5th EAST ASIA AMS SYMPSIUM

OCT. 15-18 2013.

KIGAM

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5.	AR	Archaeology and general application
6.	AN	Study on anthropogenic nuclides
7.	BI	BioAMS

Symposium Venue and Host

International School for Geoscience Resources (IS-Geo)
Korea Institute of Geoscience and Mineral Resources (KIGAM)
124 Gwahak-ro, Yuseong-gu, Daejeon, 305-350, Republic of Korea.

International Advisory Committee

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Free Special Tour
(Tomb of King Muryeong & Baekje Cultural Land)

Free special tour, which will be started at 13:40 on October 17, is the sightseeing of Baekje culture in Buyeo and Gongju. The King Muryeong ruled the Baekje Kingdom from 501 to 523. His tomb is a crucial source for the understanding of Baekje. Baekje Cultural Land is the first restored Baekje palace in the country. The buildings in the palace and the temple show down pointing cantilever architecture, and the gracefully painted tiles represent the sophisticated art trend in Baekje's architecture. All buildings in Sabiseong will help you better understand the artistic and historical values of Baekje.

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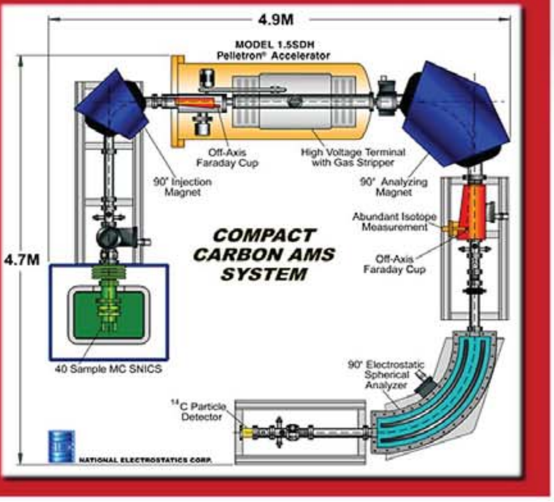

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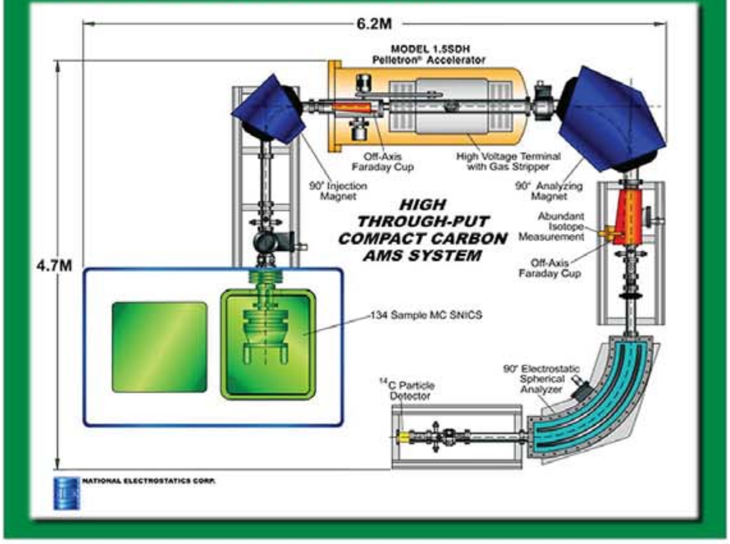

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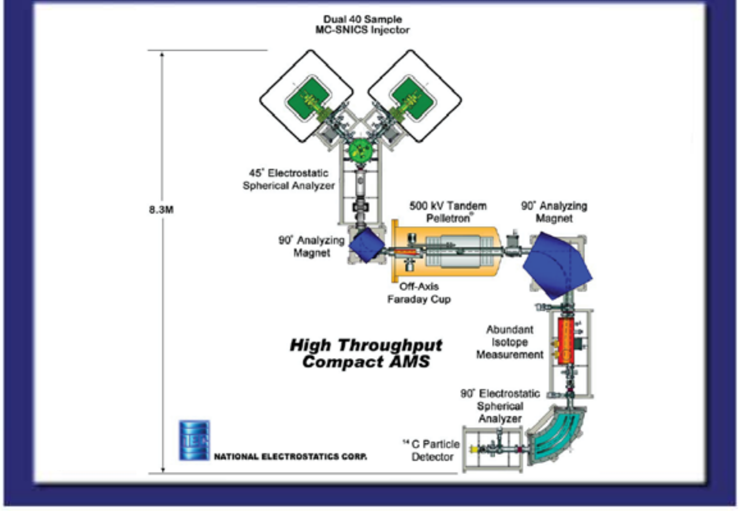

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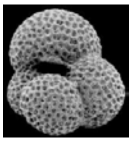

For radiocarbon dating, pre-treatment usually takes much longer time(4 to 5 days) than the AMS measurement(30 to 45 min).

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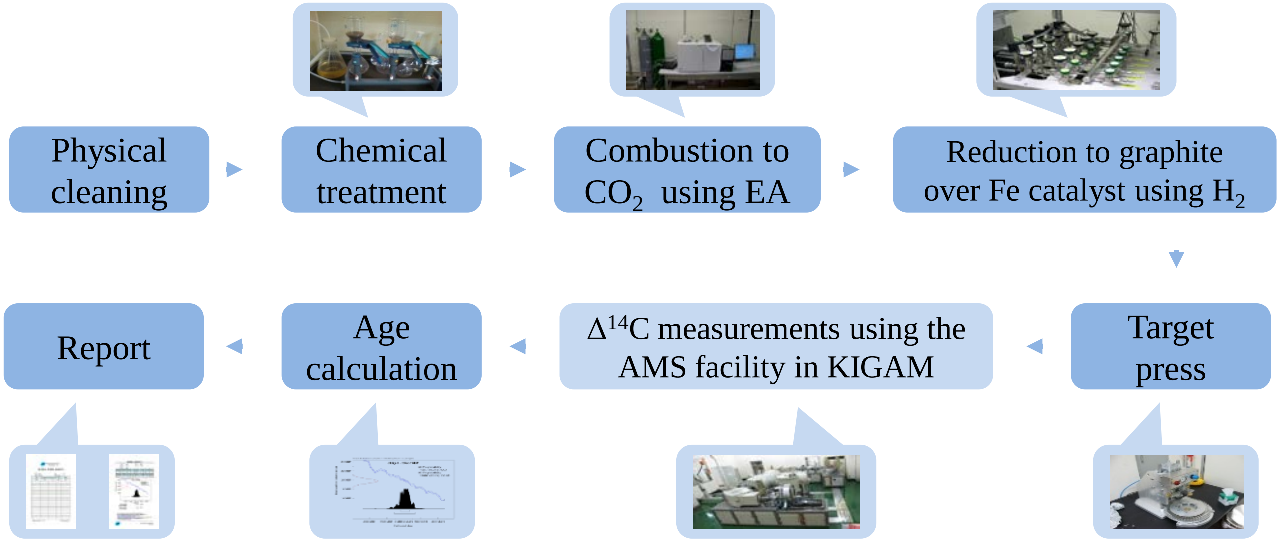

Physical cleaning ▸ Chemical treatment ▸ Combustion to CO_2 using EA ▸ Reduction to graphite over Fe catalyst using H_2

▾

Report ◂ Age calculation ◂ $\Delta^{14}C$ measurements using the AMS facility in KIGAM ◂ Target press

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Time Table

From	To	Nuri Hall	City
Tuesday, October 15, 2013			
9:00	10:00	Registration at lobby of IS-GEO Bldg. of KIGAM, Daejeon	**Daejeon (KIGAM)**
10:00	10:20	Opening of EA-AMS 5	
10:20	11:20	AMS technique development (TE)-I	
11:20	11:40	Coffee break	
11:40	12:40	AMS technique development (TE)-II	
12:40	14:00	Lunch, Cafeteria of KIGAM	
14:00	15:40	Status report and new facilities (ST)-I	
15:40	16:00	Coffee break	
16:00	18:00	Carbon-14 application (CA)-I	
Wednesday, October 16, 2013			
9:00	10:20	Archaeology and general application (AR)	
10:20	10:40	Coffee break	
10:40	12:00	Study on anthropogenic nuclides (AN)	
12:00	12:30	Photo time, Front of IS-GEO Bldg.	
12:30	14:00	Lunch, Cafeteria of KIGAM	
14:00	16:00	Poster session (Lobby)	
16:00	18:00	KIGAM AMS Lab Tour, AMS lab of KIGAM	
18:00	20:00	Banquet, Backyard of KIGAM	
Thursday, October 17, 2013			
9:00	10:40	Status report and new facilities (ST)-II	
10:40	11:00	Coffee break	
11:00	12:00	Carbon-14 application (CA)-II	
12:00	13:00	Application of long half-life nuclides (LO)	
13:00	13:40	Lunch, Cafeteria of KIGAM	
13:40	21:30	Free special bus tour, Departure at the front of IS-GEO Bldg.	
21:30		Arrival at KIGAM (after dinner)	
Friday, October 18, 2013			
9:00	9:40	Business Meeting of EA-AMS 5	
9:40	10:00	Coffee break	
10:00	12:30	Departure for KIST (Seoul) by bus, Front of IS-GEO Bldg.	
12:30		Arrival at KIST (Seoul)	**Seoul (KIST)**
12:30	14:00	Lunch, Cafeteria of KIST(Seoul)	
14:00	16:00	KIST AMS Lab Tour (Seoul)	
16:00		Closing of EA-AMS 5 (Seoul)	

** Bulletin boards for posters will be available from the Tuesday morning.
** Presenters for posters need to keep their position during the poster session.
** Posters should be withdrawn before the departure for KIST on Friday.

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	From	To	Presenter	Title	Time (min)	Abst. No.
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	10:20	11:00	Shan Jiang	The limitations of AMS measurement for heavy nuclides	40	INV-TE-1
	11:00	11:20	Hong-Tao Shen	A preliminary study on 41Ca-AMS technology for early diagnosis of cancer bone metastasis **This is moved to the poster session**	20	O-TE-1 **→P-TE-12**
	11:20	11:40	Coffee break		20	
	11:40	**12:40**	**Oral Session 2-II**	**AMS technique development, TE**	**60**	
	11:40	12:00	John Eliades	Expanding the applications of AMS: A low energy instrument for isobaric interferences and new research areas at KIST	20	O-TE-2
	12:00	12:20	George Burr	Carbon in clay minerals radiocarbon results from stepped-combustion experiments	20	O-TE-3
	12:20	12:40	Junghun Park	Various peaks near carbon peak in E-ΔE spectrum of ionization chamber	20	O-TE-4
	12:40	14:00	Lunch		80	
	14:00	**15:40**	**Oral Session 1-I**	**Status report and new facilities (ST)**	**100**	
	14:00	14:40	Hiroyuki Matsuzaki	Current status and future plan of MALT, The University of Tokyo	40	INV-ST-1
	14:40	15:20	Hong-Chun Li	Progress report on the AMS Lab at National Taiwan University	40	INV-ST-2
	15:20	15:40	Yoko Kokubu	Present Status of JAEA-AMS-TONO: Progress of multi nuclide AMS	20	O-ST-1
	15:40	16:00	Coffee break		20	
	16:00	**18:00**	**Oral Session 3-I**	**Carbon-14 application (CA)**	**120**	
	16:00	16:40	Weijian Zhou	Using AMS-14C technique to trace fossil fuel CO2 in the atmosphere in Xi'an	40	INV-CA-1
	16:40	17:00	Ju Yong Kim	AMS Chronology Applied on the Spaio-temporal Variations of Sedimentation Rate in Korea since MIS 3	20	O-CA-1
	17:00	17:20	Quan Hua	Marine radiocarbon reservoir effect along the north-eastern coast of Australia during the Holocene	20	O-CA-2
	17:20	17:40	Shigenobu Nagasawa	^{14}C ages of TOC in the BIW08B sediment core from Lake Biwa, Japan	20	O-CA-3
	17:40	18:00	Minoru Sakamoto	Precise AMS radiocarbon dating of Japanese tree rings from 4th to 7th century AD.	20	O-CA-4

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Oct.16	**9:00**	**10:20**	**Oral Session 5**	**Archaeology and general application (AR)**	**80**	
	9:00	9:20	Yoshiki Miyata	Reconstruction of paleodiets in potteries using radiocarbon dating, stable isotope analysis and lipid analysis from Late to Final Jomon Periods, Atumi Peninsula, Japan	20	O-AR-1
	9:20	9:40	Wan Hong	Determination of the fabrication ages of metal types by radiocarbon dating of meok(Korean black ink) stained on the type surfaces	20	O-AR-2
	9:40	10:20	Jong-Chan Kim	Timing of rice cultivation in Korea	40	INV-AR-1
	10:20	10:40	Coffee break		20	
	10:40	**12:00**	**Oral Session 6**	**Study on anthropogenic nuclides (AN)**	**80**	
	10:40	11:20	A. J. Timothy Jull	CARBON-14 AND IODINE-129 AS TRACERS IN THE ENVIRONMENT	40	INV-AN-1
	11:20	11:40	Takashi Suzuki	Migration of iodine-129 in the ocean from theFukushima Daiichi nuclear power plant accident after one year	20	O-AN-1
	11:40	12:00	Maki Honda	Evaluation of Iodine-129 mobility in the contaminated soil around 30km from the Fukushima Dai-ichi nuclear power plant	20	O-AN-2
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	16:00	18:00	KIGAM AMS Lab Tour		120	
	18:00	20:00	Banquet		120	

Time Table

	From	To	Presenter	Title	Time (min)	Abst. No.
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	9:40	10:00	Kimikazu Sasa	Future prospects of the 6 MV AMS project at the University of Tsukuba	20	O-ST-2
	10:00	10:20	Hirohisa Sakurai	Present status of YU-AMS system	20	O-ST-3
	10:20	10:40	Jonghan Song	The 6 MV AMS facility at KIST	20	O-ST-4
	10:40	11:00	Coffee break		20	
	11:00	**12:00**	**Oral Session 3-II**	**Carbon-14 application (CA)**	**60**	
	11:00	11:40	Mineo Imamura	Time variations of atmospheric 14C and the climate in the East Asia	40	INV-CA-2
	11:40	12:00	Tetsuya Matsunaka	Paleoclimatic changes on the southern Tibetan Plateau after the Last Glacial Maximum recorded in Lake Pumoyum Co, and its implication for the Southwest monsoon evolution	20	O-CA-5
	12:00	13:00	**Oral Session 4**	**Application of long half-life nuclides (LO)**	60	
	12:00	12:20	Li Zhang	In situ cosmogenic nuclides 10Be and 26Al exposure ages of fluvial terraces, at the mountain front of the Qilian Shan	20	O-LO-1
	12:20	12:40	Yeong Bae Seong	Improvement of Catchment-wide Denudation Rate (CWDR) measurement by coupled in-situ cosmogenic 10Be and 14C abundances of riverine sediments: a case study from the Seti River, Nepal	20	O-LO-2
	12:40	13:00	Yi Re Choi	AUTHIGENIC BERYLLIUM ISOTOPES OF SEDIMENTS FROM THE LAKE	20	O-LO-3
	13:00	13:40	Lunch			
	13:40	21:30	Departure for Free Special Bus Tour			
	Around 21:30		Arrival at KIGAM (after dinner)			

Time Table

	From	To	Presenter	Title	Time (min)	Abst. No.
Oct.18	9:00	9:45	Business Meeting of EA-AMS 5			
	10:00		Departure for KIST by bus			
	12:30		Arrival at KIST (Seoul)			
	12:30	14:00	Lunch			
	14:00	16:00	KIST AMS Lab Tour			
	16:00		Closing of EA-AMS 5			

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O-LO-3	Yi Re Choi	UST/KIGAM	AUTHIGENIC BERYLLIUM ISOTOPES OF SEDIMENTS FROM THE LAKE	43

Full name of organization

Guangxi Normal University (GNU)	Kanazawa University (KAU)
National Taiwan University (NTU)	NSF Arizona (NSF-A)
The University of Tokyo (UT)	Nihon University (NIU)
Nagoya University (NAU)	Yamagata University (YAU)
National Museum of Japanese History (NMJH)	Korea University (KOU)

INVITED TALKS

Current status and future plan of MALT, The University of Tokyo

Hiroyuki MATSUZAKI[1], Yoko S. TSUCHIYA[1], Chuichiro NAKANO[1], Akira MORITA[1], Seiji ITO[1], Kazumi KATSUNO[1], Haruka KUSUNO[1], Marina KAWASE[1], Masako KOIZUMI[1], Yasuto MIYAKE[1], Maki HONDA[1,2]

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Keywords: AMS; Beryllium-10; Carbon-14; Chroline-36; Iodine-129;

Current status

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 Pelletron^{TM} 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, NRA, Microbeam NRA, ERDA/RBS systems. For the advantage for AMS, MC-SNICS^{TM} negative ion sources is used as an ion source. Annual operation time of the accelerator is 5,000-6,000 hours these years. Within 70% of whole operation time occupied by AMS, ^{129}I-AMS machine time has increased after the Fukushima Daiichi Nuclear Power Plant accident for the analysis of environmental ^{129}I around Fukushima originated in the accident. Totally 1,790 targets for ^{129}I were measured in the year 2012.

For other nuclides, the numbers of targets measured annually are about 1,000, 1,000, and 300 of ^{10}Be, ^{14}C, and ^{26}Al, respectively. Compared with these nuclides, we are not content with ^{36}Cl-AMS performance at MALT. So far choosing 6+ charge sate and using Gas Filled Magnet, ^{36}Cl/Cl of 10^{-14} order background is practical, but counting efficiency is not enough.

Future plan

We have an idea for ^{14}C-AMS with only mass 13 and 14 injection. In this idea ^{13}C/^{12}C ratio of the target is calculated from the ratio of $^{13}C^{4+}$ current from $^{13}CH^{-}$ molecular (mass = 14) and $^{12}C^{4+}$ current from 12CH- (mass = 13). The ^{13}C/^{12}C ratio is considered to be preserved in molecular ions. We are now testing this method and confirm. For practically use we should newly install another off-set faraday cup after the analyzing magnet. It is not necessary to inject mass 12 ion, we can extract much current from the ion source being expected very high efficient measurement.

We also now testing the possibility of ^{236}U-AMS at MALT. For such a heavy ion, required magnetic field should be high for the analyzing magnet for enough charge state. As a result of the preliminary test, the cooling ability of the analyzing magnet at MALT was found to be insufficient.

For the ^{36}Cl-AMS, we are investigating for more efficient and sensitive system. Without Gas Filled Magnet for high efficiency, the detector configuration should be improved. Another possibility for the isobar suppression, we are focusing on the laser photo detachment technique in which Sulfur is neutralized before the injection.

