 km) in Denmark, Sweden, and Lithuania have been collected in March and September 2007, meanwhile lichen, pine needle, surface water, and rain water samples have also been collected near the air sampling sites. Iodine in 25 lichen and pine needle samples has been separated using the combustion furnace. The results show a high $^{129}I/^{129}I$ ratio in air sample as well as lichen samples in the short distance to the North Sea, especially those collected in a 10 km distance to the North Sea. The lowest value was observed in the Lithuania, where is 1000 km far from the North Sea. The application of anthropogenic ^{129}I released from reprocessing plant for geochemical cycle is discussed in this work.

EAR#12 **SESSION 6A** **Tuesday 22nd March, 1600 - 1740**

Anomalous Elevated Radiocarbon Measurements of PM2.5

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[2] Radiocarbon Dating Laboratory, Earth Chemistry, Research School of Earth Sciences, The Australian National University,
[3] Cooperative Institute for Research in the Atmosphere, Colorado State University

Two-component models are often used to determine the contributions made by fossil fuel and natural sources of carbon in airborne particulate matter (PM). The models reduce thousands of actual sources to two end members based on isotopic signature. Combustion of fossil fuels produces PM free of carbon-14 (^{14}C). Wood or charcoal smoke, restaurant fryer emissions, and natural emissions from plants produce PM with the contemporary concentration of ^{14}C/C. Such data can be used to estimate the relative contributions of fossil fuels and biogenic aerosols to the total aerosol loading and radiocarbon analysis is becoming a popular source apportionment method. However, critical analysis of sampling sites for possible sources of elevated PM needs to be completed prior to embarking on sampling campaigns. Results are presented for two ambient monitoring sites in different areas of U.S. where ^{14}C contamination is apparent. Our experience suggests that such contamination is uncommon but is also not rare (~ 10%) for PM sampling sites. These data are intended as a warning regarding uncritical interpretation of ^{14}C results, particularly when ^{14}C data are within the expected range and contamination would not be obvious.

This work performed in part under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.

EAR#13 **SESSION 6A** **Tuesday 22nd March,1600 - 1740**

Investigation of the Origin of Environmental Compounds from Indoor Air Samples via AMS

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Many organic environmental compounds are potentially dangerous due to their allergic or carcinogen impact on humans. For an effective program to reduce their concentration in houses, their sources have to be detected. Our investigation is focussed on aldehyde compounds since their indoor concentration is relatively high and since they originate from biogenic or anthropogenic sources. Both types of sources can be distinguished by their different ^{14}C content which can be measured via AMS.

We developed a compact sampling device, using the conventional dinitrophenolhydrazine (DNPH) derivatization method. Isolation and purification of the corresponding derivative is done by high performance liquid chromatography (HPLC). The isolated derivative is then injected into an elemental analyzer and fed via a gas handling system into the gas sputter source for the ^{14}C AMS measurement.

First samples were taken from a small beer tavern where smoking is allowed, and from various living or sleeping rooms. After a sampling time of 4 hours the carbon content of the isolated derivatives from acetaldehyde and formaldehyde ranged from 30 – 100 microgram which is enough for an AMS measurement. The ^{14}C results will be discussed in this contribution.

EAR#14 **SESSION 6A** **Tuesday 22nd March, 1600 - 1740**

AMS biocarbon measurements - from liquid fuels to flue gases

Oinonen M [1,5], Antson O [2], Nieminen J [3], Palonen V [4,5], Pesonen A [1,5], Tikkanen P [4,5]
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[3] Finnish Customs Laboratory,
[4] Department of Physics, University of Helsinki,
[5] Radiocarbon Analytics Finland, University of Helsinki

As a response to the world-wide increase of biofuel usage and control, biocarbon determinations have gained interest in Finland during the recent years. Longstanding collaborations between VTT, local enterprises and FMNH Dating Laboratory have yielded to procedures to determine biocarbon fractions of flue gases (Hämäläinen et al 2007) and liquid fuels (Oinonen et al 2010). Presently, the R&D concentrates in the development of faster fuel-combustion methodology with elemental analyzer (Pesonen, this issue), in flue gas collection & treatment methodology, in AMS development (Palonen & Tikkanen, this issue) and establishment of procedures under a new RACAF organization within the University of Helsinki – together with the external collaborators. This contribution presents the status of the biocarbon measurements as a part of the multidisciplinary research environment in Finland.

Hämäläinen K, Jungner H, Antson O, Räsänen J, Tormonen K, Roine J 2007.

Measurement of biocarbon in flue gases using ^{14}C. Radiocarbon, Vol. 49: pp. 325-330

Oinonen M, Hakanpää-Laitinen H, Hämäläinen K, Kaskela A, Jungner H 2010, Biofuel proportions in fuels by AMS radiocarbon method. Nucl. Instr. Meth. Phys. Res. B 268: pp. 1117-1119.

REP#2 **SESSION 6B** **Tuesday 22nd March, 1600 - 1740**

The new 6 MV-AMS-facility DREAMS at Dresden, Germany

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The research activity at the **DRE**sden **A**ccelerator **M**ass **S**pectrometry facility (DREAMS) [1] based on a 6 MV Tandetron is primarily dedicated to the radioisotopes of ^{10}Be, ^{26}Al, ^{36}Cl, ^{41}Ca, and ^{129}I [2].

During first experiments at the accelerator an energy calibration of the machine has been carried out. For this purpose the $^{1}H(^{15}N,\gamma\alpha)^{12}C$ nuclear reaction with a sharp resonance at an energy of 6385 keV has been used. Nitrogen-15 ions have been produced from nitrogen-15 enriched sodium azide. The charge states 1+, 2+ and 3+ corresponding to different terminal voltages of the accelerator have been investigated to obtain an absolute energy calibration. The total energy resolution for the system is about 12 keV.

Excellent background levels have been found of $\sim 2 \times 10^{-16}$ for $^{10}Be/^{9}Be$, 7×10^{-16} for $^{26}Al/^{27}Al$, and 8×10^{-15} for $^{41}Ca/^{40}Ca$, respectively. The background of 2×10^{-13} for $^{129}I/^{127}I$ originates from intrinsic ^{129}I from AgI produced from commercial KI (MERCK), whereas the reason for the high $^{36}Cl/^{35}Cl$ background of about 3×10^{-15} remains yet debatable. Further experiments are ongoing especially for a better understanding of the ion source performance.

References
[1] www.dresden-ams.de
[2] Sh. Akhmadaliev et al., ECAART-10, 13-17 Sept. 2010, Athens, Greece.

REP#3 **SESSION 6B** **Tuesday 22nd March, 1600 - 1740**

A New AMS Facility at Inter University Accelerator Centre, New Delhi, India

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[3] Indian Institute of Science Education and Research, Kolkata, India

Accelerator Mass Spectrometry (AMS) facility has been developed at Inter-University Accelerator Centre (IUAC) upgrading its existing 15UD Pelletron Accelerator. The 15UD Pelletron is mainly used for Nuclear Physics, Materials Science, Atomic Physics, Radiation Biology and AMS is a new program added. Many changes were incorporated in the existing 15UD Pelletron system to develop this new AMS facility. The major changes for modifications include installation of a bi-directional 40 cathodes MC-SNICS ion source, Recirculating Turbo-molecular pumps based gas stripper system, an offset Faraday cup after analyzer magnet, a Wien filter, a quadrupole system, double slits, gas cell and a multi-anode gas detector.

Presently ^{10}Be measurements are being carried out in several types of geological samples and soon ^{26}Al & other long lived radio-isotopes will also be studied. The simultaneous injection of $^{9}Be^{17}O$ and $^{10}Be^{16}O$ is being done for detecting $^{10}Be^{+3}$ in the gas ionization detector and $^{17}O^{+5}$ in the offset Faraday cup after analyzing magnet. A maximum transmission of 19%, for $^{9}Be^{+3}$ charge state at a terminal potential of 10MV, has been achieved with foil and gas stripper combination for BeO beam. A gas cell present before gas detector is used to stop ^{10}B using Nitrogen gas, while isobutane gas was used in the gas ionization detector to detect ^{10}Be. NIST standard reference material SRM 4325 is used to calibrate the system.The test experiments for $^{26}Al/^{27}Al$ ratio with standard samples of different concentrations show good agreement between quoted and experimental value.

A clean chemistry lab with all the modern facilities has also been developed at IUAC for the chemical processing of samples prior to the AMS measurements. Chemical procedure for ^{10}Be separation from Mn nodules and sediments has been established. A description of the facility, method of measurement, chemical processing of samples and results are being presented.

REP#4 **SESSION 6B** **Tuesday 22nd March, 1600 - 1740**

One year of operation with XCAMS, the 0.5 MV Pelletron Compact ^{14}C AMS extended for ^{10}Be and ^{26}Al at New Zealand's National Isotope Centre

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[2] National Electrostatics Corp.

In 2009, GNS Science purchased from NEC an extended version of the standard Compact AMS (CAMS) system, based on the 0.5 MV Pelletron, originally designed for radiocarbon measurements near the peak of the 1+ charge state distribution. We will describe NEC's implementation of this multi-isotope (^{14}C, ^{10}Be, ^{26}Al) system and present the results of the acceptance tests. Since the installation and commissioning during the first quarter of 2010, ~2000 samples from the graphite providing radiocarbon labs have been measured with this new eXtended Compact AMS (XCAMS) system. We will compare its performance record against that of previous years with the 6 MV EN-tandem based system and discuss some of the conditions that impact on the likelihood of obtaining ^{14}C results with precision near the 0.2% (15 CRA years) benchmark.

At ETH-Zürich it was demonstrated that ^{10}Be/^{9}Be near 10^{-14} could be measured below 1 MeV by the use of a thin Si-nitride membrane as energy-degrader to deflect the ^{10}B beam away from ^{10}Be and by the addition of a third magnet in front of a high-resolution gas-ionisation particle detector to effective remove all charge-exchanged and scattered ^{9}Be [A.M. Müller et al., NIM-B 266 (2008) 2207–2212]. We intend to present early experiments with different Si-nitride membrane thicknesses, in an effort to find a cleaner way of separating the ^{10}Be from its isobar and to reduce the loss in transporting the ^{10}Be^{2+} beam, broadened due to energy- and angular straggling in the degrader, to the particle detector.

REP#5 **SESSION 6B** **Tuesday 22nd March, 1600 - 1740**

Accelerator mass spectrometry at the Munich Tandem accelerator

Korschinek G, Faestermann T, Fimiani L, Ludwig P, Rugel G
Technische Universität München

We report on recent improvements and applications in accelerator mass spectrometry at the Munich MP Tandem (TV≈14MV). Because of the high energy available, the aim of our applications and improvements concerns mainly radio nuclides with mass numbers larger than of A≥26. One difference to a dedicated AMS facility is that other experimental activities, like material science and nuclear physics are ongoing as well. Hence AMS experiments consume only around 20% of the total beam-time. The main features of the AMS furnishings are a separate AMS injector with a high mass resolution and the use of several single-cathode ion-sources dedicated to individual isotopes. Double foil stripping in the tandem to get higher charge states from molecular beams is also implemented (see poster). There are two AMS beam lines which have two Wienfilter in common, one line got a time of flight measurement and a gas filled magnet (GFM) with an ionization chamber [1], and the other one got an additional highly resolving Wienfilter [2] (altogether three Wienfilter for this line), a passive absorber, a time of flight measurement, and finally an ionization chamber. The line with the GFM is mainly used for masses until around 130 amu, the other one is utilized for isotopes with heavier masses. The focus of our measurements is on isotopes like ^{53}Mn, ^{59}Ni, ^{60}Fe, ^{63}Ni, but also up to ^{244}Pu and heavier. Examples of the measurements will be shown.

[1] K. Knie et al. NIMB 172, 2000, 717
[2] D. Berkovits et al. NIMB 172, 2000, 372

REP#6 **SESSION 6B** **Tuesday 22nd March, 1600 - 1740**

Accelerator Mass Spectrometry at Purdue University PRIME Lab

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PRIME Lab, Purdue University

The Purdue Rare Isotope Measurement Laboratory (PRIME Lab) is a dedicated AMS research facility measuring ^{10}Be, ^{14}C, ^{26}Al, ^{41}Ca, and ^{129}I. PRIME Lab houses chemical processing facilities for both geoscience and bioscience sample preparation. Recent improvements include continued modification of the ion source, addition of diagnostic tools, computer control, improved beam-line optics, testing of an electrostatic "bouncing" system for a new injector, the construction of a new beam-line utilizing a gas-filled magnet, and testing of a new data acquisition system. We have also implemented a new, streamlined quartz preparation facility and improved our chemistry methods, resulting in enhanced productivity both in terms of the numbers of geological samples analyzed, and turnaround time in sample preparation. We have replaced the "rabbit" ion source that shuttled cathodes into the source through differentially pumped stages. After years of routine use and extensive testing we determined that differential pumping did not adequately exclude oxygen from the source, particularly as wear inevitably degrades the vacuum over weeks to months. The new system places the sample cassette under vacuum on the ion source. Cathodes are pushed from the cassette into the sample rod, which lowers them into position. This new sample changer has proven to be extremely reliable with much improved secondary ion currents. We have completed a LabView based computer control system that controls beam-line elements and monitors critical parameters. We have also finished construction of a new beamline that terminates with a gas-filled magnet. A major initiative is the testing of a new data acquisition system based on the XIA PIXE. Although this hardware was supplied with software, we have extensively modified it to enable real-time analysis of coincidence data from multi-anode particle detectors. Funding for PRIME Lab is provided by NSF and NASA.

TEC#14 **SESSION 7** **Wednesday 23rd March, 0900 - 1040**

Including scattering and molecular dissociation in ion optics calculation for AMS

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Laboratory of Ion Beam Physics, ETH Zurich

The ion transport from ion source to the detector plays an important role for the performance of AMS facilities. Transmission as well as background is strongly related to the ion optics. For designing new facilities or improving existing ones, it is therefore important to have methods, which include effects such as small angle scattering and energy loss in the stripping process in such calculations. Small angle scattering leads to a correlation of angles with energies, therefore it is not allowed to treat the corresponding phase space distribution in the ion transport independently. Also the dissociation of molecules in the high voltage terminal of a tandem accelerator leads to a correlation of energies with angles. With some modification of the existing ion transport program ETH-optics, as described at AMS-11, simulations of the individual ion tracks can now be made with a Monte Carlo method including elements describing physical processes, which change the phase space of the beam (position, angle and energy). So the effect of ions passing through some matter can be included. In addition, the program checks, whether a particle is transmitted through all apertures or other beam limiting devices. In defined planes the fraction of transmitted ions is available and the distributions in position, angle and energy can be calculated and displayed. The power of the program is shown by several examples: Experimental results obtained with the degrader foil method for ^{10}Be with the compact facility at ETH Zurich as well as data from ASTER (presented at this conference) are compared with the corresponding simulations. Also described are effects of the dissociation of molecules (e.g. BeO) in the stripper and beam losses due to small angle scattering. Finally, possible extensions of the program for background estimations are discussed.

TEC#15 **SESSION 7** **Wednesday 23rd March, 0900 - 1040**

Reducing Size and Complexity of Radiocarbon Detection Systems

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ETH Zurich

Since molecular interferences in charge state 1+ can be efficiently suppressed in multiple collisions of ions with stripper gas atoms or molecules, a new class of AMS spectrometers has been developed. Systems operating at the maximum yield of the 1+ charge state can be regarded as state-of-the-art, matching the requirements of high performance radiocarbon dating. At ETH an even more compact spectrometer was developed using a vacuum insulated high voltage platform operated at 200 kV (MICADAS). Such systems are in operation as dedicated instruments for biomedical research and as optimized radiocarbon dating systems. Their superb performance emphasized more laboratories exploit the possibilities of this kind of instrumentation.

Further investigations were performed at ETH to explore the basic principle behind the detection technique of radiocarbon at even lower energies. Dissociation cross section of mass 14 molecules in He gas are fairly constant at energies between 40 and 100 keV and are sufficiently large to reduce the intensity of molecular beams extracted from a graphite target by 10-11 orders of magnitude. The light He stripper gas keeps the distortion of the low energy ion beam small enough that together with a >50% yield for 1+ ions beam transport is still efficient.

These favourable conditions have encouraged us to build a prototype of a radiocarbon detection system using ions as they are extracted from the source and a molecule dissociation unit kept at ground potential. With this purely mass spectrometric system we could clearly demonstrated the feasibility of radiocarbon dating measurements using standard reference materials. A new era for radiocarbon detection seems possible.

TEC#16 **SESSION 7** **Wednesday 23rd March, 0900 - 1040**

Preliminary Studies of Pu Measurement by AMS using PuF_4^-

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[2] CRL Dosimetry Services, Chalk River Laboratories,
[3] IsoTrace Laboratory, University of Toronto

Using targets made with PbF_2 matrices, it is found that a Cs^+ sputter source tends to yield element-specific patterns of fluoride anions that may be beneficially utilised for mass spectrometry. In the case of Pu and U, PuF_4^- and UF_5^- are produced with the highest yield, respectively. This results in a partial chemical separation of PuF_4^- and UF_4^- in the ion source, by reducing the yield of UF_4^- by two orders of magnitude. This, in turn, reduces scattering from U ions when measuring Pu in the high energy components of the AMS system. This could be advantageous in cases that require rapid Pu analyses by simplifying chemistry and by saving steps of Pu/U separation in sample processing. In this case, Pu can be co-precipitated with another element as fluoride, which is then mixed with sufficient amount of PbF_2 powder to form sputter target. A series of tests were carried out and NdF_3 was identified as one such suitable carrier. Measurements of Pu^{+3} at ~0.85MV terminal voltage show that all $^{239,240,241,242}Pu$ isotopes can be detected with a manageably low background, high efficiency and a 1fg detection limit. The preliminary tests were carried out using the existing IsoTrace AMS system, unmodified, except that electronic controls were added to automatically adjust the terminal voltage, along with the injection magnet bouncer and all high-energy electric analyzers. However, both the injection and detection systems were non-optimal for the task, so considerable room is available for pushing the detection limit into the ag range with modern AMS systems – such as that to be commissioned at University of Ottawa.

EAR#15 **SESSION 7** **Wednesday 23rd March, 0900 - 1040**

A catchment level study of soil erosion and soil formation rates using 239Pu and ^{10}Be, in the wet-dry tropics of northern Australia

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The Australian National University

A catchment level study to obtain soil erosion and soil formation rates using plutonium-239 (^{239}Pu) and beryllium-10 (^{10}Be) tracers has been undertaken in the Daly River Basin in the wet-dry tropics of northern Australia. ^{239}Pu, released in the 1950s and 1960s by atmospheric nuclear weapons tests, is used to obtain a quantitative assessment of recent rates of soil loss. Soil cores 40-50 cm deep have been collected from fields with various land uses including peanut and hay cropping and cattle grazing. Cores taken from undisturbed and unburnt areas in open eucalypt woodland have been used as reference sites. The soil loss rates have been established by comparing the excess or deficiency of the ^{239}Pu tracer over that of the reference sites. Since land use practices in the catchment are similar, it is likely that the measured soil loss rates are indicative of soil loss rates over the Daly Basin as well.

Due to agricultural practices, modern soil loss rates can be significantly higher than long-term soil formation rates, but establishing soil formation rates has proved to be a difficult problem. At long-term equilibrium, however, soil formation from the underlying rock is balanced by soil loss from the surface. This long-term rate at which soil is being lost can be determined using the cosmogenic tracer ^{10}Be, created in spallation of atmospheric nitrogen and oxygen by cosmic rays. Since the annual fallout rate of ^{10}Be is known, the complete ^{10}Be inventory over the depth of the top soil can be used to establish the soil formation rates. Three soil cores have been collected to bedrock, with depths ranging from 1-4 m.

The ^{10}Be isotope is also formed *in situ* in rock outcrops rich in quartz (SiO_2). Since these outcrops are close to the present day surface, they must have been eroding at the same rate as the land surface. Hence, the *in situ* ^{10}Be concentrations provide an alternative measure of the soil formation rates, and a number of samples have been collected over a wide area for this purpose. Results from the work carried out to date will be presented.

EAR#16 **SESSION 7** **Wednesday 23rd March, 0900 - 1040**

AMS radiocarbon dating on the Taal Lake cores of central Philippines

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Taal Lake is located ~55 km south of Manila and occupies the Taal Volcano. Core TLS2 (120-cm long) retrieved from 15-m water depth in 2006, was dated by AMS ^{14}C on plant remains. The $\Delta^{14}C$ curve formed by 16 measured samples matches very well with the bomb ^{14}C curve and allows us to establish the chronology of the core which yields a constant sedimentation rate of 2.04cm/year spanning the past 60 years. In 2008, an 84-m long core, Core B2, was drilled from the lake shore. We have selected plant remains (4), carbonate shells (12) and bulk soil carbon samples (13) from 19 core depths for AMS ^{14}C dating. The 29 age dates exhibit that (a) plant remains and shells from the same layers have similar ages, indicating minor reservoir effect due to well mixed water column and strong CO_2 exchange in the lake. (b) Bulk organic carbon has significantly older age than that of shell in the same layer. This old radiocarbon contamination may be caused by reworked sediments and black carbon in the sediments. (c) The 12 shell ^{14}C ages with good age sequence allow us to reconstruct the chronology of Core B2, which illustrate a depositional history of Taal Lake since 6,100 years ago. (d) The ^{14}C ages of bulk organic carbon in the sediments between 35m and 6m depth are much older than the dates below than 35m. We suspect that Taal Volcano had a very strong eruption between 2500 yr BP and 400 yr BP. Large amount of sediments in 6-35m depths were from older sediments. Further investigation will be carried out to pin down this event by dating shell samples and measuring elemental concentrations from this interval. With the reliable chronological control, we are able to interpret depositional history of Taal Lake sediments.

EAR#17 **SESSION 8A** **Wednesday 23rd March, 1110 - 1250**

The dispersion of ^{129}I in the northwest Canadian Arctic and southern Canada

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Nuclear fuel reprocessing has released large amounts of anthropogenic ^{129}I in a number of specific locations, which has led to an increase in the concentration of ^{129}I and its $^{129}I/^{127}I$ ratio in the environment. As a biophilic and mobile radionuclide, ^{129}I is a major contaminant of concern for long term radioactive waste storage. Therefore, a detailed understanding of its movement and concentration in the environment is essential. The Arctic has been identified as a location that may be affected by ^{129}I fallout from fuel reprocessing in Europe and Asia. A comparison of ^{129}I concentrations between Arctic watersheds and water from southern Canada is a valuable tool to judge the amount of contamination in both environments. The most likely source of anthropogenic ^{129}I in southern Canada is atmospheric fallout from the nuclear fuel reprocessing facility in West Valley, NY that closed in 1972. Water samples from large watersheds were collected in the Yukon Territory, Canada starting in Whitehorse (60°43′00″N) and moving north to Tsiigehtchic, Northwest Territory (67°26′26″N). Water samples were also collected in southern Canada at 18 locations from New Brunswick to Saskatchewan. The results have shown that values of iodine up to 27 x 10^6 atoms/L are present in northwest Canada. These quantities substantially exceed literature values for waters containing only geogenic or cosmogenic production. This implies that the contribution of anthropogenic ^{129}I in the Arctic is significant. However, these values are up to five times lower than the levels found in southern Canada, where values reaching 196 x 10^6 atoms/L were measured in southern Ontario. The large differences between the north and south suggest that the Arctic environment is still relatively unaffected compared with southern Canada but that human nuclear activities have caused ^{129}I to become a very widespread contaminant.

EAR#18 **SESSION 8A** **Wednesday 23rd March, 1110 - 1250**

Study for natural iodine isotope system: Implication from $^{129}I/^{127}I$ depth profiles of Indian ocean

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To examine whether the natural iodine is fully mixed in the ocean and whether the initial value previously proposed ($^{129}I/^{127}I$ = 1.5 x 10-12 by Moran et al., 1998) is valid enough, depth profiles from surface to bottom of $^{129}I/^{127}I$ ratio are being measured for seawater samples collected from several points in the Indian ocean spanned from 20°N to 20°S in the latitude along with near the longitude 70°E line on the KH09-5 cruise of R/V Hakuho, JAMSTEC, Japan.

Most samples were collected from CTD-bubble category with 0.2μm filter to avoid microbes or particulates. It is about a thousand year for a surface water column come to deep sea, so dissolved component of anthropogenic ^{129}I could not yet reach deep sea. Microbes or organic particulate component would carry modern iodine more quickly from surface to deep sea, however they should directly cumulate on to sea floor and it would take much more time to release their iodine back into seawater than several decades. Thus $^{129}I/^{127}I$ ratio in dissolved iodine component in deep sea should reflect that of natural origin.

Though AMS measurements of these samples are still under going at MALT, The University of Tokyo, preliminary results show significantly low $^{129}I/^{127}I$ ratio (around 2x10-13) in the middle to deep layer. We will examine about global iodine circulation and the natural initial value of $^{129}I/^{127}I$ ratio through following discussions:

1) How much anthropogenic ^{129}I is contaminated at the surface and how deep and to what extent it intrudes into deeper layer.

2) What a portion is exchanged between particulate iodine and dissolved iodine at each depth of seawater.

3) How much anthropogenic ^{129}I is back into dissolved component in the sea from the bottom sediment.

EAR#19 **SESSION 8A** **Wednesday 23rd March, 1110 - 1250**

Pore-water mobility: Distribution of $\Delta^{37}Cl$, $^{36}Cl/Cl$ ratio and dissolved 4He concentration in the core drilled in the Mobara Gas Field, Japan

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The Mobara Gas Field is not only the major production area for dissolved natural gas but for iodine. Isotopic ratios of $^{36}Cl/Cl$ and $\delta^{37}Cl$, and noble gases concentration dissolved into pore water in the drilled rock core were measured for estimating the pore-water mobility. The $^{36}Cl/Cl$ ratio and concentration of ^{4}He dissolved in pore water suggests that the residence time of pore-water vertically ranges 0.3-1.25 Ma and 0.12 – 1.05 Ma, respectively. They are harmonized with the formation age (of 0.45 – 1 Ma). Furthermore, $\delta^{37}Cl$ (- 0.14±0.13 ~ + 0.45±0.07 ‰) in pore water were measured under the chloride concentration increasing 5000 mg/L to 17000 mg/L at the depth from 642 m to 1902 m below the ground surface. The simulating analyses of $\delta^{37}Cl$ was conducted under the boundary conditions of washing out by freshwater at the depth of 600 m below the ground surface, chloride concentration gradient of 17000/500 ((mg/L)/·m) and diffusion alone without advection flow during the past 0.12 to 0.72 Ma. The fractionation factor for ^{35}Cl and ^{37}Cl was 1.0012. The analyses indicated that the variation of $\delta^{37}Cl$ was significantly happened by diffusion alone. This suggested that mobility of pore water was so small that ^{35}Cl atoms were slightly separated from ^{37}Cl atoms by diffusion. The origin of pore-water was estimated to be connate seawater left in pore of sediments thickly depositing on the slope of continental shelf in deep sea. Consequently, iodine in pore-water was not transported from other places or deep stratum, but was released into pore-water from the deposited sediments, which iodine was retained with a high concentration on organic matters, under a strong reducing condition. Finally, we concluded pore-water was immobile in the deposited sediments and high concentration of iodine and methane was produced in situ.

EAR#20 **SESSION 8A** **Wednesday 23rd March, 1110 - 1250**

Distribution of ^{236}U in Japan Sea: Feasibility of ^{236}U as a tracer of water masses in ocean

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The Japan Sea is a marginal sea of western North Pacific Ocean which is enclosed by four straits. Since the Japan Sea has similar physical process with open ocean, the Japan Sea is called "Miniature ocean" and which is a appropriate analog for the oceanic research. Recently, runup of water temperature, decrease of dissolved oxygen in deep water and escalation of marine pollution have been reported in the Japan Sea. These are urgent Pan-Japan Sea issues, which may be related to global environment change in near future. To take countermeasure to these problems, it is important to investigate the detail of seawater dynamics in the Japan Sea.

In our previous studies, ^{236}U has been found in surface soil as an globalfallout nuclide from nuclear test, which suggests that ^{236}U will be a useful tracer for geochemical dynamics. In sea water, ^{236}U appears to be dissolved as $UO_2(CO_3)_3^{4-}$ after introducing to surface seawater. Thus, ^{236}U has a possibility to be a useful tracer for ocean circulation. In this study, we attempted to get the information on ^{236}U and another globalfallout radionuclides, ^{137}Cs and $^{239+240}Pu$, in the Japan Sea to investigate seawater dynamics. Sea water (7 sites), suspended solid (SS) (7 sites), and sediment (5 sites) samples were collected from the Japan Sea in the summer of 2010 (KH10-02 research cruise). ^{236}U and $^{239+240}Pu$ in water, SS and sediments were measured with accelerator mass spectrometry (AMS) after appropriate sample treatment and purification for those nuclides by using anion exchaning resin. ^{137}Cs in seawater was purified and collected with ammonium molybdophosphate precipitation (AMP), and γ-ray was measured with a low-background Ge spectrometer.

We could measure ^{236}U in the small amount of sea water samples and obtained depth profile of ^{236}U. The results will be given in this presentation.

EAR#21 **SESSION 8A** **Wednesday 23rd March, 1110 - 1250**

Determinations of iodine and $^{129}I/^{127}I$ ratios in hot springs around the Kusatsu-Shirane hydrothermal systems, Japan

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Concentrations of iodine, bromine and chlorine as well as ratios of $^{129}I/^{127}I$ (half-life of ^{129}I: 16 Ma) have been determined in hot springs and crater lake waters around the Kusatsu-Shirane Volcano, which is located at the volcanic front on Honshu Island, Japan. Analytical methods used are AMS (MALT, University of Tokyo) for $^{129}I/^{127}I$ ratios, ICP-MS for iodine and bromine and ion-chromatography for chlorine. Iodine concentrations obtained were markedly higher than those in seawater by factors up to 100, while chlorine concentrations are below that of seawater. Relationships between the increase of halogen concentrations and the volcanic activity (e.g. frequency of earthquakes) of Mt. Kusatsu-Shirane were observed in the crater lake Yugama, in which iodine showed the highest increase among the three halogens. The $^{129}I/^{127}I$ ratios in samples from the crater lake were above the pre-anthropogenic value ($^{129}I/^{127}I$: $1.5x10^{-12}$; Fehn et al., 2007), indicating the presence of anthropogenic ^{129}I through atmospheric precipitation, but ratios in hot springs were generally lower than the pre-anthropogenic ratio. The lowest value (around $0.2x10^{-12}$) is similar to that observed in iodine rich brines collected from deep wells in Chiba, Pacific coast of Honshu Island (Muramatsu et al. 2001) and suggests that iodine in the Kusatsu-Shirane hydrothermal system is derived from subducting marine sediments.

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REP#7 **SESSION 8B** **Wednesday 23rd March, 1110 - 1250**

CologneAMS, a dedicated Centre for Accelerator Mass Spectrometry in Germany

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CologneAMS is a new centre for Accelerator Mass Spectrometry (AMS) at the University of Cologne. It has been funded by the German Research Foundation (DFG) to improve the experimental conditions especially for the German scientists who apply the AMS technique for their research work. The new AMS-facility has been built by High Voltage Engineering Europe (HVEE) and has been set up in the existing accelerator area of the Institute of Nuclear Physics. Special laboratories for sample preparation will be built at the Institute for Geology and Mineralogy. In the future a complete service for sample preparation will be offered for external users. The AMS-facility is designed for the spectrometry of all standard cosmogenic nuclides like ^{10}Be, ^{14}C, ^{26}Al, ^{36}Cl, ^{41}Ca, ^{129}I and in addition to measure sensitively heavy ions up to ^{239}U and ^{244}Pu. The central part of the AMS-facility is a 6 MV TANDETRON accelerator with an all solid state power supply which can deliver a maximum up-charge current of about 750 µA. The accelerator is equipped with foil and gas stripper. The high energy mass spectrometer consists of a 90° dipole magnet (2 m bending radius and 351 AMU MeV mass energy product) and two electrostatic analyzers (35° deflection angle). An additional switching magnet is used as a further filter element and supplies additional ports for future extensions of the existing detector systems. One exit channel is equipped with a device for putting degrader-foils followed by a 120° dipole magnet for suppression of isobaric contaminations like ^{36}S in case of the spectrometry of ^{36}Cl. In this report we will present the actual status of CologneAMS and the results of the first test measurements. In addition, future projects of local groups will be presented.

REP#8 **SESSION 8B** **Wednesday 23rd March, 1110 - 1250**

SUERC ^{36}CL AMS

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SUERC Cl-AMS is of ~550 prepared cathodes annually including field samples, a QA programme and development samples. Gas-stripped 30 MeV $^{36}Cl^{5+}$ ions are made and transported to the detector in ~20% abundance and are there separated from ^{36}S interference with a ~1:100,000 resolution and ~50% efficiency; 15-20 μA $^{35}Cl^{-}$ and machine background ^{36}Cl/Cl<1e-15 are typical [1,2]. Our results and procedures, including use of isotopically-spiked carrier, are described.

References

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REP#9 **SESSION 8B** **Wednesday 23rd March, 1110 - 1250**

Major Programs of AMS laboratory at CIAE in recent 12 years

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Several AMS conferences have been convened since we last reported on the status of the AMS program based on the HI-13 tandem accelerator at the China Institute of Atomic Energy (CIAE) in AMS-8, 1999, Vienna. The HI-13 accelerator is best suited for AMS of medium to heavy nuclides owing to its high terminal voltage and large magnets that, as a general rule, improve the identification of heavy nuclides. As described in last report, the HI-13 tandem accelerator in CIAE is a multi-user facility, and for many years only a small part of beam time had been allocated to AMS. The research had been mainly focused on limited common AMS nuclides, such as ^{10}Be, ^{36}Cl, ^{26}Al, ^{41}Ca, and their applications. On the request of CIAE AMS group, the AMS beam time has been increased in recent years. That enabled us to implement a series of programs on the facility upgrading, the improved techniques for nuclides previously measured, and the establishment of measurement procedures for some new nuclides. A series of projects are being implemented or planned for AMS measurements of some fission products such as ^{79}Se, ^{93}Zr, ^{99}Tc, ^{107}Pd, ^{121m}Sn, ^{126}Sn, and heavy nuclides such as ^{182}Hf, ^{210}Po, ^{236}U etc which have great potential in the fields of geoscience, environmental science, astrophysics, and nuclear environment engineering. It is worth mentioning that a new dedicated 6 MV AMS is being schemed and will be set up at CIAE in the near future. After that, the range of measurable nuclides will be wider, and the scope of applications broader. Major progresses already achieved in methodology and relevant applications of AMS at CIAE, and future perspectives will be briefly presented.

SAM#1 **SESSION 8B** **Wednesday 23rd March, 1110 - 1250**

The role of chemistry in setting-up a new AMS facility

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Medium-energy AMS facilities such as the British 5 MV-NEC machine at "SUERC", the French 5 MV-HVEE-machine "ASTER" and the two German 6 MV-HVEE-machines "DREAMS" at Dresden [1] and "Cologne AMS" have been recently installed in Central Europe. Of course, these machines need physicists to get them running but also scientists to establish AMS chemistry on-site. As it is not advisable to change simultaneously two "things", i.e. machine and chemistry, a close cooperation with the teams of ASTER and VERA helped to check the new sample preparation laboratories of DREAMS.

Generally, a "good" AMS sample has two features: high stable isotope current and low isobar concentration. High chemical yields and low concentrations of other elements originating from the matrix or chemical products used are less important, but may play a role if e.g. a matrix contains Ti being introduced into BeO-targets as shown by µ-XRF [2] and recent µ-PIXE analyses of final AMS-targets at HZDR. A processing blank with low radionuclide/stable nuclide ratio is, however, essential for projects near the detection limit. For high sample throughput and reasonable costs a fast, easy and cheap chemical separation is also favourable.

The results from first samples processed at DREAMS are excellent: For ^{10}Be-AMS-targets isolated from quartz-rich river sediments (Himalaya, erosion rate study) ^{9}Be-currents had been as high as ASTER standards and machine blanks. Corresponding processing blanks were in the same order as the machine blank ($1x10^{-15}$), thus, more than one order of magnitude lower than the lowest sample ratio. Chlorine-36 targets originating from calcite-rich boulders from a medieval rockfall had been well-measurable with blank-corrections lower than 8 %. Finally, ^{36}Cl prepared from river terraces (Anatolian Plateau, Turkey, uplift rate study) showed also perfect performance at VERA.

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Acknowledgments: Thanks to T. Schildgen and C. Yildirim (Potsdam) performing ^{36}Cl chemistry tests at DREAMS.

SAM#2 **SESSION 8B** **Wednesday 23rd March, 1110 - 1250**

Progress in measurement of 182Hf with AMS at CIAE

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AMS measurement of ^{182}Hf was first developed at CIAE in 2006[1]. Since then, a series of measures have been taken to improve the sensitivity and measurement accuracy. In 2007, a dedicated injection system with high mass resolution was installed to separate the interferences with neighboring molecular weight from $^{182}HfF_5^-$. In order to increase the beam current, a method based on solid-phase reaction for the preparation of HfF_4 samples from HfO_2 was developed in 2008[2]. In 2009, the Electrostatic Analyzer on the high-energy side of the AMS system was redesigned, consequently the unwanted high energy tail of ^{180}Hf was cut successfully[3]. At the same time, the transmission efficiency was increased by about 3 times, compared with that of original setup.

Also, the measurement procedure has been further optimized. In 2009, the offset faraday cup on the image side of the injection magnet was used to monitoring the current of $^{180}HfF_5^-$, which is proportional to that of the Offset Cup. In this way, the counts of ^{182}Hf measured in the target chamber and the current of $^{180}HfF_5^-$ from the offset Faraday cup can be obtained simultaneously.
Recently, the preparation of HfF_4 samples has been further improved by changing reaction temperature. Consequently, the efficiency of fluorination was increased to a certain extent, and a corresponding reduction of ^{182}W, a major interference in AMS measurement of ^{182}Hf, is expected to be achieved.

Now, a sensitivity of 1.0×10^{-11} (^{182}Hf/^{180}Hf) has been achieved, which is the best so far obtained in our lab[2,3]. Further study will be focused on the improvement in efficiency and measurement accuracy.

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GLO#12 **SESSION 9A** **Wednesday 23rd March, 1400 – 1540**

Evaluating cosmogenic exposure ages of boulders from glacial deposits

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Cosmogenic exposure dating has greatly enhanced our ability to determine glacial chronologies, and glacially-deposited boulder exposure ages are now routinely used to constrain deglaciation ages. However, exposure dating involves assumptions about the geological history of the boulders that may impact the inferred age. There are two primary geological factors that can result in erroneous ages: exposure of the boulders prior to glaciation (yielding exposure ages that are too old) and post-depositional processes that effectively change the integrated shielding of the boulders (yielding exposure ages that are too young). We have analyzed datasets of boulder exposure ages. The datasets we have used include boulder ^{10}Be exposure ages from the Tibetan Plateau (1272 boulders), Northern Hemisphere palaeo-ice sheets (631 boulders), and present-day glaciers (208 boulders). Our observation is that no boulders from present-day glaciers and few boulders from the palaeo-ice sheets have exposure ages significantly older than independently known deglaciation ages. Evidently, at least for this dataset, prior exposure of the boulders to cosmic rays is not a significant factor. What is clearly observed is that the spread in the boulder ages from individual features increases with increasing landform age. Prior exposure could in principle account for this spread but this would seemingly demand that the prior exposure is not occurring on younger features. A more plausible explanation is that the spread in boulder ages is attributable to post-depositional processes. We have developed a model, based on post-depositional processes, that qualitatively accounts for this spread in ages. Based on the large dataset and the results of our modelling we believe, in the absence of other evidence, that glacial boulder exposure ages should be viewed as minimum limiting deglaciation ages.

GLO#13 **SESSION 9A** **Wednesday 23rd March, 1400 – 1540**

Quantifying geomorphic process rates in Alpine landscapes with cosmogenic nuclides

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Meaningful geomorphic process rates are notoriously difficult to measure in mountainous settings, as many of the erosional systems operate according to negative frequency-magnitude relationships. Measurement timescales are typically limited to <100 years for direct observation. Based on the negative relationship between event frequency and magnitude, this means that we tend to miss the largest, and potentially most effective, events. Cosmogenic nuclides provide a means of measuring these rates over 1000-100000 year timescales. Such studies in the European Alps have yielded promising, and occasionally surprising results.

At the largest scale, ^{10}Be-derived denudation rates have shed light on the complex tectonic architecture of the European Alps. The Central Alps show a consistent trend of denudation rates across the entire mountain belt, compatible with isostatic compensation in a decaying orogen, while the denudation in the Eastern Alps is highly variable, reflecting multiple controls such as the metamorphic and tectonic fabric of bedrock, soil cover, and rock uplift due to ongoing convergence. Cosmogenic nuclides have also been applied at the drainage basin scale to investigate the impact of glacial-interglacial transitions on channels and hillslopes. Denudation rates from the Swiss Mittelland record rapid post-glacial hillslope stripping followed by incision into relict surfaces. Cosmogenic nuclides can also be used as sediment tracers. Debris flow basins in the Italian Alps supply disproportionately large amounts of sediment to the trunk streams. Detailed sampling of both streams and soils in the high Swiss Alps also provide evidence for focused erosion from rock fall and debris flow basins. Denudation rates of soil-mantled slopes are up to an order of magnitude slower than the adjacent rock slopes. When combined with soil mass loss, the ^{10}Be derived soil erosion rates provide the first measurements supporting the notion that rapid physical erosion may not yield rapid chemical weathering.

GLO#14 **SESSION 9A** **Wednesday 23rd March, 1400 – 1540**

Paleoclimate and environmental change of the Potrok Aike, Argentina using beryllium isotopes

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Recently, an investigation of paleoclimate and environmental change using beryllium isotopes was accomplished using a 19 m core obtained from the Laguna Potrok Aike, Argentina as a part of SALSA (South Argentinean Lake Sediment Archives and Modelling) program. This study shows the sedimentary records of beryllium isotopes are associated with its hydrological balance, and also a strong signal of paleoclimate change was observed for the past 16,000 ca. BP. For warmer period, both the concentrations of beryllium isotopes were relatively high similar to previous studies elsewhere. As a new investigation as part of the International Continental Scientific Drilling Program (ICDP) program (PASADO: the Potrok Aike Maar Lake Sediment Archive Drilling Project), we are investigating a high resolution beryllium record for a 102 m length core. Our preliminary investigation of beryllium study of the SLASA project was accomplished as a sample depth of 1 m interval. The sample depth interval for new investigation is mostly involved in 16 cm, and the corresponding age span is about 700 kyr. Considering of the sedimentation rate of this site (approx. 1 mm/y), we expect that unravelling recent climate change is feasible using top few meters. Also, the issue of ^{10}Be flux increase around 12,000 cal BP observed by Muscheler et al. 2004, in the GRIP ice core may be identified by this study. Along with beryllium isotopes, major chemical fluxes are compared for our study. Especially, Ca and Sr balance in the lake environment will guide us hydrological balance. Our presentation will introduce recent lacustrine environment of Laguna Potrok Aike for 16,000 cal. BP using the results from both SALSA and PASADO programs. This study may be a useful approach for understanding climate change for this region as well as global scale of paleoclimate change.

GLO#15 **SESSION 9A** **Wednesday 23rd March, 1400 – 1540**

Overturned mega boulders on coastal cliff-tops and in bedrock river channels : can cosmogenic nuclides constrain tsunami and palaeo-flood events in Australia?

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Jacks Waterhole at the Durack River in the Kimberley region of north west Australia is an exposed bedrock paleo-channel, excavated by hydraulic plucking of well-jointed bedrock. This section of the channel consist of arc-shaped disconnected stacks of imbricated meter-sized slabs dislodged from bedrock steps immediately upstream of the boulder-filled channel. The semi-arid climate is punctuated by summer tropical storms/cyclones causing occasional violent floods. High magnitude floods with high flow velocities are required to erode and transport such large rock slabs.

Along the south-eastern Australian coastline, at Little Beecroft Head, large detached sandstone boulders are found unconformably on horizontal cliff top escarpments and benches of identical lithology some 20-35 meters above present day sea-level. For some boulders, local stratigraphy indicates transport from the nearby cliff face, implicating tsunami or exceptional storm events. In other cases, an interpretation of differential erodibility along bedding strata, slow emergence and preservation from the contemporary platform is applicable.

For both locations, detailed geomorphic mapping, cross-bedding orientation and tracing from the identified detachment site clearly indicates that boulders have experienced at least one flipping event. Consequently, previously buried surfaces are instantaneously exposed to an enhanced production rate of cosmogenic nuclides. The possibility of dating the 'flipping' event depends largely on a comparison of measured cosmogenic concentrations from 4 surfaces (upper and lower boulder, shielded and exposed bedrock) to that predicted on the boulder as a function of boulder thickness.

In this paper, we describe our model and its sensitivity to boulder thickness, inheritance and post-flipping time. Preliminary results of ^{10}Be and 26Al analysis from flipped and non-flipped boulders at Jack's Waterhole and Little Beecroft Head are given.

GLO#16 **SESSION 9A** **Wednesday 23rd March, 1400 – 1540**

In-situ cosmogenic exposure dating in the Meirs and Garwood Valleys, Denton Hills, Antarctica

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It has been hypothesised that during interglacials, thinning of the Ross Ice Shelf allowed a more open water environment with increased local precipitation. This resulted in adjacent glaciers within the Transantarctic Mountains to advance during moist warmer periods, apparently out of phase with colder arid dry periods.

The geomorphology of the Denton Hills in the Royal Society Range, West Antarctica, is a result of Miocene fluvial incision reworked by subsequent warm and cold-based glacial advances throughout the Quaternary. Outlet glacials, which drain ice into the Shelf, should thus show maximum extent during interstadials. To understand the chronology of late Quaternary glaciations, 15 granitic boulders from terminal moraines in the Garwood and Miers Valleys were sampled for ^{10}Be and ^{26}Al cosmogenic dating.

Obtaining reliable exposure ages of erratics within moraines that represent timing of deposition (i.e. glacial advances) is problematic in polar regions, where glacial activity is principally controlled by ice sheet dynamics. Recycling of previously exposed debris, uncertainty in provenance of glacially transported boulders and a lack of a post-depositional hydrologic process to remove previously exposed material from a valley system, leads to ambiguities in multiple exposure ages from a single coeval glacial landform. More importantly, cold-based ice advance can leave a landform unmodified resulting in young erratics deposited on bedrock that shows weathering and/or inconsistent age-altitude relationships. Primarily, inheritance becomes a difficulty in qualifying exposure ages from polar regions.

Preliminary results based on average ages indicate that glaciers in the Denton Hills advanced to their maximum position between 30-35 ka, earlier than the Antarctic LGM (18-22 ka), then retreated leaving little evidence of late interglacial or Holocene advances. However, accounting for inheritance and taking the youngest ^{10}Be ages, advance occurs at 20-22ka during the LGM. Hence support for the out-of-phase hypothesis depends largely on the exposure age model adopted.

SAM#3 **SESSION 9B** **Wednesday 23rd March, 1400 – 1540**

Separation of microgram carrier free iodine from geological and environmental samples for AMS determination of ultra low level ^{129}I

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Separation of carrier free iodine from low iodine level samples and accurate measurement of ultra low level ^{129}I in microgram iodine target are of essential but bottleneck in geological dating of terrestrial system and tracer research using naturally produced ^{129}I. In this work, we present a carrier free method using coprecipitation of AgI with AgCl for preparing micrograms of iodine target, associated with combustion using a tube furnace for separating iodine from solid samples and anion chromatography for pre-concentrating iodine from large volume of water. An accelerator mass spectrometry was used to measure ultra low level ^{129}I in microgram iodine target. The recovery of iodine in the entire separation procedure is higher than 80% and 65% for solid and water samples respectively. One microgram iodine target (AgI-AgCl) can produce a stable ^{127}I signal for AMS measurement of ^{129}I/^{127}I, and a detection limit of this method for ^{129}I is calculated to be 10^5 atoms. This will allow us to accurately determine ^{129}I in pre-nuclear geological samples of low iodine concentration with ^{129}I/^{127}I of 10^{-12}, such as loess, soil, coral, rock, sediment, and ground water. Some quaternary sediments with low iodine content have been successfully analyzed, and the lowest value of ^{129}I/^{127}I ratio of 2×10^{-11} was observed in 23.5m and 63.5m loess samples collected in loess plateau, China. The developed method sheds light on a wide application in the earth science.

SAM#4 **SESSION 9B** **Wednesday 23rd March, 1400 – 1540**

Screening criteria for the radiocarbon dating of bone apatite

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Radiocarbon dating of bone apatite remains a difficult task given the relative easiness with which the *in vivo* ^{14}C bone apatite signal is diagenetically altered by the deposition of secondary carbonate minerals, precipitation of authigenic apatite, crystal growth, and carbonate exchange.

For the last thirty years, sporadic research has been undertaken into cleaning treatments, mainly relying on a weak acid treatment, of contaminated bone apatite. The results obtained have, however, failed to provide a consistent agreement with reference ages. In particular, criteria to assess apatite radiocarbon dating reliability are still lacking.

Simultaneously, during the last decades, significant research has been undertaken into preservation assessment of soil deposited bone material. This opens the possibility of combining much of the existing research to define criteria for the preservation status of bioapatite. Established criteria should permit the screening and selection of viable dating targets, and provide guidelines for sample tailored cleaning protocols.

A systematic research project is currently under way to identify the optimal preservation criteria of bioapatite in archaeological human long bones. Six human long bones, originating from a single Neolithic German site, have been radiocarbon dated both for collagen and apatite, with the level of agreement between the two dates providing an indication of exogenous carbon contamination. Several techniques have been employed to determine the preservation status of each sample's bioapatite. In addition, ^{15}N measurements on bone collagen and ^{13}C on both collagen and apatite were used to identify possible dietary effects. Study of the bone microstructure alterations were studied using histological analysis. Crystallinity, crystal size, and shape were determined using SAXS, XRD, FTIR, and TEM. The uptake of trace elements along each bone's radial profile were determined using LA-ICP-MS combined with micro-FTIR to establish a possible relationship with variations in inner bone crystallinity. Cortical bone porosity estimated by tomographic measurements. We will present the results of these tests and their correlation in the assessment of reliable bio apatite ^{14}C dating.

SAM#5 **SESSION 9B** **Wednesday 23rd March, 1400 – 1540**

Development of a nanofiltration method for bone collagen dating

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Ultrafiltration of bone collagen, dissolved as gelatin (M ~100,000 D), has received considerable attention as a means to obtain more reliable dates (Brown et al. 1988; Bronk Ramsey et al. 2004; Higham et al. 2006; Mellars 2006). Ultrafiltration is an effective method of removal of low-molecular weight contaminants from bone collagen but it does not remove high-molecular weight contaminants, such as cross-linked humic collagen complexes (Brock et al. 2007). However, comparative dating studies have raised the question whether this cleaning step itself may introduce contamination with carbon from the filters used (Bronk Ramsey et al. 2004; Brock et al. 2007; Hüls et al. 2007; Hüls et al. 2009).

In this research bone collagen was hot acid hydrolyzed to amino acids. Hot acid hydrolysis releases practically all of the amino acids bound to humic acids (Griffith et al. 1976). The hydrolysate was then nanofiltered. A ceramic nanofilter was used to avoid carbon contamination. We choose a filter with a cutoff of 450 Dalton in order to collect the amino acids in the permeate (The M of amino acids vary between 75.07 and 204.23 Dalton) and the humic substances in the retentate.

Two nanofiltration methods, dead end filtration and cross flow filtration, were tested. Humic acid solutions and collagen-humic acid mixtures were hydrolysed, filtered and analyzed with different techniques (spectrofluorescence, High performance liquid chromatography and ^{14}C dating). Cross flow nanofiltration indicates the most efficient removal of humic substances.

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Bronk Ramsey C, Higham T, Bowles A, Hedges R. 2004. Improvements to the pretreatment of bone at Oxford. *Radiocarbon* 46(1):155–63.

Brown TA, Nelson DE, Vogel JS, Southon JR. 1988. Improved collagen extraction by modified Longin

method. *Radiocarbon* 30(2):171–7.

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Hüls CM, Grootes PM, Nadeau M-J. 2007. How clean is ultra filtration cleaning of bone collagen? *Radiocarbon* 49(2):193–200.

Hüls CM, Grootes PM, Nadeau M-J. 2009. Ultrafiltration : Boon or bane? *Radiocarbon* 51(2):613–625.

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SAM#6 **SESSION 9B** **Wednesday 23rd March, 1400 – 1540**

Influence of pH changes on graphitic components in Archaeological Charcoal

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The main motivation for this work is the need for alternative ^{14}C pre-treatment methods for charcoal samples that do not survive the standard Acid-Base-Acid (ABA) without compromising the accuracy and precision of the date. Charcoal obtained from burning wood and seeds at temperatures above 400°C have similar molecular compositions and structures, mainly represented by stacks of graphene layers parallel to each other [1]. These graphitic components are considered the most stable in charcoal, and are therefore the most suitable fraction to recover for radiocarbon measurement. Post-depositional processes play a decisive role in preservation or degradation of charcoal and it has been observed that charcoal is usually absent -or at best present as microcharcoal- in alkaline environments. In contrast, it has been suggested that paleo-pH changes from alkaline to acidic and then back to alkaline conditions in the sediments surrounding the charcoal may contribute to its preservation.

In this work we examine the chemical composition (FTIR), thermal decomposition (DTA/TGA) and structural stability (TEM) of poorly preserved charcoal and micro-charcoal from wood and seeds preserved in different environments upon ABA chemical treatment. The influence of pH on the stability of the graphitic components during treatment in the laboratory is compared in charcoal samples from different archaeological sites. The feasibility of using HF to effectively remove clay mixed with micro-charcoal has been studied. Its influence on the radiocarbon age and on the graphitic components is discussed.

References:

1. F. Braadbaart, I. Poole, A.A. van Brussel, Preservation potential of charcoal in alkaline environments: an experimental approach and implications for the archaeological record, J AS 36 (2009) 1672-1679.
2. Rebollo NR, Cohen-Ofri I, Popovitz-Biro R, Bar-Yosef O, Meignen L, Goldberg P, Weiner S & Boaretto E, Structural characterization of charcoal exposed to high and low pH: implications for ^{14}C sample preparation and charcoal preservation. Radiocarbon 50 (2008) 289-307.

SAM#7 **SESSION 9B** **Wednesday 23rd March, 1400 – 1540**

Compound specific radiocarbon content of lignin oxidation products from the altamaha river and coastal georgia

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University of Georgia

Compound-specific isotope analysis (CSIA) is a powerful tool in organic geochemistry by providing detailed information about individual organic compound's history with regard to source and process of formation. Most CSIA involves measurement of the stable isotope ratio of carbon (^{13}C /^{12}C) and hydrogen (D/H) following separation by gas or liquid chromatography. New applications are being developed using compound-specific radiocarbon (^{14}C) content for delineating age of materials, rates of decomposition and residence time in various environments. This paper details the isotopic work on specific lignin monomers derived from terrestrial plants transported and deposited within the Altamaha River, Estuary and the South Atlantic Bite off the Georgia coast. By using gas chromatographic separation and identification of selected lignin oxidation products (LOP), harvesting of these compounds using preparative fraction collection, and measurement of their ^{14}C content using accelerator mass spectrometry, details of the age and presence of specific biomarkers unique to a given terrestrial source are revealed. Challenges encountered in the method with regard to derivatization of the less volatile lignin phenols, their correction algorithms and the impact of background ^{14}C activity in this application are reviewed. Radiocarbon ages determined from water-column particulate organic carbon and sediment LOP indicate a range of ages from modern to well over 5Ky for the former and latter. Transport mechanisms and particle size associations on mineral grains may play a significant role in ^{14}C distribution in estuary and coastal environments. This data indicates post-modern ^{14}C activity in larger particle-size sediment in contrast to older LOP ^{14}C ages found associated with large, coarse grain sediments. Individual LOP ^{14}C ages substantiate older terrestrial carbon persist in the off-shore environment although minor in quantity relative to modern marine ^{14}C sources.

TEC#17 **SESSION 10** **Thursday 24th March, 0900 – 1040**

On-line Ion Chemistry for the AMS Analysis of 90Sr and 135,137Cs

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The analysis of ^{90}Sr by AMS has so far required the use of very large tandem accelerators in order to separate the isobar ^{90}Zr by the rate-of-energy-loss method. The analysis of $^{135,137}Cs$ by AMS has never been attempted as the separation of the isobars $^{135,137}Ba$ by the traditional method requires even higher energies, so that this approach would become prohibitively expensive for routine analysis. Following the successful demonstration of Cl^-–S^- separation by the Isobar Separator, the same apparatus was used to test the separation of other pairs of isobars. Surprisingly effective results were obtained with NO_2 gas in the cases of SrF_3^-–ZrF_3^- and CsF_2^-–BaF_2^- separations. Reduction factors of $\sim 4\times10^{-6}$ for ZrF_3^-/SrF_3^- and $\sim 2\times10^{-5}$ for BaF_2^-/CsF_2^- were measured. SrF_3^- and CsF_2^- are both super-halogen anions and are preferentially produced in the ion source rather than ZrF_3^- and BaF_2^- when using the PbF_2 matrix-assisted method. Reduction factors for ion source production with such targets of $\sim 3\times10^{-5}$ for ZrF_3^-–SrF_3^- and $\sim 5\times10^{-4}$ for BaF_2^-–CsF_2^- were found. The combined methods would suggest a theoretical detection sensitivity for $^{90}Sr/Sr \sim 6\times10^{-18}$, $^{135}Cs/Cs \sim 7\times10^{-15}$ and $^{137}Cs/Cs \sim 1\times10^{-14}$, assuming 10ppm Zr and Ba contamination in the samples. In addition to the earlier Cl^-–S^- separation work, these measurements further illustrate the potential of on-line ion chemical methods for broadening the analytical scope of small AMS systems.

REP#10 **SESSION 10** **Thursday 24th March, 0900 – 1040**

Strange bedfellows: the curious case of STAR and MOATA

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The 2 MV tandem accelerator named 'STAR' was installed at ANSTO in 2003 and commissioned in 2004. It is used for ion beam analysis (IBA) and for radiocarbon measurements by accelerator mass spectrometry (AMS). Convenient space for the accelerator was found in the same building occupied by the decommissioned Argonaut-class nuclear reactor 'MOATA'; the name derives from the aboriginal word for 'gentle firestick', appropriate for a 100 kW research reactor. This reactor operated between 1961 and 1995.

In 2007 ANSTO's Engineering Division assembled a team to dismantle and remove the reactor structure, along with its 12 tonnes of graphite reflector. The removal and remediation was completed in November 2010 and has won the team a number of prestigious awards. The entire operation was conducted inside a negatively- pressurised double-walled vinyl tent. An air curtain was positioned around the reactor core. The exhaust air from the tent passed through 2-stage HEPA filters before venting through an external stack. Neither ANSTO staff nor contractors received any significant radiation dose during the operation.