Progress report on the AMS Lab at National Taiwan University

Hong-Chun Li*
Department of Geosciences, National Taiwan University

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Keywords: AMS, Graphitization line, Carbon-14 dating, Standards, Background

A HVE 1.0MV Tandetron Model 4110 BO-AMS has been installed in the Department of Geosciences at the National Taiwan University since September 25, 2012. Since then, the NTUAMS Lab started to function. In January of 2013, the AMS was passed its final acceptance tests for ^{14}C, ^{10}Be and ^{26}Al. The AMS background values for $^{14}C/^{12}C$ (C^{++}), $^{10}Be/^{9}Be$ and $^{26}Al/^{27}Al$ are 2.75×10^{-15}, 1.70×10^{-14} and 3.92×10^{-14}, respectively. Two graphitization lines for AMS ^{14}C dating have built up in the department with capability of 10 samples at one times. We have processed the principal modern radiocarbon standards including Oxalic Acid I (HOx1), Oxalic Acid II (HOx2) and ANU (Australian National University) sucrose. In the earlier stage, Li_2^{++} interference became a problem when we measured $^{14}C^{++}$. To avoid the Li_2^{++} interference, we used $^{14}C^{+++}$ measurement. The $^{14}C/^{12}C$ and $^{13}C/^{12}C$ ratios for HOx2 under the $^{14}C^{+++}$ mode are $(1.030\pm0.069)\times10^{-12}$ and $(8.939\pm0.066)\times10^{-3}$, respectively. The activity ratio of HOx2/HOx1 for our measurements is 1.2905, similar to the reported ratio of 1.2933±0.001. However, the activity ratio of ANU/HOx1 for our measurements is 1.4606 which is slightly lower than the reported ratio of 1.5081. By adjusting gas pressure and slit positions, we are able to separate Li_2^{++} with $^{14}C^{++}$ so that the problem of Lithium interference has been solved. We have found a carbonate background (NTUB) which is from the upper Devonian Limestone in Guilin of China and a fossil wood (CWOC) that is from the middle Pleistocene fluvial deposit in central coast of Taiwan. The $^{14}C/^{12}C$ ratios of NTUB and CWOC are $(3.216\pm1.638)\times10^{-15}$ (15 analyses) and $(3.158\pm0.780)\times10^{-15}$ (7 analyses), respectively. These values are very close to the AMS background. After the standards and backgrounds have been examined, we begin to analyze some samples such as shells from lake sediments, carbonate and organic matter from a stalagmite.

Fig. 1 HVE 1.0MV Tandetron Model 4110 BO-AMS in the NTUAMS-Lab

Table 1 Measured $^{14}C/^{12}C$ and $^{13}C/^{12}C$ ratios of the international standards from the NTUAMS Lab for four measurements of each standards

	C+++ mode			
Standard	$^{14}C/^{12}C$ ratio	Stdev.	$^{13}C/^{12}C$ ratio	Stdev.
OXI	8.361E-13	2.627E-14	9.202E-03	1.230E-04
OXII	1.079E-12	7.110E-14	8.986E-03	3.043E-05
ANU	1.221E-12	1.763E-14	9.072E-03	1.551E-05
OXII/OXI	1.2905E+00			
ANU/OXI	1.4607E+00			

Present status of ^{14}C AMS system at Nagoya University (2012/13)

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Keywords: AMS; C-14; SF$_6$ insulator gas; magnet power supply; ferro-fluid feedthrough; Turbo molecular pump, accelerator terminal pump

1. Introduction

An AMS system (Model 4130-AMS) dedicated to^{14}C measurements, built by High Voltage Engineering Europe (HVEE), B.V., the Netherlands, was delivered to Nagoya University in 1996/97. Acceptance tests of its performance on carbon isotope measurements were completed in January of 1999, and routine measurements began in mid-2000. Since completion of the acceptance tests in early 1999, we have encountered a lot of troubles with the machine, in particular severely in 2002. Since the end of 2002, the machine has worked relatively well, expect for minor problems. The standard deviation (one sigma) of the ^{14}C/^{12}C ratio is around ±0.3% to ±0.4% (a bit larger than the uncertainty of about ±0.3% calculated from ^{14}C counting statistics) and that of the corresponding ^{13}C/^{12}C ratio is ±0.03% to ±0.07%, as are tested for HOxII targets. The number of targets measured was 330, 1430, 2077, 1003, 1,979, 1679, 1771, 1115, 1339, 866, 1300, 1701, 1346, 1449, 1634, 706 (July 31st) in each year from 1999 to 2013, respectively, and total number of targets measured by July 31st of 2013 is 20,379. We report here troubles and improvements as well as application studies, in 2012 and 2013.

2. Troubles and Improvements

We describe here the problems occurred after the last EA-AMS Symposium held in Dec. 16th, 2011, in Tokyo. The Tandetron AMS system worked well in the early half of 2012, with only minor failures. In September, a noise became large from the ^{12}C$^-$ beam chopper, in the recombinator system, owing to the problem of a ferro-fluid feedthrough, which had been used since June, 2008. We have replaced the ferro-fluid feedthrough to a new one. Soon after the chopper problem, the turbo molecular pump (TMP) in the recombinator system was damaged with the bearing of the rotating fan. We sent the pump to the supplier for repair. Because of the broken bearing, the rotating fan was seriously damaged, and we must purchase a new one. On October 24th, a large noise was generated from inside of the accelerator tank. We decided to open the tank and check every moving element equipped inside the tank when the accelerator is in operation. The problem was also a bearing mounted in the power generator that supplies electric power to a terminal turbo-pump mounted inside the tank. We could have gotten a new generator in a few weeks, because HVEE possessed one for spare by chance. We purchased it and replaced the damage generator on November. After tank opening, inner surfaces of the accelerator tank absorbed water in the atmosphere, and we spent much time to remove water vapor from SF$_6$ insulation gas. We had experienced twice of high voltage sparks, but no detectable damage occurred with the accelerator system. We could have restarted ^{14}C measurements at around mid of December. Owing to these difficulties with the machine, the total number of graphite targets measured was 1634 in 2012.

In 2013, we have encountered another problem with the terminal pumping system. In May, big periodic noise was radiated from the accelerator tank suddenly. The noise disappeared when the power supply to the pumping system was switched off. We opened the tank and checked every elements of the terminal pumping system. When operated manually, the system worked well, but the power switch is on, then the big noise came out. We have checked every elements again and again and finally found out that the tension of the coupling belt was a bit too lose to be operated perfectly. We reassembled the power transfer system and coupling belt, the noise disappeared perfectly.

Table 1 Annual values of measured targets and measurement time (from 1999 to July 31st, 2013)

item	No. of measured target			Measurement time	
yr.	annually	monthly av.	integrated	annually	monthly av.
1999	330	28	330	352	29
2000	1,430	119	1,760	2,234	186
2001	2,077	173	3,837	3,161	263
2002	1,003	84	4,840	1,545	129
2003	1,979	165	6,819	3,219	268
2004	1,679	140	8,498	2,837	239
2005	1,771	148	10,269	3,456	288
2006	1,115	159	11,384	1,584	264
2007*	1,339	134	12,723	2,136	214*
2008*	866	144	13,589	1,488	248**
2009	1,300	186	14,889	2,470	350
2010	1,701	155	16,590	3,072	279
2011	1,449	140	18,039	2,856	286***
2012	1,634	163	19,673	3,204	320***
2013	706	141	20,379		

*)operation was suspended by the reconstruction of AMS facility building against earthquake (2007/11/1-2008/06/20); **)operated for 6 months; ***)operated for 10 months

Another problem occurred on a magnet power supply, type B-MN 2x40/120, produced by Bruker Analytische Messtechnik GmbH, Germany. Output current of about 100A from the power supply was not maintained stably. Magnetic field of the two high-energy magnets fluctuates and cannot be used for mass analysis of carbon isotopes. We have checked every elements and connections of the power supply, and finally detected that one of three power diodes which rectifies the AC 240V power supply was broken and cannot rectify regularly anymore. We replaced all three diodes and have recovered a stable operation of high-energy magnets.

3. Applications of ^{14}C AMS

We have so far carried out a lot of application programs for the last two years and dated a lot of samples in cultural property, archeological, geological and carbon-cycle research fields from Japan as well as overseas.

(1) ^{14}C age offset analysis of Japanese tree rings from IntCal09 and SHCal.

(2) ^{14}C dating of charcoal samples from Tappe Sang-e Cakmaq archeological site, Iran.

(3) ^{14}C wiggle-match dating of huge wooden poles excavated from Mawaki archeological sites in Japan.

(4) Estimation of sedimentation ages for bored core samples from Hovsgol Lake and Darhard Basin, Mongolia.

(5) Estimation of sedimentation ages for bored core samples from Hatsuryu Swamp, Nagoya, Japan

(6) Estimation of growing age for huge wood from a school garden in Japan.

(7) Measurements of ^{14}C age of ground water samples.

(8) Measurements of ^{14}C age for cultural materials and bone samples excavated at archeological sites in Japan.

(9) Estimation of manufacturing date for modern exquisite statue made of ivory.

The limitations of AMS measurement for heavy nuclides

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Keywords: limitation; heavy nuclides; AMS

Because of Accelerator Mass Spectrometry (AMS) with ability of elimination for molecular and isobaric background interferences, it has a very high sensitivity of isotopic abundance, 10^{-15}. Up to now, AMS has almost replaced the radiation detection methods in the research field of ^{14}C measurement.

In recently, it was found that the sensitivity (10^{-11}-10^{-14}) is lower for the measurement of heavy nuclides (A>100) than ^{14}C, ^{36}Cl measurements by using AMS. This is a big problem for the deeply and widely application of heavy nuclides. What are the limitations of sensitivity for heavy nuclides measurements? It include transmit efficiency and molecular fragment background and so on, which will be introduced, how to solve the limitations will also be discussed.

A dedicate smallest AMS system for heavy nuclides measurement will be proposed at the symposium.

Using AMS-14C technique to trace fossil fuel CO2 in the atmosphere in Xi'an

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Keywords: AMS; ^{14}C; CO_2; fossil fuel;

According to the Copenhagen Accord reached at Copenhagen Climate Change Conference, actions should be taken to keep global temperature increases to below 2 ℃, and to stabilize levels of CO_2 to 450 ppm or lower. All countries are in obligations to reduce their carbon emissions. Quantifying the fossil fuel CO_2 in the atmosphere can provide an accurate basic and important data to authorities and policy makers for monitoring if the individual nations reach their obligations for CO_2 emissions reductions. Due to dead carbon (extremely low ^{14}C) in fossil fuel, measurement of ^{14}C in the atmosphere can precisely estimate the amount of fossil CO_2 emission in the local area. Accelerator Mass Spectrometry (AMS) is the most sensitive method for measurement of ^{14}C, and therefore an effective tool for this purpose. In our lab, a time-integrated air sampler has been designed for collection of CO_2 from the atmosphere using so called Displacement of Phosphoric Acid Solution Method. Air samples have been collected from October, 2011 to December, 2012 in Xi'an, China, and one-year growth vegetation (*Setaria viridis*) were also collected in 2010 in urban areas. The collected atmospheric CO_2 was purified and carbon in the vegetation samples was converted to CO_2, which was then converted to graphite by reduction. ^{14}C in the graphite was then measured using the 3MV multi-nuclides AMS in Xi'an AMS Center. The results show that the concentration of fossil fuel CO_2 in Xi'an ranges from 17.0 to 67.0 ppm between October, 2011 and December, 2012. Higher values in winter in January were observed, which suggest that fossil fuel CO_2 emission was greatly enhanced by domestic heating in winter, because January is the coldest month of the year; The lower fossil CO_2 concentration between April and August is attributed to the reduced amount of fossil fuel use with the rise of temperature. The fossil fuel CO_2 accounts for 77% to 97% of the total amount of the newly increased CO_2 concentrations in the atmosphere, which indicates that fossil fuel CO_2 is the major source of CO_2 in Xi'an. The results of the one-year growth vegetation samples show the highest concentration of fossil fuel CO_2 in downtown (47 ppm), and the lowest in suburban areas (14 ppm), where were distant from industrial and densely populated areas.

Acknowledgements: Thanks to Dr. Xu Xiaomei from University of California, Irvine, for her help in many ways and useful discussion

Time variations of atmospheric ^{14}C and the climate in the East Asia

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Keywords: Carbon-14 production rate, solar activity, regional offset, East Asian Monsoon, climate change

Atmospheric radiocarbon is well-mixed and its concentration is usually assumed to be constant in the semi-hemispheric scale. Two major effects may cause time-dependent radiocarbon variations: solar effect (solar activity) and regional effect. The solar activity is one of the very important factors controlling the earth's climate, and the ^{14}C regional offsets in East Asia seem to be caused by the partial mixing of the atmospheric air mass between north and south hemispheres in the relevant regions. Therefore time-dependent ^{14}C variations are closely correlated with the climate changes in East Asia. In this paper I discuss the past climatic changes in East Asia in connections with the solar activity (deduced from ^{14}C production rate based on the radiocarbon calibration datasets, INTCAL) and the monsoonal effect (deduced from regional offsets observed in Japanese tree- rings).

As is well known, the past solar activity is reflected in the ^{14}C production rate in the earth's atmosphere. ^{14}C in the atmosphere has its origin mostly in marine ^{14}C and it goes back to the ocean. During the residence time (τ)of atmospheric carbon, neutron-induced ^{14}C is accumulated in the atmosphere. The ^{14}C production rate can be calculated using INTCAL datasets (atmospheric and marine) under assumption of constant τ and CO_2 concentration. The high solar activity periods (lower ^{14}C production rate) coincide with the periods of high summer temperature records in East Asia for the last 2000years reported by Bao Yang et al.(2002), showing that the sun played a significant role in the East Asian summer climate. EL Nino and La Nina tend to occur in low solar magnetic activity, suggesting more stable climates in the high solar activity periods than in the low solar activity periods. There are a few exceptional periods (2 out of 16 cases) when high summer temperature prevailed in the low solar activity periods.

Japanese tree-rings in some periods show large regional offsets from INTCAL particularly in the periods of 1st~2nd century AD. As is discussed in the previous EA-AMS conference, we interpret these offsets by exceptionally strong East Asian Monsoon in these periods, since time series of Beijing warm-time proxies (based on stalagmite thickness) reported by Tan et al. (2003) shows a synchronous behavior with those of the regional offsets in Japanese tree-rings. Large offsets mean that the temperature is substantially high.

I will show some of the historical events (such as the spread of wet-rice cultivation in Japan to the northern Honshu in 5th c.BC ~4th c. BC) which seem to correlate with the climates estimated from ^{14}C records.

Timing of rice cultivation in Korea

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Keywords: AMS; Carbon-14

Rice (Oryza Satva) is one of the most important staple foods in the world. The study for the origin of its introduction or beginning of cultivation has been much debated subject and intensively discussed in archaeolgical and paleobotanical communities. However, there is much confusion over the timing of its first introduction to the Korean Peninsula, since it is claimed that it started during the Bronze Age, or the Neolithic Age, sometimes even during the Paleolithic.

Archaeological study of plant or crop remains is very difficult in general, since they are poorly preserved and difficult to identify with the naked eye in the field.

However, with the advent of accelerator mass spectrometry, which can date sub-milligram size samples and flotation technique of the sample collection, the study of this subject has been greatly advanced in recent years. The charred plant materials, especially the crop remains, obtained by flotation provide direct evidence for the study of the origin of agriculture. We will take a brief look at the recent development in East Asia, particularly China. Then we will describe the present status of the study in Korea and make some comments based on the C-14 data we have measured in our laboratory so far.

CARBON-14 AND IODINE-129 AS TRACERS IN THE ENVIRONMENT

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Radiocarbon dating is a critical tool in the estimated of the age of many samples. Carbon-14 is produced by cosmic-ray effects in the upper atmosphere and is rapidly incorporated into the biosphere and the ocean. This makes it is a very useful tracer of oceanic processes, atmospheric processes and changes in cosmic-ray production, as well as man-made events. I will show some examples. Another example of a different tracer is Iodine-129, which is mainly produced from fission. The ^{129}I signal in the ocean is a unique tracer of ocean circulation and is dominated by releases from nuclear reprocessing plants and accidents. I will discuss some applications of ^{129}I measurements by AMS, in the ocean and also groundwater. I will focus in particular on recent ^{129}I input into the ocean from reprocessing and nuclear accidents such as Fukushima.

ORAL PRESENTATIONS

1. STATUS REPORT AND NEW FACILITIES

Present Status of JAEA-AMS-TONO: Progress of multi nuclide AMS

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The JAEA-AMS-TONO (Fig) has not only been continuously in operation for the routine measurement of ^{14}C since 1998 after it was installed at Tono Geoscience Center of JAEA in 1997$^{1)}$, but also has been made available for ^{10}Be- and ^{26}Al-AMSs in recent years.

The ^{14}C-AMS has applied to research into deep underground environments for R&D program related to the geological disposal of High-Level Radioactive Waste, and has also been used by researchers from universities and other institutes for studies of geoscience and environmental science under the common-use facility program of JAEA.

Development of ^{10}Be-AMS had been implemented for the past few years to apply studies of geochronology. After series of optimization of instrument/measurement conditions and test measurements, we completed the development last year and have started routine measurement from this year. From the results of test measurements of standard samples, the ^{10}Be-AMS showed good performance and had low background (^{10}Be/^{9}Be ratios of blank samples = $< 10^{-14}$).

Since March 2013, we have started development of ^{26}Al-AMS because of similar use as the ^{10}Be-AMS. The instrument set up for ^{26}Al-AMS and test measurement was carried out. Ratios of ^{26}Al/^{27}Al in standard samples were almost corresponding to values reported by Nishiizumi$^{2)}$. The development has so far done well and routine measurements of the ^{26}Al-AMS will be started in near future.

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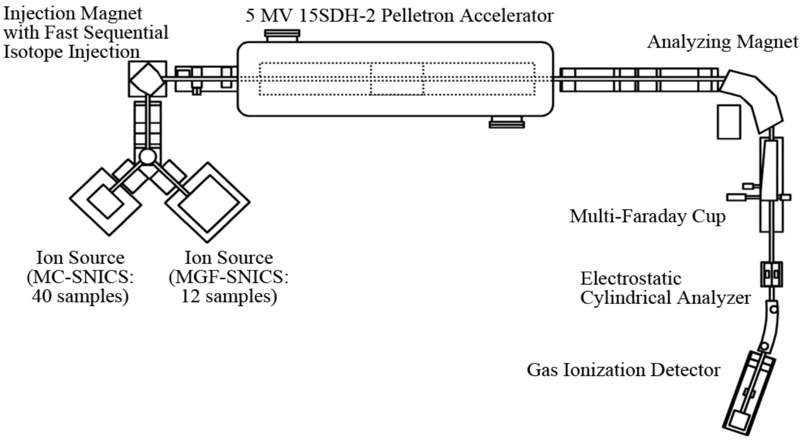

Fig. Schematic diagram of the AMS in JAEA-AMS-TONO

Future prospects of the 6 MV AMS project at the University of Tsukuba

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Keyword: New AMS facility; 6 MV AMS; Research project; Multi-nuclide AMS

A new AMS system has been designed and constructed at the University of Tsukuba after the Great East Japan Earthquake [1]. The AMS system consists of the 6 MV Pelletron tandem accelerator, two 40 multiple cathode AMS ion sources (MC-SNICS), a dedicated AMS beam line and a rare particle detection system. The 6 MV Pelletron tandem accelerator will also be applied to nanotechnology science, IBA, heavy ion irradiation, nuclear physics and so forth. We will introduce a CO_2 gas introduction system for one of the two MC-SNICS ion sources for ^{14}C-AMS. The magnets at the high energy side have a mass energy product of $ME/Z^2 = 176$ amu MeV. A 22.5° electrostatic cylindrical analyzer (ECA) with a 3.8 m radius is provided to filter out unwanted ions. The ECA has a resolution of E/ E = 200. The rare particle detection system with a five-electrode gas detector is provided to measure the rate of energy loss in the gas for each particle entering the gas detector chamber. Differences in the energy loss rate for different ions are used to discriminate between counts from the rare isotope of interest and counts from interfering ions that enter the gas detector chamber. The rare particle detection system will be capable of measuring environmental levels of long-lived radioisotopes of ^{10}Be, ^{14}C, ^{26}Al, ^{36}Cl, ^{41}Ca and ^{129}I. The 6 MV AMS system is also expected to measure other nuclides such as ^{32}Si, ^{90}Sr, and so on.

The construction of the 6 MV AMS system is scheduled in the spring of 2014. Beam delivery will start in September 2014. In this presentation, the status of the 6 MV AMS project and the research program at the University of Tsukuba will be introduced.

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Present status of YU-AMS system

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Keywords: *AMS; Carbon-14*

Accelerator mass spectrometry (AMS) is a method of measuring extremely low ratios of isotopes in a very small sample of less than 1 mg. In particular, AMS measurements for ^{14}C, which has a half-life of 5700 ± 30 years, have been widely utilized for radiocarbon dating in various fields such as archaeology, environmental science, geology, and space and earth sciences. In 2009, Yamagata University (YU) installed an AMS (YU-AMS) system as shown in Figure 1 [1,2], this is a Pelletron accelerator (1.5SDH-1) developed by National Electrostatics Corp. The system consists of 40 samples of a multicathode negative ion source by cesium sputtering (MC-SNICS) so as to convert the sample to negative carbon ions, a 45° electrostatic spherical analyzer (ESA), a 90° bending magnet with a biased chamber for sequential injection, an acceleration tube (NEC 1.5 SDH-1), a 90° analyzing magnet, off-set Faraday cups for measuring ^{12}C and ^{13}C beam currents, a 90° ESA, and a solid-state detector for counting the ^{14}C beams. About 240 s was required for one measurement with a cycle repeat rate of 10 Hz. Since the 45° ESA is rotatable, it is possible to install a second ion source on a spare port at a position 90° from the first one. If there are multiple samples to be measured, the ion source can be made ready for the subsequent measurement by setting the samples in a chamber and evacuating it while the other source is being used for AMS measurement. Hence, this system can shorten the entire measurement time. Currently, we are planning to install a second new ion source by March 2013. An automated graphitization line was also installed at the same facility for sample preparation. Figure 2 shows the system. The system consists of an elemental analyzer (EA Vario MICRO Cube, Elementar), a stable isotope ratio mass spectrometer (IRMS, IsoPrime), and an automatic cryogenic CO_2 trapping system. This AMS system is the first AMS system installed in a university in the Tohoku-Hokkaido region of Japan. The facility also provides radiocarbon dating for samples from other universities, institutes, and public organizations.

Performance tests of the YU-AMS system were carried out by measuring the C series standard samples (C1 – C9) and HOxII provided by IAEA and NIST, respectively. The precision of ^{14}C measurements for the standard samples is typically higher than 0.2%. Long-term stability more of than one year was demonstrated by carrying out the periodic measurement of standard samples C6 and C7 of IAEA. We evaluated the YU-AMS system by comparing the ^{14}C ages of Japanese tree rings having dendrochronologically determined calendar ages with calibration data.

In the medical and pharmaceutical fields, microdosing studies using AMS measurements of ^{14}C have been attracting considerable attention for drug development. The microdosing study is used to predict the pharmacokinetics of new drugs by labeling them with ^{14}C and then administering them to human volunteers [4]. However, there are few AMS facilities in Japan for conducting measurements of the samples obtained from microdosing studies. To satisfy the requirement of ^{14}C AMS for microdosing and medical studies as well as those of radiocarbon dating, we also carried out some performance tests using control serum, normal human serum, and a ^{14}C-labeled drug (Oxaliplatin). In this paper, we describe the status and approach of the YU-AMS facility.

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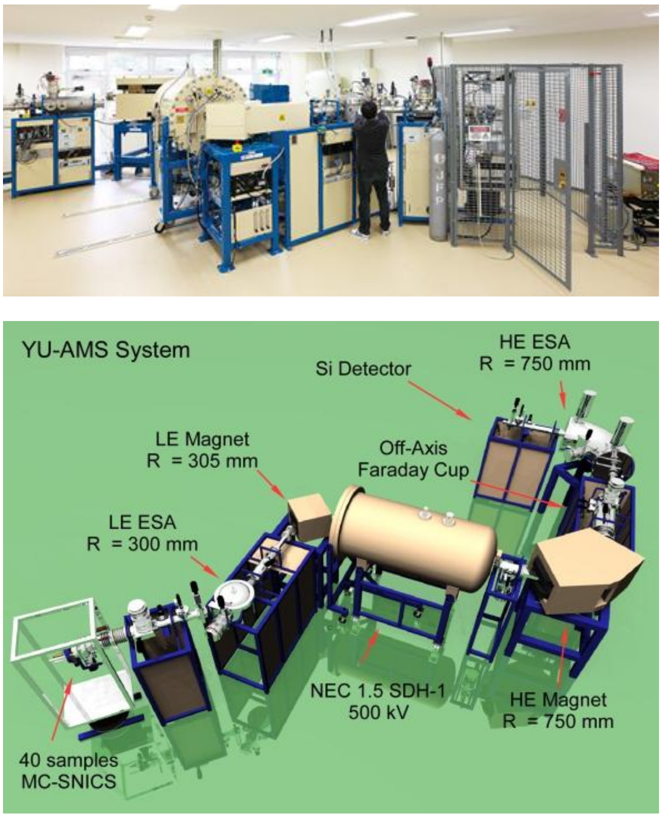

Fig.1 Photo and schematic view of YU-AMS system. The ion source is placed at a 45° angle to allow possible future expansion with an additional ion source.

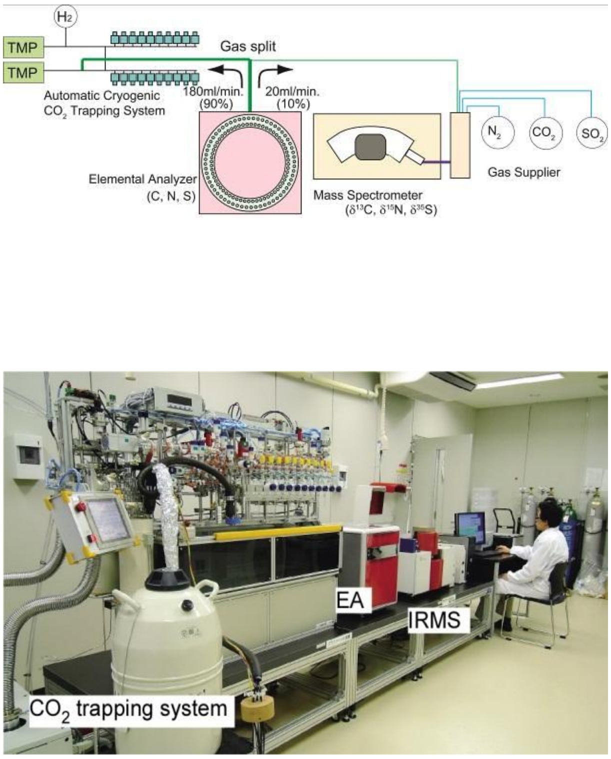

Fig.2 Schematic view and photo of automated graphitization line. The system consists of an elemental analyzer (EA Vario MICRO Cube, Elementar), a stable isotope ratio mass spectrometer (IRMS, IsoPrime), and an automatic cryogenic CO_2 trapping system.

The 6 MV AMS facility at KIST

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Keywords; KIST Tandetron, AMS, Background level

A new 6 MV Tandetron accelerator was commissioned at Korea Institute of Science and Technology (KIST) in February 2013. The system is equipped with two SO-110 Cs^+ sputter ion sources and a beam line for accelerator mass spectrometry. There are two additional plasma ion sources for use with three in-house designed beam lines that were added to extend the applications of this 6 MV system. During the commissioning period, we tested the basic operation performance of the system, the high voltage terminal stability and endurance, and the beam current extraction capabilities of the ion sources. In particular, the AMS background limits were assessed by comparing reference samples for the major six radioisotopes - C-14, Be-10, Cl-36, Al-26, Ca-41 and I-129. In this presentation we will report the results of the initial performance tests performed in February and compare those of the other recently installed 5~6 MV systems [1-4].

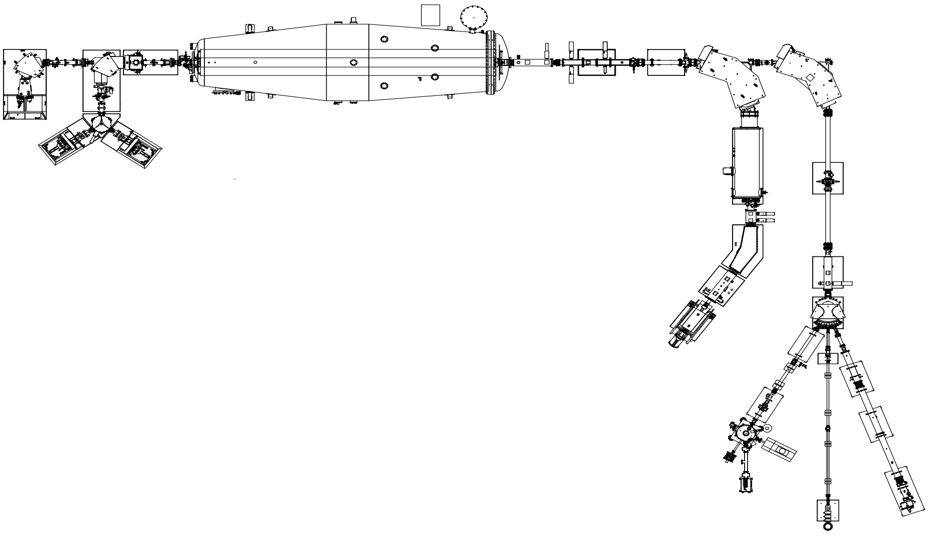

Figure 1 Layout of KIST 6 MV Tandetron

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ORAL PRESENTATIONS

2. AMS TECHNIQUE DEVELOPMENT

A preliminary study on 41Ca-AMS technology for early diagnosis of cancer bone metastasis

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Keywords: AMS; early diagnosis; bone metastasis

The annual incidence of new cancer patients in China is about 2 million, 50-60% of which will end up with bone metastasis. The bone metastasis of cancer usually causes a variety of bone-related events, such as the pathological fracture, malignant hypercalcemia and bone marrow infiltration, which lead to the shortened median survival time (8-10 months) for the metastasis patients. So, profound study on the mechanism and early diagnosis of cancer bone metastasis are very significant for the prevention and treatment of bone metastasis and the improvement of the survival rates for cancer patients.

Due to their limited sensitivities, traditional methods in early diagnosis of bone metastasis of cancer cells do not work very well. In order to monitor the processes of bone metabolism and early detection of bone metastasis of cancer cells, a technique of 41Ca isotope tracer combined with highly sensitive accelerator mass spectrometry will be developed and applied in the study on the bone metastasis of cancer cells by mouse simulation. Taking the advantages of high sensitivity, fast analysis speed, and small sample size requirement, the 41Ca-AMS technique developed in this work is expected to provide an important scientific basis for the early diagnosis, prevention and treatment of bone metastases of cancer cells in clinical medicine.

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Expanding the applications of AMS: A low energy instrument for isobaric interferences and new research areas at KIST

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Keywords: AMS, radiofrequency quadrupole, ^{36}Cl, ^{41}Ca, $^{135/137}$Cs, ^{182}Hf, ^{90}Sr, instrumentation, collision cell, ion gas interactions

Although accelerator mass spectrometry (AMS) is a very powerful analytical technique for detecting rare radionuclides and has become popular across the world, it is generally limited to a narrow range of radionuclides because of the background from isobaric interferences. Solutions to reducing isobaric interferences and ion beam kinetic energy spreads in mass spectrometry (MS) using low kinetic energy ion-gas interactions in radiofrequency quadrupoles (RFQ's) were described by Douglas [1] and Douglas and French [2]. They were subsequently adapted to many MS systems. More recently, such approaches have been applied to AMS.

Proof-of-principle studies have indicated such RFQ based techniques could make routine analyses of ^{36}Cl and ^{41}Ca possible at 1 MV, and open new isotopes to routine AMS analysis at < 3 MV, including ^{90}Sr, $^{135/137}$Cs, ^{182}Hf, ^{238}Pu [3-8]. Large AMS systems could also benefit from the lower background. For example, 6 MV tandem accelerator AMS systems typically have a lower ^{41}Ca/Ca limit of ~ 10^{-15}, which is near modern levels. Lowering the background by 3 orders of magnitude (a method for > 4 orders of magnitude attenuation of the K interference was described in [5]) would be roughly equivalent to age dating capabilities over 1 million years before present. The potential for novel studies in physical chemistry has also been demonstrated [4].

Currently, an RFQ instrument to facilitate ion-gas interactions at low kinetic energy is under development for installation in the recently commissioned 6 MV AMS system at Korea Institute of Science and Technology (KIST). It consists of 3 RFQ collision cell chambers and a novel deceleration region. Simulations using the modeling software SIMION indicated 100% acceptance for a 35 mrad ion beam with a Gaussian kinetic energy distribution of $\sigma = 8$ eV. For Cl^- ions incident on He gas, assuming a centre of mass electron detachment threshold of 7 eV [9], 100% acceptance was maintained. However, only 98% acceptance was achieved when using CH_4 as the initial collision gas, assuming the centre of mass electron detachment threshold to be the electron affinity of Cl (3.61 eV). In the case of a mass 98 amu anion (e.g. $^{41}CaF_3^-$), only taking electron detachment from a single collision into account (e.g. not accounting for dissociation due to induced vibrational modes and the excitations during multiple collisions), 100% acceptance was achieved in both He and CH_4. Design considerations and simulation results will be discussed.

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Carbon in clay minerals: radiocarbon results from stepped-combustion experiments

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We report here on recent developments using the stepped-temperature combustion method for the analysis of carbon in pure clay minerals and in the very fine (<64 μm) size fraction of sediments. We present new ^{14}C data from clays and marine sediments measured at different temperatures. These results are compared with published results from a wide range of sedimentary environments.

Experiments employing the stepped-temperature combustion method have shown repeatedly that two distinct organic compounds can be isolated by combustion at different temperatures. Most of the work to date has focused on a low temperature fraction (LT) <400°C and a high temperature fraction (HT) >400°C of oxidized carbon in sieved sediments. In order to refine the method we have: 1) studied the reproducibility of the technique by making measurements on samples from the same stratigraphic horizon; 2) expanded the number of temperature steps used to extract carbon to improve temperature resolution; 3) utilized X-Ray diffraction to determine which clay minerals are present in a particular sample; 4) performed stepped-temperature combustion experiments on pure clay minerals; 5) developed a pretreatment technique to isolate clay minerals from the sediments; and 6) constructed and tested a new dedicated stepped-temperature combustion line for samples of this type. Results from these efforts will be presented in this talk.

Various peaks near carbon peak in E-ΔE spectrum of ionization chamber

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There are various peaks near carbon peak in E- ΔE spectrum of ionization chamber. These peaks sometimes interrupt counting the number of carbon peak. Therefore for exact measuring $^{14}C/^{12}C$, various peaks near carbon peak in E- ΔE spectrum need be identified. Typical peak interrupting carbon peak are from $^{7}Li_2$. Other candidate peaks which can interrupt carbon peak may be from N and ^{13}CH. For clarifying N, I used samples composed of Si_3N_4, Mg_3N_2 and Si. After comparing between spectrums of carbon standard sample and Si_3N_4, Mg_3N_2 and Si sample, we could find negative nitrogen peak in the area near ^{14}C peak in E-ΔE spectrum of ionization chamber. The peak positions are also similar to those of simulation using SRIM software. Additionally we can see Si peak in E-ΔE spectrum of ionization chamber.

ORAL PRESENTATIONS

3. CARBON-14 APPLICATION
EARTH AND ENVIRONMETAL SCIENCE

AMS Chronology Applied on the Spaio-temporal Variations of Sedimentation Rate in Korea since MIS 3

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Radiocarbon dating by AMS is a robust tool for geoarcheology and geology since 50ka in Korea. In principle AMS radiocarbon ages represent times ellapsed after the cessation of organic metabolism. In actual situation radiocarbons as datable materials may be influenced by various media of carbon transferring-process in the various land surfaces, pedogenical and sedimentological processes, as well as anthropogenic interferences. This means that radiocarbon ages may imply not only the chronology of radiocarbon decay-history, but reflect various geochronological bias indicative of various secondary surface processes. In this paper database of spatio-temporal variations of Sedimentation Rate(SD), as an example of bias, reveals that the older the sedimentary deposits (since MIS 3) in Quaternary geological profiles, the smaller the SD, and the thicker the sedimentary deposits (> 5m), the larger the SD in general; The SD of terrace deposits are smaller than those of flooding, tidal or wetland deposits in general. Lastly the SD of anthropogenic sediments also shows conspicuously higher than those of sedimentary deposits as the natural process.

Marine radiocarbon reservoir effect along the north-eastern coast of Australia during the Holocene

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Keywords: AMS, radiocarbon, marine reservoir effect, corals, South-Western Pacific

Radiocarbon dating of surface ocean samples involves estimates of marine radiocarbon reservoir effect (e.g., marine reservoir age (R) and correction (ΔR)). These values for a given location are generally assumed to be constant with time when calibrating marine ^{14}C ages. However, recent studies have reported large variability in the marine radiocarbon reservoir effect of several hundred to a couple of thousand years for various regions in the Pacific, Atlantic and Mediterranean during the Late-glacial and Holocene (Siani et al., 2001; Bondevik et al., 2006; Burr et al., 2009; Hua et al., 2009; Yu et al., 2010; Ortlieb et al., 2011; Sarnthein et al., 2011). These variations result from changes in ocean circulation and the carbon cycle associated with climate change.