Given the sensitivity of STAR for detection of $^{14}C/^{12}C$ ($\sim 10^{-16}$) and the numerous routes for production of ^{14}C in the reactor such as $^{13}C(n,\gamma)^{14}C$, $^{14}N(n,p)^{14}C$ and $^{17}O(n,\alpha)^{14}C$ there was the potential to directly contaminate the STAR environment with ^{14}C. Furthermore, there was concern that reactor-^{14}C could find its way from this building into the building where the radiocarbon sample preparation laboratories are located. This necessitated restrictions on staff movement between the buildings.

We report on ^{14}C measurements made during and after the operation. These involved direct measurements on the reactor graphite and concrete bioshield, blank targets that were exposed in the building, swipe samples taken inside the tent and around the building and aerosol samples that were collected inside the building throughout the operation.

REP#11 **SESSION 10** **Thursday 24th March, 0900 – 1040**

A versatile gas interface for routine radiocarbon analyses with a gas ion source

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In the last year more than 500 real gas samples were measured with the gas ion source at the MIni CArbon DAting System (MICADAS) at ETH Zurich and the number of measurements is rising quickly. While most samples contain presently less than 50 µg C, the gas ion source is attractive as well for larger samples because any time-consuming graphitization is omitted. Additionally, modern samples are now measured down to 5 per-mil counting statistics in less than 30 minutes with the improved gas source.

A versatile gas interface allows continuous and stable measurements of different kinds of samples. A stepping motor driven syringe presses the CO_2 of a sample continuously into the gas ion source [1]. Today, samples can be provided in four principally different ways. As a primary method, CO_2 is delivered in glass or quartz ampoules [2]. In this case, the CO_2 is released in an automated cracker with 8 positions for individual samples. Second, samples are combusted in an elemental analyser (EA) and the formed CO_2 is transferred to the syringe via a zeolite trap [3]. Third, CO_2 is released from carbonates with phosphoric acid in septum-sealed vials from where it is transported in a He flow to the same trap used with the EA. An auto-sampler allows to access different sample prepared in vials. Finally, a thermo-optical OC/EC analyzer can be used for the step-wise combustion of aerosols [4]. The first 3 methods allow fully automated measurements of samples, even though minor user input is still required at present.

An overview of the present measurement capabilities and routine analyses will be given by means of examples.

[1] M. Ruff, et al., Radiocarbon 49 (2007) 307.

[2] S.M. Fahrni et al., NIMB (2010) 787.

[3] M. Ruff et al., Radiocarbon 52 (2010) 1645.

[4] N. Perron et al., Radiocarbon 52 (2010) 761.

REP#12 **SESSION 10** **Thursday 24th March, 0900 – 1040**

Can biomedical and traditional applications of radiocarbon dating co-exist at the same AMS facility?

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Accium BioSciences

Biomedical applications of radiocarbon AMS measurements are mistakenly considered to exclusively produce "hot" samples requiring no more than 3–5% precision and accuracy. This is not the case. As a matter of fact more than 50% of all samples we measured in 2010 had a fraction of modern value lower than 1 and an additional 25% were between 1 and 2. Biomedical applications require the full extent of precision and sensitivity offered by a carbon-based AMS, with $^{14}C/^{12}C$ ratios ranging from background (low 10^{-16}) up to the equivalent of 100-times-modern samples. It is therefore essential to prevent all forms of cross-contamination between samples, either during chemical procedures or as memory effects in the ion source.

In this paper we present a series of controlled experiments we conducted with the purpose of isolating the most likely cross-contamination pathways. Various components and chemicals routinely used for the production of graphite were exposed to 'hot' CO_2. The materials most likely to absorb contaminants were identified and new procedures were established to minimize the risk of cross-contamination. We thereby demonstrated that biomedical and more traditional application of radiocarbon dating, such as dating of precious historical artefacts [1], can co-exist at the same state-of-the-art facility.

[1] U. Zoppi, G. Kawasaki and N. Dorman (2010) The dating of the Seattle Art Museum's Italian room, this book of abstracts.

LIF#1 **SESSION 10** **Thursday 24th March, 0900 – 1040**

Bomb-Pulse Biology

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The past decade has seen an explosion in use of the ^{14}C bomb-pulse to answer fundamental cell biology questions. Studies in the 1960's used decay counting to measure tissue turnover when the atmospheric $^{14}C/C$ concentration was changing rapidly. Today bulk tissue measurements are of marginal interest since most of the carbon in the tissue resides in proteins, lipids and carbohydrates that turn over rapidly. Specific cell types with specialized functions are the focus of current cell turnover investigations. Tissue samples serving as the sources of the specific cell type need to be fresh or frozen. Fixation or preservation of tissue samples introduces petroleum-derived carbon that cannot be totally removed. Cell or nuclear surface markers are used to sort specific cell types, typically by fluorescence-activated cell sorting (FACS). Specific biomolecules then need to be isolated with high purity from these cell populations and AMS measurements must accommodate samples that generally contain less than 40 micrograms of carbon. Independent means such as UV absorbance must be used to confirm molecule purity. Furthermore, the sample isolation and preparation must not introduce new carbon to the sample. We describe approaches for separating specific proteins and DNA and for combating contamination of undesired molecules. This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.

LIF#2 **SESSION 11A** **Thursday 24th March, 1110 – 1250**

Biological Accelerator Mass Spectrometry at Uppsala University

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Uppsala University

A status report is presented concerning the biological accelerator mass spectrometry activity at Uppsala University. The research utilizes the Uppsala University Tandem laboratory facilities, including a 5 MV Pelletron tandem accelerator and two stable isotope ratio mass spectrometers. In addition, a dedicated sample preparation laboratory for biological samples with natural activity is in use, as well as a second laboratory specifically for ^{14}C -labelled samples with elevated levels of carbon-14. A variety of projects are described and presented. Examples are: 1) Ultra-small sample AMS. We routinely analyze samples down to a few µg C. Data is presented regarding the sample preparation method, 2) Bomb peak Biological dating of ultra-small samples. A long term project is presented where purified and cell-specific DNA from various part of the human body including the heart and the brain are analyzed with the aim of extracting regeneration rate of the various human cells, 3) Bomb peak biological dating of various human biopsies, including atherosclerosis related plaques. The average built up time of the surgically removed human carotid plaques have been measured and correlated to various data including the level of insulin in the human blood, and 4) In addition to standard Microdosing type measurements using small pharmaceutical drugs, pre-clinical pharmacokinetic data from a number macromolecular drug candidates (e.g peptide) are presented.

LIF#3 **SESSION 11A** **Thursday 24th March, 1110 – 1250**

^{14}C bomb peak dating of human DNA samples at the microgram level

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The preparation of carbon samples below 10 µg for ^{14}C AMS measurements is still a challenging task. In a collaboration between the Karolinska Institute in Stockholm and the VERA Laboratory in Vienna, we developed graphite sample preparation methods in the µg range for measuring ^{14}C in genomic DNA extracted from neuronal cells of the human brain. Emphasis was put on the reduction of carbon background throughout the whole sample preparation process. For this procedure DNA material from neurons of known age, consequently with a known ^{14}C/^{12}C ratio, was used. The mass of the carbon background from AMS sample preparation involving freeze drying of aqueous DNA solution, combustion and graphitization could be reduced to < 0.2 µg carbon. AMS measurements allowed us to conclude that it contained no ^{14}C. There is an additional background adhered to the DNA samples, most likely consisting mainly of proteins, with carbon of 8.8 ± 4.4 % of the DNA carbon mass. However, its influence on the ^{14}C measurement results of DNA generated during the bomb peak era is minor due to its modern ^{14}C content (F^{14}C (fraction modern carbon) = 1.07 ± 0.13). Furthermore, carbon background additions during the separation of cell type and extraction of DNA were observed to be negligible.

^{14}C measurements of µg-size DNA samples allows one to perform retrospective ^{14}C bomb peak dating [1] of neurons from the human olfactory bulb, thereby studying possible neurogenesis in this small region of the human brain. First ^{14}C AMS measurements from this material were performed with graphitized samples between 2.3 and 3.7 µg C. A precision of 1.8 to 3.5 % for ^{14}C/^{12}C ratio measurements could be achieved. Sample preparation and carbon background investigations currently applied at VERA for µg-size carbon samples will be presented. Furthermore, the potential of applying the method to study the human olfactory bulb will be discussed.

[1] K. L. Spalding et al., Retrospective Birth Dating of Cells in Humans, *Cell* 122 (2005) 133.

ARC#1 **SESSION 11A** **Thursday 24th March, 1110 – 1250**

Accelerator Mass Spectrometry ^{14}C Dating of Lime Mortars: Methodological Aspects and Field Study Application at CIRCE (Italy)

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Centre for Isotopic Research on Cultural and Environmental heritage (CIRCE) has, recently, begun an intensive testing campaign on the feasibility of Dead Carbon contamination suppression by means of a laboratory procedure on a series of simplified mortars. Observed results confirmed the overall successful character of the proposed methodology encouraging its comparison with radiocarbon dating of other materials/mortar-fractions on real study cases. Several authors reported the possibility to achieve accurate radiocarbon dating of mortar matrices by isolating lime lumps.

In this paper preliminary data for the absolute chronology reconstruction of the cemetery complex of Ponte della Lama (Canosa di Puglia, Italy), with a specific emphasis on the Basilica, will be discussed. The interest on this structure is due to the coexistence of different interpretations both on the age and attendance/rehash of the building and its role in the complex.

Preliminary petrographic characterization of sampled mortars (i.e. thin section microscope analysis), performed on a representative number of samples of each stratigraphic unit (SU), indicates the coexistence of different sources of carbonates (i.e. calcination residues and calcareous aggregates).

Hereby, a comparison between the absolute chronology of samples performed by lime lumps, charcoal (when found) and CIRCE laboratory isolated fractions will be shown and a preliminary reconstruction of the chronology of the basilica will be discussed. Accuracy of the procedure will be quantified by comparing ^{14}C data on a funerary inscription found in the context of the same site of presumed known age.

ARC#2 **SESSION 11A** **Thursday 24th March, 1110 – 1250**

The Radiocarbon Ages of Sorori Ancient Rice of Korea

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The Sorori Paleolithic site is located at Sorori, Oksan-myeon, Cheong-won County in Chungchungbuk-do, Korea. The excavation of this paleolithic site has been carried from 1994 to 1998 by Chungbuk National University. There are 46 paleolithic sites in Korean peninsula. These are either open site or cave site [1]. Before the development of the Ochang Industrial Complex, during the field-survey for cultural properties at the area, many lithic tools (chopper, scrapers, points, etc) were discovered. The Sorori is located around the Kum River in Kongju and from this site, peat layers and 51 grains of rice samples were collected. Radiocarbon ages of some of rice samples were obtained by Geochron and SNU. The dates of ancient rice samples were found to be 12,500~14,800 yr BP, and the age range for lower peat layer was found to be 16,300~17,300 BP [1]. However, later time, most rice grains were treated using hardening chemicals for the conservation purpose. When some rice grains were dated recently, the results of radiocarbon age were found to be mostly modern. With this situation, a new investigation for radiocarbon ages for the Sorori samples was accomplished in 2009 though the NSF Arizona AMS Laboratory. Both ancient rice and surrounded peat samples from the Sorori samples were dated. The AMS results confirmed that the ages of the rice and peat soil were found to be 12,520±150 and 12,552±90 BP, respectively. These radiocarbon ages are consistent with the previously published data. However, interestingly rice samples from this site which were treated for conservation purpose were all found to be modern. This presentation introduces characteristics of the Sorori rice samples with respect to sample treatment for dating as well as the paleolitic cultural environment of the study area.

[Reference]

[1]. Y-J. Lee and J-Y. Woo, "The Oldest Sorori Rice 15,000 BP : It's Findings Significance" *Prehistoric Cultivation in Asia and Sorori Rice,* pp. 27~46(Chungbuk National Univ. Museum).

ARC#3 **SESSION 11A** **Thursday 24th March, 1110 – 1250**

Duration period of shell midden estimated by radiocarbon dates: two examples at Higashimyo site, southern Japan and Kime site, southern Korea

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The Higashimyo archeological site is located in huge Saga Plain, the largest in western Japan, at the northern end of Saga city, in North Kyushu. The Saga plain faces southwards the innermost part of Ariake bay, a bay of 15 km wide and 90 km long with relatively shallow water depths. A huge volume of shell fragments were accumulated at the Higashimyo site, and the most impressive archeological interest is that more than 400 of baskets knitted with twisted ropes made of thinly sliced wood were recovered. The knitted wooden baskets excavated here are the oldest (ca. 7800-7900 cal BP) recorded in the earliest Jomon period.

Six shell middens were detected at the Higashimyo, and No.1 and No.2 middens were intensively excavated. For the No.1 midden, thickness of the mound was ca. 1.2m and the elevation of the uppermost layer was -1.1m, and for the No.2, the respective values were 1.5m and -0.5m. We have collected shell fragments and terrestrial plant remains from the full layers, from the bottom to the top, of the two middens for ^{14}C dating, to estimate the duration necessary to make up the total volume of the middens. Geographically it was certain that the middens had been formed during the sea-level-rising period a few thousand years after the start of Holocene, and our estimates yielded relatively shorter duration periods, i.e., 50-150 years and 150-250 years for the No.1 and No.2 middens, respectively.

The shell midden at the Kime site, southern Korea, accumulated shells mainly of oyster and clam as thick as 8m. We collected clam and charcoal fragments throughout the layers for ^{14}C dating. The shells showed calibrated dates from the end of 1st C BC to the beginning of AD 3rd C, indicating the duration of shell accumulation of 250-300 years.

AST#1 **SESSION 11B** **Thursday 24th March, 1110 – 1250**

Numerical Simulation of Particle Fluxes and Cosmogenic Nuclide Production Rates

Masarik J
Comenius University

The particle fluxes and production rates of cosmogenic nuclides depend on many parameters. Reliable interpretation of the measured in-situ-produced cosmogenic nuclides requires a good understanding of involved nuclear processes. We present results obtained by updated physical model for the simulation of the relevant processes. This model is enabling an investigation of nuclide production dependence on composition, altitude, geomagnetic field intensity and depth under the surface of irradiated object. LCS and GEANT codes are used in our simulations for the calculation of spectra of particles inducing reactions that produce cosmogenic nuclides. Having calculated neutron fluxes with these codes, the production rates of nuclides are determined by integrating over energy the product of these fluxes with experimental and evaluated cross sections for the reaction producing particular nuclide. Dependences of production rates on chemical composition of irradiated object were obtained and altitude - latitude scaling factors were obtained. We present also new elemental production rates calculated from our new particle fluxes and updated excitation functions. Production rates for ^{41}Ca, ^{26}Al and ^{32}Si production in the Earth atmosphere and on the Earth surface will be presented.

AST#2 **SESSION 11B** **Thursday 24th March, 1110 – 1250**

Cosmogenic-Nuclide Production Rates: Reaction Cross Section Update

Reedy R
Planetary Science Institute

Recent and future work on reaction cross sections for making cosmogenic nuclides will be discussed. Good production rates are needed for cosmic-ray-produced nuclides to interpret their measurements. Approaches to doing production-rate calculations have been presented at earlier AMS meetings. Calculations usually use particles fluxes calculated by Monte Carlo production and transport codes with cross sections for the relevant reactions. Recently, experimental cross sections for making cosmogenic nuclides by protons have been compiled and evaluated. Most of these proton cross sections are well determined, including those for major target elements. These cross sections have been used to study cosmogenic nuclides made by solar energetic protons in lunar samples and meteorites. Neutrons make most galactic-cosmic-ray-produced nuclides. Most neutron cross sections have been estimated by adjusting proton cross sections to fit measurements of cosmogenic nuclides in documented samples. However, rates calculated with these cross sections often need to be normalized to get absolute rates. One recent use of these cross sections (Argento et al., this meeting) has been in calculating the production-rate distribution of terrestrial in situ cosmogenic nuclides as a function of location and elevation. There are only a few measurements of cross sections for neutrons making cosmogenic nuclides because it is hard to make good fluxes of mono-energetic neutrons. Usually, a neutron beam has a significant low-energy tail of neutrons that requires good corrections to get the cross section. Nishiizumi and colleagues (this meeting) are measuring many cross sections for neutron-induced reactions using such quasi-monoenergetic neutron beams. Some cross sections have been measured using intense beams of 'white" neutrons with a wide range of energies, such as ~1-750 MeV. To get better calculated production rates, all existing and new cross sections will be used with measurements in documented samples to get improved sets of neutron cross sections.

AST#3 **SESSION 11B** **Thursday 24th March, 1110 – 1250**

Re-measuring the half-life of 60Fe

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Recently there has been a strong renewed interest in the half-life of ^{60}Fe. In particular, a recent experiment both at PSI and at Munich on the ^{60}Fe lifetime points to a half-life for ^{60}Fe that is 70% higher (i.e. 2.6x10^6 years) than the previously accepted value (1.5x10^6 years). ^{60}Fe is mainly produced in core collapse supernovae explosions and these new results open up a number of questions as many factors scale with this number; from the ^{60}Fe abundance determination with gamma ray telescope measurements to recent ^{60}Fe(n, γ) cross section studies.

We are presently working on a double-pronged attempt at re-measuring this half-life using the "old" AMS technique used by the Kutschera group in 1984 coupled to a low-background activity measurement on the growth of ^{60}Co from the decay of ^{60}Fe. Both rely however on a clean production of a ^{60}Fe sample that contains as little ^{60}Co as possible as both measurements rely on measuring the ^{60}Co decay γ-line from ^{60}Co produced by the decay of ^{60}Fe.

We will report on the ^{60}Fe production run that was made at the NSCL to produce a well characterized ^{60}Fe sample at the focal plane of the A1900. We will present first AMS measurements of these samples using the gas-filled magnet technique to separate the ^{60}Ni-^{60}Fe isobars at the Nuclear Science Laboratory at the University of Notre Dame.

AST#4 **SESSION 11B** **Thursday 24th March, 1110 – 1250**

New AMS Method to Measure the Atom Ratio $^{146}Sm/^{147}Sm$ for a Halflife Determination of ^{146}Sm

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[2] Hebrew University,
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[5] Joint Institute for Nuclear Astrophysics,
[6] Université Libre de Bruxelles,
[7] Faculty of Chemistry, Institute of Science and Engineering, Kanazawa University

The extinct *p*-process nuclide ^{146}Sm ($t_{1/2}$ = 1.03 × 10^8 yr) is known to have been present in the Early-Solar System from ^{142}Nd isotopic anomalies measured in meteorites and has been proposed as an astrophysical chronometer measuring the time between a last *p*-process event and Solar-System condensation. Earth crust samples themselves display a systematic positive anomaly in their $^{142}Nd/Nd$ abundance relative to meteoritic (chondritic) ratio, possibly implying that planet differentiation occurred while ^{146}Sm was still live. The α decay of ^{146}Sm to ^{142}Nd thus constitutes a Solar-System clock for planetary processes, enhancing the importance of an accurate knowledge of the ^{146}Sm halflife. We have made a new determination of the ^{146}Sm halflife by measuring both the α activity ratio and the atom ratio of ^{146}Sm to naturally occurring ^{147}Sm (1.06 × 10^{11} yr). ^{146}Sm was produced via the reactions $^{147}Sm(n,2n)$, $^{147}Sm(p,2n\varepsilon)$ and $^{147}Sm(\gamma,n)$ and activities were measured with an α spectrometer. The $^{146}Sm/^{147}Sm$ atom ratio was determined by accelerator mass spectrometry at the ATLAS facility of Argonne National Laboratory .The Enge gas-filled magnetic (GFM) spectrograph served to separate ^{146}Sm from stable isobaric ^{146}Nd impurities. In order to reduce systematic errors in the AMS determination of the $^{146}Sm/^{147}Sm$ ratios (in the range 10^{-7} to 10^{-8}), both ions were alternatively counted in the same detector in the focal plane of the GFM, respectively in continuous-wave and attenuated mode. Quantitative attenuation is obtained with the 12 MHz pulsed and ns-bunched ATLAS beam by chopping beam pulses with an RF sweeper in a ratio down to $1:10^6$, digitally measured. The experiments and preliminary results are discussed. This work is supported in part by Grant-in-Aid for Scientific Research Program of Japan Society for the Promotion of Science (20740161). This work is supported by the U.S. Department of Energy, Office of Nuclear Physics, under contract No. DE-AC02-06CH11357.

AST#5 **SESSION 11B** **Thursday 24th March, 1110 – 1250**

Measuring the astrophysically important $^{40}Ca(a,g)^{44}Ti$ reaction with AMS

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The astrophysically important $^{40}Ca(\alpha,\gamma)^{44}Ti$ reaction is thought to be the main production method for the short-lived radionuclide, ^{44}Ti ($t_{1/2}$ = 58.9 ± 0.3 yr). Its creation in the inner layers of core-collapse supernovae and relative short halflife, make ^{44}Ti an excellent probe for young supernovae remnants and an important radioisotope for constraining current supernova models.

For a new measurement of the $^{40}Ca(\alpha,\gamma)^{44}Ti$ reaction in the astrophysically interesting temperature region of T_9 = 1 – 2.8 K, a new AMS facility was built at the University of Notre Dame. Four ^{44}Ti activations were performed with a ^{40}Ca beam incident on a He gas cell with recoiling ^{44}Ti atoms being captured then chemically separated and subsequently counted via AMS. The four discreet energy ranges over which the activations occurred all lie within the temperature range relevant for α-rich freeze-out. The resulting measurements are presented here.

Poster Abstracts – Session 2

REP#P120 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

High precision ^{14}C AMS-analysis of oak tree rings – Can we observe a modulation of the ^{14}C content according to the 11 years solar cycle?

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Trees cataloged by dendrochronology are the most valuable source for ^{14}C calibration, as past fluctuations of the atmospheric ^{14}C level are preserved in tree rings with annual resolution.

Oak tree rings from Southern Germany covering the AD 1000-1100 years have been analyzed by AMS radiocarbon dating at the laboratory at ETH Zurich. High-precision measurements with an accuracy down to 12 years radiocarbon age and a time resolution of two years aimed to observe a modulation of the ^{14}C concentration in the samples derived by the 11 years solar cycles, a feature that is not visible in the IntCal calibration curve so far.

Our results are in good agreement with the current calibration curve IntCal09. However, we observed an offset in radiocarbon age of 15 – 25 years. Hence, various pretreatments have been tested (e.g. by varying: chemicals, test glasses and process steps) to reveal possible sources of sample contamination. The numerous measurements using the AMS-MICADAS system validated its suitability for high precision measurements with high reproducibility.

REP#P121 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Summary of current AMS system and research projects at MALT, The University of Tokyo

Matsuzaki H [1], Nakano C [1], Sunohara Tsuchiya Y [1], Ito S [1], Morita A [1], Miyairi Y [2], Matsushi Y [3], Yamagata T [1], Abe K [1], Tokuyama H [1]
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MALT (Micro Analysis Laboratory, Tandem accelerator, The University of Tokyo) is designed for highly sensitive and precise elemental and isotopic microanalysis system using ion beam generated by MC-SNICSTM solid state ion sources and PelletronTM 5UD tandem accelerator. Currently multi-nuclide AMS (^{10}Be, ^{14}C, ^{26}Al, ^{36}Cl, ^{129}I) system is available and shows good performance as well as PIXE and NRA system.

The activity is constantly as high as the annual operation time has been over 6,000 hrs in recent years.

One of recent system improvement is the upgrade of the ion sources to the high intensity type. With new ion sources, extracted current for ^{10}Be, ^{26}Al-AMS was greatly increased roughly by 3 times. For ^{14}C-AMS, small graphite samples (less than 0.1mg-C) can be effectively ionized.

Good performance in ^{129}I-AMS system is one of specific features of MALT. We tried and examined charge states 5+, 6+, and 7+. The 5+ system (which seems to be employed at most facilities) is advantageous in the efficiency (charge fraction), but the accelerator terminal voltage is limited to low value due to the limit of analyzer magnet. Besides, isotopic interference (^{127}I) seems to be higher in 5+ system by our observation. 7+ system has highest isotopic resolution due to its high beam energy, however there is severe molecular interference by $^{37}Cl_2$+ with a kind of samples. We chose 6+ system for most application because of good balance of good background and enough efficiency.

Among many collaborating scientific projects running at MALT, "Study on natural iodine isotope system", "Application of in situ cosmogenic radio nuclides to the geomorphologic processes", and "Analysis of cosmogenic radio nuclides in the Antarctic ice core" are currently especially promoted projects.

REP#P122 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Installation of hybrid ion source on the 1-MV LLNL BioAMS spectrometer

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CAMS, LLNL

A second ion source was recently installed onto our 1-MV AMS spectrometer, which is dedicated to the quantification of ^{14}C and ^{3}H within biochemical samples. The primary use of this source is for the measurement of $^{14}C/^{12}C$ ratios from gaseous CO_2 samples, as well as $^{3}H/^{1}H$ ratios from soild TiH_2 targets. This source is a heavily modified version of the NEC MCGSNICS ion source and is attached to the existing AMS system through a second port on a 45° ESA which can rotate to enable the operation of either ion source. The injection beam line has been designed to allow for the direct quantification of either $^{14}C/^{12}C$ or $^{3}H/^{1}H$ isotopic ratios without the need for fast electrostatic or magnetic field switching. In order to have confidence in the results obtained using this new ion source, a series of performance tests were conducted using solid graphitic targets with $^{14}C/C$ isotope ratios spanning 3 orders in dynamic range which encompasses the majority of bioAMS samples. The use of solid graphitic targets allowed for the direct comparison of the performance of this source to that of the other ion source which can only accept solid samples. The results compare favorably to our other ion source.

Work performed (partially) at the Research Resource for Biomedical AMS which is operated at LLNL under the auspices of the U.S. Department of Energy under contract DE-AC52-07NA27344. The Research Resource is supported by the National Institutes of Health, National Center for Research Resources, Biomedical Technology Program grant #P41 RR13461.

REP#P123 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Status of the 1MV AMS Facility at KIGAM

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An 1MV AMS system for multi-element measurements has been in normal operation at Korea Institute of Geoscience and Mineral Resources (KIGAM) since 2008. The number of commercial samples slowly increased year by year; 500 samples in 2008, 1600 in 2009, and 900 in 2010. The number of total samples measured at KIGAM is almost two times larger than the commercial samples. Alpha-cellulose extraction method was established for wood samples needed a precise measurement. Recently, this method was improved to enhance the alpha-cellulose purity. A 24-fold automatic reduction system developed at our laboratory has been used in routine work with good stability. To confirm the stability, the reduction yields are calculated accurately by weighing Fe catalyst before and after the reduction for every single sample. The average reduction yield was found to be higher than 90%. Using the 24-fold automatic reduction system in routine analysis, our throughput is expected to be 3,000 ^{14}C samples per year with only six staffs. In this work, the detail status of our facility, results of technical improvements and the accuracy study using IAEA standard samples are presented.

REP#P124 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Status report of AMS preparation laboratory at GADAM Centre, Gliwice, Poland

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A laboratory for the preparation of samples for ^{14}C AMS (Accelerator Mass Spectrometry) dating has been developed in the Gliwice Radiocarbon Laboratory in 1999. The system is used to produce graphite targets from various types of samples destined for AMS radiocarbon dating, e.g. plant macrofossils, charcoal, peat, bones, shells, wood. Due to the very small sample amount, considerable effort is put into avoiding contamination with either modern or inactive carbon during the sample preparation.

Conducted research activities include ^{14}C dating for the purposes of environmental science, Earth science, archaeology, geology and geomorphology, hydrology, reconstruction of past climate changes and human activity, investigation of CO_2 emission form fossil fuel combustion.
The scientific and research equipment comprises station for chemical preparation and high vacuum lines for preparation, purification and graphitisation of carbon dioxide.

The present capacity allows for production of ca. 400 targets per year for the purposes of scientific projects and external orders for radiocarbon dating, realised continuously in the GADAM Centre of Excellence.

The presentation will summarise the 10-years activity of the laboratory, including recent improvements of the system, such as combustion line for samples of low carbon content. Most of them have been made after movement to the new rooms.

REP#P125 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Progress on ^{36}Cl AMS with the 12UD Pelletron tandem accelerator at the University of Tsukuba

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[3] Kyoto University,
[4] Radiation Science Center, KEK

We report on the progress of an accelerator mass spectrometry system with the 12UD Pelletron tandem accelerator at the University of Tsukuba (Tsukuba AMS system). The maximum terminal voltage of 12 MV is available for AMS. The Tsukuba AMS system has been able to measure environmental levels of long lived radioisotopes of ^{14}C, ^{26}Al, ^{36}Cl and ^{129}I by employing a molecular pilot beam method. Recently, the performance of ^{36}Cl AMS was improved in AMS technique and system, such as a sample preparation technique, an ion source upgrade, an improved gas detector and a new data acquisition system. $^{35}Cl^-$ currents have increased to 20 μA. The standard deviation of fluctuations is typically ± 2%, and the detection limit is ~1×10^{-15} for the ^{36}Cl/Cl ratio. We use the isotope dilution method for simultaneous measurements of ^{36}Cl and stable Cl in natural samples, by using a ^{35}Cl enriched carrier. A detailed description of the AMS system with the 12UD Pelletron tandem accelerator and recent applications of ^{36}Cl measurements will be presented.

REP#P126 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Three years on: an update on the ANU SSAMS

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In January 2007 ANU received a single stage accelerator mass spectrometer from NEC. We have now been operating the instrument for three years and have measured ~5500 targets, with the last 12 months seeing ~2500 unknowns analysed. In 2009 we underwent a major re-alignment of the entire instrument after quantifying the degree to which the low energy end was misaligned. Beam transmission is now ~35% with a decrease in ^{12}C fractionation at higher beam currents. In 2010 we installed a new NEC hybrid gas/graphite ion source that resulted in increased beam currents. We still limit the beam output to ~45uA of $^{12}C^-$ to obtain unfractionated ^{13}C/^{12}C ratios.

REP#P127 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Recent advances of radiocarbon measurements at NIES TERRA

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NIES-TERRA AMS facility, Environmental Chemistry Division, National Institute for Environmental Studies

The status of the AMS facility at National Institute for Environmental Studies (NIES) and recent progress for the carbon analysis are described. The high precision of ^{14}C measurements, equivalent to ca. 0.2 % for HOXII standard was achieved by controls of ionizer current (MC-SNICS, NEC) using simultaneous feedback of ^{12}C current from multi-faraday cup, which was done by program described by Python language to TERRA1 main controller. The two automatic graphitization systems for small amount level (<ca. 0.01-0.5mgC) and normal (0.5~1mgC) were also developed with low blank level. The details will be presented in the conference.

REP#P128 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

A new ^{14}C-AMS facility at UFF, Niterói, Brazil

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Federal Fluminense University

Our group at UFF has been developing projects on ^{14}C-AMS in the last years, in collaborative experiments using external facilities such as Australian National University, Purdue University and University of California-Irvine. The research areas of these projects are Archaeology, Climatology, Marine Geology and Biology and Oceanography. We have also built high performance detectors for use with isotopes like ^{36}Cl.

Recently we have installed our own sample preparation laboratory. We have already prepared our first samples, which are being checked in the Primelab of Purdue University.

More recently we have bought from NEC one single stage AMS system, which is scheduled to be delivered in September 2011.

With the laboratory for ^{14}C sample preparation and running the SSAMS system, we will become the first fully dedicated ^{14}C-AMS facility in Latin America. We believe that the number of researchers from Brazil and Latin America who will use our facilities will increase one or two orders of magnitude, comparing with the number that nowadays use the AMS technique.

We plan to present our new facility during this conference.

AST#P101 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

^{36}Cl Cross Section Measurement for In-Situ Production in the Early Solar System

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Evidence of radionuclides that existed at the beginning of the solar system has been found in the form of enrichments of their daughter isotopes in Calcium- Aluminium- rich Inclusions (CAIs) in carbonaceous chondrite meteorites. These radionuclides (e.g. ^{10}Be, ^{26}Al, ^{36}Cl, ^{60}Fe) have half-lives that are significantly shorter than the 4.46 Ga age of the Solar System and are thus called short-lived radionuclides (SLRs). SLRs can be used as fine tuned chronometers to study the early solar system. Measured overabundances of ^{36}S have been interpreted as evidence of the decay of ^{36}Cl ($t_{1/2}$ =0.3 Ma). Two possible origins of SLRs in the early solar system are: (1) in-situ production by irradiation of nebular gas and dust from the young Sun, (2) production in a supernova or an asymptotic giant branch star and injection into the solar nebula. Current stellar models under predict ^{36}Cl abundances compared to meteorite measurements, which suggests proto-Sun irradiation. However, there is a lack of experimental data on the production reactions' cross sections in the astrophysically important energy range. Instead, irradiation models rely on Hauser-Feshbach calculations to estimate the cross sections. One of the reactions we are studying with AMS is ^{33}S(α,p)^{36}Cl. The activation will be done in inverse kinematics with a ^{33}S beam incident on a He gas cell. A thin Aluminium foil collects the reaction products. The Aluminium catcher is then dissolved and precipitated as AgCl. During the chemical separation of the ^{36}Cl, stable chlorine carrier will be added as well as sulphur reduction chemistry. The AMS counting will be done at the MANTIS setup at the Nuclear Science Lab. Material selection and cleaning procedures have been tested to reduce sulphur content prior to the separation of ^{36}Cl from its isobar ^{36}S in the spectrograph run in Gas Filled Mode (GFM).

AST#P102 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

^{93}ZR beam development for AMS measurement

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^{93}Zr has the neutron magic number N=50 and lies on the 1st s-process peak. Accurate neutron capture cross sections coupled with isotopic abundances of nuclei of this kind are important for studies of the s-process. As a weak branching point ($t_{1/2}$= 1.5Ma), ^{93}Zr can provide direct clues to stellar neutron density, temperature, etc. The recommended Maxwelliam-Averaged Cross Section at 30keV for ^{92}Zr (n,γ) ^{93}Zr is the weighted mean of three different TOF measurements, between which there is 10% disagreement. The model predictions for Zr isotopic ratios under different stellar conditions are also often systematically either too high or too low, suggesting the need for accurate cross sections. The re-measurement of this value by independent AMS method could resolve this discrepancy. Also, ^{93}Zr is believed to be produced in massive stars that end their lives in supernova, thus the detection of ^{93}Zr is another candidate for testing near-earth supernova hypothesis besides using ^{60}Fe. The separation between ^{93}Zr and its stable isobar ^{93}Nb is the first obstacle to overcome as they are only separated by one atomic number and behave almost identically in conventional isotope separation methods. By using Gas Filled Magnet technique with additional multiple ΔE measurements in a focal plane ionization chamber, identification and separation of isobars is promising. Studies are currently being performed at the Nuclear Science Lab at University of Notre Dame, to maximize the suppression of the ^{93}Nb contaminating isobar and minimize its interference, with plans for the measurement of an enriched sample to determine the lowest concentration we could measure.

AST#P103 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Determination of the detection limits for the $^{36}Cl/^{35}Cl$ isotopic ratio in AgCL pellets in the micro AMS system at ITN.

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The determination of the detection limits for the $^{36}Cl/^{35}Cl$ isotopic ratio in AgCl pellets was carried out at the micro-AMS system installed at the ion beam laboratory of Instituto Tecnológico e Nuclear (ITN). The micro-AMS system is based on a 3 MV tandem accelerator, which makes it impossible to reach the high energy regimes necessary to fully separate the well-known isobaric interference between the ^{36}Cl and the ^{36}S isotopes, using a conventional E-Δ E detector. In order to improve this separation and therefore improve the detection limits of the system, a special E-ΔE detector was used with three anode plates instead of the usual two.

The detection limits are also affected by the low intensity of the primary beam, which is on average two orders of magnitude lower than the normal primary beam in a conventional AMS source.

Test targets were produced at the ITN experimental nuclear reactor. They consisted of pellets of high purity AgCl powder irradiated by neutrons for different amounts of time so as to produce $^{36}Cl/^{35}Cl$ isotopic ratios that ranged from 10^{-6} to 10^{-9}.

In this work we describe and discuss the results and technical limitations related with the measurements.

AST#P104 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

High-Sensitivity Detection of ^{244}Pu via Electron-Cyclotron Resonance Ionization and Linear Acceleration

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The r-process nuclide ^{244}Pu ($t_{1/2}$= 80.8 Myr) was extant in the Early Solar System and is presently considered extinct. However fresh ^{244}Pu, continuously produced in the Galaxy, may reach the Solar System and Earth as direct ejecta from supernovae and through influx of interstellar dust. Detection of such traces requires high abundance sensitivity, discrimination power and efficiency. Accelerator mass spectrometry (AMS), despite low efficiency, is the method of choice for sensitivity and discrimination power. We report on the successful detection of ^{244}Pu by AMS, using highly-charged positive ions produced in an electron cyclotron resonance ion source (ECRIS) and accelerated with the superconducting heavy-ion linear accelerator ATLAS at Argonne National Laboratory. Calibrated samples were produced as mixed oxides of ^{244}Pu, ^{nat}Tb and ^{nat}Fe, spanning the range of 10^5 to 10^8 ^{244}Pu atoms/mg oxide with an atom ratio Tb:Fe = 1:2. Monoisotopic terbium was included to serve as monitor of ion source output. $^{244}Pu^{24+}$ ions extracted from the ECRIS were accelerated and decelerated in ATLAS to a final energy of 0.7 MeV/u to match the acceptance of the Fragment Mass Analyzer after stripping through a carbon foil. $^{244}Pu^{34+,35+,36+}$ ions were dispersed by m/q and counted, well discriminated from parasitic ions. A count rate of 0.7 ^{244}Pu counts/minute was observed for a sample containing 2.7x10^8 ^{244}Pu atoms/mg. The technique presented here is presently used with considerably improved setup and accelerator conditions, for the measurement of neutron capture cross sections in the actinide region (see R. Pardo et al., this Conference).The Office of Basic Energy Science, US Department of Energy, is gratefully acknowledged for the use of the ^{244}Pu calibration sample through the transplutonium element production facilities at Oak Ridge National Laboratory. This work is supported by the U.S. Department of Energy, Office of Nuclear Physics, under contract No. DE-AC02-06CH11357.

AST#P105 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Measurements of light nuclides production cross sections for Cu and Y with 300 MeV proton

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The production cross sections by high energy protons are important for deciphering the cosmic-ray irradiation history. The build-up of cosmic-ray-produced nuclides in extraterrestrial material provides an opportunity to sample the energetic particle environment of the solar system. To best interpret the concentrations of cosmogenic nuclides in solar system materials we need production cross sections for each of the reactions leading to the production of these nuclides. These data also serves as a comprehensive nuclear database for estimating residual radioactivities in accelerator facilities.

Those cross sections are indispensable for studying the formation mechanism of nuclides by nuclear spallation and fission reactions but also via fragmentation processes by which light nuclides are produced. The proton cross section data for nuclides via nuclear spallation reactions that are close to target nuclides have been well-studied. The production of light nuclides via fragmentation processes that can only be determined using accelerator mass spectrometry (AMS) measurements are not necessarily reported comprehensively. To understand the formation mechanism of nuclides via fragmentation processes the proton induced cross sections for the production of light nuclides are required.

In this work, we measured ^{10}Be and ^{26}Al production cross sections for Cu and Y induced by 300 MeV protons, which have never been reported, using AMS at PRIME Lab (Purdue University) and at MALT (University of Tokyo). We then estimate the contribution of the fragmentation process from the yield of light nuclides in high-energy reactions. The proton irradiation was performed at the Research Center for Nuclear Physics (RCNP), Osaka University.

Additionally, we intend to present ^{7}Be and ^{24}Na production cross sections for those two targets, which are obtained by gamma-ray spectrometry, to compare with the data obtained by AMS.

AST#P106 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Nuclear astrophysics and nuclear physics programme at VERA

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Measurements of neutron- and charged-particle induced cross sections relevant to nuclear astrophysics and nuclear physics have become a main research topic at the VERA (Vienna Environmental Research Accelerator) facility:

(I) In a fusion reactor and other future advanced reactor types, long-lived activation products contribute significantly to long-term waste disposals and radiation damage of structural reactor materials. The most prominent long-lived "fusion products" in this regard are accessible to studies with accelerator mass spectrometry (AMS). We present new measurements of such studues. Various samples were irradiated with fusion-like neutrons. A series of radionuclides, such as ^{10}Be, ^{14}C, ^{26}Al, ^{55}Fe and ^{210m}Bi were measured by AMS at the VERA facility in Vienna. In addition, production of long-lived ^{53}Mn and ^{59}Ni was measured utilizing the 14-MV tandem accelerator of the Maier-Leibnitz-Laboratory in Garching/Munich. Our data, for the first time based on AMS, indicate that previous data seem to strongly underestimate the production of ^{53}Mn and ^{59}Ni.

(II) The observed elemental and isotopic pattern of our environment requires the understanding of the various nucleosynthesis processes in stars which eventually tailored solar-system abundances. A key ingredient is the accurate knowledge of cross-section data. AMS allows one to measure cross sections precisely, thus elucidating current open questions e.g. within the s- and p-process path. For specific reactions the sensitivity of AMS offers a unique tool to pin down their uncertainties. An overview on recent activities at VERA with respect to nuclear astrophysics will be given including applications relevant for Big-Bang nucleosynthesis, s-process nucleosynthesis, and the search for live extraterrestrial radionuclides, like ^{26}Al and r-process nuclide ^{244}Pu.

We will also report on the recently launched programme 'Eurogenesis', organized by the European Science Foundation, in which AMS measurements will play a substantial role.

AST#P107 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Stable Isotope Measurements in Presolar Grains

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The most abundant presolar grains in primitive meteorites are nanodiamonds. These grains survived the formation of the solar system and kept their own individuality. However, existing measurements of their isotopic pattern do not allow for a consistent understanding of their origin. The reasons are mainly due to their small size (nm) and the low abundance of trace elements. Most likely, such nanodiamonds were formed in a supernova environment. Positive measurements of trace-element isotopic signatures will help understanding heavy element nucleosynthesis in massive stars and dust formation from their ejecta. They will also enable testing predictions of r-process nucleosynthesis and understanding the uniformity of the "main r-process".

A first approach applying AMS to measure Pt in nanodiamonds was performed at the TU Munich [1]. We have continued our search for stable isotope anomalies in nanodiamonds at VERA. Recent experiments showed that AMS provides the required measurement precision together with a low Pt machine background. Moreover, we observed for the first time enhancements of $^{198}Pt/^{195}Pt$ isotope ratios in two diamond residues from the Allende meteorite, which were prepared by different separation techniques. Variations in other isotopic ratios were within analytical uncertainty, and no anomaly was identified in a third diamond fraction. An enhanced $^{198}Pt/^{195}Pt$ ratio is predicted by models that either include or exclude a simultaneous negative anomaly in $^{194}Pt/^{195}Pt$. This negative anomaly, however, was not observed via AMS and is in contrast to data obtained for tellurium.

The robustness of these first results needs to be verified by detailed and systematic studies of possible mass-fractionation effects and potential scatter due to inhomogeneities within samples. We will present our measurement approach and plans for other isotopes. The latter is part of the Eurogenesis programme organized by the European Science foundation.

[1] S. Merchel et al., Geochim et Cosmochim Acta **67** (2003) 4949.

FOR#P101 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Can we blame discrepancies of year-of-birth ^{14}C determination on mom? Preliminary isotope results of fingernails of breastfed mother-infant pairs

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Researchers have investigated the possibility of acquiring the year-of-birth and year-of-death dates by using radiocarbon (^{14}C) measurements from a broad range of human tissues. This is possible due to high concentration of radiocarbon in the earth's atmosphere during the thermonuclear bomb testing carried out between 1953 and 1963, and its propagation into the food chain through photosynthesis. Measuring the magnitude of this ^{14}C concentration allows year-of-birth determinations for individuals that were born in this period. Recently, Hodgins [1] studied human tissues of 36 deceased individuals of known birth dates. To estimate the year-of-birth, Hodgins [1] measured ^{14}C of tooth enamel. More than 50% of his results were consistent with the true birth dates, and uncertainties for most were as low as 1.5 years. However, a significant percentage of the measurements yielded estimated birth dates off as much as 4 years. Since diet life histories of individuals were unknown, Hodgins [1] speculated that a ^{14}C depleted marine diet may have played a role in explaining some of these deviations. Since some human non-turnover tissue, such as crystalline eye lens tissue and tooth enamel, start forming while in utero and stop at approximately age of 3 and 3-16 years (depend on completion of the permanent crown formation and tooth type [2]), respectively, this notion raises the question of how much an individual's childhood diet can affect the age determinations. To examine this possibility the authors measured isotopes δ13C, δ15N, and ^{14}C in fingernails collected from breast milk fed infants and their mothers from before birth through the weaning period. In this study, the mother-infant pairs were from the same region in the United States and their protein diet was recorded during the course of sampling. The authors analyzed four mother-infant pairs, three of the four were collected between 2001-2003 and the fourth was collected over a two year span beginning in 2008. Results from this preliminary investigation will be show and discussed.

[1] Hodgins G. 2009 Measuring atomic bomb-derived ^{14}C levels in human remains to determine Year of Birth and/or Year of Death. National Institute of Justice Final Report.

[2] Wang N. et al. 2010 Improved application of bomb carbon in teeth for forensic investigation. Radiocarbon 52(2-3): 706-716.

FOR#P102 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Long-lived radionuclides in residues from nuclear power plants operation and decommissioning

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Nuclear residues are commonly classified depending on their activity and the half-life of their radioactive components. This explains the interest of the nuclear authorities on having a better knowledge of the residues coming both from normal operation of power plants and from decommissioning of those that are being dismantled. This interest includes the necessity of determining the concentration of long-lived radionuclides that are very difficult to detect by radiometric methods. At CNA we have determined the presence of ^{129}I in different samples from nuclear power plants as resins, dry muds and smears. Residues from normal power plant operation show ^{129}I concentrations typically in the order of 10^{9}-10^{10}at/g. Smears from the José Cabrera nuclear plant (which is in dismantling process now) show between 10^{8} and 10^{10} ^{129}I atoms. Also the concentration of Pu isotopes and the isotopic ^{239}Pu/^{240}Pu ratios have been determined in some of these samples. Currently, first ^{36}Cl measurements are being carrying out in our facility. Although the present status of our 1MV tandem makes it impossible to discriminate ^{36}S from ^{36}Cl, the purification of both nuclides in the chemical process is expected to be enough to guarantee minimum detection levels that allow considering these samples virtually free of ^{36}Cl.

FOR#P103 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

The AMS measurements of fission products at CIAE

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Fission products are inherently present in special nuclear materials as contaminants remaining from isotope separation or reprocessing, or through ingrowth due to spontaneous and neutron induced fission. Although natural abundances of the long-lived Fission products (LLFPs) are extremely low, artificially produced LLFPs have entered our environment through nuclear activities and may locally lead to strongly enhanced concentrations. The long half-life makes them the more nasty nuclides to the environment. Therefore, LLFPs are very important nuclides to monitor the nuclear contamination and the ultra-high-sensitivity measurement of LLFPs in rocks or soil samples from the fission environment would provide very important information for nuclear safety inspection.

Accelerator mass spectrometry (AMS) is a highly sensitive nuclear analytical techniques and the most effective method to measure these long-live nuclides in fission products. However, some difficulties, especially isobaric interference, still pose obstacles in AMS measurement of ultratrace LLFPs, especially for those AMS facilities with low terminal voltages. The Beijing HI-13-AMS facilities with a high terminal voltage of 13MV is very suitable for measuring LLFPs, especially for these heavy fission products such as such as ^{79}Se, ^{93}Zr, ^{99}Tc, ^{107}Pd, ^{121m}Sn, ^{126}Sn, ^{129}I and ^{135}Cs. In this paper some new methods were developed for AMS measurement of ^{79}Se, ^{93}Zr, ^{99}Tc, ^{121m}Sn,^{126}Sn ^{129}I and ^{151}Sm. Major features of the methods including the preparation of samples, the selection of target material and molecular ions for the AMS measurements, and the detection, identification technology are to be introduced. The results indicate that sensitivities of 1.0×10^{-12} for ^{79}Se/Se, 1.0×10^{-10} for ^{93}Zr/Zr, 4×10^{-11} for ^{99}Tc/^{93}Nb, 4.0×10^{-10} for ^{121m}Sn/Sn, 5.0×10^{-12} for ^{126}Sn/Sn, 1.0×10^{-13} for ^{129}I/^{127}I and1.0×10^{-8} for ^{151}Sm/Sm have been reached by measuring blank samples. Development of ^{107}Pd and ^{135}Cs AMS method for HI-13-AMS facilities are being planned.

FOR#P104 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Actinides AMS at CIRCE and ^{236}U, ^{x}Pu measurements at the Garigliano Nuclear Power Plant

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Accelerator Mass Spectrometry (AMS) is presently the most sensitive technique for the measurement of long-lived actinides, e.g.^{236}U and ^{239}Pu [1,2]. A new actinide line [3], based on a 3-MV AMS pelletron tandem system, is operated at the Center for Isotopic Research on Cultural and Environmental Heritage (CIRCE) [4] in Caserta, Italy.

Using the actinide line a uranium concentration sensitivity of better than 1 μg has been reached measuring with a 16-strip silicon detector [5,6] and a ^{239}Pu background level of about 0.1 fg has been obtained [7]. A Time of Flight-Energy (TOF-E) system in conjunction with the 16-strip silicon detector [7], is being implemented in order to push, as low as possible, the abundance sensitivities.

In this work we also discuss the preliminary results on the environmental and structural samples from the shut-down and decommissioned Garigliano Nuclear Power Plant (GNPP) [7]. The environmental sample measurements have several points of interest: to assess the contamination over the years and to lower the level of risk perceived by the public. Measurements of structural samples that are underway are relevant to the optimization of the decommissioning programme of the GNPP.

References

[1] L. K. Fifield, 2008, Quaternary Geochronology 3, 276

[2] P. Steier et al., 2010, Nucl. Inst. And Meth. in Ph. Res. B 268, 1045

[3] M. De Cesare et al., 2010, Nucl. Inst. and Meth. in Ph. Res. B 268, 779

[4] F. Terrasi. et al., 2007, Nucl. Inst. and Meth. in Ph. Res. B, 259, 14

[5] M. De Cesare et al., 2010, Radiocarbon 52(2-3), 286

[6] ECAART10 conference, contribution: P2-28, Mario De Cesare: ^{236}U concentration sensitivity at CIRCE

[7] M. De Cesare, 2006-2009, II University of Naples, PhD Thesis: Accelerator Mass Spectrometry of actinides at CIRCE

FOR#P105 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Measurement of Pu and U isotopes on the 1 MV AMS system at the Centro Nacional de Aceleradores

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In the last decade, compact AMS systems have demonstrated their potential to measure actinides (^{236}U, ^{239,240,244}Pu, ^{237}Np). With an appropriate detection system, kinematic filters with enough mass resolution, and a simple chemical procedure, the determination of plutonium isotopes and ^{237}Np at environmental levels is currently possible with this new generation of facilities with even better performance than with conventional AMS systems. However, the measurement of ^{236}U ($T_{1/2}$=23.4 My), produced by neutron capture on ^{235}U, is still a challenge, due to the interference caused by ^{235}U and ^{238}U. In this work, we will explore the possibilities that the 1 MV AMS system at the CNA offers for the measurement of uranium isotopes at environmental levels, in terms of detection limit, efficiency, and precision. Considering the very promising ^{239}Pu/^{238}U mass suppression factor achieved with our system, of about 10^{-9}, a limiting ^{236}U/^{238}U atomic ratio of about 10^{-11} was expected, approaching the levels expected in natural uranium. However, to date, only the 10^{-9} level has been obtained, possibly due to the lack of an appropriate uranium material. Currently, different natural uranium materials are being studied, in order to elucidate the origin of the interference. On the other hand, we will discuss the status of the plutonium measurements at our facility, based on the experience we have accumulated in recent years from the analysis of different matrixes over a wide range of plutonium concentrations.

FOR#P106 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

AMS applied in the research for the first fusion reactor

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This paper presents a hot new AMS domain, for the research of fusion facilities and for finalising the construction of the first International Thermonuclear Reactor (ITER) in Cadarache, France. Tokamaks around the world are performing experiments to resolve the last problems related to this goal, employing over 100 diagnose tools. Out of these, AMS has been rising to the level of supremacy of its kind, significantly contributing to the perfecting of the usage of the fusion power as a safe controlled, clean and virtually limitless energy source.

Due to its sensitivity level AMS is able to characterize the plasma confinement and its stability. It determines the quality of the neutral beam injectors used for energy input and also their perturbing interaction produced on the plasma confinement. AMS also localizes the plasma disruption phenomenon. It provides the dosimetry in the Tokamak. It measures the migration of materials inside of the reaction vessel. For the divertor assembly, that eliminates the exhaust particles (e.g. He) escaping from the hot plasma, AMS determines the T and D retention and characterizes the efficiency of the magnetic field geometry. Furthermore, AMS performs a rapid and sensitive comparison of the remnant T content after the application of laser detritiation techniques.

During the functioning of ITER, Be will be eroded from its First Wall and it will be re-deposited on the divertor tiles leading to the formation of mixed material films, modifying the original properties. By measuring the results of experimental simulations of such depositions of Be and W on carbon (CFC) substrates performed under exposure to D and T low energy fluxes, AMS will eliminate these of major problems in the future reactor.

Based on current successes, an introduction to the Tokamak physics focused on the above AMS applications will be the topic of this contribution.

SAM#P101 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Preparation of aluminum metal targets for ams analysis

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Aluminum-26 measurements often suffer low precision relative to those of ^{10}Be due to low beam currents associated with extraction of Al^- from Al_2O_3 targets. Although extraction of AlO^- offers a tenfold increase in beam current, it requires suppression of ^{26}Mg by a gas-filled magnet, precluding application at most facilities. Another option would be to use Al metal targets, which can give higher currents (although not universally[1]). However, routine production of milligram quantities of Al metal has been daunting. Here, we present a simple, fast, and effective method for producing Al metal from Al_2O_3.

We modified the Deville process, which was used industrially in the late 19th century. Aluminum oxide is converted by carbochlorination to anhydrous aluminum chloride, which is then reduced by elemental sodium to aluminum metal. For our procedure, we add Al_2O_3 and a measured amount of either carbon tetrachloride (CCl_4) or triphosgene ($C_3O_3Cl_6$) to a quartz tube, which is flame sealed under vacuum. Upon heating to ~900ºC the reaction is complete within minutes, producing $AlCl_3$ and CO_2. The cooled tube is cracked, a flake of Na metal is added in excess, and the tube is evacuated and re-sealed. Upon heating to >170ºC the $AlCl_3$ sublimates and reacts with the Na to produce a crust of Al metal and NaCl. Excess Na is then reacted with ethanol and NaCl is removed using de-oxygenated water, leaving a very fine Al powder. Yields are 80% or better.

At the time of writing, multiple Al targets have been made, but not yet analyzed by AMS. It is not known to what extent beam currents will be improved, if at all. If effective, this method should provide a rapid, easily accessible method to improve Al currents at any lab.

[1]Flarend, R., Hasan, M. E., and Reed, C. S., 2004, NIMB 223-224:263-266.

SAM#P102 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

New Be-cathode preparation method for the ETH 6 MV Tandem

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Systematic tests have shown that both the output and the efficiency of the High Current Source (HCS) used at the 6 MV Tandem are significantly enhanced for beryllium samples, when a mixture of silver and iron oxide is used as sample matrix. Additionally, the application of an iron co-precipitation step facilitates the final procedure of Be-cathode preparation, particularly for small (low carrier) samples. The new cathode preparation scheme will be presented. Be-cathodes prepared with the new Fe-Ag-method produce high currents and are very reproducible. Compared to our older preparation methods for Tandem ^{10}Be-samples (Ag-matrix or Cu-matrix) the Fe-Ag-matrix increases the apparent ionization efficiency for BeO^- (i.e. the ratio of collected BeO^- ions to total BeO in the sample) by more than 70%. This effect is reproducible and was tested with samples containing 100 µg and 200 µg of Be-carrier. A positive effect on the ionization efficiency of Be-samples could not be observed, when niobium powder was used as sample matrix.

A dilution series of our in-house secondary standard S2007 was prepared to determine the apparent ionization efficiency for the new method in dependence of the amount of Be in the sample. Our results show that after 20 min (representing a typical measurement time during routine Be-measurements) the apparent ionization efficiency increases from 2.6 ‰ (200 µg and 250 µg carrier) to 4 ‰ for samples containing only 50 µg Be carrier. With the current setup for ^{10}Be measurements on the 6 MV Tandem this implies an effective overall efficiency (20 min measurement time, including sample preparation, negative ion formation, transmission through the AMS system, and software gating) of $(3 - 4)x10^{-4}$ for samples containing between 50 µg and 250 µg of Be.

SAM#P103 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

^{10}Be measurements at MALT for reduced size samples of bulk sediments

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We attempted ^{10}Be measurements on reduced-size samples (1 to 10 mg) of "recent" sediments using MALT-AMS system at the University of Tokyo. For assessing the robustness of the measurements, we used two lacustrine- and one marine-sediment samples, the ^{10}Be concentrations of which (7–11 x 10^8 atoms g^{-1}) had been determined in previous works by applying our ordinary method (e.g. Horiuchi et al., 2000).

We examined four layouts of the pretreatment in this study. Those are: A) A 10 mg of sample with 300 mg of ^{9}Be carrier was pretreated by applying chemical disintegration, ion exchange separation, and washing of the precipitated $Be(OH)_2$; B) A 10 mg of sample with 300 mg of ^{9}Be carrier was pretreated by applying chemical disintegration and washing of the precipitated $Be(OH)_2$; C) A 10 mg of sample with 50 mg of ^{9}Be carrier was pretreated by applying chemical disintegration and washing of the precipitated $Be(OH)_2$; D) A 1 mg of sample with 30 mg of ^{9}Be carrier was pretreated by applying chemical disintegration and washing of the precipitated $Be(OH)_2$. All the pretreated $Be(OH)_2$ was converted to BeO by heating in a microwave crucible, and it was then mixed with Nb powder prior to the AMS measurement at MALT.

The result of each trial (A to D) for the all sediments agreed well with the previously determined value on the ordinary (not reduced) size samples within their standard deviations (ca. ± 4 %). However, the BeO^- beam currents of the trials C and D were approximately five times lower than the other trials, causing the duration of the measurements to be longer than usual and the precision of those to be lower. The layout to meet the requirements of both low pretreatment cost and high beam current was B, but enough suppression of the isobar boron in the AMS system was necessary as well as that in trials C and D. This study demonstrates that reliable determination of ^{10}Be using milligram (and probably submiligram) level of "recent" bulk sediments is possible at MALT. However, the combination of about ten mg of sediments and a few hundred mg of carrier is more convenient at this stage.