In this paper we present an investigation of possible variability in the marine radiocarbon reservoir effect along the north-eastern coast of Australia in South-Western (SW) Pacific during the last 8000 years. This study aims to get a better understanding of ocean circulation changes associated with climate change for the study area during the Holocene and to improve radiocarbon dating of marine samples.

Coral samples used in this study, including *Acropora* sp., *Goniostrea* sp., *Platygra* sp., *Favia* sp. and *Porites*, were from shallow cores and storm-uplifted blocks collected on Heron Reef (23°26'S, 151°55'E) in southern Great Barrier Reef and Moreton Bay (27°36'S, 154°40'E) in southern Queensland, Australia. Surface waters at the two study sites are mainly derived from the East Australian Current, which originates from the southern branch of the South Equatorial Current. These samples were screened in order to select pristine corals for Th/U dating and ^{14}C analyses. They were checked for deleterious diagenetic products such as calcilte, cements and extensive bioerosion using Scanning Electron Microscope. The other selection criteria included initial δ^{234}U within 5‰ of accepted seawater values and high initial ^{230}Th/^{232}Th values.

A total of thirty six unaltered coral samples containing 3-10 years of growth were analysed for ^{230}Th/U and ^{14}C. ^{230}Th dates, which reflect the absolute ages of the corals, were determined by TIMS and MC-ICP-MS in the Radiogenic Isotope Laboratory at the University of Queensland with a precision better than 0.5% (2σ). Sub-samples 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 AMS ^{14}C analysis is <0.4% (1σ).

Our results indicate that there are no significant R variations for the SW Pacific during the last 5 ka. However, large R variability of up to 500 ^{14}C years for this region is evident for the period 5-8 ka. The timing of significant R variations for the SW Pacific is very similar to that for Papua New Guinea (Edwards et al., 1993; McGregor et al., 2008), the South China Sea (Yu et al., 2010) and southern Peru – northern Chile (Ortlieb et al., 2011), indicating that these variations may not be due to local factors only. Changes in the intensity of ocean upwelling in South-Eastern Pacific, the sources of these upwelled waters and large variability in large-scale ocean circulation might be responsible for large R variations across the Pacific Ocean during 5-8 ka.

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^{14}C ages of TOC in the BIW08B sediment core from Lake Biwa, Japan

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Keywords: ^{14}C, TOC, Lake Biwa sediment

Lake Biwa sediments contain a continuous and high-resolution record of climate and environment changes during the last 430 ka. A 100-m long sediment core (BIW08B) was taken from the central part of Lake Biwa in 2008. In order to reconstruct a high-resolution climate and environment changes in East Asia and compare with proxy record in other regions, a reliable chronology of the BIW08B sediment core is necessary.

The chronology of the lake sediment core for the past 50 ka has been generally constructed using ^{14}C ages of terrestrial plants such as wood fragments, seed and leaves. However, few terrestrial plants are contained in the BIW08B sediment core. Up to now, we obtained only four ^{14}C ages of terrestrial plants. We need to improve the chronology to interpret the high-resolution records from the BIW08B sediment core. In the case that few terrestrial plants are contained in the lake sediment core, the chronology of the lake sediment core has been constructed using ^{14}C age of total organic carbon (TOC). There is often the offset between ^{14}C age of terrestrial plant and TOC in the same layers because TOC is the mixtures of aquatic organic carbon and terrestrial organic carbon.

Bertrand et al. (2012, Quaternary Geochronology, 12, 23-29) introduced a method to correct ^{14}C age of TOC with C/N ratio of TOC which was related to the contribution of terrestrial organic carbon at four sites in Northern Chilean Patagonia. However, it is unclear that this method is applicable to the BIW08B sediment core because lake environment completely different.

To construct the chronological framework of the BIW08B sediment core, we examined the C/N-based correction of TOC ^{14}C age data from the BIW08B sediment core.

Precise AMS radiocarbon dating of Japanese tree rings from 4th to 7th century AD.

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Keywords: tree ring; radiocarbon; AMS; calibration; regional effect

Radiocarbon measurement of Japanese hinoki cypress obtained at Miyada-mura village, Nagano Prefecture, Japan, has been carried out. Although the decadal measurement of the same sample was already reported (Sakamoto et al., 2003), the accuracy was not satisfied. Ozaki et al., (2009) accumulated radiocarbon data of this period using the building wood of Horyu-ji temple, however their statistical errors made difficult to understand the regional effect in comparison with IntCal calibration curve.

Courtesy of Prof. Nakatsuka and Dr. Xu of Nagoya University, sample preparation was processed as follows. A 10cm length, 1cm width and 1mm thick of butt end were cut off using a low-speed diamond wheel saw. The sample plate was put between Teflon perforated sheets and bleached by chlorine. After treatment of concentrated aqueous sodium hydroxide to remove hemicellulose, acidification and neutralization, the sample was put into toluene-ethanol solvent not only to remove lipid or resin but also prevent from shrinking during drying process. The prepared tree rings were cut into five years each under the stereomicroscope. Graphitization and radiocarbon measurement were carried out by Paleo Labo. Co. Ltd., Japan. The statistical error was around 20 ^{14}C yrs.

Although there seems to be a small offset to older age in general, radiocarbon ages of Miyada-mura tree rings were almost in good agreement with IntCal calibration curve. However, obvious anomalies can be found around AD 500 and middle of 7th century AD. The latter coincide with the calibrated age of plant remains in wall clay of Naniwa-no-miya palace, Osaka, Japan established in the middle of 7th century AD (Sakamoto et al., 2012). And the former explains well that the human bone excavated at Imdangdon tombs, Jingshan, Korea agrees well with archaeological observations (Sakamoto et al., 2013), suggesting that this anomaly might be extended in East Asia.

^{14}C anomaly in Japanese tree rings seems to link to the wiggle of calibration curve, that is, the variation of ^{14}C concentration of northern hemisphere. There is a certain offset at the plateau and overshooting during the curve goes upward, that is, ^{14}C concentration decreases in time while little anomaly at the steep slope.

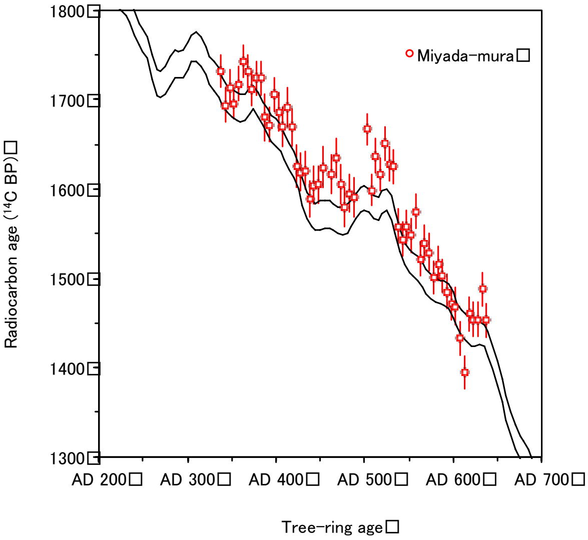

Fig. 1 Radiocarbon ages of Miyada-mura tree rings comparing to IntCal09.

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Paleoclimatic changes on the southern Tibetan Plateau after the Last Glacial Maximum recorded in Lake Pumoyum Co, and its implication for the Southwest monsoon evolution

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Keyword: southern Tibetan Plateau; lake sediments; multi-proxy analysis; ^{14}C dating; Southwest monsoon

The paleoclimatic changes on the southern Tibetan Plateau (TP) after the Last Glacial Maximum (LGM) were studied by multi-proxy analysis, including pollen, aquatic plants, TOC, $\delta^{13}C_{TOC}$, grain size (sands), and Ca-carbonates of three sediment cores from Lake Pumoyum Co (28°33'N, 90°24'E, 5,030 m a.s.l.). AMS ^{14}C dating has been applied to these sediment cores [1]. The following paleoclimatic characteristics of the southern TP were suggested by comparing the multi-proxy data with the paleoclimatic records (mainly paleobotanical records [2], [3], [4]) from various regions within the Southwest (SW) monsoon domain on the TP.

1) Soon after the LGM, the deglaciation in the southern TP had already started at 18.5 cal ka BP and more actively increased after 16.5 cal ka BP with the periodic hydrological circulation in a 1,170 year cycle on the basis of increase in sands (5 to 45 %) from 18.5 cal ka BP, continuous increase in Artemisia pollen (Alpine steppe, 30 to 60 %) and decrease in Chenopodecea pollen (Alpine desert, 30 to 5 %) after 16.5 cal ka BP, and the periodic variations (1,170 year cycle) of sands.
2) An abrupt increase in humidity occurred at 15.0 cal ka BP on grounds of the lake level rising and expansion of Alpine meadow inferred from sudden decrease in Ca-carbonates (4 to 1.5 %), aquatic plants (40 to 1 %), $\delta^{13}C_{TOC}$ (-16 to -23 ‰), and increase in Cyperacea pollen (Alpine meadow, 10 to 20 %) regardless the reduced the SW monsoon intensity in the stalagmite $\delta^{18}O$ records from the western Himalaya [5]. The climate amelioration in the southern TP started from 15.0 cal ka BP several centuries earlier than other regions of the TP [2], [3]. And then the humidity sharply increased over the Bølling/Alløred period (14.7–12.9 cal ka BP) by the SW monsoon evolution results of continuous increase in Cyperacea (15 to 30 %), decrease in Ca-carbonates (15 to 0 %), and the SW monsoon intensification in the western Himalaya [5].
3) Unlike the paleobotanical records in many regions on the TP [2], [3], [4], the southern TP experienced almost no impact on Younger Dryas event, and also other major dry/cold reversals, such as Heinrich event-1, the 8.2 ka event, the humid conditions remained relatively unchanged based on Cyperacea and Ca-carbonates data.

4) The SW monsoon intensity in the southern TP reached at a maximum between 10.8 and 10 cal ka BP in the past 19 ka judging from the highest level of Cyperacea (45 %) and undetectable Ca-carbonates.
5) The Holocene climate optimum in the southern TP lasted from 11.4 cal ka BP until 2.5 cal ka BP, and was characterized by the earliest start timing and latest end timing within the SW monsoon domain on the TP on the basis of abrupt increase in Cyperacea (30 to 45 %) from 11.4 cal ka BP, increase in Ca-carbonates (1 to 5 %) at 2.5 cal ka BP, and duration of the Holocene climate optimum in the various regions on the TP [2], [3], [4].

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ORAL PRESENTATIONS

4. APPLICATION OF LONG HALF-LIFE NUCLIDES

In situ cosmogenic nuclides ^{10}Be and ^{26}Al exposure ages of fluvial terraces, at the mountain front of the Qilian Shan

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Keywords: Fluvial terraces; ^{10}Be and ^{26}Al; Qilian Shan

Exposure dating, based on in situ cosmogenic nuclides ^{10}Be and ^{26}Al, as a dating technique, is widely used in geoscience researches. Firstly we optimized the experimental procedures for sample preparation through the systematic conditional experiments. Then we chose two international comparative samples using our improved sample preparation method. Our results show that the exposure dating in our lab gives good agreements with the published data [1], and demonstrate the reliability of the improved exposure dating method.

On the basis of the above, we focused on the exposure dating of the three fluvial terraces, at the mountain foot of the Qilian Shan (39°26′N, 98°41′E), the northeastern margin of the Tibetan Plateau combined with the field investigation. The exposure dating gave ages of fluvial terraces in Jinfosi site: 55.7±5.2 ka for T3, 11.0±1.0 ka for T2 and 7.3±1.0 ka for T1. After we measured the height differences of each terrace, we could calculate the river incision rate from 0.76±0.10 $\mathrm{mm \cdot a^{-1}}$ at 55.7±5.2 ka to 13.24±2.19 $\mathrm{mm \cdot a^{-1}}$ at 11.0±1.0 ka at Jinfosi. Fortunately, our results show good agreements with that of fluvial terraces of Shiyou River determined by Hetzel *et al.* [2]. Because this is the first time for us to do the exposure dating, more work need to be done in the future.

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Improvement of Catchment-wide Denudation Rate (CWDR) measurement by coupled in-situ cosmogenic ^{10}Be and ^{14}C abundances of riverine sediments: a case study from the Seti River, Nepal

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Keywords: Seti River; Lesser Himalaya range; Catchment-wide denudation rate, in-situ cosmogenic nuclide ^{10}Be and ^{14}C

The Himalayan–Tibetan orogen have built due to active plate collision and therefore uplift rate, denudation rate and sediment influx have measured for understanding landform formation of this area via various method. Moreover, precipitation data of high mountain ranges show that precipitation gradients are influenced by topographic effects and therefore the Himalayan-Tibetan orogen is a effective barrier of moisture wind. Relation between tectonic setting and climate variation in the mountain area could be explained by denudation rate.

Catchment wide denudation rate(CWDR, 10^2-10^3 yr) measured cosmogenic nuclides in fluvial sediment have used widely, because it constrains denudation rate at intermediate time scales between thermochronological data (10^5-10^6yr) and sediment discharge (10^0-10^1yr). Single nuclide in quartz – commonly 10Be – have used for measuring CWDR in order to document denudation rates and sediment flux at the basin wide scale. However denudation rates, determined from floodplain samples, only accurately reflect partial streams which have not effected by high magnitude/low frequency event or inflow of plenty of burial sediment. In this research, we tried to explain Seti river CWDR using ^{10}Be concentration, however there will be coupled with state-of-the art of in-situ ^{14}C result. We suggest multiple nuclides analysis method which use in situ ^{10}Be and in situ ^{14}C extracted by KU-KIST in situ ^{14}C extraction line can help application of CWDR method to diverse streams as consideration of exceptional assumption.

The Seti river collects water from the Mardi khola (khola means small river) and upstream of the Seti khola. The Seti River is a trans-Himalayan river near the Pokhara in central Nepal. With headwaters on the southern edge of the Tibetan plateau, it flows into the monsoon-soaked Lesser Himalaya. The Mardi confluence to the Seti river in northeasten of Pokhara. Two tributaries of the Seti River show widely different condition of sediment evacuation: the Seti Khola is extensively covered by thick (up to a couple of meters) terrace deposits and wide valley form. A tragic flash flooding occurred in the Seti River of Western Nepal on Saturday 5 May 2012, and resulted in the death of more than 50 people and caused great loss of property. The flood occurred in Seti Khola (a tributary of the Seti River) originating from the east of Mount Machhapuchhre. Glacial cover of upper stream may have caused multiple high magnitude/low frequency event. The adjacent river, the Mardi Khola shows typical, V-shaped valley form with little fill terrace but a few of narrow, rock-cut strath terraces.

This research has double-folds. We can quantify the role High-Magnitude Low-Frequency event plays on the process of sediment evacuation via measuring CWDR in the Seti Khola due to collecting a pair of samples from 1~10 m thick sediment layer on the river bank and current river flood plain. Secondly, we can estimate the storing effect of the fill deposits such as terraces, alluvial fans, etc.

which is held for substantial time but has been poorly constrained in the catchment-wide denudation rates using single ^{10}Be or a pair of ^{10}Be and ^{26}Al. Total of 26 samples were collected for estimating the concentrations of a pair of in-situ produced cosmogenic ^{10}Be and ^{14}C in the riverine sediments. Especially we collected good samples effected by collapse of huge terrace from current river flood plain in the Seti river. Mardi khola data verifies CWDR error and establishes influence of tributary confluence. ^{10}Be result is depicted in the Figure 1. Base on the assumption of CWDR, ^{10}Be concetration increase to downstream, however the basin-averaged denudation rates show the nonlinear increase that is expected (e.g. Roering et al., 1999; Roering et al., 2007; Montgomery and Brandon, 2002; Binnieet al., 2007). Samples in upper Mardi and Seti have higher concetration than entire basin that is affected by non-correction of glacial cover effect, and recent rainfall pattern (Lupker et al, 2012). However except uppermost samples, other results relatively increase to downstream. Some low concentration in section of the Seti Khola might have affected by inflow of terrace sediment that can be interpreted by in situ ^{14}C concentration result (now in course of experiment).

Most of the present model of catchment-wide erosion rate using single cosmogenic nuclide of ^{10}Be tends to underestimate the effective denudation rate, because single nuclide of ^{10}Be with long half-life (1.36 Ma) is difficult to detect any change caused by burial shorter than the effective time scale of 10Be. However, the use of short halif-life (5.7 ka), in situ ^{14}C coupled with ^{10}Be makes us better quantify the time of storing in depositional systems which is less evacuated by the common, low energy fluvial condition but can be incorporated back into the active fluvial system. One of interesting things is wide range of ^{10}Be concentration measured sediment which is formed after catastrophic flood. During the field trip, we observed that height of flood sediment in several sections is oddly higher, although the heights of almost sediments are decreasing to downstream. Probably it is influenced by bottleneck phenomenon that cause water level to rise. It bring to local disturb of sediment and increasing of sediment amount in some area, and therefore it do not follow common expected result. Multiple nuclide method also constrains what element influences to scattering concentration result.


N
STRCW1 (742119)
STRCW1_1 (428319)
STRCW2 (800096)
STRCW2_1 (591328)
MDRCW1 (714422)
STRCW3 (462363)
STRCW3_1 (1355782)
STRCW4 (589257)
MDRCW2 (495712)
STRCW4_1 (648683)
MDRCW3 (529624)
STRCW5 (576097)
MDRCW4 (474547)
STRCW6_1 (373139)
MDRCW5 (494857)
STRCW7 (894623)
MDRCW6 (641541)
STRCW7_1 (771801)
STRCW8 (377914)
STRCW9 (434562)
STRCW8_1 (804356)
STRCW10 (487875)
STRCW11 (566948)
STRCW12 (653522)
0
2.5
5
10
km

AUTHIGENIC BERYLLIUM ISOTOPES OF SEDIMENTS FROM THE LAKE HOVSGOL FOR THE LAST 19,000 YEARS, MONGOLIA

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Keywords: Beryllium isotopes; Younger Dryas; Paleoclimate change; Lake sediment; Lake Hovsgol

Because of recent phenomena of the global warming and climate change, the most important things is to understand geological features on paleoclimatic and environmental change. Beryllium-10 has been frequently used to trace paleoclimatic and environmental change. It can help us to understand paloeclimatic and environmental change. For this study, a gravity sediment core HS-3(50°45′03″N, 100°20′11″″E, 1660 m.a.s.l) obtained from a south central part of the Lake Hovsgol in 2004 was used. A paleoclimatic signal of the Lake Hovsgol was investigated by authegenic beryllium isotopes from the 20 sediment samples. The beryllium isotopic records of this study show that there are three dry and cold periods as indicated as around 9,400, 12,700 and 17,100 cal. yr BP. The significant 10Be signal during the Younger Dryas period is found to be lower. This result indicates that the Lake Hovsogol area has a cold and dry condition with a minimum dust input to the lake, which appeared as a low 9Be. For warmer and wetter climatic condition, 10Be concentration was found to be higher and this also corresponds to the sedimentation record of this study. These climatic signals of the Lake Hovsgol similarly appear as a worldwide record of a decreased beryllium record for example Laguna Potrok Aike, 10Be concentration in sediment tends to increase during deglacial period. The authigenic elements as a function of age of the sediment also investigated in this study. These experiment results show that authigenic elements of Si, Al, Na, and Fe have a similar profile of Be, and Sr, Ca, Mg, and Mn have an inverse pattern of Be concentration profile. The results confirm that the Lake Hovsgol also experienced with the global paleoclimatic change associated with the Younger Dryas event around 12,700 cal yr BP. These results show that cosmogenic nuclide 10Be and stable isotope 9Be can be used in understanding paleoclimatic change with respect to the lake water level change and inflow of cosmogenic nuclide 10Be from atmosphere and 9Be from the land. A further investigation using worldwide lake records by the analytical technique of authigenic beryllium will be useful in understanding global paleoclimatic change pattern in conjunction with lake level change.