SAM#P104 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Carrier-free $^{10}Be/^{9}Be$ measurements with low energy AMS: Determination of sedimentation rates in the Arctic Ocean

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We will present our method of determining the sea water derived (authigenic) $^{10}Be/^{9}Be$ ratio of marine sediment samples without the addition of carrier at the TANDY AMS facility (0.5MV) in Zurich and the current technique of sample preparation. The new method reduces systematic uncertainties because the $^{10}Be/^{9}Be$ ratio of a sample is determined by only one (AMS) measurement. One challenge of carrier-free AMS is to avoid any contamination of the sample with stable ^{9}Be during the chemical preparation. Also the leaching procedure that tries to attack only the authigenic Be of the sediments and should leave the detrital Be untouched must be reproducible. Further, the low amount of stable ^{9}Be in the samples causes very low currents (down to about hundred pA) during the AMS measurement. This requires a good stability and sensitivity of the AMS setup. Our first results show that the new preparation method is reliable and that background from stable ^{9}Be is avoided.

For a comparison study sediment samples from two sediment cores located in the Arctic Ocean (HLY0503-09JPC, HLY0503-14JPC) were available. For these samples the authigenic $^{10}Be/^{9}Be$ was determined using the conventional method (i.e. ^{10}Be and ^{9}Be are measured separately by AMS and ICP-MS; Sellén et al., Global and Planetary Change 68, 38-47, 2009). The resulting sedimentation rates were in discrepancy with values derived from biomarkers. To cross check the $^{10}Be/^{9}Be$ based age model two samples from each core were measured again with the new carrier-free method. The new results show systematically higher authigenic $^{10}Be/^{9}Be$ ratios, probably caused by differences in the chemical leaching procedure. However, the calculated sedimentation rates of about 0.2cm/kyr are consistent for both (carrier free and conventional) methods. We therefore conclude that the new carrier free method is ready for the determination of sedimentation rates in marine sediments.

SAM#P105 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Reprocessing of ^{10}B-contaminated ^{10}Be AMS targets

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Forty ^{10}Be samples of Antarctic ice (DSS0506-pit) along with associated procedural blanks, measured at the ANTARES AMS facility at ANSTO were found to have 10-100 times the ^{10}B levels of routine BeO samples and blanks (full procedural blanks with this beryl carrier are typically ^{10}Be/^{9}Be $<5 \times 10^{-15}$). These exceptionally high boron rates (measured via an active absorber cell filled with argon gas), coupled with the relatively low ^{10}Be/^{9}Be ratios of ice samples, made any correction to the raw ^{10}Be detector count rate highly unreliable and uncertain. As this was a unique sample set, a method for reprocessing the targets to remove the boron was developed and tested.

For measurement on ANTARES ~0.5mg BeO is mixed with ~2.0mg of niobium powder and rear-pressed into an aluminium target holder with a 1.6mm diameter recess at 120 kPa. To reprocess the samples, this BeO/Nb mixture was physically removed from the target holders by pushing the sample loading pin forward with a hand press. The beryllium was separated from the niobium by dissolving the BeO in concentrated H_2SO_4. This solution was then heated with HF to remove the boron as BF_3. The beryllium was then re-precipitated as $Be(OH)_2$ and calcined to BeO, which was then mixed with new niobium powder before being rear-pressed into a detachable cap target holder with a smaller (1 mm) diameter recess. Overall yields for this process averaged 40%. Boron levels for all the original samples and blanks returned to acceptable levels, with ^{10}Be/^{9}Be blanks of ~10×10^{-15}. Extensive testing of the equipment, reagents and laboratory failed to determine the source of the boron. As a precautionary measure, a similar H_2SO_4/HF step has been subsequently added to the standard ice processing method, resulting in consistently low boron levels without any decrease in processing yields.

SAM#P106 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

A new method for separation and purification of beryllium and aluminium using the eichrom DIPEX® resin

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ANSTO

The DIPEX® resin manufactured by Eichrom was originally developed for the separation and pre-concentration of actinides from nuclear industry waste streams and digested environmental samples. The resin has in recent years been investigated for use in separation of beryllium from a wide range of other elements which interfere with the determination of beryllium by ICP-AES. Application of this resin to purification of beryllium from environmental samples for analysis by Accelerator Mass Spectrometry (AMS) may allow for simplified sample processing in a single step and reduced interferences.

AMS measurements of the cosmogenic isotope ^{10}Be however are susceptible to a different selection of interfering elements than those which affect ICP-AES measurements. ^{10}Be measurements are most commonly performed on melted ice and purified quartz. Both these sample types are generally low in elemental impurities such as magnesium, calcium, aluminium, titanium and iron with concentrations typically no more than a few hundred ppm in purified quartz and only a few ppm in ice however potential interferences still exist that must be removed prior to analysis. Two of the most significant interfering elements are boron and titanium. The isobar ^{10}B, if sufficiently abundant, interferes with ^{10}Be measurements by increasing the measurement background. Titanium has a retarding effect on caesium sputter ionisation and so on ion source output.

The DIPEX resin has been evaluated as a single column purification and separation method for preparation of samples for AMS analysis. In this paper we present data on this evaluation including:

- Evaluation of the resin capacity and selectivity for aluminium in a simulated matrix representing digested quartz and melted ice
- Evaluation of the selectivity of the resin for beryllium in a simulated matrix representing digested quartz and melted ice
- Assessment of the resin's capacity to separate interfering matrix elements from the beryllium fraction.

SAM#P107 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Extraction and purification of quartz using phosphoric acid

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ANSTO

Quartz extraction and purification from rocks, sediment, soil and dust samples is essential for the successful measurement of ^{10}Be and ^{26}Al by Accelerator Mass Spectrometry (AMS). The common procedure used involves initial water washing to remove fines then Aqua Regia treatment followed by density separation using lithium silicon tungstate then magnetic separation and finally selective etching of powder samples by ultrasonic heating and agitation in a dilute aqueous (~2% w/w) hydrofluoric acid solution (HF). This technique has proven adequate for quartz rich rock types (ie granite, quartzite). The etching method alone typically involves 4-5 cycles of HF 2% etchings and the result is ~10-30% mass loss. However for fine grained and or low quartz (non-felsic) bearing samples such as flint, silcrete, andesite, diorite) density and magnetic separation are inefficient. Furthermore, HF etching will readily dissolve fine quartz grains and thus severely affects yields. We have developed an alternative method using hot phosphoric acid (~250°C), which preferentially dissolves silicates and many other minerals but not quartz. Differentiation of quartz from other minerals (e.g., feldspars, plagioclase) is excellent, density and magnetic separation is not required and usually fewer cycles are required than with conventional HF etching. Hence the hot phosphoric acid method is particularly effective on rocks containing fine grain quartz, e.g., greywacke, silcrete and chert, to enhance quartz recovery. As a bonus this method will bulk extract zircons if required. The technique is far more cost effective by using cheap commercial grade reagents and reduced risk compared to handling highly hazardous HF solutions. We present semi-quantitative data that compares the efficiency and the benefits of the two methods.

SAM#P108 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Improving the accuracy of aluminium assay in purified quartz for in situ cosmogenic exposure dating

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Precise and accurate measurement of the natural aluminium content in purified quartz powder, [Al], extracted from surface bedrock and/or sediment samples for in situ cosmogenic nuclide dating is critical for reliable ^{26}Al exposure ages and ^{26}Al/^{10}Be ratios for burial dating. Numerous articles have cited issues regarding reliability of ^{26}Al ages paired to ^{10}Be ages, not only due to poor statistical error, but also due to uncertainty in [Al]. Loss of Al during aliquot preparation for ICP-OES from bulk HF solutions of dissolved quartz or inaccurate assay via ICP (or AA) will result in reduced ^{26}Al concentrations. In turn this will, depending on magnitude of the loss with respect to typical age errors, lead to lower-than-expected ^{26}Al ages when compared to corresponding ^{10}Be ages. If the loss is excessive, this may result in depressed ^{26}Al/^{10}Be ratios and thus a false burial signal. Over the past 4 years we have performed repetitive Al assays from a parent HF solution prepared from ~25 g of a low-iron glass sand (NIST-165a; ~320 ppm [Al]) using identical methods as for all quartz samples. The solution was used as an in-house laboratory standard for [Al] and shows a limiting 1σ of $\pm$5% (n ~50) via ICP-OES at a commercial laboratory. The spread in paired NIST-165a duplicates measured per batch is better than $\pm$1%. To determine the accuracy of our procedures, we prepared sets of solutions (1–10 ppm Al) from 3 different quartz powders using the standard addition method. Initial results indicate a 3-7% offset between [Al] based on the standard addition method and that based on the conventional calibration curve.

SAM#P109 POSTER SESSION 2 Thursday 24th March, 1400 - 1540

3H bioAMS Sample Preparation at LLNL Using Septa Sealed Vials

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Biological AMS studies are effected by the availability and cost of study compounds. There are a large variety of tritiated compounds available off the shelf. While these compounds may have ^{14}C analogues, often an analogue would have to be synthesized. Also, having a ^{3}H AMS capability enables dual-isotope studies. Therefore, there is great interest in developing ^{3}H AMS for biological studies. We have developed a method to prepare solid TiH_2 samples from biological matrices using septa-sealed vials. Dried samples containing at least 0.2 mg hydrogen are first combusted in sealed quartz tubes at 900ºC. Following combustion, the vial is introduced into a reusable tube cracker and cracked open. The gases produced are carried in a helium gas stream to a septa-sealed vial containing 400 mg Zn shavings and 10 mg Ti powder. The H_2O is trapped out using the septa sealed vial as a cold finger in a Dry Ice/Isopropanol slurry. Non-condensable gases are evacuated from the vial. To limit sample-to-sample carryover the tube cracker and transfer lines are kept heated. The septa-sealed vial is placed in a block heater at 400ºC for 4 hours and the H_2O is reduced to solid TiH_2, which is then analyzed in our BioAMS Spectrometer. This system is capable of producing 20 – 30 samples per day for AMS analysis. Importantly, this set-up is also capable of trapping CO_2 from the same sample for subsequent conversion to solid graphitic targets for ^{14}C AMS analysis.

Work performed (partially) at the Research Resource for Biomedical AMS which is operated at LLNL under the auspices of the U.S. Department of Energy under contract DE-AC52-07NA27344. The Research Resource is supported by the National Institutes of Health, National Center for Research Resources, Biomedical Technology Program grant #P41 RR13461.

SAM#P110 POSTER SESSION 2 Thursday 24th March, 1400 - 1540

Separation of ^{129}I and ^{127}I in pre-nuclear-era marine algae with ultra low $^{129}I/^{127}I$ isotopic ratios

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We propose a method for effectively extracting ^{129}I and ^{127}I from marine algae that is simpler and safer than conventional extraction methods. Our method avoid atmosphere much higher ^{129}I level than that of pre-nuclear test, and this method is demonstrated to be applicable for separating iodine isotopes with ultra low $^{129}I/^{127}I$ ratios from marine algae collected during the pre-nuclear era. The iodine isotopes ^{127}I and ^{129}I were isolated from marine algae samples to obtain $^{129}I/^{127}I$ ratios by means of acceleration mass spectrometry (AMS). The collection efficiency of iodine was obtained by activation analysis (KUR) and XRF. Our separating method was effective for measuring ultra low $^{129}I/^{127}I$ ratios of about 10^{-12}, which were observed in algae samples from the pre-nuclear era (before 1945). The $^{129}I/^{127}I$ ratios observed in algae collected from 1928 to 1987 ranged from 10^{-12} to 10^{-10}. The $^{129}I/^{127}I$ ratio in algae collected from 1987was 100 times as high as the ratio measured in algae from before 1945. This dramatic increase in $^{129}I/^{127}I$ ratio after 1945 was attributed to human activity.

SAM#P111 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Automated Combustion Interface for Routine Rafter Radiocarbon Samples on EA-CF-IRMS

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The Rafter Radiocarbon Laboratory and GNS Stable Isotope Laboratory have implemented a system for the routine collection of CO_2 from radiocarbon samples at New Zealand's National Isotope Centre. The system operates on a Europa Geo 20/20 isotope ratio mass spectrometer (IRMS), and collects CO_2 produced by combustion in the elemental analyser (EA). The principle of the device is that 1% of the sample is routed from a split to the continuous flow (CF)-IRMS interface, as is normal practice for the determination of C and N stable isotopes. The 99% that would normally go to waste is cryogenically trapped, and transferred to one of twelve pneumatically operated sample bottles for subsequent graphitisation and AMS measurement. The system operates in LabView using a control computer interfaced to the Geo 20/20, and includes the development of sample protection mechanisms to prevent the loss of irreplaceable samples. Testing of the apparatus has involved two stages. In the first stage, the $^{14}C/^{12}C$ ratios of 62 standards were shown to be indistinguishable from conventional sealed tube combustion. In addition, blanks were shown to have average conventional radiocarbon ages (CRA) in excess of 49 ky. The successful outcome of these tests enabled a second stage of testing to begin. In the second stage of testing, 63 duplicates of sealed tube combustion measurement of real unknown samples were completed. These yielded a difference of less than 1‰ or 7 years (CRA) between methodologies. The device has therefore been deemed operational and application on unknown samples is underway. The development is expected to improve the cost-efficiency of our laboratory and improve sample turnaround times. The device will be valuable for both conventional dating and C-cycle studies.

SAM#P112 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

The sample preparation line for radiocarbon measurements on atmospheric aerosol at INFN-LABEC (Florence, Italy)

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The carbonaceous particles are among the major constituents of the atmospheric aerosol [1]. They are thought to play an important role in both the health and the climatic effects of aerosols. Due to their complexity, the knowledge of the sources for this aerosol fraction is still very low.

Radiocarbon measurements on the Total Carbon (TC) fraction have been demonstrated as an effective tool for aerosol source apportionment: ^{14}C is absent in fossil fuel combustion emissions while it is present in the aerosol from the biogenic and biomass burning sources with almost the same concentration as in the atmosphere. ^{14}C measurements on the carbonaceous aerosol sub-fractions (EC, elemental carbon, and OC, organic carbon) allow an improvement in the source apportionment since they give an unambiguous distinction between the two non-fossil sources (i.e., the biomass burning and the biogenic source), supposing that the OC/EC emission ratio for biomass burning is known [2]. Therefore, ^{14}C measurements on EC and OC lead to the quantification of the contributions of all the three carbonaceous aerosol sources (fossil fuel, biogenic, biomass burning) and, hence, to the assessment of the contributions from the natural and the anthropogenic activities.

A key point in the ^{14}C measurements of aerosol samples is sample preparation, since the separation of the carbonaceous fractions demands special requirements generally not satisfied in lines dedicated to "common" organic samples (e.g. from archaeological contexts). At the INFN-LABEC laboratory of Florence (Italy), a new sample preparation line was designed and realized to fulfil all the procedures for the TC, EC and OC separation and to graphitize them to be measured by AMS [3]. Here we report on the first tests performed using this line. In particular, for TC measurements, reproducibility, accuracy and background were tested, indicating that reliable results can be obtained on aerosol samples.

[1] Ten Brink, H., Maenhaut, W., Hitzenberger, R., Ganuk, T., Splinder, G., Even, A., Chi, X., Bauer, H., Puxbaum, H., Putaud, J.-P., Tursic, J. & Berner, A. (2004). Atm. Env., 38, 6507-6519

[2] Szidat, S., Jenk, T.M., Synal, H.-A., Kalberer, M., Wacker, L., Hajdas, I., Kasper-Giebl, A. & Baltensperger, U. (2006). J. Geophys. Res., 111 D07206

[3] Calzolai G., Bernardoni V., Chiari M., Fedi M., Lucarelli F., Nava S., Riccobono F., Taccetti F., Valli G., Vecchi R., Nucl. Instr. & Meth. B (in press), doi: 10.1016/j.nimb.2010.12.021.

SAM#P113 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

AMS measurement of samples smaller than 300 microgram at Center for Applied Isotope Studies, University of Georgia

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The Center for Applied isotope studies has developed a technique for the measurement of radiocarbon in the sample size range 0.01-0.3 mg of carbon. There were analyzed a series of radiocarbon free and modern standards using the same sample preparation procedure as for unknown samples. We have studied the dependency of ^{12}C, ^{13}C beam currents and $^{14}C/^{13}C$ ratio from the carbon content in the targets in the range from 0 to 1mg of carbon. It was found that iron catalyst used for graphite preparation has some carbon contamination, which shows about 0.05 μA of ^{12}C current, 1ηA of ^{13}C current and $^{14}C/^{13}C$ ratio about $2X10^{-13}$, that corresponds to ~20 pMC. A very significant dependency between current and the sample size was shown by the targets in the range 0-50 μg. In this range the current increased twenty fold; between 50 and 100 μg the current increased twofold. Samples larger than 300 μg have shown negligible current variation. The $^{14}C/^{13}C$ ratio was significantly affected only for the samples less than 50 μg. Larger samples have shown very little variation in the $^{14}C/^{13}C$ ratio. So, for the measurement of ultra-small unknown samples in the range of 10-50 μg, which can be routinely measured in our laboratory, it is very important to use blanks and modern standards with the same target size of carbon which makes it possible to apply a mass-balanced correction.

SAM#P114 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Effect of HF leaching on ^{14}C dates of pottery

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Absolute dating of potsherds may give direct information on development of societes and their interrelationships. Most reliable ^{14}C dates can be obtained on organic-rich coating or charcoals. In many cases carbon is dispersed rather homogenously inside the sherds, and no clear organic remains can be separated for dating. The carbon suitable for dating is that originating from the fuel used during pottery production ,but the shred usually contains also the carbon bound in the clay used by the potter, and also that of the humic asids fixed in a sherd during its burial in sediments. To minimize the influence of carbon bounded in clay Delque-Kolic (1995) proposed lower combustion temperature. Effectiveness of humic acid extraction in NaOH, difficult to eliminate by simple AAA treatment, can be largely increased by the combined treatment with HF and AAA (Kovaljuch and Skripkin, 2007). Two samples of potsherds, from archaeological sites in Opatowice (Poland) and Kosice (Slovakia) ^{14}C dated without HF treatment gave dates too young with respect to the archaeological expectations. Supposing that the wrong dates were produced by ineffectively removed humic acids, some experiments on influence of HF leaching on ^{14}C dates were made. The results of ^{14}C measurements demonstrated that the volume of shreds contains carbon fractions of different isotopic signatures. The performed tests with HF leaching demonstrate indeed, that this step is necessary for removal of humic acids with NaOH, however the most proper concentraction of HF may be different for different shreds, and at this stage, impossible to predict. Simple combination of HF and AAA treatment is insufficient in responsible ^{14}C dating of carbon homogeniccaly dispersed in the volume of potsherds.

SAM#P115 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

The processing line for the extraction of dissolved inorganic carbon in seawater samples at CEDAD

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A dedicated sample processing line for the extraction of dissolved inorganic carbon (DIC) from seawater for AMS (Accelerator Mass Spectrometry) ^{14}C analysis has been developed at CEDAD, the Center for Dating and Diagnostic of the University of Salento, Lecce, Italy, in the frame of an ongoing industrial research project.

DIC is extracted from the sample as gaseous CO_2 on a vacuum line almost entirely built in glass (Pyrex™) in order to minimize the parts to be replaced because of corrosion processes due to salt water vapor. The vacuum system consists of a diaphragm pump and a thermocouple vacuum gauge for vacuum pressure monitoring. Seawater is sampled on site, poisoned and stored in glass bottles until processing and laboratory analysis is performed.

The bottle is attached to a stripping probe which is then connected to the vacuum line. The process of carbon dioxide extraction is carried out by acidification with phosphoric acid while a high purity carrier gas (N_2) is forced through the end of the stripping probe producing a stream of fine bubbles throughout the seawater. The stripping process continues for some minutes and after that the carrier gas is pumped away. During the stripping phase, N_2 bubbles transport gaseous CO_2 that is frozen into a liquid nitrogen trap, while water vapors are frozen in a -80°C cold trap. The system has been designed such that CO_2 is extracted in a calibrated volume. The gas pressure extracted from the sample is measured by pressure transducer. Gaseous CO_2 is then transferred to the existing lines for the catalytic reduction to graphite for AMS analysis.

Preliminary tests were carried out by processing seawater sampled at different locations along the Ionian and Adriatic coasts and the system performances are presented in terms of functionality, background and samples throughput.

SAM#P116 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

An automated graphite preparation line for hydrogen or zinc reduced graphite

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In an effort to increase sample preparation an automated graphite line has been developed at the ANU. The line has 20 tube crackers that are evacuated then the glass tubes of CO_2 are cracked. The CO_2 is processed one sample at a time, first trapping out water using a dry ice and ethanol trap. The CO_2 is then transferred to a calibrated volume for size measurement. This measured volume has an adjustable bellows to obtain the correct pressure (sample size) for the individual reactors. Samples are transferred using LN, the measured volume has a motorized cup that moves up/down to freeze the CO_2 sample. The individual reactors are submerged in an insulated trough of LN during both the sample transfer and hydrogen introduction. A PC running a LABVIEW program written for the system controls the entire system. The reactor system can also be configured to prepare 10 samples using the zinc reduction method. It is hoped that next we will add an Elemental Analyzer to prepare the CO_2 instead of using sealed quartz tubes. Results from standard and blank ^{14}C free samples will be presented.

SAM#P117 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Treatment for carbonate samples for radiocarbon dating

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Various types of carbonate are used as material for radiocarbon dating. Very common are shells of foraminifera, mollusk, ostracodes, corals and stalagmites/stalactites. Other such as eggshells or pearls are less common but might be equally challenging. Previous studies have shown that secondary carbonates might cause problems in providing accurate radiocarbon ages. Different methods of treatment have been proposed to remove the potential contamination by leaching of the surface either with acid or hydrogen peroxide. For example, treatment of foraminifera shells was addressed in the inter-comparison exercise, where all these methods of treatment were applied to the handpicked single-species foraminifera from the same depth (Broecker et.al., 2006), resulted in different ^{14}C ages of treated and untreated fractions. It remains to be clarified which of the method is most effective and when should be applied.

Similarly, a treatment of macroscopic shells (mollusk, gastropodes and ostracodes) has not been fully investigated. In general, a removal of more then 50% of a surface assumed to be sufficient and applied to large shells. However, sporadically effectiveness of this treatment is questioned, especially when ages of the shells are close to the limit of ^{14}C dating.

In this study we compare the effects of various treatment methods applied to very old shells of different type, age and location.

W.S. Broecker et al., Palaeocenography 21 (2006) PA2008 doi.10.1029/2005PA001212.

SAM#P118 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Radiocarbon Dating of linen from an Egyptian Mummy

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In the 19th and early 20th centuries, many museums acquired Egyptian coffins containing mummies from private donors who bought them from dealers in Egypt. Owing to the unknown context of such acquisitions, it cannot be assumed that the mummified individual inside the coffin is the same person named on it. Radiocarbon dating is a key diagnostic test, within the framework of a multidisciplinary study, to help resolve this question. The dating of an adult mummy in the Nicholson Museum at the University of Sydney was therefore checked using ^{14}C dating. For over 150 years, mummy NM R28.2 was identified as Padiashaikhet as per his coffin, dated to the 25th Dynasty, c. 725–700 BC. Radiocarbon results from samples of linen wrappings revealed that the mummy was an unknown individual from the Roman period, 68-129 cal AD. The mummification technique can now be understood within its correct historical context.

SAM#P119 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Lose 5,000 radiocarbon years in just one hour; improved backgrounds using zinc reduction for graphite target preparation

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Lose 5,000 radiocarbon years in just one hour; improved backgrounds using zinc reduction for graphite target preparation

All instrumental analysis requires the identification, quantification and removal of background activity that will mask a sample's true signal. During radiocarbon analysis this background is attributed to contamination introduced during sample preparation, or to physiochemical properties of the graphite that hinder performance of the targets within the accelerator. One common method for producing graphite targets uses hydrogen reduction over an iron (Fe) catalyst. This study details changes the Australian National University's Radiocarbon Laboratory is making by adapting a zinc (Zn) reduction method for graphite production. Multiple aliquots of carbon dioxide (CO_2) derived form a radiocarbon "dead" coal have been prepared on our modified hydrogen graphite line. Optimization has included testing a variety, and the quantity of, Fe and Zn powders at different temperatures. Considerable improvements have been made with the addition of an oxidation step during preconditioning, and significant reduction of the reactor volume. Reaction times have been reduced from ~6 to <1 hour and yield is >95% for full sized samples (1mgC). This has meant that samples of radiocarbon dead materials introduced to our NEC Single Stage Accelerator Mass Spectrometer are giving backgrounds improved by ~5,000 years (to >51,000 yrs) compared to those using the hydrogen reduction method. This study compliments our laboratory's work in progress to develop a range of preparatory protocols that can be implemented depending on the size, type and estimated age of samples that are submitted for radiocarbon analysis.

SAM#P120 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Radiocarbon dating of VIRI bone samples using ultrafiltration method

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Ultrafiltration is considered to remove contaminants with low molecular weight (MW) from bone samples and select high MW protein, which is derived from original bone collagen. Therefore, the ultrafiltration method can be effective to obtain more certain ^{14}C dates of bones. However, there have been few data of bones with the ultrafiltration method yet, compared with only gelatin extraction method, and remains doubt of new contaminants adding to bone samples during ultrafiltration procedure. To study effects of the ultlafiltration method on ^{14}C age, we analyzed C/N ratio, $\delta^{13}C$ and $\delta^{15}N$ values, and ^{14}C ages of some fractions of a bone: acid-soluble collagen, gelatin, high MW gelatin, and low MW gelatin, which are obtained sequentially through decalcification, gelatin extraction followed by ultrafiltration. The samples used are VIRI bone samples of E (mammoth), F (horse), G (human), and I (whale).

The gelatin yields of VIRI-E, F, G, and I were around 17, 19, 21, and 24%, respectively, suggesting that the VIRI bone samples are well preserved without suffering severe chemical weathering. The ^{14}C ages, $\delta^{13}C$ and $\delta^{15}N$ values of gelatin and high MW gelatin fractions were almost same for each of the VIRI bones, and similar to the consensus values within errors. The low MW gelatin shows different values from those of the other fractions, indicating presence of foreign matters, e.g. fulvic and humic acids, and/or degraded gelatin. The low MW gelatin exists in even well-preserved bones, and therefore ultrafiltration protocol is effective for ^{14}C dating for most bone samples. However, fractions contaminated by ultrafilters during ultrafiltration procedure could have older ^{14}C ages because pre-cleaned filters have almost ^{14}C-free carbon. We need further to study various bones with different degree of degradation for more accurate ^{14}C dating by the ultrafiltration method.

SAM#P121 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Reproducibility in radiocarbon dating of carbonized materials adhering to pottery

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Our research laboratory (Dating Materials Laboratory) at the National Museum of Japanese History (NMJH) started in 1998 and extended its space and equipments in 2004 to meet a requirement of increasing samples in our own research projects such as the project:"The origin of the Farming in the Yayoi Period and East Asia: Establishment of High-Precision Chronology by Carbon-14 Analysis". During this research projects (from April 2004 to March 2009), we have measured more than 2000 charred matters on potsherds and conducted archaeological and historical researches.
In this paper, we describe the method of AMS-^{14}C dating of carbonized materials adhering to pottery, discuss the reproducibility on the same aliquots of samples in the individual ^{14}C laboratories and compare the measured values of the same aliquots (contain the same graphite) among different ^{14}C laboratories.

This work was supported by a Grant-in-Aid for Young Scientists (B) No. 18700679 & No 20700663 (Y.M.) and Creative Scientific Research No. 16GS0118 (T.N.) of the Japan Society for the Promotion of Science.

SAM#P122 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Preparation and measurement of microgram samples with the ARTEMIS AMS facility in Saclay, France

Moreau C, Delque-Kolic E, Bavay D, Caffy I, Comby C, Dumoulin J, Ferkane S, Hain S, Quiles A, Setti V, Souprayen C
CEA LMC14

The ARTEMIS facility routinely measures 4500 samples per year for French organizations covering several fields of research like environmental science, archaeology or hydrology. For a few years, research teams working on specific compounds from soils or organic fractions from water ask for measurements on very small samples. These demands have leaded us to evaluate our ability to reduce microgram samples with our usual graphitization lines and to measure them with our 3MV NEC Pelletron AMS. Our reduction facility consists of two graphitization lines fully automatic each of them containing twelve reduction reactors of 18 and 12 ml. We have studied, under these routine conditions, the evolution of the reduction yield with decreasing mass and the minimum mass that can be reduced with acceptable reproducibility.

Several sets of micro samples produced from our normalizing standard OXI I, International References and blanks have been measured with optimized source set-up to minimize the deterioration of the smallest targets under the cesium beam. The first measurements allowed us to adjust the amount of Fe catalyst for very small quantities of carbon to avoid too quick destruction of the target under the beam. We have observed the evolution of the $^{14}C/^{12}C$ ratio with decreasing $^{12}C^{3+}$ beam current intensity and the machine-induced fractionation compared with thus of the graphitization step. With the measurement of the blanks and modern samples, we are able to evaluate the modern and dead contamination of our graphitization lines using the approach of Santos et al.. Reactors with smallest volume (5 ml) are under study to increase the graphitization yield and reduce the effect of contamination. The carbon extraction process - combustion for organic matters and hydrolysis for carbonates – is also considered in terms of modern carbon contamination. As expected, the contamination is slightly higher and needs to be more precisely identified.

G.M. Santos, J.R. Southon, S. Griffin, S.R. Beaupre, E.R.M. Druffel, Nucl. Instrum. Meth. B 259 (2007) 293.

SAM#P123 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Newly developed automatic graphitization system for AMS ^{14}C measurements

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In order to improve the sample preparation throughput and correspond to shortages of manpower in laboratories, we have developed an efficient system for producing the graphite for AMS ^{14}C measurements. This system allows for the automation of combustion of organic materials and hydrogen reduction of CO_2 with iron catalysis. The newly developed temperature-controllable cooling system for trapping CO_2 into small finger of graphitization reactors make it possible to reduce the size of preparation system. All the system is controlled by a LabVIEW program on a Windows PC. Further system developments for applications to other type samples (e.g. carbonate and CO_2 gas in sealed glass tube) are possible with small modification. We demonstrate the configuration of our present system in detailed and some examples of system operations on samples, blanks and standards.

SAM#P124 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Preparation and AMS dating of charcoal samples from northern Poland

Nawrocka D
Adam Mickiewicz University

Czarnowko is an archaeological site in northern Poland used by over 800 years by populations of different cultures, beginning from 8 BC. From 7th to 3rd cent. BC it was a settlement occupied by populations of Lusatian culture, replaced by the cemetery of Pomeranian culture with indefinite boundaries. Between 1st cent. BC and 3rd cent. AD this area was using as a cemetery by Oksywie and Wielbark cultures. The geoarchaeological research and microscopic observation enable to choose the appropriate samples for radiocarbon dating. Charcoal, wood fragments, and single textile were collected from graves and residual burrow. The chosen samples have been dated via accelerator mass spectrometry (AMS). The radiocarbon dating by AMS was coupled with taxonomic identification of charcoal and wood samples using polarizing optical microscope and scanning electron microscope (SEM). We aimed to verify not only the estimations made by archaeologists and to indicate the stages of development and extension of the settlement and cemetery, but also the applied preparation and sample selection methods. The basic stages of preliminary preparation of charcoal for ^{14}C dating are based on acid-base-acid method (ABA). We continue experimental studies and observations how each of the ABA procedure steps influences the sample, depending on the state of charcoal preservation, age and environment. Most of the obtained results are in agreement with the established relative chronology. The dates obtained from charcoal samples sometimes give ages that are too old. The main source of this error seems to be related to the old wood effect. The research was supported by the Polish State Committee for Scientific Research, within the grant no N N307 059437.

SAM#P125 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

The detection of PEG using GC/MS for AMS radiocarbon dating of preserved wood

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Polyethylene glycol (PEG) is the most useful conservation substance and commonly used for stabilization of the size and shape of waterlogged woods that are excavated from many archaeological sites. When radiocarbon dating of the conserved woods is required, we must eliminate PEG completely from the woods, because PEG was manufactured from fossil fuel. In theoretical sense, PEG can be dissolved easily in water, but there is no acceptable result indicating that normal decantation process with even hot water can extract PEG perfectly in previous studies. In order to estimate the degree of PEG elimination with water from sample woods, we tried elimination of PEG with the normal decantation process at around 70-80 ℃ from known-age test samples which were prepared from waterlogged woods [method-1], and performed AMS radiocarbon dating of the test sample remains recovered after treatments. As another method to eliminate PEG, a soxhlet extractor with organic solvent was employed. The extractor will remove the conservation substance efficiently than the normal decantation method. As the results, method-1 and method-2 could not isolate PEG perfectly. Consequently, we assumed that the PEG is confined physically by cell wall of the wood. Removing PEG in cell wall completely, size of wood sample should make smaller. In these processes, we used known age samples to estimate the degree of PEG elimination. In most cases, however, we cannot obtain the true age of samples. Therefore, we also need to know whether PEG was clearly isolated from the conserved woods or not before radiocarbon dating. To verify nonexistence of PEG in the woods after the elimination process, pyrolysis GC/MS were conducted. From the analysis using pyrolysis GC/MS, we discovered pyrogram which characterize existence of PEG. Therefore, pyrolysis GC/MS will help to AMS radiocarbon dating of the conserved woods with PEG.

SAM#P126 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

A modular sampling system for atmospheric and soil CO_2 samples

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We have developed a new modular molecular-sieve CO_2 sampler for atmospheric and soil CO_2 samples. Based on our previous system (Hämäläinen et al 2010), the present setup was optimized for modularity and gas-tightness, enabling the collection of up to 20mg CO_2 samples for high precision AMS measurements. The large sample size also enables the use of one molecular-sieve container to remove CO_2 prior to chamber measurements.

The new molecular sieve container consists of a 25-mm-OD quartz tube and off-the-shelf Swagelok valves and fittings. The molecular sieve material is held in the quartz tube by two metal bushings, tightly fixing the sieve and ensuring optimal gas contact with the sieve material. Containers are gas-tight and very easily constructed, cleaned, used, and replaced. Particularly, the design avoids use of vacuum grease – potential carbon contaminant - in sealings thus allowing for user-friendly operation.

In this contribution, we discuss the design and performance of the setup. Furthermore, initial results of using the setup to study soil respiration with CO_2 and $^{14}CO_2$ measurements will be presented. In 2011-2013, a large measurement campaign will be directed to atmospheric, soil, and wetlands $^{14}CO_2$ studies.

K. Hämäläinen, H. Fritze, H. Jungner, K. Karhu, M. Oinonen, E. Sonninen, P. Spetz, M. Tuomi, P. Vanhala, and J. Liski, Molecular sieve sampling of CO_2 from decomposition of soil organic matter for AMS radiocarbon measurements. Nucl. Instr. and Meth. B 268 (2010) 1067.

SAM#P127 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

HASE - The Helsinki adaptive sample preparation lin

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We have constructed an adaptive sample preparation line with modules for combustion, molecular sieve handling, CO_2 gas cleaning, CO_2 storage, and graphitization. In addition, the line is connected to an elemental analyzer (Pesonen, this issue). Vacuum equipment, a flow controller, pressure sensors, ovens, and graphitization reactors are automated with a reliable real-time system.

Stepped combustion can be performed in two ovens at 0-900 °C temperatures. Depending on the application, CuO or O_2-flow combustion can be used. A flow controller is used to adjust the O_2 flow and pressure during combustion. When handling molecular sieves, a module for molecular sieve regeneration and sample desorption is attached to the line instead of the combustion module.
A metering valve is used between the combustion module and the CO_2 cleaning module to lower the pressure for easy H_2O, O_2, and CO removal. A calibrated volume is used to measure sample mass during the CO_2 cleaning.

In the storage module, CO_2 samples can be stored behind a gas-tight diaphragm valve and either stored for later graphitization or taken for measurements with separate equipment (AMS gas ion source or a separate mass spectrometer).

The graphitization module consists of four automated reactors, capable of graphitizing samples with masses from 3 mg down to 50 µg. The duration of graphitization is typically four hours.

We present the design and commissioning of the setup and discuss present and future applications within the broad field of AMS radiocarbon measurements.

SAM#P128 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Elemental Analyzer combustion of liquid fuel samples for AMS biocarbon measurements

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AMS radiocarbon sample preparation remains very often a time- and labour-consuming process. In order to decrease the time spent on sample preparation we established an Elemental Analyzer (EA) sample combustion and collection system. Main focus was on liquid fuel samples due to increasing interest in their biocarbon determinations. We have previously measured liquid fuel bioportions by traditional Closed-Tube Combustion (CTC) method (Oinonen et al., 2010) and on this project the same samples were used allowing good comparison between the CTC and EA combustion methods.

CO_2 collection line was built and connected to the EA. Liquid fuel samples were packed in tin cups and combusted in EA in 1020 °C. CO_2 was cryogenically trapped with liquid nitrogen and transferred into sample vials in which they were transferred to CO_2 purification vacuum line and graphitization reactors.

We have also connected the EA on a newly-developed automated sample collection system (Palonen, this issue) allowing even faster sample preparation. In this presentation we will present the layout of the EA combustion and sample collecting equipment and discuss the results.

Oinonen, M., Hakanpää-Laitinen, H., Hämäläinen, K., Kaskela, A., Jungner, H. 2010, Biofuel proportions in fuels by AMS radiocarbon method. Nucl. Instr. Meth. Phys. Res. B 268: pp. 1117-1119.

SAM#P129 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Testing the effect of Sodium Polytungstate on pollen concentrate sample preparation procedures for AMS ^{14}C dating

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With the recognition that terrestrial plant macro- and microfossils often produce more reliable radiocarbon ages than bulk sediments, there is an increasing emphasis on sample preparation methods to separate tiny botanical remains. A number of methods have been published for the concentration of pollen and palynomorphs from sediments and soils. Most procedures rely on a combination of sieving and density separation using a tungsten-based heavy liquid such as sodium polytungstate (SPT) or lithium metatungstate (LMT, LST). In addition to concentrating pollen, SPT is used for the isolation of phytoliths and when suspending organic matter from the mineral components in sediments. SPT is also commonly used in the separation of soil density fractions in the study of the soil organic matter dynamics.

Although it was recognized more than a decade ago that SPT contained minute amounts of carbon, an apparent reformulation of SPT by the manufacturer sometime around 2005 resulted in anecdotal reports of higher levels of carbon contamination in samples processed with "new SPT" than those processed with "old SPT". Concerned that repeated exposure to SPT through the process of iterative separations with decreasing density used in our pollen concentration method would alter the sample age, we decided to investigate the effect of exposure to SPT. We tested different batches of SPT and sample material soaked for days in both SPT and LST, as well as other consumables used in the pollen concentration process. While we were able to confirm that various batches of SPT contain tiny but measurable amounts of carbon, we were not able to demonstrate sample contamination as a result of exposure to SPT. Nevertheless, a beneficial outcome of this project was a modification of the pollen concentration procedure to reduce the number of density separations required to obtain a satisfactory pollen fraction.

SAM#P130 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Optimization of sealed tube graphitization method for environmental ^{14}C studies using MICADAS

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In the near future a more developed and modern technology is expected to take over the old ^{14}C measuring methods in Hungary, which is based on isotope separation by accelerator mass spectrometry using a MICADAS type AMS system specialized for environmental applications.

In most cases the last step of the sample preparation for ^{14}C dating by AMS is to produce graphite from the pure CO_2 gas samples. Catalytic reaction is generally used to produce graphite for which stabilized temperature reaction cells are developed in certain laboratories. The properties (e.g. purity, conductivity) of the produced graphite vitally influence the quality of the AMS measurement.

Although the internationally validated graphitization line of ATOMKI is able to produce high quality graphite for AMS ^{14}C analyses, the throughput of the prepared targets is highly limited.

We were looking for a rapid production and low cost graphitization method, whereby we are capable to handle numerous biomedical and environmental samples per day. The sealed tube zinc reduction method mostly suits to these criteria. We have adapted the method in ATOMKI and the goal of this study was to find out the proper conditions of this graphitization process. We have analyzed how does the graphitization time and the amount of zinc and titanium hydride reagents influence the ^{12}C ion current and the measured radiocarbon content of the sample and how big the caused isotope fractionation. One important task was to reach the achievable minimum background level and decrease the $\delta^{13}C$ shift as minimal as possible. We have also investigated the reproducibility of the graphitization process using graphite targets made of oxalic acid standard (NIST-SRM-4990c).

All of the graphite targets were prepared in ATOMKI laboratory and the AMS measurements were carried out on the MICADAS developed and hosted in ETHZ, Zürich.

SAM#P131 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Early results from the ANSTO/NIWA ^{14}C of atmospheric methane program

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Following development and proving of the laser heated microfurnace we have used it to prepare 45 samples of ~ 16 µg of carbon. These comprised CO_2, derived from atmospheric methane, frozen back into glass breakseals following measurement for $\delta^{13}C$ at NIWA. There were three sample sets: 15 from Baring Head, NZ (BHD), collected each ~ 15 days between March and September 2009, 9 from Arrival Heights, Antarctica (SCT), collected each ~ 41 days between February 2008 and January 2009, plus 21 samples taken along a Pacific Ocean voyage from Nelson (NZ) – Osaka (Japan) in December 2005 (FTW). All samples were measured to better than 1% precision, sufficient to reveal a $^{14}CH_4$ signal. The BHD set shows significant temporal variation in ^{14}C for baseline air passing over the Southern Ocean, whereas the SCT set shows a lesser variation for Antarctic air. The FTW set covers a S-N transect across the Pacific Ocean, showing the influence of the ITCZ (5°-10° N) and different meteorological conditions on the concentration, $\delta^{13}C$ and $\Delta^{14}C$ of CH_4 and demonstrates that CH_4 is not well mixed.

Graphitisation reactions averaged 32 min with 0.7 mg of Fe, reduced from Fe_2O_3, as the catalyst. The samples, blanks and standards were measured in two 10 minute blocks; some were measured again to improve statistics. Average $^{13}C^{4+}$ currents per microgram of carbon were 13, 4 and 2 nA/µg for each 10 min block. Similarly-sized targets prepared in the conventional furnace with Fe_2O_3 gave 8, 5 and 2 nA/µg for each 10 min block. Graphitisation efficiencies were typically 90-100% for microfurnace samples, compared with 37-84% for conventional furnace samples. Subsequent examination by microscope showed that the cesium beam was well-centred on the 1 mm diameter recess and that effectively all C/Fe was sputtered, leading to a (minimum) estimation of ~4% overall AMS measurement efficiency.

SAM#P132 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Radiocarbon measurements of carbonaceous aerosols: The new sample preparation line at University of Bern

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Carbonaceous aerosols (total carbon, TC), which comprise the large fractions of elemental carbon (EC) and organic carbon (OC), badly affect climate and human health. However, there is a large uncertainty about detailed apportionment and quantification of its sources due to the vast number of origins and chemical compounds associated with the aerosols. Radiocarbon measurements of the carbonaceous aerosol sub-fractions EC and OC allow an improvement in source apportionment, leading to a full and unambiguous distinction and quantification of the contributions from non-fossil and fossil sources [Szidat, 2009]. In order to perform radiocarbon measurements on different fractions (TC/OC/EC) in aerosol samples, a new sample preparation line was developed at University of Bern to fulfill all the pre-treatment procedures necessary to isolate OC and EC. To evaluate and reduce the extent of positive and negative artifacts during OC and EC separation, we performed sample preparation with a commercial thermo-optical OC/EC Analyzer (Sunset Laboratory Inc.). As the major advantage compared to the previous setup [Szidat, 2004], the Sunset OC/EC Analyzer allows online optical monitoring of the filters during analysis. Here, we present an optimized temperature program of the Sunset OC/EC Analyzer using pure O_2 aiming at total OC removal before EC is isolated. Charring is significantly reduced to less than 5% when analyzing the water-extracted filters under pure O_2. For ^{14}C determination of each fraction, CO_2 resulting from the sample analysis is transferred to the gas ion source of the accelerator mass spectrometer MICADAS [Ruff et al., 2007].

Ruff et al., Radiocarbon 49, 307-314 (2007).

Szidat et al., Nucl. Instr. Meth. Phys. Res B 223-224, 829-836 (2004).

Szidat, Science 323, 470-471 (2009).

SAM#P133 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

CO_2-laser decomposition method of carbonate for AMS ^{14}C measurements

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A CO_2-laser decomposition technique allowed for an efficient and effective preparation of carbonate samples for AMS ^{14}C measurements. The carbonate samples in a vacuum chamber are emitted through ZnSe window by CO_2 laser beam (MIR-10, New Wave Research). The released CO_2 are directly collected in a small finger trap of graphitization reactors, and reduced by a hydrogen gas reduction method using iron catalysis. Our technique is much more efficient and effective for ^{14}C measurements of small-size carbonate samples than conventional acid decomposition methods, and might make it possible to determine spatial ^{14}C distributions of carbonate samples (e.g., molluscs, corals, speleothems, etc) with a high spatial resolution. We demonstrate the configuration of our prototype system, the operational condition, and some examples of blank and samples measurements.

SAM#P134 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

High-yield recovery of contamination-free organic matters from plant remains for AMS ^{14}C measurements

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To remove possible contamination, samples are chemically treated before ^{14}C measurements. Most commonly, AAA (acid-alkali-acid) treatment and chemical separation of α-cellulose are applied for plant remains such as woods, twigs and leaves. Depending on the extent of sample preservation, these methods may decompose a great extent of organic matters which are efficacious for ^{14}C measurements. The decomposition of efficacious components during the sample treatments results in sample size reduction for ^{14}C measurements. It may limit the extent to which ^{14}C method is applied. In order to assess a separation method of contamination-free organic matters in high yield, we have examined two methods for cellulose extraction with cuprammonium solution (regenerated cellulose from totally dissolved cellulose in cuprammonium solution) and diglyme-HCl (crude cellulose with other organic matter decomposition). ^{14}C contents of the regenerated cellulose and crude cellulose form known age woods (laboratory blank, FIRI-D and FIRI-F) were compared with the consensus value.

SAM#P135 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Development and Characterisation of a Small Mass H_2/Fe Graphitisation Line

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We will present the commissioning data for our prototype, small volume, conventional graphitisation line and a comparison will made with our 2.5 mL general purpose graphitisation lines. This new graphitisation line has an internal volume of ~1.1 mL and uses the H_2/Fe graphitisation method. An Impress ME506 ceramic diaphragm pressure sensor is used in a custom stainless steel housing, which also incorporates the gas inlet valve and Ultratorr® style ports for connection of a replaceable graphitisation tube and cold finger. A custom designed, water cooled, resistance heated tube furnace is used to heat the Fe catalyst / reaction volume.

To use with the new graphitisation line we have developed a small volume CO_2 transfer line, which allows transfers from the sample combustion tube directly into the graphitisation line unit. This new transfer line has been developed using CF UHV fittings to minimise the possibility of sample contamination and leaks. Information will also be presented on a water-cooled, Peltier based chiller unit which is used to freeze out, at -52ºC, the water produced in the H_2/Fe reaction. Protocols have been developed to minimise (and standardise) the quantity of the background carbon incorporated in the overall processing of the sample into graphite.

SAM#P136 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

A novel approach to process carbonate samples for radiocarbon measurement

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Radiocarbon analysis of carbonates is often applied. Presently, laboratories prepare samples by acid hydrolysis in evacuated glass tubes, subsequent CO_2 purification and reduction to graphite in self-made reduction manifolds. This process is time consuming and labor intensive. In this work, we have tested a new approach for the sample preparation of carbonate, which should in the future process up to 21 carbonate samples in an automated way. The CO_2 hydrolyses of the carbonates with phosphoric acid is performed in a similar way as it is done in stable isotope ratio mass spectrometry where CO_2 is released in septum sealed tube under He atmosphere. The released CO_2 is later flushed in a He flow by means of a double walled needle mounted from the tubes to the automated graphitization equipment (Wacker et al., 2010), essentially replacing the elemental analyzer normally used for the combustion of organic samples. The process can be fully automated from sampling the released CO_2 in the septum-sealed tubes with a commercially available auto-sampler to the graphitization with an automated graphitization equipment containing a zeolite trap.

The new method yields in very low sample blanks of about 50’000 years. Results of processed reference materials (IAEA-C2, FIRI-C) are in good agreement with their consensus values. We will show in detail how the method works and present first data on reference materials, blanks and unknown samples.

L. Wacker et al., NIMB 268 (2010), 931-934.

SAM#P137 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Cosmogenic in-situ ^{14}C analysis at ETH Zürich

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With its short half-life (5730 y) terrestrial cosmogenic in-situ produced ^{14}C is fastly adapting to geomorphological changes provoked, e.g., by climate, tectonics or human activity. It is therefore a useful tool in detecting complex surface histories and recent changes in landscape-forming processes. However, the analysis of the terrestrial cosmogenic in-situ ^{14}C nuclide requires a time-consuming procedure, first removing the atmospheric contamination from the sample (quartz) surface and then extracting the in-situ produced fraction from the crystal lattice.

At the ^{14}C extraction line at ETH Zürich in-situ ^{14}C is routinely analyzed in quartz samples. No flux agent is used for sample outgassing and thus the quartz is not melted even at extraction temperatures of 1650°C. Standard measurements using the PP-4 sample from the University of Arizona yield comparable results to those reported from U. Arizona [1] and SUERC [2], showing that quartz melting is not needed for a quantitative in-situ ^{14}C release. A good reproducibility of the measured ^{14}C concentrations within less than 5% can be proven by PP-4 and other samples.

Interestingly, the total amount of extracted CO_2, which is mainly $^{12}CO_2$, reveals a strong dependence on the origin of the quartz sample. Sedimentary quartz tends to release up to 5 times more CO_2 than plutonic quartz which gained as little as 5 µg of C in the processed 5 g of quartz. These small samples are measured without dilution or graphitization with the gas ion source at the AMS system MICADAS yielding analytical uncertainties <1% and $^{12}C/^{14}C$ ratios up to 7 times above the modern ratio. A low mean procedural blank of ~4 x 10^4 ^{14}C atoms contributes to very precise in-situ ^{14}C analyses.

References

[1] Lifton et al. (2001), Geochim. et Cosmochim. Acta **65**, 1953-1969. [2] Fülöp et al. (2010), Radiocarbon **52**, 1288-1294.

SAM#P138 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Towards single-foraminifera-dating with a gas ion source

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Carbonate shells from foraminifera are often analyzed for radiocarbon to determine age of deep-sea sediments or to access radiocarbon reservoir ages. However, a single foraminiferal test contains typically only a few micro-gram carbon, while most laboratories require more than 100 µg for a radiocarbon dating with accelerator mass spectrometry. The collection of the required amount of foraminifers for a single analyses is therefore time consuming and not always possible.

Here, we will present a simple way to measure the CO_2 directly to the gas ion source after hydrolyses of 100 – 500 µg carbonate (about 10 – 50 µg C) in septum sealed vials. Only a small adaption on our previously existing gas interface (Ruff et al 2010) had to be done. The CO_2 is collected on a tiny zeolite trap and transferred to a syringe from where the CO_2 is constantly pressed into the ion source. The system can be fully automated and the sample preparation is vastly reduced.

A sample of 400 µg carbonate (40 µg C) gives typically a $^{12}C^-$ current of 15 - 20 µA over 20 minutes and yields in a measurement precision of less than 7 permille on a modern sample.
We will present the used method and demonstrate on real samples that even single-foraminifera-dating is now possible.

M. Ruff et al., Radiocarbon 49 (2007) 307.

SAM#P139 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Testing the ABOx-SC pretreatment protocol: Radiocarbon dating charcoal below the Campanian Ignimbrite tephra

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The Acid Base Oxidation-Stepped Combustion protocol (ABOx-SC) (Bird et al., 1999) aims to remove the most chemically unstable components from ancient charcoal. The pretreatment technique is thought to produce accurate radiocarbon dates because it often increases the age of a charcoal sample in comparison to the standard Acid-Base-Acid (ABA). However, it is not fully understood why this pretreatment protocol works from a chemical perspective. The composition of both degraded charcoal and likely contaminants are poorly known, and it is unclear how the cleaned product, known as Oxidation Resistant Elemental Carbon (OREC), relates to the original charcoal structure. It is therefore imperative that known age samples are dated to test the method and ensure that the ages obtained are not just older than the age of charcoal treated with the ABA protocol, but are accurate. Ancient known age charcoal samples are vanishingly scarce, and so such testing is rarely undertaken.

Here we test a suite of ten charcoal samples found beneath the Campanian Ignimbrite at three European Palaeolithic sites. This tephra, whose visible deposits stretch from Italy to western Russia, is the product of a super eruption and is dated by $^{40}Ar/^{39}Ar$ to 39,280 ± 55 yr (de Vivo et al., 2001). We demonstrate that the ABOx-SC protocol currently used at the Oxford Radiocarbon Accelerator Unit routinely produces reliable results. The ABA protocol, on the other hand, appears to systematically underestimate the true age of the charcoal fragments.

BIRD, M.I., et al., 1999. Radiocarbon dating of "old" charcoal using a wet oxidation, stepped-combustion procedure. Radiocarbon, **41**(2), 127-140.

DE VIVO, B., et al., 2001. New constraints on the pyroclastic eruptive history of the Campanian volcanic Plain (Italy). Mineralogy and Petrology, **73**(1-3), 47-65.

SAM#P140 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

A comparison of ultrafilter membranes used in bone collagen pretreatment for radiocarbon dating

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Ultrafilters are increasingly being used in pretreatment protocols that aim to purify bone collagen for radiocarbon dating and stable isotope measurement. The introduction of this step at the Oxford Radiocarbon Accelerator Unit (ORAU) has had a marked impact, producing determinations on Pleistocene aged bones that are often older than previously dated samples and appear to make greater geo-archaeological sense. However, ultrafiltration is complex, and the process by which the method seems to decontaminate gelatin is not straightforward. Membranes used within ultrafilters are categorised by their molecular weight cut off (MWCO) determined using a small group of molecules. However, MWCOs are dependent upon the chemical, molecular and electrostatic properties of a sample, and may differ for mixtures of degraded collagen and unknown contaminants from ancient bone. Additionally, the filters can be severely affected by a process known as fouling, where the membrane pores are blocked by the molecules ultrafiltered.

This poster presents a comparison of commercially available ultrafilters containing different membrane materials with 30 kDa MWCOs: Vivaspin® VS15® and VS20® polyethersulphone (PES) membrane ultrafilters and VS 15R® Hydrosart® (cellulose based) membrane ultrafilters. The proportion of collagen retained above the PES membrane is found to be substantially greater than that retained by the extremely hydrophilic Hydrosart® membrane. Examination of water flow through the membrane before and after ultrafiltration suggests that this difference can be attributed to fouling of the PES membrane. VS15® is used by the ORAU. It is likely that use of the Hydrosart® membrane will lead to unnecessarily low yields, resulting perhaps in the removal of gelatin that is uncontaminated and leading to the failing of samples which would otherwise be dateable. More work, including characterisation of the <30 kDa fraction, is clearly required to elucidate the precise reasons why ultrafiltration appears to be effective.

SAM#P141 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

A cold finger cooling system for the efficient graphitisation of microgram-sized carbon samples

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At ANSTO we use the Bosch reaction to convert sample CO_2 to graphite for production of our radiocarbon AMS targets. Key to the efficient graphitisation of ultra-small samples is the type of iron catalyst and the effective trapping of water vapour in a 'cold finger' during the reaction. We have developed a simple liquid nitrogen cooling system that enables us to rapidly adjust the cold finger temperature in our laser-heated 'microfurnace', optimised for the graphitisation of microgram-sized carbon samples. This system is used to firstly transfer the CO_2 into the microfurnace, to maintain the cold finger at -80°C for ~ 5 minutes while the CO_2 is converted to CO and then at -160°C for ~ 25 minutes for the remainder of the reaction as the CO is converted to graphite. It comprises a machined aluminium cylinder mounted in the insulated cap of a 600 ml Dewar. The lower end is submerged in liquid nitrogen (LN_2). The upper end has a smaller diameter which is wound with an electric heating element and is provided with a thermocouple and a central hole into which the cold finger is inserted. Electrical power to the heater is adjusted by PID control, permitting the cold finger temperature to be adjusted over the range -50°C to -160°C at rates of up to 40°C/min. This simple system uses modest amounts of LN_2 (typically < 0.2 L/hr during graphitisation) and is compact and reliable. We have used it to produce over 120 AMS targets containing between 5 and 20 µg of carbon, with conversion efficiencies for 5 µg targets of typically 90-100%. We are currently modifying this cooling system for use with our conventional graphitisation reactors.

SAM#P142 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Natural Radiocarbon Sample Preparation at LLNL/CAMS

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LLNL/CAMS

Natural radiocarbon graphite production at Lawrence Livermore National Laboratory is based on catalyst studies by Vogel et al (1987) and has evolved over two decades to accommodate smaller samples and the demands of the high intensity LLNL ion source design. To improve sample throughput we changed from cobalt catalyst to iron. Prior to entering 'production mode', we ran experiments with several iron lots in order to find iron low in carbon and lithium compatible with operation of our AMS system. We then ran a series of experiments over a range of sample sizes to determine the optimal carbon to catalyst ratio for making graphite. In addition to reducing the reduction time to from 5-6 hours to 90-120 minutes, the iron catalyst also produces 30% more current from our ion source. Dry ice slush traps were replaced with magnesium perchlorate water traps initially to reduce dry ice consumption (by half) but has the additional benefit of reducing the laboratory dead carbon "background". The carbon to catalyst ratio was optimized for small samples to improve graphite quality and performance in the ion source. Reducing the amount of catalyst enabled us to routinely reduce small carbon samples (20-50 µg C) to graphite for analysis in our basic normal sized reactor. Having less catalyst in the reactor necessitated lowering the reduction temperature to prevent the iron from sintering. In cathodes, the bulk of the target volume is catalyst, thus for very small samples the level of the sample drops deeper into the target. A filler was added to maintain the face of the graphite in relation to the Cs sputter beam. We introduced Niobium powder to the target prior to loading and pressing the graphite into the AMS target. Niobium has no effect on sample measurement and is compatible with our AMS source.

This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.

CAL#P101 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Managing the Transition to ^{14}C AMS Operations and Calculations at Routine ≤0.2% Precision

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The Rafter Radiocarbon Laboratory has relied heavily on AMS for over 20 years, and has now transferred its operation to a new generation 0.5 MV compact AMS system from NEC. The previous generation 6 MV EN-Tandem AMS was heavily modified over time to greatly improve routine precision, but the new system provides routine 0.2% (2‰) precision, typically exceeding the best precision ever delivered from the EN-Tandem. Given that 1-2% precision was common early in the AMS era when many lab procedures and calculations were standardised, the transition to the new compact AMS represents an important opportunity to update procedures and calculations. Current precisions represent approximately an order of magnitude improvement during the AMS era, emphasising the need to re-evaluate assumptions and identify inconsistencies. We have found that that the following issues are relevant to laboratories reflecting on the long-term transition to routine ≤0.2% precision:

- Counting statistics no longer necessarily relay the main sources of error required to report robust error intervals associated with samples. Evaluating error between runs and associated with calibration to the primary standard is now critical.
- We confirm results from other AMS laboratories that our routine measurements of ANU Sucrose deviate significantly from the "accepted" value.
- Some intercomparison samples can be confirmed as variable beyond typical precisions. A typical example is the TIRI-D Hekla Peat (~1% standard deviation).
- Monitoring and corrections for backgrounds requires improvements, including much more frequent monitoring and matching to samples, to avoid bias and improve the validity of calculated error intervals.
- A new convention for reporting in Fraction Modern is desirable, to avoid confusion in translating Stuiver and Polach's concepts to the high-precision AMS era.