ORAL PRESENTATIONS

5. ARCHAEOLOGY AND GENERAL APPLICATION

Reconstruction of paleodiets in potteries using radiocarbon dating, stable isotope analysis and lipid analysis from Late to Final Jomon Periods, Atsumi Peninsula, Japan

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Keywords: Radiocarbon dating; Lipid analysis; Stable isotope; Paleodiet; Atsumi Peninsula

We studied AMS radiocarbon dates and lipids in pottery by GC-MS from the Hobi and Ikawatsu archaeological sites, from Late to Final Jomon Periods, Atsumi Peninsula, Japan (1400- 750 cal BC). Judging from the excavation of animal reminds and hunting tools, people in Atsumi Peninsula, especially at Hobi site rather than Ikawatsu site, depended on the open sea fishery and the hunting of the terrestrial animals from late to final Jomon Periods.

The measured AMS dating results of charred materials taken from the inner surface on potsherds (food origin) indicated marine reservoir effect. The results of stable isotope analysis together with the values of C/N ratios of the food residues possibly derived from marine products. By the lipid analysis using GC-MS, the ω-(o-Alkylphenyl)alkanoic acids with 16, 18, 20 and 22 carbon atoms were detected from potsherds at Hobi site, which are presumed to form during heating of triunsaturated fatty acids ($C_{16:3}$, $C_{18:3}$, $C_{20:3}$ and $C_{22:3}$) by pottery, commonly found in the tissues of marine animals. These results of the lipid and stable isotope analyses and the radiocarbon dating are consistent with the archaeological hypothesis that sea products were cooked in pots at the archaeological site, from Late to Final Jomon Periods, Atsumi Peninsula, Japan.

This work was partly supported by a Grant-in-Aid for Scientific Research (B) No. 25282072 & 22700845 (Y.M.) of the Japan Society for the Promotion of Science.

Determination of the fabrication ages of metal types by radiocarbon dating of “meok”(oriental black ink) stained on the type surfaces

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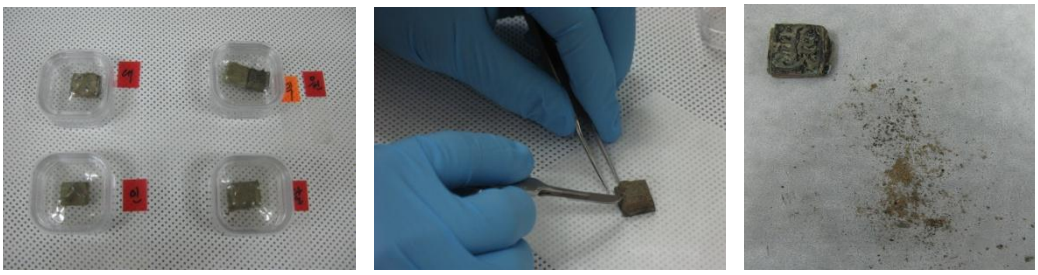
Printing technology using typeset is a cultural legacy of ancient Korean dynasties. Development of printing technology was started during Koryo Dynasty (918 – 1392 AD), and the technology becomes popular for Choseon Dynasty in the Korean history. Development of typeset technology made publishing innovatively easy because of the reusability of types. Jikjishimcheyojeol (直指心體要節, simply called Jikji), a publication related with Buddhism printed in 1377 AD, was known as the oldest publication printed using metal types, which is prior to the Gutenberg Bible by around 60 years.
Recently, several Korean media have reported that metal types to be thought to be older than Jikji were found. The metal types are thought to be used for another publication, Zeungdoga(證道歌), which was printed in 1239 AD. The fabrication age of the metal types was discussed. KIGAM tried to estimate the age of the metal types.

Since the metal types were made by a metal, it is hard to get carbon contents for radiocarbon dating from the samples. Since these samples were used for printing publications, “meok” was remained on the surface of the types, which was covered by dried mud for several types. “Meok” is oriental black ink made of soot of burning pine tree or plant oil.



Meok was collected from 12 samples, 悲, 佛, 大, 人, 源, 胱, 我, 等, 切, 令, 爲, 福, after removing of the surface mud. The carbon contents in the meok samples were higher than 60% except for three samples with very low carbon contents from 人, 源, 胱. Since meok from two of the samples, 令 and 爲, was not enough for the next process, meok from the two samples was added and treated as one sample. Collected meok samples were combusted in an elemental analyzer and CO_2 samples were converted to graphite. The graphite samples were measured by 1MV AMS system of KIGAM.

The youngest ages of the samples was calculated to be 798 ± 44 yrBP, of which the calendric age is ranged from 1160 AD to 1280 AD with 95% confidence level. This age means the growing date of the wood of the meok. And the fabrication date of the metal types is estimated older than 798 yrBP.

ORAL PRESENTATIONS

6. STUDY ON ANTHROPOGENIC NUCLIDES

Migration of iodine-129 in the ocean from the Fukushima Daiichi nuclear power plant accident after one year

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Keywords: Iodine-129; Fukushima Daiichi Nuclear Power Plant accident

The Fukushima Daiichi nuclear power plant (FNPP) accident released ^{129}I into the ocean [1]. Because of the long half-life of ^{129}I (1.57×10^7 y), the accident derived ^{129}I is useful for the oceanographic tracer to study the migration of radionuclide in the Pacific Ocean. In this study, the ^{129}I levels before the accident and after 1-7 months are reviewed [1], and then the migration of ^{129}I in a coastal and offshore region after one year is discussed.

Seawater samples were collected before the accident [1], after 1-7 months in a coastal region [1], after 13 months in the coastal region by the R/V *Tansei Maru* cruise and after 11 months in an offshore region by the R/V *Mirai* cruise. Iodine was extracted from seawater by the solvent extraction technique. Iodine isotopic ratios were measured by accelerator mass spectrometry at the Aomori Research and Development Center of the Japan Atomic Energy Agency.

The ^{129}I level in the western North Pacific before the accident (background level) is important to evaluate the accident-derived ^{129}I in the ocean. Between 32^{o}N and 44^{o}N, ^{129}I concentration in surface seawater before the accident had a distribution tendency with higher concentration at higher latitude, which was expressed as a linear function of latitude. At most stations, the ^{129}I concentrations after 1-7 months in the coastal region were higher than that of the background level. The highest ^{129}I concentration was 73 times higher than that of the background level. The ^{129}I concentration in surface water after 13 months in the coastal region was the same as the background level at all station except at a station P8 located in about 80 km south of the FNPP. The ^{129}I surface concentration at the station P8 was one order magnitude higher than that of the background level. Taking account for the salinity and temperature data, the surface seawater at station P8 originated from the Oyashio current region. These results suggest that the southward current along the coast clearly affected the distribution of ^{129}I in the surface water. The ^{129}I concentration in surface seawater after 11 months in the offshore region at the Oyashio and the Oyashio-Kurosio transition region was 2 and 1.5 times higher than that before the accident, respectively. Although the ^{129}I concentration in surface seawater at the Kuroshio region was the similar to that of the background level, the accident-derived ^{129}I was found at 400-500 m depth in this region. This is probably due to the isopycnal mixing along the $\sigma\theta$=26.0 - 26.2 which is outcropped around 38^{o}N.

[1]. Suzuki, T. et al., Biogeosciences, 2013. **10**: p.3839-3847.

Evaluation of Iodine-129 mobility in the contaminated soil around 30km from the Fukushima Dai-ichi nuclear power plant

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Keywords: Iodine-129; soil; AMS; Fukushima accident

I. INTRODUCTION

The Fukushima accident (on 11 March, 2011) released a large amount of radionuclide to the terrestrial environment mainly noble gasses and volatile radionuclide such as ^{129}I ($T_{1/2}$= 1.57x107y), ^{131}I ($T_{1/2}$= 8.01d) of which ^{131}I is absolutely essential radionuclide for the estimation of primary dose. Unfortunately the data on deposition amount and distribution pattern of ^{131}I in most contaminated area, is totally lacking because of its short half-life. However it can be reconstructed from the Fukushima-derived ^{129}I deposition amount [1]. For the correct reconstruction of ^{131}I, an identification of the Fukushima-derived ^{129}I in soil distinguished from that of previously existed is necessary, first. In addition the rate of vertical migration of the Fukushima-derived ^{129}I is also needed. From these points, the objectives of this study are to estimate accurately the Fukushima-derived ^{129}I inventory and to obtain quantitative information on the ^{129}I mobility in the upper horizons of a crop field soil from ^{129}I depth profile. A crop field is ideal because soil should have been tilled and well mixed by farmers to the depth of around 30cm until just before the accident. Therefore it is speculated that the crop field soil had been made homogeneous, so that the direct accumulation from the accident should be clearly observed.

II. RESULTS AND DISCUSSION

Four core were collected from almost the same position in Kawauchi village crop field 20 km apart from the Fukushima Dai-ichi nuclear power plant at different times between April 2011 and March 2012 to observe the temporal variation of depth profile of ^{129}I in soil. Clear enhancement of the accident-derived ^{129}I was observed and able to be fitted by exponential equation.

$$C(t) = C_0 e^{-x/\mu} \qquad (1)$$

The parameter [μ] appeared in eq. 1 is “relaxation length” and used for the evaluation of the ^{129}I penetration efficiency. The time variation of the relaxation lengths is shown in Fig. 1 It is shown that Fukushima-derived ^{129}I had been moving downward slightly. Transfer rate of Fukushima-derived ^{129}I estimated from Fig. 1 was estimated to be 1cm/yr.

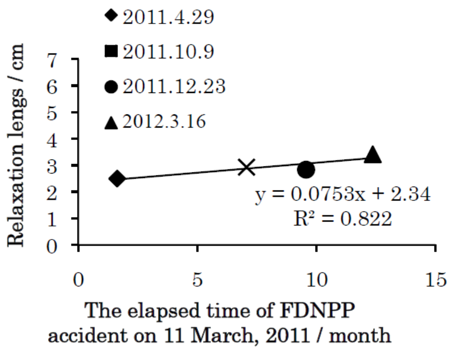

Fig. 1 Time variation of the relaxation lengths.

[1] T. Straume et al., Health physics, Vol. 91, pp7-19, 2006

POSTER PRESENTATIONS

1. STATUS REPORT AND NEW FACILITIES

The graphitization system for KIST AMS

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Keywords : AMS, graphitization, reduction, magnesium perchloate

Graphitization is one of the most important steps in radiocarbon dating using AMS. Usually the graphitization unit is big and complicated because of the liquid nitrogen feeding system for collecting carbon dioxide, and the low temperature system for removing moisture. The graphitization system at KIST is compact and very simple. It consists of 12 reactors, 3 liquid nitrogen feeders, and 4 gas supply lines. The reactor temperature can be controlled individually by 12 small 50W electrical furnaces and can be heated up to 800 ^{o}C. The KIST graphitization system has an inlet for an Elemental Analyzer to receive carbon dioxide and a storage bottle connector for gas phase samples. Magnesium perchlorate ($Mg(ClO_4)_2$) desiccant was used to remove moisture which is produced during reduction. Every reactor has a small pressure transducer to measure the internal pressure of its reactor. Pressure data are stored in a PC and displayed on a display monitor. Graphitization reactions are performed at 550 ^{o}C for 2 hours. The graphite on the iron catalyst was analyzed by EDS.[1-3]

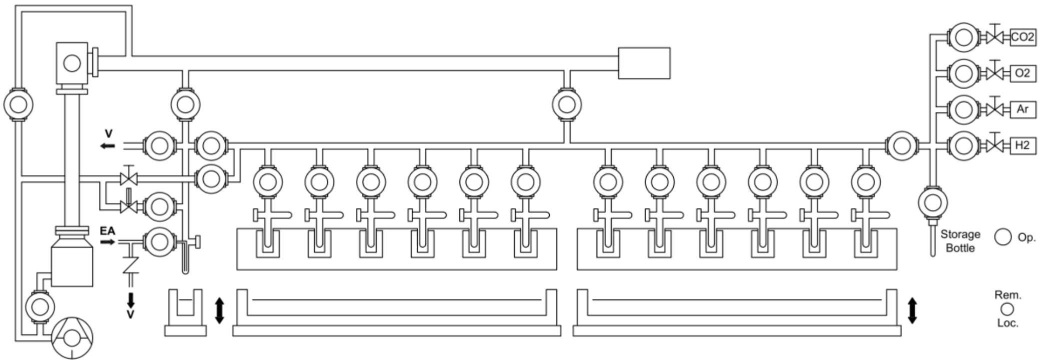

Figure. KIST graphitization system.

[1] T. Goslar, J. Czernik, *Journal of methods and Application of Absolute Chronology,* **18** (2000) 1

[2] M. Dee, C.B. Ramsey, *Nuclear Instruments and Methods in Physics research B,* **172** (2000) 449

[3] M.D Elia, L. Calcagnile, G. Quarta, C. Sanapo, M. Laudisa, U. Toma, A. Rizzo, *Nuclear Instruments and Methods in Physics research B,* **223** (2004) 278

Evaluation of radiocarbon contamination of the chemical treatment for age dating

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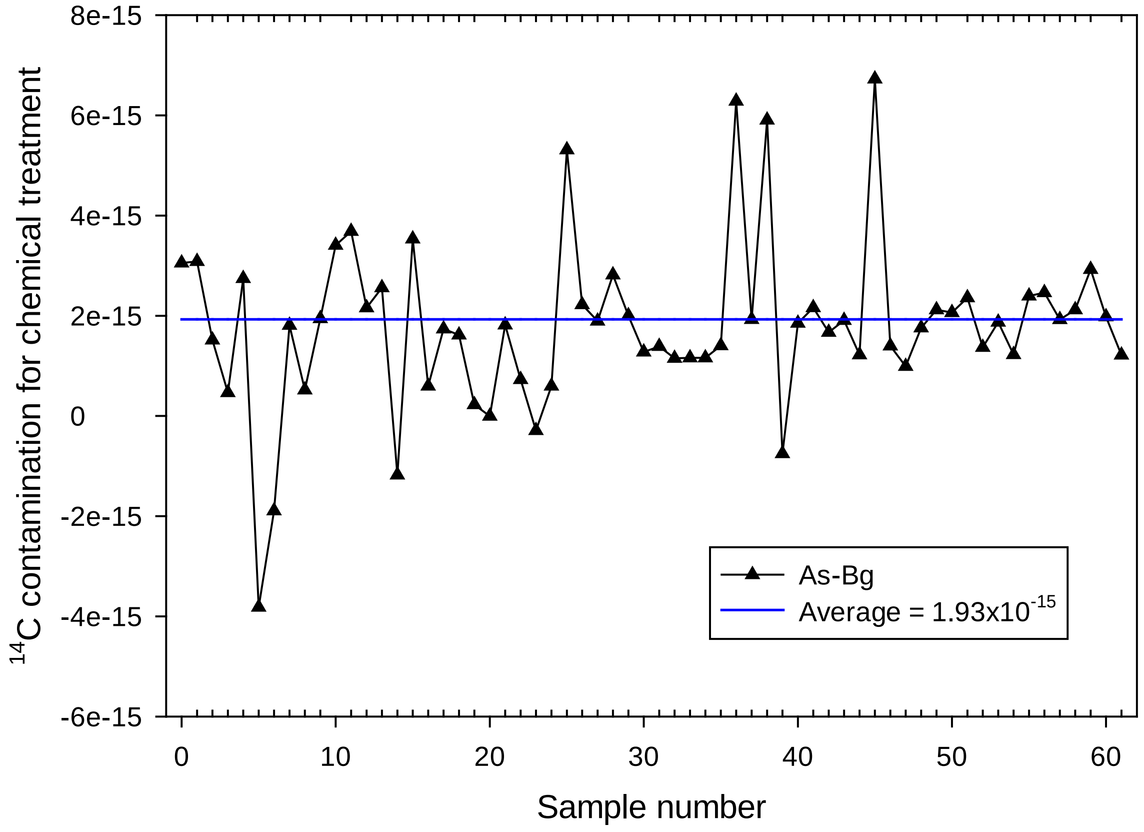
From sample collection to the chemical process for radiocarbon age dating, radiocarbon contamination can’t be avoided. Possibility of the contamination from the experimental stuffs such as not clean experimental tools, contaminated water and reagents, is always present. In order to evaluate the contamination during the chemical treatment, wood samples from Aso-san in Japan were treated by AAA method and alpha-cellulose extraction method and measured with a 1 MV AMS system of KIGAM, and compared with samples made of CO_2 gas extracted from petroleum, which does not contain any radiocarbon. Aso-san (阿蘇山) is the secondary largest active volcano in Japan. Aso-san samples with the age of about 100,000 years were discovered under an old volcanic ejecta layer.

For the AAA method, the Aso-san samples were treated for 30 minutes with 0.5M HCl and 0.1M NaOH followed by 0.5M HCl treatment. For alpha-cellulose extraction method, the samples were treated with 1:1 mixture of cyclohexane and ethanol and solution of 120 mg of $NaClO_2$ in 50 ml of 1 M HCl, purged with nitrogen gas in 12% NaOH solution and rinsed with 2M HCl. The samples after the chemical treatments were converted to CO_2 gas by combustion in an EA(Elemental Analyzer), and the CO_2 gas was transferred to an automatic reduction system. CO_2 gas was purified and reduced to graphite with Fe catalyst and hydrogen at the 620^{o}C. The radiocarbon ratios of the graphite samples were measured by AMS.

To evaluate radiocarbon contamination during the reduction and AMS measurement, CO_2 gas obtained from petroleum was transferred to the automatic reduction system and reduced to graphite with the same method as Aso-san samples. The radiocarbon ratios of the graphite samples from CO_2 gas were measured with the AMS system, and subtracted from Aso-san values.

Since Aso-san samples are treated with the chemical processes but CO_2 samples are not, the differences between the two samples mean the contamination for only the chemical pretreatment. The average values of $^{14}C/^{12}C$ ratios of 62 Aso-san samples and 62 CO_2 samples measured from 2,012 to 2,013 were found to be 4.54×10^{-15} and 2.74×10^{-15}, respectively. Figure shows the distribution of the deviation of the two values. The average of the deviations was calculated to be 1.93×10^{-15}. In the figure, around 84% of data points are distributed between 0 and 4×10^{-15}. Figure shows that the contamination for chemical process converged to the average value. This means increasing of stability of chemical treatment procedure.


^{14}C contamination for chemical treatment
8e-15
6e-15
4e-15
2e-15
0
-2e-15
-4e-15
-6e-15
0
10
20
30
40
50
60
Sample number
As-Bg
Average = 1.93x10^{-15}

Evaluation of radiocarbon contamination of the hydrolysis treatment of carbonate samples for age dating

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KIGAM installed hydrolysis preparation system to convert calcium carbonate, which is a major component of limestone, calcite, shells, and also barium carbonate samples to CO_2 gas for radiocarbon age dating. It is true that we are making efforts to reduce contaminations of samples for hydrolysis procedure in many ways. However, there is always existence for the possibility of contamination which bothers radiocarbon measurement. In order to evaluate the contamination during hydrolysis treatment, IAEA-C1 samples were treated by hydrolysis method, measured by 1MV AMS system of KIGAM, and compared with CO_2 gas from petroleum. Both samples are ^{14}C free materials. IAEA-C1 marble was produced from a slab of freshly cut Carrara marble and milled down to a dust free fraction of 1.6 - 5.0 mm diameter particles.

For treatment of a C1 sample by hydrolysis method, CO_2 dissolved in 1~1.5 ml H_3PO_4 acid was pumped out by an acid resistance pump for 1-1.5 hours. C1 samples reacted for 2~3 hours with the purified H_3PO_4 to be converted to CO_2 gas. CO_2 was reduced to graphite with Fe catalyst and hydrogen gas at the 620°C in reduction system. The radiocarbon ratios of the graphite samples were measured by AMS. To evaluate radiocarbon contamination during the reduction and AMS measurement, CO_2 gas from petroleum was transferred to the reduction system and reduced to graphite with the same method as CO_2 from the C1 samples. The $^{14}C/^{12}C$ ratios of the graphite samples from petroleum were measured by the AMS system, and subtracted from C1 values.

Average values of radiocarbon ratios of 11 C1 samples and 11 CO_2 samples were 2.84×10^{-15} and 2.60×10^{-15}, respectively. Figure 1 shows the distribution of the deviation of the two values. The average of the deviations was calculated to be 8.08×10^{-16}, which means the contamination of our hydrolysis system.

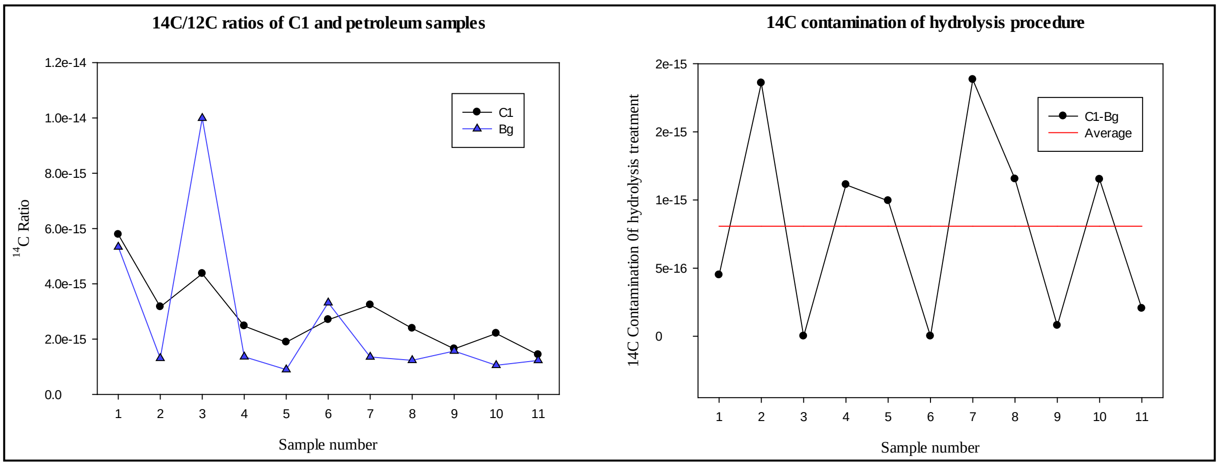

Figure 1 (a) $^{14}C/^{12}C$ ratios of C1 and petroleum samples, (b) ^{14}C contamination of hydrolysis procedure

Status report of NIES-TERRA: progress of 17 years' operation and perspectives for next decade

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Keywords: ^{14}C; ^{129}I, Chemical preparation; Environmental sciences; Compact AMS

The AMS facility (NIES-TERRA) at the National Institute for Environmental Studies has now been operating for seventeen years since 1996. The facility consists of a 5MV tandem Pelletron accelerator (NEC,15SDH-2) and a solid ion source with sequential injection system. Our main target is radiocarbon analysis in environmental sciences such as paleoclimate, carbon cycles studies, and atmospheric sciences, especially with development of various chemical applications such as compound specific ^{14}C analysis. Most recently we started measurement of ^{129}I as part of environmental studies associated with the Fukushima nuclear power plant accident. In 2014, a new compact AMS (NEC 0.5MV 1.5SDH-2) will join the NIES-TERRA. We expect a high precision ^{14}C analysis of background atmospheric CO_2 collected for past more than 10 years in global monitoring networks. For past 10 years, we see successful throughput of measurements about 1000 samples per year including standards except for temporal shutdown since the 2011 megaearthquake. To date our operational status is fortunately getting back to the condition before the shutdown. During the interval of the shutdown, the AMS system was refurbished by exchanges of a overall computer system for control and data acquisition for ^{129}I analysis and various hardware including a new power supply (Heizinger, co.ltd., Germany) of an analyzing magnet. However, recently we confirmed that the beam lines of the AMS (15SDH-2) was out of alignment by 3 mm between high and low energy system, which is most likely caused by the earthquake. This was seriously critical for ^{129}I analysis, although beam adjustment for^{14}C analysis could be done with high precision as in the previous analyses before the earthquake. We have improved our preparation laboratory by semi-automatic graphitization lines to increase sample throughput. CO_2 production and purification using a commercial elemental analyzer connected to a vacuum line were investigated. Two types of elemental analyzers with column separation and chemical trap were investigated for aerosol filters and soil samples. This newly designed graphitization system showed high precision and accuracy with around 0.5% and 50 kBP. In the conference, we also present the perspectives of our facility for next decade in the various fields of environmental science studies with new compact AMS.

Current status of the Compact AMS system at Paleo Labo Co., Ltd. (2013)

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Keywords: ^{14}C-AMS; Compact AMS

Paleo Labo Co. Ltd., a private company in Japan installed a compact ^{14}C-AMS system in November 2004. The system was designated as CAMS-500 (NEC, U.S.A.) and is based on a 500 kV Pelletron accelerator. It was designed very compact so that the beam tuning components are simple with only one Einzel lens, three steerers, one ESA (electrostatic analyzer) and two analyzing magnets (Fig.1).

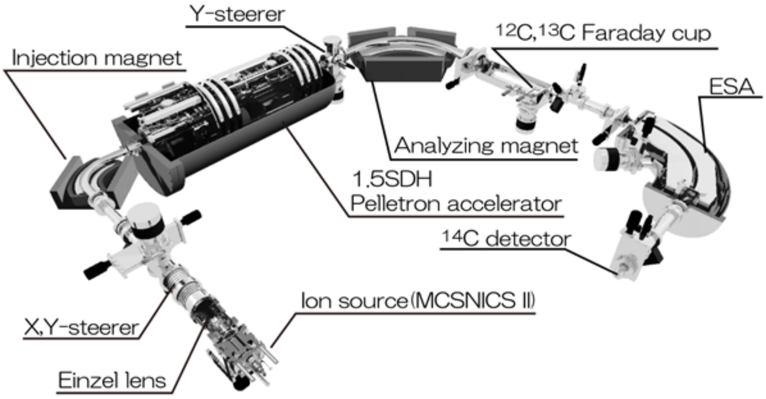


Fig.1 A schematic of the Compact AMS system.

In order to estimate every measurement, we simultaneously measure the standard samples of IAEA C1, C5 and C6. Fig.2 shows the results of standard samples measured during this one year. Average and standard deviation (1σ) of pMC value of each standard sample were 0.162 ± 0.037 (consensus value: 0.00 ± 0.02), 23.15 ± 0.21 (consensus value: 23.05 ± 0.02), 150.26 ± 0.28 (consensus value: 150.61 ± 0.11). These results also show very stable and high precision measurements**.**

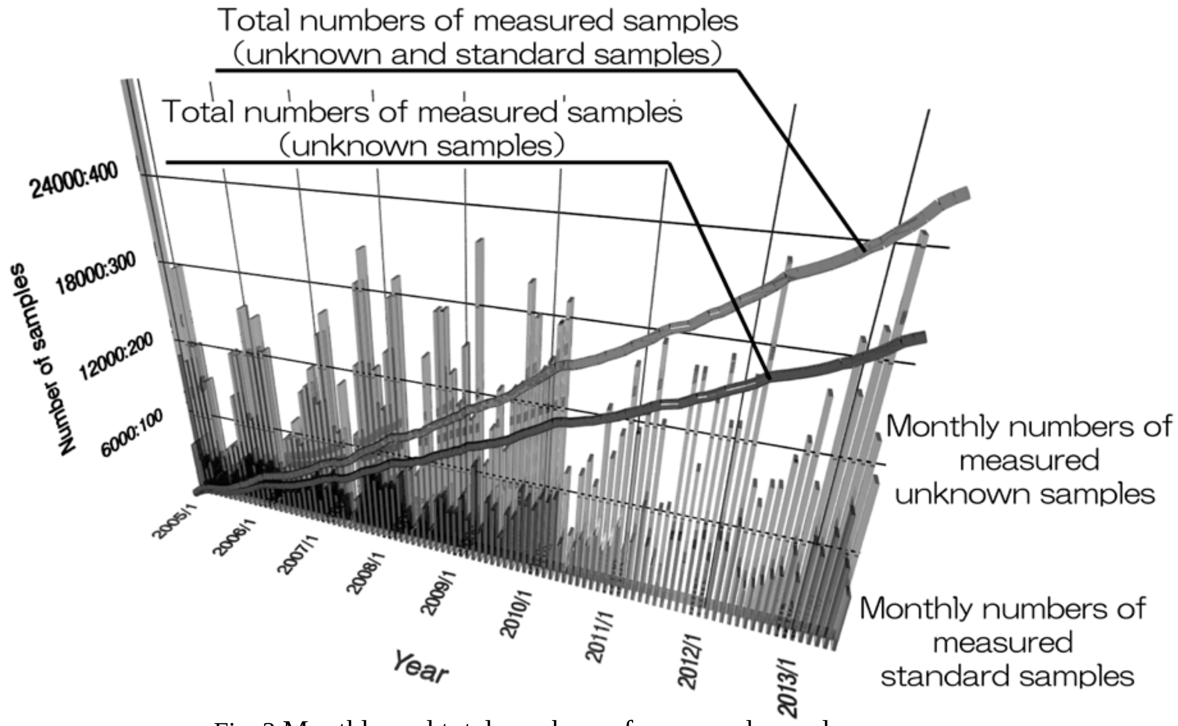
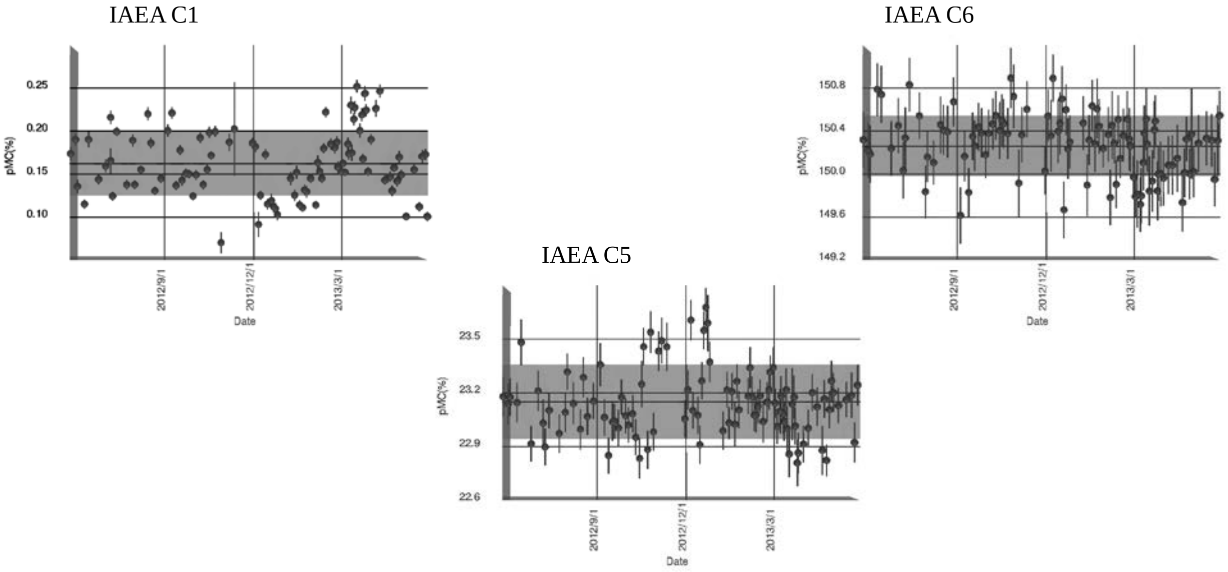


Fig. 3 Monthly and total numbers of measured samples.


IAEA C1

IAEA C6

IAEA C5

Fig. 2 The results of standard samples

Since its installation, a total of 27,010 samples (20,386 unknown samples and 6,624 standard and test samples) have been measured until the end of June 2013. Fig.3 shows monthly numbers of measured samples and the total samples measured by the end of the month after installation.

Soon after the huge earthquake and tsunami disasters occurred in Tohoku district of Japan on March 11, 2011, aid and support for researches on disaster histories were conducted by our company. Results of the researches have been widely published in academic journals. We report the current status of our AMS system.

Status of AMS laboratory of KIGAM including performance of a 1MV compact AMS system and a 24-line automatic reduction system

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Since installation of a 1 MV compact AMS system (411Bo, HVEE) at KIGAM in 2007, this machine has dedicated to measure ^{14}C for radiocarbon age dating and ^{10}Be. During the periods, two serious troubles, and several minor troubles were occurred to the machine. One serious trouble was that a resister of accelerator tube was shorted. It was estimated as fail-out because there was no noticeable fault around it. The other one was very high leak current between extractor and ground. This was fixed by changing the design of the extractor electrode and replacement. Minor troubles were several electronic part failures in power supplies and several times of target missing due to the mechanical errors of the target exchanging system. Since 2011, a new ion source head (SO110-B) with larger cooling area has been used at our ion source. This new source head shows improved performance with very long source maintenance term (maximum 11 months) despite of lower beam current than old one at the same Cs temperature. Our ion source has a 50-sample carrousel and two carrousels are measured in a week. Typical measuring time for routine work is 30 minutes per a sample.

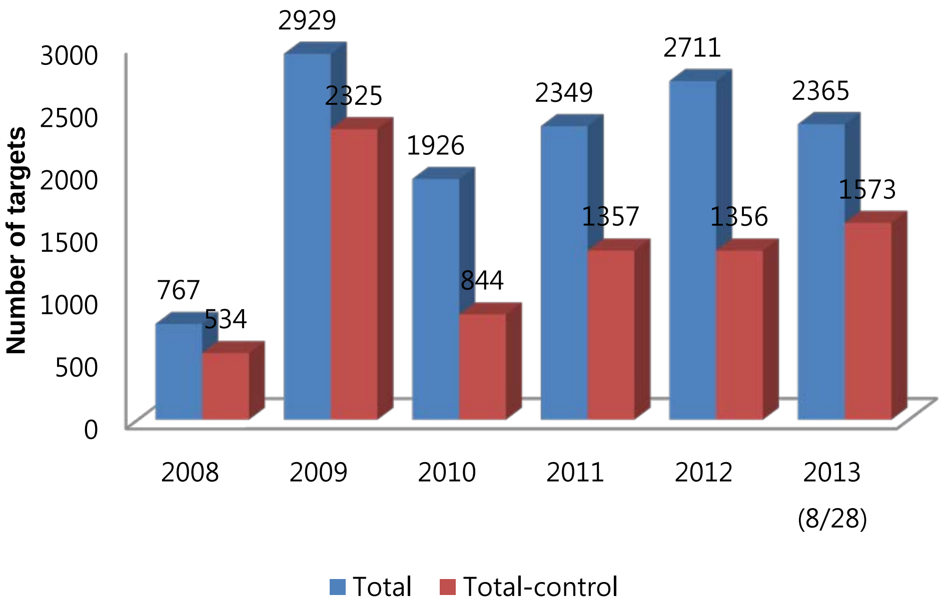

Figure 1 Number of samples measured at KIGAM from 2008 to 2013.

From 2008 to 2012, 10,682 targets for ^{14}C dating and 275 targets for ^{10}Be were measured. All the data of these samples including data of chemical process, reduction and target pressing as well as the results of AMS measurement were stored in a data-base system. Figure 1 shows the annual changes of carbon sample numbers measured by KIGAM AMS. Red bars in the figure represent the numbers obtained by subtracted from the numbers of total samples by the numbers of control samples such as oxalic, blank and known samples. The number of the control samples was around 40% of it of the total samples. In 2009, needs for AMS measurement drastically increased because of temporary shutdown of the AMS system of SNU. A 24-line automatic reduction system was designed in 2008 and fabricated in 2009. Since the system was used for the routine work from 2010, the limitation of throughput of our lab was improved to 5,000 samples per year with only 3 regular staffs and two contract workers. With the system, 120 samples can be reduced in a week with the reduction yield of 93% and all the data from the reduction process can be stored in data base automatically.

We have a plan to fabricate additional reduction systems to supply them to other laboratory who want to provide sample preparing facilities for radiocarbon dating. The quaternary team of KIGAM already has our prototype reduction system, which is a semi-automatic system, and they are making their own targets (500 targets in 2013). It is very efficient way that many laboratories have their own sample preparing system and KIGAM plays a role as measurement hub. The automatic reduction system which is very easy to operate would be very helpful for the purpose, even though the cost of the system is relatively high.