CAL#P102 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Offset from SH calibration curve based on Chilean Fitzroya cupressoides tree ring dating in the range 1500-1950AD

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Radiocarbon dating is one of the most reliable and well–established methods, for dating the Holocene and late Pleistocene. The current internationally-ratified calibration curve for terrestrial samples from Northern hemisphere is Intcal09, which covers the past 50,000 calendar years. The difference in natural atmospheric ^{14}C concentration between the Northern(NH) and Southern hemispheres(SH) known as the inter-hemispheric ^{14}C offset is about 40 years and varies in time. The SH has a larger surface ocean area than the NH. As a result, more ^{14}C in the southern troposphere is transported to the oceans through air-sea exchange of CO_2 and more ^{14}C-depleted CO_2 from the oceans is transported to the southern troposphere. Natural ^{14}C levels in the southern troposphere are therefore usually lower than those in the northern troposphere, and the radiocarbon ages of terrestrial materials in the SH for a particular period of time are usually older than those in the NH. The current internationally-ratified radiocarbon calibration curve for terrestrial samples from the Southern Hemisphere is SHCal04. However, more than 50% of data in the SH dataset came from New Zealand trees placed on the relatively small island compared to South America. Nevertheless these data mostly applied by archaeologists for calibration of radiocarbon dates of the South American Indian cultures. The calibration curve does not allow seeing the difference for the calibrated dates between Colonial and Inca periods even if the measurements have been done with high enough precision. So, we have tried to analyze the Chilean cross-dated tree rings from Fitzroya cupressoides for the last 450 years and compared them with the existing calibration curve. The results have shown the irregular significant offset from the curve which was about 20-30 years.

CAL#P103 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

May ^{14}C be used to date Contemporary Art?

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The use of radiocarbon in forensics is by now widespread, thanks to the so-called bomb peak, which makes it possible to perform high-precision dating. Indeed, since 1955, ^{14}C concentration in atmosphere had strongly increased due to nuclear explosions, reaching its maximum value in 1963-1965; after the Non-Proliferation Treaty, ^{14}C started to decrease as a consequence of the exchanges between atmosphere and the other natural carbon reservoirs. Nowadays, it is still slightly above the pre-bomb value.

This work is based just on the idea of exploiting the bomb peak to "precisely" date works of contemporary art, even with the aim at identifying possible fakes.

We analysed two kinds of materials from XX century: newspapers and painting canvases. Newspaper samples were obviously chosen not for their artistic values, but because they represented dated samples (date on the issues). Our data (28 samples) showed a trend similar to atmospheric data in the literature, although with some differences; the paper peak is flatter and shifted towards more recent years (about five years) with respect to the atmospheric data. This can be explained taking paper manufacturing processes into account. As to the canvas samples, the measured ^{14}C concentrations were generally consistent with the expected concentrations (based on the year on the paintings). However, this does not indicate that the interpretation of the results is simpler and more straightforward. As it is well known, we just measure the ^{14}C concentration of the fibre used in the canvas; moreover, most of the times, calibration of the experimental data by the bomb peak gives us two probable calendar periods: which period might be excluded can be derived only from independent information.

In this presentation, sample preparation and experimental results will be discussed, in order to show the potential but also the limitations of radiocarbon to date contemporary art.

CAL#P104 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Wiggle-matching of wooden coffins of Kofun Period: Supporting regional offsets on Japanese tree-ring from IntCal

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Recent developments on AMS radiocarbon dating provide efficient measurement and precise results. Consecutive radiocarbon dating of regional tree-ring is implemented and their offset from IntCal can be discussed. We had measured Japanese trees of Yayoi period using AMS, and pointed out their regional offsets during 1st to 2nd century AD. Although this offset should be confirmed, other tree-rings of Japan were not available so far.

Two core samples from wooden coffin of Kofun period that follows Yayoi in Japan were dated. Both coffins were excavated in Nara pref., Japan (NRSCK: Sakurai-chausuyama tomb, NRYOK: Yanagimoto-otsuka tomb), and tree species were Japanese umbrella pine (Sciadopitys verticillata). Although tree-ring dating was not successful, two dendrochronological patterns were synchronized with each other, and the difference between both outmost rings was three years.

The core samples, NRSCK of 278 rings and NRYOK of 230 rings, were cut into five years each and AMS radiocarbon dating was carried out. Their consecutive results were wiggle-matched to IntCal09 and the pattern of Japanese tree-ring, respectively. The difference between both estimated dates of the outmost ring matched to Japanese tree-ring pattern coincided with dendrochronological research better than IntCal09, partly confirming the regional offset on Japanese tree-ring from IntCal in this period.

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CAL#P105 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Reviewing the Mid-First Millennium BC ^{14}C 'Warp' Using Decadal ^{14}C/Bristlecone Pine Data

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The current calibration data set for the period 2350-2700 cal BP document the largest ^{14}C "warp/wiggle" of the middle and late Holocene, the deVries effect IIIb ^{14}C time scale excurses.

Data based on ^{14}C measurements obtained at the University of Washington (Seattle), Queen's University (Belfast), and Heidelberger Akademie der Wissenshaften on dendrochronologically-dated wood has been used to construct the IntCal04 data set which, for this period, is identical for IntCal09.

We recently published a preliminary set of seven ^{14}C measurements on dendrochronologically-dated Bristlecone pine wood which spanned the period 2450-2700 cal BP. (Taylor RE, Beaumont WC, Southon J, Stronach D, Pickworth D. 2010. Alternative explanations for anomalous ^{14}C ages on human skeletons associated with the 612 BCE destruction of Nineveh. Radiocarbon 52 (2-3):372-382.) The dendrochronological age of these samples had been determined in the 1960s by C. Wesley Ferguson (Laboratory of Tree Ring Research (LTRR), University of Arizona). The LTRR has kindly made these samples available to us. Many of them had been supplied to Han Suess (La Jolla/Mt. Soladad Radiocarbon Laboratory, University of California, San Diego) who measured some of them by decay counting. Our preliminary data identified several possible offsets from the existing consensus tree-ring data set currently used for IntCal04/InCal09.

We will report on the results of the additional AMS-based ^{14}C measurements on decadal dendrochronologically-dated bristlecone pine samples for the period 360 to 790 cal BC with particular attention to 2 shorter episodes within that period at ~2400 cal BP and ~2600 cal BP.

CAL#P106 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Homogeneity Evaluation of Chinese Sugar Carbon (CSC) Standard for AMS ^{14}C Measurement

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The Chinese Sugar Carbon (CSC) was introduced as the national radiocarbon standard in 1981. CSC was produced from sugar beets harvested in 1977. After several rounds of measurements made in three well-established radiocarbon laboratories in China, a weighted average ^{14}C activity ratio to 95% of OXI was given as 1.362±0.002 (n=14), as well as an average δ^{13}C value of -19.32±0.56‰ (n=9). The corresponding Fraction Modern (FM) of CSC can be calculated as 1.346 ± 0.002 after ^{13}C correction to -25‰ (by definition). However further measurements on ^{13}C indicated that CSC may not be homogenous, especially for mg-sized aliquots, and its radiocarbon content appeared to be more variable as well. As a result, some AMS laboratories in China stopped using CSC as a primary standard in recent years. We randomly picked out ten new bottles and combusted three aliquots (~3.7±0.5mg) from each bottle. CO_2 was extracted and graphitized using the sealed tube Zinc reduction method and measured for ^{14}C at the UCI Keck Carbon Cycle AMS facility. The FM of all 30 data points resulted in an average of 1.3538±0.0031 (1 sigma stdev), using the in-situ AMS ^{13}C measurement for fractionation correction. However, δ^{13}C measured by a Finnigan IRMS Delta-Plus coupled with a GasBench revealed relatively large variation: from -15.9 to -22.2‰ with an average of -18.9±1.3‰. With all additional measurements from total 12 bottles, an average of 1.3533±0.0034 (n=56), and -18.9±1.1‰ (n=37) were obtained for ^{14}C (FM) and δ^{13}C respectively. From these results we propose that CSC can be measured to within 2.5‰ and thus can be viewed as homogenous in terms of ^{14}C (after ^{13}C correction). The in-situ simultaneous AMS ^{13}C/^{12}C measurement that allows for correction of all isotopic fractionations, including manufacture, graphitization and machine induced fractionations is the key for obtaining high precision ^{14}C measurement on this standard.

ARC#P101 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Investigation of Mi-deer fossil age in Qingdun site, Jiangsu Province, China

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Mi-deer (Elaphurus davidianus) is one of the few species of large mammals that became extinct in wild field but preserved domestically in the world. It is necessary to learn the characteristics of wild Mi-deer habitat when people try to make the Mi-deer to be wild again. Recently Mi-deer sub-fossils from Qingdun site, Jiangsu Province, China were dated with the NEC compact AMS system at Peking University. The ages of Mi-deer fossil samples from 4550BP to 5820BP indicate that during the Neolithic Period large number Mi-deer lived in this area. The investigation of the ancient climate and environment of this area is helpful to reintroduce Mi-deer in wild field successfully.

ARC#P102 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Radiocarbon dating of lacustrine sediment from an impact crater in northeastern China

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In order to investigate the origin of a 1.8 km diameter bowl-like crater in northeastern China, a core drilling program was carried out recently at the center of the crater. A 106 m thick unit of lacustrine sediment is revealed under a surface layer of about 2m yellow soil. Beneath the lacustrine sediment is a very thick unit of unconsolidated boulder or coarse lastic debris from basement rock. The compact origin has been confirmed based on geological and metamorphosed analysis about the boulder layer [1]. In this paper, we report the AMS ^{14}C measurement results of lacustrine sediment and analyze the evolution of the crater-lake.

[1] M. Chen et al., Xiuyan crater, China: Impact origin confirmed, Chiness Science Bulletin, June 2010, Vol.55, No.17, 1777-1781.

ARC#P103 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Mussels with Meat

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Historical chronologies are often based on the radiocarbon dating of human bones. Human aquatic based diets may introduce a ^{14}C deficient signal that will result in a radiocarbon age offset towards older chronologies, known as reservoir effect. Increasing evidence has shown the importance of considering dietary reservoir effects both in marine and freshwater contexts.

Local reservoir ages are often estimated based on the difference between the radiocarbon dating of associated aquatic and terrestrial material, for which no reservoir effect is expected. Often, the selected aquatic material consists of mussel shells that are typically well preserved in the archaeological record. The presence, for instance, of voluminous refuse shells middens attests for the importance of mussel consumption, especially for hunter-gather societies.

It is to expect that mussel feeding habits, according to species, and age, coupled with environmental factors will determine individual reservoir ages. Furthermore, differentiated metabolic routing associated with the building of mussel tissue and shell may result in differences in reservoir ages. Given that humans only consume mussel tissue, it becomes necessary to characterize and quantify reservoir age differences between mussel tissue and shell.

Mussel tissue-shell radiocarbon dating variability has been empirically studied by considering mussel samples of different age and species, originating from different environmental backgrounds.

ARC#P104 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Edit Regine Cineres hic Sarcophagus Habet: Confirming the Identity of Queen Editha, Wife of Otto, the First German Emperor

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A grave monument in honor of Queen Editha (AD 910-946), first wife of Otto the Great, the first Emperor of Germany, has since AD 1510 been prominent in the Dome of Magdeburg. Yet, the whereabouts of her bones was for a long time unknown until, in 2008 as part of a research excavation during the Dome restauration, a lead box with the inscription "**Edit Regine Cineres hic Sarcophagus Habet"** and the year **1510** was found in the cenotaph. In this box, wrapped in a white fabric, were bones, fragments of silk and linen, and earth with insects and plant remains. An international research team was assembled by the Archaeological Service of Sachsen-Anhalt, the state in which Magdeburg is located, to evaluate the content of the box and, if possible, to confirm the identity of the bones. Radiocarbon dating was carried out in the Leibniz Laboratory in Kiel and in the newly established Klaus-Tschira-Laboratory in Mannheim. The bones, surprisingly, gave early ages, not directly compatible with the AD 946 death of Queen Editha. The anthropological evaluation of the bones and the strontium and oxygen isotope analyses of teeth gave, however, results fitting the historical information about Editha, princess of Wessex. These also indicate a protein (meat, fish) rich diet, which in combination with the Christian fasting rules of the time, could indicate a large contribution of fish to the diet and a fresh-water reservoir age offset for the bone dates. The dates on the fabrics and beetle remains, however, document various historic reburials over a 500-year period and, thus, contribute to the identification of the remains as those of Queen Editha and provide a fascinating account of the fate of Queen Editha's remains.

ARC#P105 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Radiocarbon dating of tomb in Hepu, China

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An ancient tomb was considered belong to Han Dynasty (206 BC-220 AD), had been excavated in Hepu, Guangxi Zhuang Autonomous Region, China. According to the style of culture relics, we can confirm that some excavated culture relics are exotic. If the age of tomb can be confirmed belong to Han Dynasty, the exotic culture relics are a very significant evidence to prove that Hepu is the oldest departure point on the country's ancient maritime trading route. Several wood samples and charcoal samples are collected for ^{14}C dating at CIRCE, Italy. The samples are pretreated with acid-alkali-acid method, and dated with a 3MV NEC tandem AMS system at CIRCE. Calibrated ages were obtained with code CALIB5. The results of these measurements are presented.

ARC#P106 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Reliable AMS Ages for Mayan Caches at Copán, Honduras based on Spondylus sp. Marine Shells

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Copán, located in western Honduras, is one of the most well-known of all ancient Mayan cities. Over a century of intensive archaeological research has revealed the development of Copán from its origins as a small agricultural village, to a major city state, followed by its decline or 'collapse' after AD 800. Copán's chronology relies heavily on changes in ceramics dated by association with hieroglyphic dates on monuments. There are surprisingly few radiocarbon dates available for a site with such a long-term history of study and researchers have expressed a general reluctance to use radiocarbon dating (mainly on charcoal) at Copán because radiocarbon ages are often too old compared to associated hieroglyphic dates. Dating marine shell offers an alternative approach for radiocarbon-based chronology building at Copán.

Spondylus sp. or spiny oyster shell is found in offering caches throughout the Copán valley. Caches are commonly associated with the dedication of buildings, altars and stelae. We have dated cached Spondylus sp. shells and compared their ages with calendrical dates derived from Maya hieroglyphs to obtain new information about Classic Maya caching behaviours and the chronology of contact with exchange partners in coastal areas from where the shell was sourced. A total of 17 Spondylus sp. shells collected from 9 independently dated contexts were analysed for ^{14}C with AMS to high precision (0.30-0.35%) using the facilities at ANSTO and Waikato. Most of our AMS dates agreed well with structural/hieroglyphic dates indicating that Spondylus sp. can be reliably used for dating contexts. The results also showed there was very little time between death of the shellfish and placement within caches suggesting that shells may have been acquired for specific caching/dedication events rather than stored for long periods.

AMS measurements were partially funded by AINSE grant 10/064.

ARC#P107 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Historical and Climatological Research in the Himalaya Region by ^{14}C AMS Dating of Wooden Drill Cores from Historic Buildings

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In recent years, the Geographical Institute of the University Erlangen could sample numerous valuable wood samples in the form of wooden drill cores from historic buildings in four regions of High Asia and could evaluate them dendrochronologically.

Part of the drill cores were collected from monasteries and temples in the Dolpo region of western Nepal, a barely studied region in the Inner Himalaya and situated in the rain shadow of the main Himalayan crest line. Another major part came from temples in Central Tibet. In many cases a tree-ring dating of these drill cores was not possible, indicating that the sample woods exhibit a higher age than the present range of the existing tree-ring chronologies which only reach back to the 11th century. So these samples can be used to extend the tree-ring chronologies of this region, which could help to detect suggested monsoon variations during the Middle Ages.

The historic tower buildings of Tibet and Sichuan are a special cultural heritage which has been rarely studied up to now. The knowledge of their exact age could help to better understand the cultural and historical context of their development and their function, and could support the effort to declare them a UNESO World Heritage site.

The Erlangen AMS laboratory has performed ^{14}C - AMS datings on 200 samples of 74 of these drill cores. With the help of Wiggle Matching these drill cores could be dated with enhanced precision, and in many cases important information about the time of construction of these important historic buildings could be obtained for the first time. In the context of this project we have developed a modification of the method for the cellulose extraction suitable for the conditions in our laboratory. This method was tested with modern tree rings from the bomb peak period.

ARC#P108 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Age determination of Neolithic cultural change and dietary reconstruction in the Amur River basin

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The purpose of this study is to establish the cultural chronological sequence of the Neolithic age in the basin of the Amur River and to evaluate the marine reservoir effect (or freshwater) and ancient diets as seen on charred remains on pottery. In this study, we present the over 100 radiocarbon dates in the Malaya Gavan site and the Knyaze Volkonskoe 1 site in the basin of the Amur River. The excavation of these sites was performed by a joint Russian and Japanese expedition in 2007-2009. The radiocarbon dates of wood charcoal in conjunction with archaeological context and charred residues on pottery at these sites were determined the Kondon cultural period to be around 7500-6200BP, the Mal'shevo culture 6000-4700BP, the Belikati culture approximately 5000BP, the Voznesenovka culture 4700-3400BP, the Koppi culture approximately 3400BP, the Uril culture 2500BP. Our data show radiocarbon age difference between charcoal and charred residues on pottery at six cultural periods, and the charred remains were older by 300-600BP. Estimated age difference were caused by marine foods which might reflect the upwelling of old deep sea water for western part of North Pacific. It is possible to be ascribed carbon origin by using carbon and nitrogen isotopic rations and C/N, and the origin of charred remains in the Malaya Gavan was clearly with marine resources (e.g. salmon). Conversely, the samples of the Knyaze Volkonskoe 1 site were different from the Malaya Gavan in carbon isotopic rations, we assume that the charred residues are derived exclusively from freshwater fish.

ARC#P109 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

^{14}C AMS dating Yongcheon cave

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As the biggest island in South Korea (33°21'31"N by 126°32'31"E), there is Jeju island with one shield volcano, Mt. Halla and it lies 80 km south of the main land. The volcanic island as whole itself and all its lava tubes have been inscribed on world heritage list by UNESCO in 2007. Among the many lava tubes on the island, a unique cave had been accidentally found, while some workers were installing a telephone pole in 2005. Until the discovery, it has been completely shielded from the outside by naturally built sand blocks. It is named as Yongcheon cave and its type is lime decorated lava tube which shows the properties of volcanic lava tube and lime stone cave together. This cave of about 3 km in length is acknowledged to be the best of this type in the world and boasts a superlative scene, including a large scale clean-water lake, lava falls, and richly developed speleothems inside of it. Even though there are archaeological evidences from well preserved ancient potteries that ancient people entered this place, the reason of good cave preservation is inferred from the possibility that a geological change which makes people's entrance difficult may happen. We have collected and dated the charcoals scattered around along the cave. The present ^{14}C AMS measurements of these young tree charcoals will provide precision dates which will be very useful not only to clarify the nature of human activities in this cave but also to provide reference dates or some clues for other dating methods such as pottery type chronology, OSL dating of sand dunes, and U/Th dating of speleothems in association with an extensive investigation of Yongcheon cave in future.

ARC#P110 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Radiocarbon dating of ancient calligraphy attributed to Fujiwara Teika: The genuine handwritings, copies, and counterfeits of the famous calligraphist

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In ancient Japan, paper was made mainly from branches of trees. In addition, old paper is not used for calligraphy because it repels India ink and is unsuitable for elegant handwriting. Therefore, ancient Japanese paper is suitable for radiocarbon dating because it is not significantly affected by the "old wood effect." Ancient Japanese manuscripts predating the 14th century are rare because their pages were separated for display as hanging scrolls. Kohitsugire are pages of lost manuscripts; therefore, they have considerable academic value. However, among the kohitsugire attributed to famous calligraphists, many copies and counterfeits written several centuries later are in circulation. Fujiwara Teika (1162–1241) is the most famous poet and calligraphist of the Kamakura period (1192–1333). In this study, we applied radiocarbon dating to four kohitugire attributed to him: a page of Teika's diary entitled Meigetsuki, a draft of Japanese poems, a page from a manuscript of "Tale of Ise", and a page of an anthology of Japanese poetry. Radiocarbon dating indicated that only the diary was written in Teika's time and the other three kohitsugire are copies or counterfeits. In the case of ancient documents or manuscripts containing many calligraphical lines, the age can generally be determined through paleographical considerations. However, it is difficult to conclusively deduce such information for kohitsugire containing only a few calligraphical lines. Hence, the results of this study suggested that when the age of kohitsugire cannot be determined by paleography because of an inadequate number of calligraphical lines, radiocarbon dating can be a useful alternative for determining the age and the historical value.

ARC#P111 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

The Research of Environmental Change, Archaeology and ^{14}C Chronology in Donglongshan, Shaanxi Province, China

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The Donglongshan Village is in Shang luo—Dan feng faulted basin of Qinling orogenic belt **(**33° 51′ N, 109° 58′ E**)**. Annual average temperature of this region is 12 centi-degree, annual average rainfall is 750 mm, and elevation is about 600-800 m. There are continuous sequences of archeological cultures relics since Holocene. We use the series Bayesian Analysis to calibrate ^{14}C ages. ^{14}C chronological sequence of the cultural development since Holocene was reconstructed as follows: The bottom of Holocene: 10400--10200BC. Period of the Yang Shao Culture: 5010--3050BC. The Long Shan culture: 2900--2085BC. The Xia dynasty: 2085--1695BC. The Shang dynasty: 1695--1125BC. According to above research, the result can be concluded: The Yang Shao and The Long Shan culture indicate the climate was warm and wet. When The Xia and The Shang dynasty the climate turn to dry and cool.

ARC#P112 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

The dating of the Seattle Art Museum's Italian room

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Seattle Art Museum's Italian room is a wood-paneled interior coming from one of numerous palazzo buildings that occur throughout the Northern Lombardy town of Chiavenna. In the 1920s the room was removed from the original location by art dealer Renato Bacchi and eventually found its way into the USA where it was used as dining room by architect John Yeon in his San Francisco apartment. It was subsequently bequeathed to Richard Brown who donated it to the Seattle Art Museum. During the painstaking restoration and installation processes [1] five samples were collected for radiocarbon dating. Our dates, together with the outcome of a dendrochronological study of several wood boards, support the hypothesis of a 16th century origin of this precious artefact.

[1] J. Boorstein and N. Dorman (2008) A "Slightly Odd-Shaped" Room; The Italian Room at Seattle Art Museum: Collaborating to Get the Job Done, Postprints of the American Institute for Conservation 36th Annual meeting, 4-9.

LIF#P101 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Study on bone resorption behavior of osteoclast under drug effect using ^{41}Ca tracing

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The mechanisms governing calcium fluxes during bone remodeling processes in Osteoporosis (OP) patients are poorly known. Understanding the changes of Osteoclast (OC) during this dynamic transition are important to prevent and cure OP. The exploration of long-lived ^{41}Ca ($T_{1/2}$ = 1.04×10^5 yrs) tracer measurements using accelerator mass spectrometry(AMS) leads to the possibility of monitoring the bone resorption behavior of OC in OP patients. In this work, the behavior of OC with the addition of Strontium Ranelate (SR), as a drug for OP, was studied by using ^{41}Ca labeled hydroxyapatite (HA) to simulate the bone and AMS on the HI-13 tandem accelerator of CIAE as a means to determine trace amount of ^{41}Ca. The results show that the technique of ^{41}Ca tracing - AMS can be used to quantitatively monitor the behavior of OC in bone resorption under drug effect. Experimental details and preliminary results will be presented.

LIF#P102 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Tracing oil spilled environment, Taean, Korea using radiocarbon and stable isotopes

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A major oil spill in Taean, Korea happened when a Samsung crane barge towed by a tug boat collided with the anchored Hong Kong registered crude oil carrier Hebei Spirit, carrying crude oil on December 7, 2007. This collision resulted in a leakage of some 10,900 tons of oil. The spill occurred near Mallipo Beach in Taean County, one of the most beautiful and popular beaches of Korea. The oil spill has impacted the regions of a national maritime park and 445 sea farms. Because the crude oil carbon contains much less radiocarbon amount than those of modern biological samples at present day, we expected that radiocarbon can be an useful tracer to monitor the recovery process of oil contaminated biological environments. We have monitored several kinds of biological samples and soil samples to measure its C/N ratio and radiocarbon amount for the six-month period. Our results indicated C/N ratios of biological samples tends to decrease as time passes while radiocarbon amount increase. Our study confirmed that the degree of radiocarbon absorption in biological samples varies based on species. The radiocarbon amount as pMC (percent Modern Carbon) among the above biological samples for the 6 months from April, 2008 to October 2008, ranged from 103.61 to 108.56. The C/N ratio ranged from 1.97 to 15.44 among all species. Our presentation introduces the detailed monitored values of C/N ratio and radiocarbon amount for each species as well as those for crude oil, sand, and mud samples of the study area to tracing the environmental change.

LIF#P103 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

AMS radiocarbon investigation of the African baobab

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We report results of our extensive research on the African baobab (Adansonia digitata) performed by AMS radiocarbon dating. The research was mainly based on a new approach, which allows for dating live baobabs. This approach consists on collecting thin wood samples from the inner cavities and also from the trunk of large baobabs, which are subsequently investigated by AMS. We dated samples obtained from nine big baobabs from South Africa, Namibia and Mozambique. The main research objectives were to determine: i) the age of the investigated specimens; ii) the growth rate dynamics over the life cycle; iii) the structure of the tree/trunk; iv) the fire history of large baobabs.

The obtained results can be summarized as follow:

1) The oldest samples of the investigated baobabs have typically radiocarbon dates close to 1000 BP or even older. These values correspond to calibrated ages of over 1000 years for the respective specimens. The results suggest that the upper age limit of the African baobab is around 1500 years.

2) The apparent growth rate, expressed by the annual increase in radius, declines gradually with the age. However, the true growth rate of the trunk, measured by the cross-sectional area and/or by the volume increase, remains relatively constant up to high ages.

3) The majority of the investigated baobabs have multi-stemmed trunks. The different stems of a trunk, which are more or less fused, could have identical or different ages.

4) Most large baobabs have survived successive natural or anthropic fires. The fire history can be established by dating segments extracted from wood samples collected from inner cavities and which consist of regrowth layers.

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AMS at NOSAMS is supported by the U.S. National Science Foundation under Cooperative Agreement OCE-0753487.

LIF#P104 **POSTER SESSION 2** **Thursday 24th March, 1400 - 1540**

Old ages of historic Romanian trees assessed by AMS radiocarbon dating

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The largest known Romanian trees are two pedunculate oaks (Quercus robur) and two poplars (Populus spp.); they also present historic interest, being associated with significant events of the past. Horea's oak in Tebea (circumference at breast height cbh=9.90 m) died in 2005 during a storm, but its cemented trunk is still standing. Under its canopy, Horea, the leader of the Revolt of 1784-85, called his peasants to battle against the feudal serfdom imposed in the Habsburg Empire. It is believed that the oak of Cajvana (cbh=11.01 m) was planted for marking the common grave of the settlement's entire male population, killed during the Tartar invasion of 1241. The black poplar (Populus nigra) of Mocod (cbh=10.60 m) was already large in the 1760s, when the Austrian borderguards carved stairs and placed a table and chairs on its trunk. According to popular belief, the huge grey poplar (Populus × canescens) of Rafaila (cbh=14.01 m) started growing when Stephen the Great reigned in Moldavia (1457-1504).

For verifying these claims supported by historic documents or based on local tradition, wood samples originating from the removed upper trunk of the Horea oak, from the cavity of Cajvana oak and from the broken trunks of the two poplars and were radiocarbon dated by AMS. The oldest radiocarbon dates were 736±23 BP for the Cajvana oak and 316±22 BP for the Rafaila poplar. Considering the original sample positions in the trunk, the radiocarbon dates suggest calibrated ages close to 800 years for both oaks and 500 years for the two poplars. These age values validate historic information on the four largest Romanian trees.

The research was funded by the Romanian National University Research Council under grant PNII-IDEI 2354.

AMS at NOSAMS is supported by the U.S. National Science Foundation under Cooperative Agreement OCE-0753487.

Oral Abstracts – Sessions 12–15

(in order of presentation)

SAM#8 **SESSION 12** **Friday 25th March, 0900 - 1040**

^{14}C analysis of groundwater down to the milliliter level

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A novel method was developed in ETHZ for AMS ^{14}C measurement of carbonate samples using He carrier gas flushing in septum sealed test tubes. The new and powerful pretreatment method can be applied for normal size (0.1-1.0 mg C) and ultra small size (10-100 μg C) carbonate samples. In this study we investigated the applicability of the new method for dissolved inorganic carbonate samples for groundwater ^{14}C analysis. The developed pretreatment method does not require vacuum during sample preparation, which significantly reduces the complexity. Reaction time and conditions can be easily controlled as carbon-dioxide content of water samples is extracted in He atmosphere using a simple septum sealed test tube. A double needle with flow controlled He carrier gas is used for CO_2 transfer out from the test tube. Carbon-dioxide is trapped on a zeolite without using liquid N_2 freezing. The new method can be combined with an automatized graphitization system like AGE from ETHZ giving a full automatizable water preparation line for AMS graphite targets. This case the needed typical sample size is between 5-12 ml of water sample. The most powerful application of the new groundwater pretreatment method is to connect it directly to an AMS using gas ion source. With a MICADAS type AMS system we demonstrated that you can routinely measure the ^{14}C content of 1 ml of water sample with better than 1% precision (for a modern sample). This direct ^{14}C AMS measurement including sample preparation of one water sample takes about 20 minutes.