POSTER PRESENTATIONS

2. AMS TECHNIQUE DEVELOPMENT

System technology for ^{10}Be and ^{26}Al measurements in the JAEA-AMS-TONO

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Keywords: JAEA-AMS-TONO; Beryllium-10; Aluminum-26; Gas ionization chamber;E_1-E_{Res} *spectrum*

The JAEA-AMS-TONO at the Tono Geoscience Center, the Japan Atomic Energy Agency has provided multi-nuclide AMS of long-lived radionuclides, such as ^{10}Be, ^{14}C, and ^{26}Al, primarily for studies of geological environments of deep underground [1]. The AMS system is a versatile system based on the Pelletron^{TM} tandem accelerator (Model 15SDH-2, 5 MV) installed in 1997 [2]. In this article, the current status of the system technology for the ^{10}Be- and ^{26}Al-AMSs is presented.

We have completed the development of system technology for routine ^{10}Be measurement [3]. The function of separating ^{10}Be and ^{10}B provided in the gas cell set in the front of an ionization chamber was experimentally confirmed through observation of variation of ΔE_1-E_{Res} spectrum with the gas pressure of the gas cell (see Figure). The test measurement with beryllium samples of an ice core shows that measured ^{10}Be/^{9}Be ratios were consistent with the values obtained by the group of the Micro Analysis Laboratory, Tandem accelerator (MALT) in the University of Tokyo.

References
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[2] S. Xu et al., Nucl. Instr. Meth. B 172 (2000) 8.
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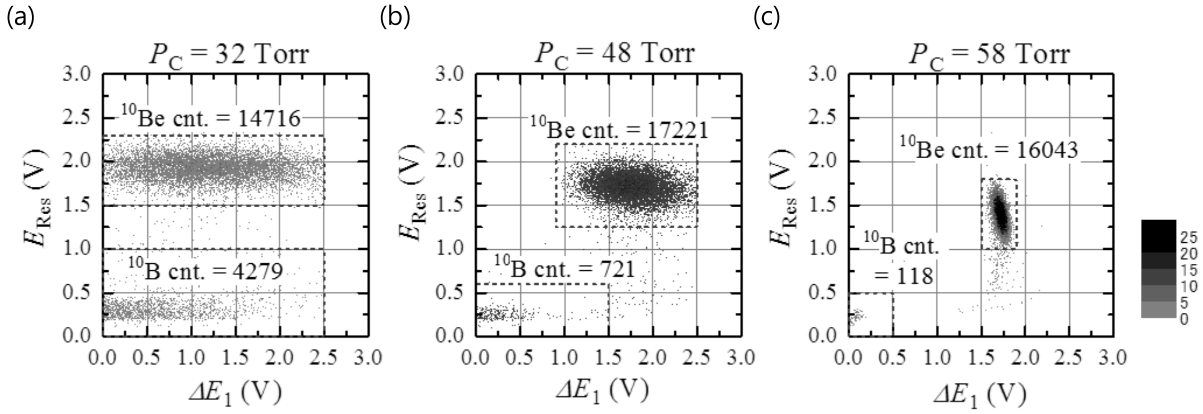

Fig. Variation of ΔE_1-E_{Res} spectrum for three values of the gas cell pressure P_{C}. Each width of ΔE_1 component for both ^{10}Be and ^{10}B peaks decreases with increasing P_{C}. The shrink of the ^{10}Be peak is due to the suppression of the base line fluctuation for ΔE_1 signal. Gas pressures of the gas ionization chamber for (a), (b), and (c) are 114 Torr, 74 Torr, and 56 Torr, respectively.

Preliminary Study of bone collagen ^{14}C-AMS dating using the stepped-combustion method

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Keyword: ^{14}C-AMS;Bone collagen;Stepped-combustion method

For good preserved bone sample, generally the gelatin obtained from hydrolyzing collagen to isolate young contaminants is as a reliable ^{14}C dating material. But in this study we found that the ^{14}C ages of gelatin and collagen from 6 bone samples have no significant difference within the error range, so we have two questions: Whether the hydrolysis of collagen can completely isolate young pollutants? Whether the gelatin can represent as a reliable ^{14}C dating material? As an effective method of separating young contaminants, stepped-combustion is successfully used in the sediment and charcoal application of extracted reliable ^{14}C dating material. We applied the stepped-combustion approach to extract different temperature components (CO_2) of the collagens from 6 bone samples with archaeological ages, combusted at a low temperature (400 °C) and then at 800 °C respectively, and prepared them into graphite respectively for AMS dating. Our results showed that the collagen ^{14}C ages of sample 1 #, 2 # at two temperatures were relatively consistent with collagen and gelatin, stepped-combustion method was not isolated young pollutants, which further demonstrated that the younger carbon could be isolated completely by hydrolyzing collagen. The collagen ^{14}C ages of sample 4 #, 5 # at 800℃ were significantly older than at 400℃, and at the same time they were older than gelatin and collagen, it suggested that stepped-combustion method could isolate young pollutants, and the hydrolysis of collagen were not completely isolated young pollutants. So sometimes we need to take more consideration about choosing gelatin as a reliable dating material, and our study of stepped-combustion establishes a new path for the pretreatment of bone samples for ^{14}C dating.

KU-KIST extraction system of in situ cosmogenic ^{14}C

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Keywords: in situ ^{14}C, AMS

Since in situ ^{14}C produced in quartz has a relatively shorter half-life(5730yr) than other cosmogenic nuclides, the possibility of application to geosciences has been widely explored. As its half-life is short, it can be used for dating young landforms such as little ice-age moraines, and can be used for comparing with ^{10}Be produced in the same quartz to identify whether a landform experienced multiple exposure histories.

The KU-KIST extraction system of in situ cosmogenic ^{14}C from quartz is composed of a gas extraction line and a gas purifying line. The former line extracts gas from quartz and oxidize the ^{14}C into $^{14}CO_2$. The latter line mixes dead CO_2 (carrier gas/extracted from fossil fuel) with the gas extracted from quartz, removes water, SO_x, NO_x, halides, and collects only mixed CO_2. The mixed CO_2 would be converted to a graphite with a graphitization system, and would be measured with AMS. In the gas extraction line, 5g of quartz sample is mixed with 20g of a lithium metaborate flux ($LiBO_2$) and is loaded in an alumina (Al_2O_3) boat. The boat is centered in a 4cm outer diameter mullite tube, which is inserted into the 5cm o.d. quartz tube. The sample quartz is heated in the 1st furnace for 1 hour at 170℃ for removing water, 1 hour at 700℃, 3 hours at 1,100℃ under vacuum. The ultra-high-purity O_2 is injected at 700℃ step to remove atmospheric contaminants, and at 1,100℃ step to oxidize ^{14}C in the quartz sample into $^{14}CO_2$. A u-shape quartz tube which has quartz bead in it is heated at 960℃ in order to delay the gas flow for enhancing the oxidization of CO. Since the flux melts from 850℃, a helix trap is immersed in a cooling bath (LN) from 850℃.

In the gas purifying line, the trapped gas is mixed with dead CO_2. It is purified by passing through fingers which are immersed in cooling baths (dry ice+acetone/-78℃ · nPentane+LN/-131℃ · LN/-196℃) and the 3rd furnace filled with with Ag wool and Cu mass and heated at 600℃ . Water, SO_x, NO_x, halides are removed in this line and the entire line is maintained at 60~80℃ for preventing gases from being absorbed in the line.

We have tested for step heated balnk (dead CO_2) test and the recovery of the gas is like the below table. We analyzed some pilot samples dated by ^{10}Be, oxalic acid, graphite, quartz bead, and the dead CO_2 with AMS

Table 1. Recovery test for time, temperature step heated blank test

Temp	**Time**	**Sample N**	**Yield (%)**	**Temp**	**Time**	**Sample N**	**Yield (%)**
170	10min	DC-11	100.52	1100	10min	DC-31	100.77
170	10min	DC-12	101.39	1100	10min	DC-32	101.02
170	1hr	DC-13	101.22	1100	10min	DC-33	96.52
170	1hr	DC-14	100.48	1100	1Hr	DC-34	99.91
500	10min	DC-21	100.77	1100	1Hr	DC-35	97.41
500	10min	DC-22	100.58	1100	3Hr	DC-36	98.30
500	1hr	DC-23	99.51	1100	3Hr	DC-37	98.96
500	1hr	DC-24	100.77	-			-

The development of AMS-^{41}Ca samples with bone

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Objective: Calcium is one of the important elements that form human bone (the main form of Calcium is $Ca_{10}(PO_4)_6(OH)_2)$).It participates in and regulates many life processes. Osteoporosis is the most common disease of calcium deficiency. It is a serious threat to human health, especially for old people, but recent research shows that organisms(especially osteoporosis organisms)take in too much calcium, possibly causing some other diseases. Thus, a clear calcium metabolism regulation mechanism is meaningful to the study of osteoporosis. Calcium isotope tracer technology is an effective method to study the biological effects of calcium. As the best tracer of all calcium isotopes, ^{41}Ca can only be tested through accelerator mass spectrometry (AMS). It is very important to pay attention to how to prepare target samples efficiently to meet the demand of AMS, as well as how to reduce the content of interference nuclide in samples. **Material and methods:**The materials that AMS uses to test ^{41}Ca are hydrogenated calcium and fluoride calcium. Hydrogenated calcium has strong beam intensity and transmission efficiency,which can effectively reduce the interference of ^{41}K. However, the process of producing hydrogenated calcium is very complex,and the sample is hard to store, costing too much to prepare and measure a large number of biological samples. We develop a new preparation of makeing fluoride calcium samples with rat's femur, which meet AMS measurement standards. Through some new physical and chemical processes such as changing the condition of ion exchange, using the secondary fluorination to prepare more pure samples of $^{41}CaF_2$, we deal with the rat's femur samples and explore a effective method which uses fluoride lead as a conductive medium.Finally, we press the mixture which uses CaF_2/PbF_2 as 1/4 to targets, and save them in the dry argon. **Results and Conclusion:**The scheme of the preparation of the sample reduces the interference of ^{41}K effectively and improve the beam intensity. After the examination, ^{41}K in the samples decreased to lower than1×10^{-6}, and further measurements by CIAE-AMS system found that the scheme was able to improve the beam intensity of CaF_3^- to be four times greater than before. In addition, the interference of ^{41}K in the lead was strongly reduced and the measured sensitivity of ^{41}Ca could achieve about 10^{-14} in the samples. The experimental results show that with these settings the background level obtained with rat's femur about $^{41}Ca/^{40}Ca$ is less than 8×10^{-14}.

Speciation Analysis of ^{129}I in Seawater by Carrier-free AgI-AgCl Coprecipitation and AMS Measurement

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KeyWord:^{129}I; speciation analysis; carrier free; coprecipitation; seawater; AMS

Due to long residence time (4×10^5 year) and high solubility of iodine in the ocean, relatively long half-life and continuous releases of ^{129}I from two European reprocessing plants, ^{129}I provides an unique tracer to study the circulation of seawater masses. Iodine predominantly exists as iodide (I^-), iodate (IO_3^-) and minor organic iodine, and chemical speciation of iodine is sensitive to the environmentof seawater. So chemical speciation analysis of ^{129}I can not only be used to investigate the conversion of chemical species of iodine, but also study iodine biogeochemical behavior combined with knowledge of stable iodine.

A rapid and simple method was developed for speciation analysis of ^{129}I in seawater by selective coprecipitation of carrier-free iodide and accelerator mass spectrometry (AMS) measurement of ^{129}I. Iodide was separated from seawater and other species of iodine by coprecipitation of AgI with Ag_2SO_3, AgCl, and AgBr by addition of only 100 mg/L Ag^+ and 0.3 mmol/L $NaHSO_3$ at pH 4.2~5.5. The separation efficiency of iodide was more than 95%, and crossover between $^{129}IO_3^-$ and$^{129}I^-$ fractions is less than 3% (Figure 1). Iodate and total inorganic iodine were converted to iodide by use of $NaHSO_3$ at pH 1~2 and then separated by the same method as for iodide. Ag_2SO_3 in the coprecipitate was removed by washing with 3 mol/L HNO_3 and the excess AgCl and AgBr was removed by use of diluted NH_3, and finally a 1~3 mg precipitate was obtained for AMS measurement of ^{129}I. The recovery of iodine species in the entire procedure was higher than 70%.

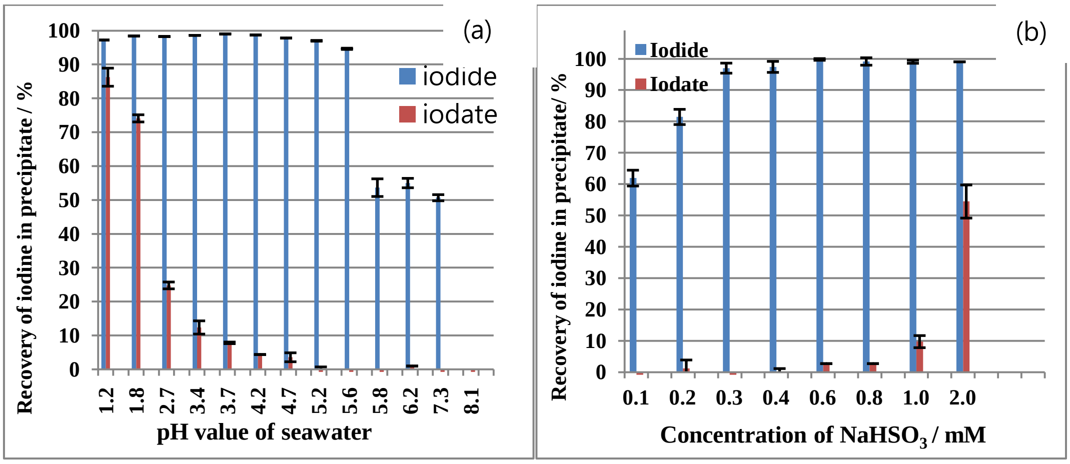

Figure 1. Effect of pH value of the solution (a) and $NaHSO_3$ concentration added to the solution (b) on the precipitation of iodide and iodate. (a): 500 mL of seawater with 200 Bq of $^{125}I^-$ and 200 Bq of $^{131}IO_3^-$, 50 mg Ag^+, 0.30 mmol/L $NaHSO_3$; (b):500 mL of seawater with 200 Bq of $^{125}I^-$ and 200 Bq of $^{131}IO_3^-$, 50 mg Ag^+, pH 4.7).

The use of carrier-free and addition of less chemicals avoid introduction of external ^{129}Ito samples from ^{127}I carrier and reduce the analytical uncertainty for analysis of ultralow levels of ^{129}I; single step separation and easy operation make the method suitable for in situ separation of ^{129}I species on board sampling vessels during expedition, therefore it reduce the risk of iodine species change during storage and transport of samples, as well as the risk of contamination by high ^{129}I levels, In the meantime, this also reduce the cost of transportation of large volume seawater samples.

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Analysis of low level ^{129}I in brine using Accelerator Mass Spectrometry

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Keywords: AMS; ^{129}I; Brine

A chemical procedure for iodine separation from brine samples has been developed at Xi'an AMS center. (Fig.1) The high iodine content in brine samples, usually several mg/L, allows direct separating iodine from the brine using solvent extraction method without addition of stable iodine carrier. The key issues in this method include:

(1) Since the existence of oil in the brine sample could make the solvent extraction failure due to formation of third phase or reduce the chemical recovery of iodine, oil in the samples has to be removed, which was implemented by phase separation through settling down sufficiently based on their immiscibility. The small amount of oil remained in the water phase can be removed by filtration through a filter paper, on which oil was absorbed and removed.

(2) Iodine in brine might exist as both iodide and iodate in brine samples, sodium bisulfite was first added and pH was adjusted to 1-2 to reduce the iodate to iodine, followed by oxidation of iodide to I_2 and solvent extraction to separate all the inorganic iodine. The sodium bisulfate as an effective reductant should be added before acidification to avoid loss of iodine by formation of I_2 in sample by reaction of iodate and iodide at pH 1-2.

(3) As pre-nuclear era sample, $^{129}I/^{127}I$ ratio in brine is normally more than 2 orders of magnitude lower than that in present surface environment samples, so the contamination control during processing procedure is very critical for obtaining reliable results, and monitoring the chemical blank is very important for quality of analytical results. The $^{129}I/^{127}I$ atoms/atoms ratio in the brine samples and chemical blank of iodine reagents were measured to be 1.9-2.7×10^{-13}, 2.08×10^{-13}, respectively, 3-4 orders of magnitudes lower than that in environmental samples in Xi'an, and the result of chemical blank is same as the previous results in past 3 years, indicating contamination is not observed in our method.