SAM#9 **SESSION 12** **Friday 25th March, 0900 – 1040**

Identifying Chemical Markers for Anomalous Radiocarbon Dates from Surface Organic Residues

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Surface residues recovered on archaeological pottery have become a valuable source of samples for radiocarbon dating. Each char is likely to result from a limited number of closely spaced cooking events, and the age offset of the char is likely to be minimal. This means these dates can be used to accurately determine when the vessels were used. The use of Bayesian statistics for chronological modelling has highlighted how important it is that items being dated are not residual within the archaeological context from which they are recovered. Pottery residues that derive from groups of refitting sherds are particularly desirable alongside other sources of dates such as articulating animal bone.

However it has been discovered during the incorporation of radiocarbon dates from charred residues within Bayesian models that these residues are more likely to return anomalous results than other sample types. Approximately 12% of the measured ages are non-reproducible between laboratories and are statistically inconsistent with the other information included in the models. Dates that are both too old and too young are encountered. There also does not appear to be a correlation between the anomalous ages and laboratories or methods of sample pre-treatment. It appears therefore that there is some form of contamination present in a proportion of the dated residues.

Rigorous chemical characterisation of a range of relatively abundant residues is being undertaken at the molecular level in order to identify the chemical features of residues that will return an anomalous radiocarbon date. The majority of these residues are from the ongoing radiocarbon dating programme funded by English Heritage and range from the early Neolithic to Anglo-Saxon periods. Analyses focus primarily on the use of pyrolysis-gas chromatography/mass spectrometry (py-GC/MS), alongside other techniques, such as organic elemental analysis (C/H/N) and solid state cross-polarisation magic angle spinning nuclear magnetic resonance spectroscopy (CP/MAS NMR), providing complementary compositional information. The results of this study will be presented with a view to identifying a pre-treatment to remove the contamination or an appropriate screening process to eliminate residues likely to return anomalous radiocarbon dates.

(Withdrawn)

ARC#4 **SESSION 12** **Friday 25th March, 0900 - 1040**

Ion Beam Analysis and AMS ^{14}C dating as complementary tools in cultural heritage diagnostics

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The availability at CEDAD (Centre for Dating and Diagnostics), University of Salento of experimental beam lines for AMS radiocarbon dating and IBA (Ion Beam Analysis) resulted in the possibility to explore the potentialities of their combined application in the field of cultural heritage diagnostics. Several cases have shown how the combined approach is very useful when the chronological information obtained by ^{14}C dating can be integrated with the compositional information as obtained by the non destructive analysis carried out by PIXE (Particle Induced X-Ray Emission) and PIGE (Particle Induced Gamma Ray Emission).

The results obtained in the study of cultural heritage objects and archaeological contexts will be presented showing how AMS and IBA can be used either to obtain complementary information on different kind of samples from the same contexts or to study the same material by the two methods.

In the first case the information obtained by AMS ^{14}C dating organic materials are used to supply the timeframe for the information obtained by the compositional analysis carried out by IBA. As case study the results of the analysis of the casting cores of the Riace Bronzes, two of the most important and well preserved masterpieces of classical art, will be presented. Organic residues extracted from the cores, such as charcoals, vegetal remains and animal hairs were submitted to AMS radiocarbon dating in order to confirm the dating of the two statues to the Vth century BC. At the same time, samples of the casting cores taken from different positions within the statues were analyzed by PIXE and PIGE, obtaining important information about the manufacturing sites and technology.

Examples will be also presented for the study of the temporal evolution of the exploitation of geological sources of raw materials (for instance for obsidians from different Neolithic contexts in the Mediterranean basin) or of metals manufacturing technology.

A particularly interesting case in which the two methods can be applied on the same kind of samples is represented by study of bones. In this case IBA analysis can supply information about the composition of the bone mineral phase both in terms of major, minor and trace elements. We will present the results of the IBA analysis carried out on ^{14}C dated cremated bones and in the quantitative determination of heavy metals (Pb, Hg and As) in archeological bones for the study of the past levels of exposure to these toxic elements.

CAL#1 **SESSION 12** **Friday 25th March, 0900 - 1040**

Effects of Laschamp geomagnetic excursion on cosmogenic isotope production

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The Laschamp excursion is a period of reduced geomagnetic field intensity occurring 40.7 ± 1.0 ky ago (Singer et al., Earth Planet. Sci. Lett., 80-88, 2009). During this period, cosmogenic isotope production was affected not only directly by the reduced magnetic field, but also due to an increased sensitivity to solar activity. The latter occurs because a larger fraction of the lower energy interstellar galactic cosmic ray particles, normally excluded by the magnetic field, is able to reach the earth's atmosphere when the geomagnetic field is reduced. The overall result is a period of increased cosmogenic isotope production having considerable structure. Using high resolution (decadal) profiles of ^{10}Be in ice cores from both Antarctic and Greenland, we estimate the expected influence of the Laschamp event on the concentration of ^{14}C in the atmosphere. We find that the maximum Δ^{14}C due to increased production during this period is likely <200 ‰. This is considerably smaller than the ~500 ‰ increase modelled by Hoffman et al. (Earth Planet. Sci. Lett., 1-10, 2010) for the same event, which those authors claim can explain their deduced Δ^{14}C profile from 44 – 41 ky BP. If such an increase in Δ^{14}C did indeed occur, we conclude that it must have resulted from some other cause, such as a redistribution of CO_2 in the environment.

(Withdrawn)

AST#6 **SESSION 12** **Friday 25th March, 0900 - 1040**

Measurements of high-energy neutron cross sections for cosmogenic nuclides

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Cosmogenic nuclides are used to reconstruct the history of solar system materials, including earth and planetary surface materials, and to study the history of cosmic rays. Monte Carlo neutron transport codes are essential tools in the reconstruction of cosmic ray exposure scenarios. However, even if the fundamental physics of neutron transport within planetary materials is modeled properly, the reliability of the modeled production rates is still limited by the lack of or the accuracy of measured pertinent cross sections. At the present time, the largest uncertainty in reconstructing cosmic ray exposure scenarios is the uncertainty in the high-energy neutron excitation functions for the nuclear reactions of interest because very few cross sections for reactions induced by high-energy neutrons have been measured. Furthermore, a good database of neutron-induced cross sections would be of significance not only for cosmic-ray interactions but also for accelerator facilities. Unlike proton induced cross sections, only a few cross section measurements in the energy region >20 MeV have been undertaken (e.g., 1-3) because of the difficulty in obtaining monoenergetic neutrons. We are extending measurements of the high-energy neutron excitation functions for reactions of cosmochemical as well as nuclear science interest. Various target materials were exposed to monoenergetic neutrons at the Research Center for Nuclear Physics (RCNP), Osaka University; the neutrons are produced utilizing the proton beams by ^{7}Li(p, n)^{7}Be. We performed exposure of neutron energy of 287 and 370 MeV. After measurements of the short half-lived nuclides by low-level g-ray counting we started measurements of the long-lived nuclides, ^{10}Be, ^{26}Al, and ^{36}Cl by AMS and ^{21,} ^{22}Ne by noble gases mass spectrometry. References [1] Imamura *et al.*, NIM B52, 595-600, 1990; [2] Kim *et al.*, JNST, 36, 29-40, 1999; [3] Sisterson *et al.*, NIM B240, 617-624, 2005.

FOR#2 **SESSION 13A** **Friday 25th March, 1110 - 1250**

Dating photographs using the bomb-spike

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Within the last few decades, original photographic prints of artistic or historic importance have dramatically increased in value. Given the nature of photographic reproduction, sorting out when a particular print was produced can be challenging. Curators of photography museums and collections of important photographs are particularly vexed trying to identify late 20th century prints from early 20th century negatives. We have been investigating methods for dating photographs based upon the radiocarbon content of both photographic paper and photographic emulsion.

For most of the 20th century, photographic emulsion was produced from of animal gelatin, a material well studied in the radiocarbon field. We hypothesized that bomb-derived radiocarbon would appear in the photographic emulsion much more quickly than in photographic paper and might be a marker for when the photographic paper was produced. We have developed purification protocols to separate photographic emulsion and from the paper substrate using the ninhydrin reagent and have measured radiocarbon levels in each in known-age photographs.

The radiocarbon measurements show that emulsion radiocarbon content is linked surprisingly closely to atmospheric levels, much more so than the levels found in the photopaper substrate. Over the course of the bomb spike, emulsion ^{14}C levels lag behind atmospheric radiocarbon levels by several years. Nevertheless, they can be used to estimate the year the paper was manufactured with an error of the order of plus or minus several years. It is probably to our advantage that photographic materials have always been sold with expiration dates so as to keep behaviour during development predictable. The measured uncertainties would be sufficient to identify late 20th century prints of early 20th century negatives. The use of gelatin emulsion in black and white and colour photographs, photographic negatives, and film stock means the method is applicable to other types of photographic materials and may be useful in forensic science.

FOR#3 **SESSION 13A** **Friday 25th March, 1110 - 1250**

Bomb ^{14}C in forensic anthropology

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Due to the high dynamical range of bomb ^{14}C in the biosphere between 1960 and today, high hopes rest on ^{14}C in forensic anthropology. However, carbon uptake and turnover in the human skeleton is known to be variable in time and skeletal location; hence the inversion of measured $F^{14}C$ to age at time of death or estimation of the lifetime of an individual is hampered by additional unknowns. We determined $F^{14}C$ of human bone and teeth of individuals of known birth and death dates. We compare our results to a recently published model, based on the development of the human skeletal system.

FOR#4 **SESSION 13A** **Friday 25th March, 1110 - 1250**

AMS of the Minor Plutonium Isotopes

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Isotopic signatures of environmental plutonium are generally used to assess the origin of the material. While decay counting is restricted to ^{238}Pu, $^{239+240}$Pu, and ^{241}Pu, all mass spectrometric methods can in principle detect the isotopes ^{239}Pu, ^{240}Pu, ^{241}Pu, ^{242}Pu, and ^{244}Pu. However, there are not too many data available so far concerning isotopic concentrations of ^{241}Pu, ^{242}Pu, and ^{244}Pu in environmental samples.

VERA, the Vienna Environmental Research Accelerator, is especially equipped for the measurement of actinides, and performs a growing number of measurements on environmental samples [1]. During the last years, we have performed measurements of the minor Pu isotopes whenever we encountered environmental samples with sufficient Pu content. This includes soil samples from different places of the world, deep-sea sediments, and sea sediment samples from near the nuclear reprocessing plant in Sellafield.

We will discuss the AMS measurement technique, and the performance in comparison to other methods. While AMS is not the optimum method for each isotope [2], the possibility to measure all of them on the same AMS sputter target is a great simplification. We will present the data obtained so far, and discuss possible applications.

[1] P.Steier, F. Dellinger, O. Forstner, R. Golser, K. Knie, W. Kutschera, A. Priller, F. Quinto, M. Srncik, F. Terrasi, C. Vockenhuber, A. Wallner, G. Wallner, E. M. Wild. Analysis and Application of Heavy Isotopes in the Environment. Nucl. Instr. and Meth. in Phys. Res. B 268 (2010) 1045-1049.

[2] E. Hrnecek, R. Jakopič, A. Wallner, P. Steier. A combined method for the determination of the isotopic vector of plutonium isotopes in environmental samples. J. of Radioanalytical and Nuclear Chemistry 276/3 (2008) 789-793.

FOR#5 **SESSION 13A** **Friday 25th March, 1110 - 1250**

Plutonium and uranium contamination in soils from the former nuclear weapon tests in Australia

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The British government performed a number of nuclear weapon tests on Australian territory from 1952 through to 1963 with the cooperation of the Australian government. Nine fission bombs were detonated in South Australia at Emu Field and Maralinga, and a further three fission weapons were detonated in the Monte Bello Islands off the coast of Western Australia.

Analysis of neutron capture products and residual nuclear material from detonated nuclear weapons can allow information on the weapon used to be inferred. In addition a nuclear forensic examination of samples from well characterised sites such as these is an important exercise to develop techniques for detection of clandestine nuclear activities.

A number of samples were collected by the Australian Radiation Laboratories in 1972 1978, 1983 and 1990 at the Monte Bello Islands, in 1977 from Emu field and in 1977 and 1984 at Maralinga as part of site management and cleanup activities to gauge residual radioactivity levels. To this end we have secured a number of soil samples from the ARL archives which had been collected from the Monte Island and Maralinga sites. These samples were originally analysed for gamma emitting fission products and in a few cases the residual weapon material, $^{239+240}$Pu, was analysed by alpha spectrometry. We have now analysed some of these soils for plutonium and uranium isotopic concentrations and also ^{240}Pu:^{239}Pu isotopic ratios using the ANTARES AMS facility, ANSTO. The neutron capture product ^{233}U was also analysed as a test of capability to detect the presence of thorium fuel cycle activities in environmental matrices.

FOR#6 **SESSION 13A** **Friday 25th March, 1110 - 1250**

A nuclear forensics use of ^{10}Be at Dolon, Semipalatinsk

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A combined research group from the above universities is trying new approaches for determining the radiation doses from historic nuclear explosions at Hiroshima, Nagasaki, and particularly Semipalatinsk, the site of historic USSR nuclear testing (400 tests). One of the new isotopes being investigated is ^{10}Be, made by bomb-origin fast neutron reactions on the ^{13}C in carbon dioxide in air by an (n,α) reaction, and its presence in explosion debris has already been verified by AMS measurements (Whitehead et al., J. Environmental Radioactivity 99:260-270,2008). The median ^{10}Be level from 13 soils (10cm depth) from Dolon (Semipalatinsk) is 1.97±0.63 x 10^8 at.g^{-1}compared with an expected background value of 1.9x 10^7 at.g^{-1} of soil, thus showing an excess thought to be due to the fallout plume, but the precise size of the anomaly does depend strongly on the conventional assumption that background fallout at a given site is proportional to rainfall. Comparisons with other radionuclides, showed that the signal to noise median ratios for detection of the fallout plume were respectively 10.4 (^{10}Be), 12.6 (^{137}Cs), 30 (^{239,240}Pu) and 5.4 (^{129}I) (the latter analysed by AMS; Endo et al., Radiation and Environmental Biophysics 47(3), 359-365, 2008)). Backgrounds were calculated from known deposition and rainfall at other similar-latitude sites. The S/N ratios seem to be highest for the most particle reactive radionuclides hence best for Pu, but analyses were cheapest for ^{137}Cs, relying on passive gamma-ray detection. ^{10}Be may still be useful under special circumstances since it had a similar S/N ratio similar to that of ^{137}Cs, and the respective half-lives are 1.5Ma and 30a. In general when the latter has decayed, the AMS-detectable nuclides will still be available, and the variety available suggests mutual cross-checking will be possible.

CAL#2 **SESSION 13B** **Friday 25th March, 1110 - 1250**

The CRONUS-Earth inter-comparison for cosmogenic isotope analysis

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As part of the NSF funded program CRONUS-Earth, a series of reference materials for ^{26}Al, ^{10}Be, ^{14}C and ^{36}Cl were prepared and circulated to US, Australian and European laboratories for analysis to explore the comparability of results from the different laboratories and hence generate consensus values for a range of reference materials, to assist laboratories in independently assessing quality and to quantify precision and accuracy. Currently, most researchers report only analytical uncertainties for all results. While researchers have acknowledged the need for realistic inter-laboratory uncertainties for cosmogenic isotopes, no previous studies have addressed this issue. One goal of the CRONUS-Earth project was to reduce the analytical uncertainty to less than 5% for Be and a similar value for Al if possible.

Two samples (A and N) were provided for ^{26}Al, ^{10}Be and *in situ* ^{14}C, one from the Antarctic, high in ^{26}Al and ^{10}Be and the other from Australia, lower in ^{26}Al and ^{10}Be. Both samples were prepared at the University of Vermont. Two further samples, a carbonate sample and a potassium feldspar sample, were provided for ^{36}Cl. More than 20 laboratories worldwide received samples.

For each sample, results have been summarised in terms of the mean activity, standard deviation and a measure of intra-laboratory variability. A number of laboratories also reported multiple assays. For in-situ ^{14}C, only one laboratory reported results so there is no further discussion. The samples for ^{36}Cl analyses were distributed much later and results are still awaited.

Initial results for samples A and N showed the existence of significant variability (greater than 8%) in results, much of which was attributable to differences in sample calculation and assumed standard values. After correction for the standard values, the variability for ^{10}Be could be reduced.

Acknowledgements: CRONUS- Earth consortium, NSF grant EAR03-345150.

CAL#3 **SESSION 13B** **Friday 25th March, 1110 - 1250**

Performance and uncertainties of ^{10}Be measurements at CAMS

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We quantify the routine performance and uncertainties of ^{10}Be measurements made on the CAMS FN accelerator mass spectrometer in combination with the CAMS high-intensity cesium sputter source. Our analysis compiles data from 554 primary and secondary standard targets measured on 47 different wheels over a one-year interval (September 2009 through September 2010). The series includes 87, 86, and 85 measurements of each of three different secondary standards and 296 measurements of our primary standard, KNSTD3110 (01-5-4) [1]. The average initial $^{9}Be^{3+}$ beam current was 22 +/- 3 microA (1 standard deviation). Secondary standard targets, which were measured as unknowns in each of the wheels, have average uncertainties based on counting statistics of ~1.6%, ~1.2%, and ~0.7% (1 sigma) for standard materials with $^{10}Be/^{9}Be = 5.35 \times 10^{-13}$, 9.72×10^{-13}, and 8.56×10^{-12} [1], respectively. The mean measured ratio for each of the secondary standards (normalized to the primary standard) falls within the 1.1% uncertainties of the reported values [1]. The standard deviation around the mean of this large number of runs is on the order of ~2.0%, ~1.7%, and ~1.3% for each secondary standard. These data indicate a fairly constant additional source of uncertainty, about 1%, above that calculated from counting statistics alone. Our results demonstrate both the high precision and accuracy of the CAMS ^{10}Be capabilities.

[1] K. Nishiizumi, M. Imamua, M.W. Caffee, J.R. Southon, R.C. Finkel, J. McAninch, Nucl. Instr. and Meth. B 258 (2007) 403.

CAL#4 **SESSION 13B** **Friday 25th March, 1110 - 1250**

Organic Backgrounds: Are they material dependent?

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Background (or "blank"), that is the ^{14}C concentration measured in a sample of "infinite" - much older than measurable – age, determines the range of ages measurable with radiocarbon, as well as the uncertainty of such measurements for old ages. Background sources include a "machine" background, consisting of stray ions masquerading as ^{14}C and real ^{14}C from ion source memory, contamination introduced during sample pretreatment and target preparation in the laboratory, contamination during sampling, transport, and storage, and *in-situ* contamination of the sampled material.

Our machine background is negligeable compared to the other factors. With marble and Icelandic doublespar, we established that CO_2 production by acid hydrolysis and the ensuing target preparation introduces less than 0.1 pMC ^{14}C in a 1 mg C target. Yet, some carbonate background materials yielded much higher, non-removable ^{14}C levels, indicating different background personalities for different carbonate shells. Our standard combustion in quartz ampoules introduces ca. 5 µg "modern" carbon in a CO_2 sample from doublespar carbonate. Tests of a variety of organic background materials such as coal, crude oil, paraffin, wood, bone, and ivory have yielded systematically different ^{14}C concentrations, which we interpret as evidence of material-dependent contamination *in-situ* and during pretreatment. This implies that for very old organic samples, and/or very precise measurements in general, the background material used to correct for process blank and *in-situ* contamination has to be selected very carefully. We will present a study of these different backgrounds and the possible source of contamination.

CAL#5 **SESSION 13B** **Friday 25th March, 1110 - 1250**

Calibration Curve from 1249 AD - 1650 AD by Tree-ring Measurement Grown in Korean Peninsula

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An 1MV AMS system constructed by HVEE B.V. was installed at Korea Institute of Geoscience and Mineral Resources (KIGAM) in 2007. This AMS machine has been dedicated to study paleoclimate change and environmental study. Since possibility of regional age offset has been suggested by several previous studies, the consistency of the data set of IntCal04, which is used to calibrate radiocarbon ages in our laboratory, with the concentration of ^{14}C in tree-rings grown in Korea has been studied. Tree-ring samples grown from 1249 AD to 1650 AD were collected from old wooden buildings such as palaces, temples and pavilions. After age measurement of the tree-ring samples by dendrochronological methods, they were cut into single-year rings. Alpha cellulose was extracted from each ring, and ^{14}C concentrations of them were measured by AMS. In this work, ^{14}C concentration variation during the 400 years is presented. Radiocarbon ages were evaluated from the concentrations using wiggle-match method. The accurate ages of tree rings and consistency between our results and IntCal04 are also presented.

CAL#6 **SESSION 13B** **Friday 25th March, 1110 - 1250**

A Record of Deglacial Atmospheric ^{14}C from Hulu Cave Speleothem H82

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The Hulu Cave speleothem H82 (Wang et al, 2001), has been analyzed for ^{14}C, $\delta^{18}O$, and U/Th through the deglacial interval 15-25 kyr, to strengthen the calibration of radiocarbon chronologies for deglaciation.

Sampling was carried out at University of Minnesota, using a 'trench and wall' method to develop closely interleaved U/Th and ^{14}C time series. Powdered calcite from small trenches drilled perpendicular to the stalagmite growth axis was used for ICP-MS U/Th measurements at University of Minnesota, and calcite walls between trenches were removed as wafers for AMS ^{14}C measurements at University of California Irvine. Stable isotope measurements were made on powdered portions of the wafers at UC Irvine.

The U/Th results showed that H82 calcite contains almost no detrital thorium, and corrections to ^{230}Th dates for initial thorium are negligible. Comparisons of H82 ^{14}C data with other ^{14}C calibration records over the interval 10-15kyr BP showed that Dead Carbon Fraction (DCF) corrections for incorporation of ^{14}C-free geologic carbonate in H82 are low (~450 years), and are remarkably stable across major climate transitions.

There is excellent agreement over the interval 15-21 kyr between the new Hulu Cave data and the Bahamas speleothem record (Beck et al., 2001), indicating that the Bahamas record is accurate despite the large uncertainties caused by large detrital thorium and DCF corrections. The consistency between these two speleothem datasets, from very different locations and geologic settings, suggests that there are no large short-term variations in DCF in either record, and that both provide good records of atmospheric ^{14}C over this period.

Systematic differences are observed between the records from Hulu Cave and Cariaco Basin (Hughen et al., 2006) at the Allerød/Younger Dryas transition and between 16 and 17kyr (Heinrich Stadial 1), suggesting that Cariaco Basin marine reservoir age may have been very low during these periods. The record of ^{14}C in macrofossils from varved Lake Suigetsu (Kitagawa and van der Plicht, 2000) shows systematically older ^{14}C ages before 16kyr, probably due to missing core or undercounted varves.

We thank the Comer Science and Education Foundation for their support of this work.

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Wu et al.. 2009. *Science in China Series D-Earth Sciences* 52, 360-368.

AST#7 **SESSION 14** **Friday 25th March, 1400 - 1520**

Pushing the limits in searches for superheavy elements in nature

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Exploring the nuclear landscape beyond the known territory of isotopes is possible with an AMS facility like VERA. Arriving at the "island of stability" around A~300 (Z=114, N = 184) with heavy ion nuclear reactions is essentially out of reach, since one needs more neutrons than are available by combining even the most exotic projectiles and targets. However, if such an island does exist – possibly with nuclides living long enough to be still around since the formation of the solar system – then one may find minute traces of them on Earth. The intriguing claims of Marinov et al. from Jerusalem to have actually observed positive evidence for long-lived neutron-deficient and neutron-rich SHEs at an abundance level of 10^{-10} to 10^{-12} using ICP-SFMS (Inductively Coupled Plasma Sector Field Mass Spectrometry), triggered our interest to use AMS for much more sensitive experiments to prove or disprove these results [1]. Similar efforts are being pursued by the AMS group at the tandem laboratory of the TU and LMU Munich [2].

The current work will summarize the AMS method at VERA to perform searches for SHEs, and will also report on results obtained so far on several natural materials. In general, the results of Marinov et al. in thorium and gold are not confirmed by the AMS experiments at a sensitivity level considerably higher than the one achieved with ICP-SFMS. In addition, our experiments were extended into the region of the above-mentioned "island of stability", where a total of about 30 nuclides were spot-tested for their existence in nature.

[1] F. Dellinger et al., Nucl. Instr. Meth. B 268 (2010) 1287.

[2] L. Lachner et al., Phys. Rev. C 78 (2008) 064313.

ARC#5 **SESSION 14** **Friday 25th March, 1400 - 1520**

Measurement of lead isotopic ratios using Micro-AMS

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The provenance of lead belonging to several ancient anchors found in various locations across the Portuguese Atlantic coast, was determined by measuring the isotopic ratios $^{206}Pb/^{204}Pb$, $^{207}Pb/^{204}Pb$, $^{208}Pb/^{204}Pb$, $^{207}Pb/^{206}Pb$, $^{208}Pb/^{206}Pb$, $^{208}Pb/^{207}Pb$ using the Micro-AMS system of the Instituto Tecnológico e Nuclear (ITN). While there have been several different analytical techniques employed in this kind of studies, namely ICP-AES, AAS, INAA, TIMS and ICP-MS, amongst others, it is the first time micro-AMS was employed. The samples consist of scrapes from anchors found in Peniche, Setúbal, Sesimbra, Faro, Portimão, Sines and Cascais, comprising a total of 15 samples. The high precision and accuracy required for this kind of measurement implied the processing of the samples, transforming the elemental lead to PbS by means of a very simple chemical process.

Prior to this process, a PIXE analysis of the composition of the samples was carried out, which was determined to be mainly lead, with a few ppm of Cr and Fe as major impurities.

A NIST Pb standard, also converted to PbS, was used for normalization.

CAL#7 **SESSION 14** **Friday 25th March, 1400 - 1520**

Calculation of the compounded uncertainty of ^{14}C AMS measurements

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The correct method to calculate conventional ^{14}C ages from the carbon isotopic ratios was summarised 34 years ago by Stuiver and Polach (1977) and is now accepted as the only method to calculate ^{14}C ages. There is, however, no concensus regarding the treatment of AMS data, mainly of the uncertainty of the final result. The estimation and treatment of machine background, process blank, and/or in-situ contamination is not uniform between laboratories, leading to difference in ^{14}C results, mainly for older ages. As Donahue (1987) and Currie (1994), among others, mentioned, some laboratories find it important to use the scatter of several measurements as uncertainty while others prefer to use Poisson statistics. The scatter of the standards, machine background and process blank is a laboratory parameter that does not obey Poisson counting statistics, but rather is often empirically estimated at 1/3 of the measured value. The contribution of these and of in-situ contamination to the uncertainty of the final ^{14}C result is also treated in different ways. The final measurement uncertainty, in percent Modern Carbon (pMC), is often translated into symmetrical uncertainties in ^{14}C years, even for older ages, which is mathematically incorrect. In the early years of AMS, several laboratories found it important to describe their calculation process in detail. In recent years this practise has declined. We will present the calculation process for ^{14}C AMS measurements used in Kiel and compare it to calculation practises published since the beginning of AMS.

FOR#7 **SESSION 14** **Friday 25th March, 1400 - 1520**

A novel approach for neutron-capture studies of ^{235}U and ^{238}U

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Improved and highly accurate nuclear data are urgently required for the design of advanced reactor concepts. This demand holds for minor actinides but also for the main fuel materials. Existing data were measured by detection of the prompt capture γ-rays. A major difficulty in these experiments is the safe discrimination against the strong γ-background from the competing fission channel. Recent studies exhibit critical discrepancies at keV energies for both, $^{235}U(n,\gamma)$ and $^{238}U(n,\gamma)$ with great impact on the k_{eff}-value of fission reactors. Neutron activation with subsequent accelerator mass spectrometry (AMS) measurement of the reaction product represents an independent technique, where interference from fission is completely excluded.

Within the European EFNUDAT project, new measurements were performed with the goal to determine the neutron capture cross sections of ^{235}U and ^{238}U via neutron irradiations at thermal (cold) and keV energies: Activations were performed with cold neutrons (Budapest Research Reactor), thermal (Atominstitut, Vienna) and with neutrons of 25 and 450 keV (Karlsruhe Institute of Technology). The produced long-lived ^{236}U and the decay product of ^{239}U, ^{239}Pu were subsequently counted by AMS at the Vienna Environmental Research Accelerator (VERA).

This method for measuring the neutron capture cross section has the advantages that the involved systematic uncertainties are in no way correlated with those inherent to previous techniques. Therefore, this experiment provides important and independent information for these key reactions of reactor physics with uncertainties expected below 5%. The high sensitivity of AMS requires only very small samples.

New results for $^{235}U(n,\gamma)^{236}U$ and $^{238}U(n,\gamma)^{239}U$ in the energy range from thermal to 500 keV will be presented. The challenges of measuring $^{236}U/^{238}U$ isotope ratios at the 10^{-12} level and to quantify ^{239}Pu with high precision will be highlighted. Finally, the potential for extending that method to other isotopes in that mass range will be discussed.

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