Acknowledge

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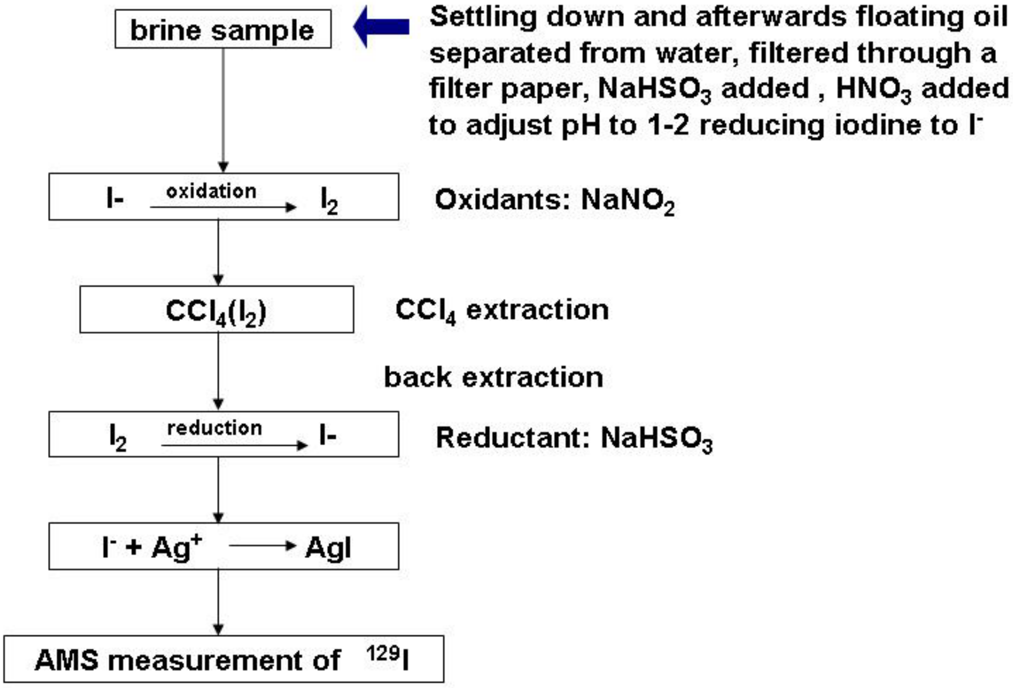

Fig.1 Solvent extraction method for separation of inorganic iodine in brine sample

A Carbonate Background Working Standard for NTUAMS Lab

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Keywords: Carbonate background; calibrate pressure meter for CO_2 *reading - C amount relationship; Lithium interference*

The NTUAMS Lab equipped with a HVEE 1.0MV Tandetron Model 4110 BO-AMS has been established since September 2012. The AMS facility is able to perform ^{14}C dating beginning January 2013 after the final acceptance tests. In order to examine background of the ^{14}C dating method in the NTUAMS Lab, we establish a carbonate background working standard, namely NTUB. The NTUB was collected from the upper Devonian Limestone in Yaji village of Guilin City in SW China. The analysis of X-ray Diffraction (XRD) indicates that the NTUB is very pure calcite. The concentrations of Ca, Mg, Na, K, Sr, Mn and Li measured by ICP-OES are 395735, 1189, 1121, 75.6, 23.6, 20.3 and 4.2 (mg/Kg), respectively. The concentrations of Ba, Cu, Zn, Ni, Pb, Co and Cr are below detection limit. As the NTUB is very pure calcite, we can use it for calibrating pressure meter for CO_2 reading - C amount relationship which yields $C\ (mg) = 0.077234 + 0.0024507 \times P_{CO2}$. About 10mg of NTUB was reacted with 1 mL pure H_3PO_4 to produce CO_2 under vacuum system. After CO_2 purification, the CO_2 was reduced to graphite by Fe at 550 ^oC over catalyst Zn at 425^oC in quartz tube. However, Lithium can be generated by quartz glass during the graphitization, which causes interference with $^{14}C^{2+}$ measurement. To avoid the interference, we used $^{14}C^{3+}$ measurement mode. A total of 15 analyses on NTUB provides average $^{14}C/^{12}C$ and $^{13}C/^{12}C$ ratios of (3.216±1.638)E-15 and (9.795±0.761)E-03. The $^{14}C/^{12}C$ ratio of NTUB is very close to the AMS background of 2.748E-15. Comparing to the $^{14}C/^{12}C$ ratio of HOx2 which is an international modern carbon standard measured by our AMS: (1.079±0.071)E-12, the results demonstrates that our lab system has very low background. By adjusting gas pressure and slit positions, we are able to separate $2Li^+$ interference from $^{14}C^{2+}$ measurement to obtain higher counting rate. The $^{14}C/^{12}C$ and $^{13}C/^{12}C$ ratios of NTUB under $^{14}C^{2+}$ measurement are 2.497E-15 and 1.302E-02, respectively.

^{129}I-AMS Analysis in Ultra-low Level Iodine Samples in Xi'an AMS Center

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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 geology and environment research using naturally produced ^{129}I. Hou et al. (2010, AC) had developed a carrier-free method to analyze such samples in Xi'an AMS Center, in which Cl^- was added instead of I carrier and AgI-AgCl co-precipitation was prepared as the sputter targets. In order to obtain a reliable ^{129}I/^{127}I data in the AgI-AgCl targets, the measurement parameters and experimental conditions were optimized such as the target preparation, holder characteristics, matrix material, and the ratio of AgI-AgCl precipitate to matrix. The method remaining the AMS to behave stable with the slit stabilization function disabled was also investigated, this presentation summarize the achievement on the techniques developed in our laboratory for ^{129}I-AMS analysis of AgI-AgCl targets in ultra-low level iodine samples.

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Temperature stepped combustion system and DOC extraction system for radiocarbon dating at the NTUAMS lab

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We have constructed temperature---stepped combustion system at the NTUAMS lab for radiocarbon dating. This system allows us to adjust the combustion temperature of any sample, with the aim of dating soil and sediments. Dating bulk soil or sediment is known to yield mixed ages, and there is no consistent relationship between ages from different chemically---pretreated sediment fractions, such as humic acid or humin. However our results show that after sieving sediments to less than 63 μm, ages of humic acid fractions are consistently younger than those of humin fractions, and the radiocarbon ages are proportional to combusting temperature from 350°C to 550°C. The organic molecules sequentially released during combustion were likely held within the interlayers of clay minerals while these minerals were formed. We separate these compounds by combusting them at successively higher temperatures. Combining δ13C values 14C results, we can identify carbon sources with distinctly different carbon isotopic compositions. We would like to refine this method by focusing on specific clay minerals in sediments from Taiwan. We hope this method will provide better age control, especially for river terrace deposits in Taiwan.

In addition to the stepped temperature combustion line, we also set up a system for extracting dissolved organic carbon (DOC) from fresh water samples for AMS radiocarbon analyses. There are several methods for isolating DOC, such as UV oxidation, ultrafiltration, solid phase extraction, wet oxidation and direct combustion. We chose the method that includes evaporation of water samples followed by wet oxidation to collect CO2. We will provide background and standard results from this system. There are very few studies of radiocarbon dating on DOC of fresh water in Taiwan. We would like to focus on dating DOC in rivers and lakes. The variation of DOC in rivers and lakes could reflect soil development along the river and the region been drained, and also could give constraints on the origin and cycling of dissolved organic matter in these fresh water system. We hope these researches could provide more information for climate change, land---use and landslide studies in Taiwan.

An organic carbon background working standard for AMS ^{14}C dating in the NTUAMS Lab

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Keywords: fossil wood, AMS, organic carbon background

A fossil wood collected from the Xiangshan stratus in Huoyanshan Mountain, Miaoli County, central western Taiwan, is used as an organic carbon background, so-called CWOC, for AMS ^{14}C dating in the NTUAMS Lab at the National Taiwan University. The fossil wood was a tree berried in fluvial deposits during the middle Pleistocene. Around the sample and inside the gaps of the sample, there are pure fabric mineral and light grey precipitate. The analyses of SEM, XRD and elemental contents on the fabric mineral indicate that this mineral is Halotrichite ($FeAl_2(SO_4)_4 \cdot 22H_2O$). The appearance of Halotrichite illustrates that the depositional environment was in reduced conditions so that the wood could be fossilized. The CWOC was cleaned mechanically and washed by acid and de-ionized water, then dried at 50°C and grinded into powder. About 3mg of CWOC with ~30mg of CuO and a piece of Ag were placed into quartz tube for vacuum. After sealed the tube, the combustion of the CWOC into CO_2 was in a muffle furnace at 850 °C for 5 hours. After the CO_2 is purified, it was reduced to graphite by Fe at 550 °C over catalyst Zn at 425°C in quartz tube. The graphite is then pressed into target for measurement. Up-to-date, seven reliable measurements under $^{14}C^{+++}$ mode yield average $^{14}C/^{12}C$ and $^{13}C/^{12}C$ ratios of $(3.158 \pm 0.780)E-15$ and $(9.001 \pm 0.048)E-03$. Using the measured $^{14}C/^{12}C$ ratio of HOx2 in our lab for the same mode: $(1.079 \pm 0.071)E-12$, we estimate that the ^{14}C age of CWOC is older than 48 BP kyrs. Recently, three measurements under $^{14}C^{++}$ measurement mode without $2Li^+$ interference provide an average $^{14}C/^{12}C$ ratio of $(6.526 \pm 1.564)E-15$. We are now conducting A-B-A treatment on the CWOC to see if there is difference.

Production of Strontium (Sr) negative molecule ions for ^{90}Sr-AMS

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Keywords: ^{90}Sr-AMS, Cesium sputtering negative ion source, SrF$^-$ negative molecular beam

^{90}Sr ($t_{1/2}$ = 28.9 y) is produced by a nuclear fission; it exists in the present environment from nuclear accidents or nuclear tests. ^{90}Sr is a bone seeker and undergoes β^- decay into its daughter ^{90}Y ($t_{1/2}$ = 64 h) which expose in the bone marrow to □ray with 2.27 MeV for a long time. For this reason, especially ^{90}Sr is harmful radionuclides on the nuclear disaster. However, conventional method for measurement of ^{90}Sr takes longer time than other gamma emitting radionuclides such as ^{137}Cs. A chemical isolation technique is necessary to determine the strontium from other radionuclides, and it is required to discriminate between ^{90}Sr and ^{90}Y to measure β^-. Usually, ^{90}Sr measurements are complicated and require longer than two weeks.

Developments of ^{90}Sr-AMS for saving time and ultra sensitive measurement have been already performed in the many facilities in the world [1-3]. However, the each facility could not reach routine analytical level, because ^{90}Sr-AMS has various inherent problems. In the present work, we have performed production of Sr negative molecular ion beams in order to solve one of the problems in ^{90}Sr-AMS. In this study, The GIC MODEL 860 negative ion source was used to produce Sr negative molecular ion beams; strontium fluoride, SrF_2, mixed with Au or Ta powder were filled in the aluminum cathode holders; the holders were installed in the ion source. The negative molecular ion beams of ^{88}SrF$^-$ with current above 500 nA were successfully extracted from the ion source. The details will be reported at the Symposium.

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POSTER PRESENTATIONS

3. CARBON-14 APPLICATION
EARTH AND ENVIRONMETAL SCIENCE

A preliminary study of AMS ^{14}C dating on a stalagmite from South Taiwan

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Keywords: AMS, stalagmite, Carbon-14 dating, chronology

A 13.7-cm stalagmite, DGS-1, collected from a cave in Dagangshan Hill located at south Taiwan was subsampled for 8 layers AMS ^{14}C dating in the NTUAMS Lab. The stalagmite was previously dated with ^{230}Th/U method by MC-ICP-MS at the HISPC Lab at NTU. However, the three ^{230}Th/U dates at 1.5mm, 51mm and 112mm intervals are 3302±9054, 1380±565, 6457±1757 BP years, respectively. The large age uncertainties in the ^{230}Th/U dates are due to high Th contents. The stalagmite contains many dark laminas that may have high organic content. Therefore, we drilled samples from eight layers and attempted to date both carbonate and organic carbon for each layer with AMS ^{14}C dating. For the 8 carbonate samples, we have obtained 7 dates under ^{14}C^{+++} measurement mode to avoid 2Li^{+} interference. Due to the lower transmission rate of ^{14}C^{+++} and target quality, the counting error are large. The preliminary AMS ^{14}C dates are 3555±697, 3178±119, 3218±131, 3142±119, 5699±604, 4188±162 and 3418±128 ^{14}C BP yr at the depths of 25, 42.5, 66, 82, 98.5, 122 and 140mm, respectively. One organic carbon sample at the depth of 66mm has the AMS ^{14}C date of ~13,000 ^{14}C BP yr, which is much older than the carbonate fraction. Although the AMS ^{14}C dates of DGS-1 are still with large uncertainties, these ages are better than the ^{230}Th/U dates. Thus, we have chance to improve the chronology of the stalagmite. The carbonate of DGS-1 was precipitated in the cave with thin and porous celling, so that the CO_2 in dripping water might exchange with atmospheric CO_2 well. On the other hand, organic matter in the stalagmite might come from soils which could be much older than the stalagmite itself. Nevertheless, AMS ^{14}C dating method has a good potential to establish the chronology of DGS-1.

Source diagnosis of high level atmospheric PAHs from Kolkata and surrounding rural sites by using compound class specific radiocarbon analysis (CCSRA)

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Keywords: AMS; Carbon-14; Polycyclic aromatic hydrocarbons; TSP aerosol; source apportionment; molecular fingerprinting

Atmospheric polycyclic aromatic hydrocarbons (PAHs) originate mostly from incomplete combustion of carbon-based fuels. 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. It has been reported that atmospheric pollution by PAHs in Indian megacities, such as Kolkata, Mumbai and Chennai, is comparable to the highest levels across the globe and Kolkata air exhibit the highest level among them.[1] Also, our previous survey revealed that sediments from Kolkata city canals have the highest PAHs concentrations (i.e., 15.9±11.6 µg of ∑14-parent PAHs/g dw, n=12) among the 174 surface sediments from 8 tropical Asian countries.[2] Examining methylated-to parental PAHs ratios of three homologous series and C30-hopane/∑PAHs ratios both in sediment samples and in probable source materials, the high level sedimentary PAHs were ascribed to those emitted from combustion sources. However, relative importances of combustion sources were not solved. This study aimed to apportion sources of combustion to atmospheric PAHs in Kolkata city and surrounding rural sites by using both source diagnostic PAH ratios and compound class specific radiocarbon analyses (CCSRA). Preliminary analysis using small portions of extracts from TSP samples showed that TSP bound ∑14-parent PAHs differ significantly between rural and urban sites (2.5–61.4 ng/m^3 and 15.2–266 ng/m^3, respectively). However molecular fingerprinting gave basically the same source information for both sites, i.e., combustion of coal in brickyards, wood for cooking, and diesel-soot to be major combustion to TSP-bound PAHs. Furthermore, three- and four ring PAHs (MW178, 192, 202) in leftover extracts were harvested on PCGC and analyzed for ^{14}C on AMS at NIES-TERRA, NIES (Tsukuba, Japan). The ^{14}C-based source apportioning between fossil and contemporary carbon fuels will be discussed in the presentation.

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Radiocarbon and optically stimulated luminescence dating of coastal sediments from western and eastern Korea

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We tested the applicability of optically stimulated luminescence (OSL) dating to fine- and coarse-grained quartz from the western and eastern coastal sediments of the Korean Peninsula. In this study, we tested the applicability of optically stimulated luminescence (OSL) to the dating of tidal and delta sediments. A single aliquot regenerative dose (SAR) procedure was applied to chemically purified quartz grains of different grain sizes (4-11 and 90-212 μm diameter). Optical dating results were compared with ages obtained from C^{14} dating of shells, woods and bulk sediments. The suitability of the material for OSL dating was confirmed by the luminescence characteristics. The D_e values are in agreement between the fine- and coarse-grained OSL in both study areas. The OSL ages of the tidal and delta sediments range from 19 ka to 1.3 ka, fitting well with the available ^{14}C ages, especially those from wood fragments. The ^{14}C ages of the bulk sediments were much older (>2000 yr) than the OSL ages and were not in stratigraphic order. This age discrepancy was most likely caused by incorporation of old and reworked carbon into the bulk sediments. OSL ages are in stratigraphic order, which suggest a complete resetting before burial. A short period (6~8 ka) of very rapid sedimentation between tidal and delta sediments is probably the result of a relative sea-level rise and abrupt transgression of the shoreline. This study is new approach to establish a reliable chronology for the tidal and delta sediments, and provides the potential to investigate late Quaternary sea level fluctuations and paleoenvironmental changes of the coastal area of the Korean Peninsula.

Keywords: quartz; OSL; C^{14} dating; tidal sediments; Korean Peninsula; western and eastern coast

Reconstruction of coastal development during the Mid-Holocene at Munam-ri, Goseong, Korea, using OSL and Radiocarbon dating

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Key words: AMS ^{14}C dating, Sea level change, Coastal barrier, Prehistoric remains, lagoon

Coastal plains along the eastern coastline of Korean peninsula were important settlement of ancient people (Im, 1989). They have been developed by the coastal progradation with the Holocene sea level changes, but their chronological evidences are still poor because of little researches based on absolute dating (Choi et al., 2007; Choi et al., in press). In this study, we used optically stimulated luminescence (OSL) dating and radiocarbon dating to unravel the history of the coastal development at Munam-ri site where many prehistoric remains were found, including the agricultural field which was dated back to The Middle Neolithic Age and which was evaluated as the oldest field of the East Asia. The study site was on the coastal plain whose sediments show at least four sedimentary facies which were lowest sand, dark silty sand, reddish sand, and upper sand from the bottom.

Absolute chronology based on 19 OSL and 11 radiocarbon dates from four sampling sites (Zone D, E, F, and G) help us reconstruct the evolution of depositional coastal landforms and the history of ancient settlements. The lowest sand layers were analyzed to be deposited at around 7 ka or earlier when the transgression rate of the sea slowed and the sea level reached the present level. The Early Neolithic Age was developed during this period. Dark silty layer with organic rich materials were deposited at around 5 ka and it likely was in the lagoonal environment because the hinterland of sand barriers was inundated by the higher sea level. The Middle Neolithic Age thrived from 7 ka to 5 ka. After 5 ka, it seemed that the sea level was slightly lower than before, and many wetlands near lagoons were changed into the cultivated land by the ancient people of The Late Neolithic Age. The radiocarbon ages were consistent with OSL ages at the sampling site of dark layer with overlying reddish sands (Zone D), because they had strongly protected the underlying dark layer from disturbances. However, the chronological consistency was not shown at another two sampling sites (Zone E and F) which has no reddish layer. The dark layer found at these two sites seemed to have been disturbed by both natural processes and anthropogenic processes including cultivation after 5 ka so that the radiocarbon ages were underestimated than OSL ages. The upper part of the study area was covered by aeolian sands as well as marine sands, which were dated to the era of The Little Ice Ages.

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Radiocarbon based source apportioning of $PM_{2.5}$ carbonaceous aerosols at Cape Hedo, Okinawa and Fukue island, Japan

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Keywords:Radiocarbon; PM2.5 aerosol; Source apportioning

Radiocarbon (^{14}C) analysis of the carbonaceous aerosol allows an apportionment of fossil and non-fossil sources of air-borne particulate matter (PM). A chemical separation of total carbon (TC) into its sub-fractions organic carbon (OC) and elemental carbon (EC) refines this powerful technique, as OC and EC originate from different sources and undergo different processes in the atmosphere. Although ^{14}C analysis of TC, EC and OC has recently gained increasing attention, Nowadays gigantic brownish haze from various burning and combustion processes is also blanketing India and surrounding land and oceans during the winter season. In China and surrounding countries, same kind of atmospheric pollution are widely observed and occurred as well. Additionally this soot-laden Brown Cloud is affecting South and East Asian climate as much or more than carbon dioxide and cause hundreds of thousands of premature deaths annually, yet its sources have been poorly understood. In this study, we investigated the contribution of continent derived aerosol to Japan. Aerosol samples with diameter of 2.5mm were collected at Fukue island, one of Goto islands and at the Cape Hedo is located at the northern end of Okinawa Island. The ^{14}C contents of EC of $PM_{2.5}$ aerosols collected from October, 2009 and May, 2010 including the Kosa event in Cape Hedo and Fukue were measured. The ^{14}C content represents in the unit of pMC . Results of EC-^{14}C in both sites were 25-30pMC in Cape Hedo and 18-44pMC in Fukue, respectively. These results mean that relative apportions of biomass burning and fossil fuel were 25-30% and 18-44% in Cape Hedo and 25-35% and 65-75% in Fukue, respectively. The observed variations of pMC in Cape Hedo during February and March were relatively smaller than those of Fukue, which was more than 20%. According to back trajectory analysis in this duration, because ca. 70% of air mass in both sites was derived from the continent. The aerosols particulate matter to be transferred to Cape Hedo from continent would be relatively smaller than those to Fukue. Our data of EC-^{14}C obtained during the Kosa event showed the relatively higher contribution of biomass burning sources in Fukue although these interpretation need to consider variation of the magnitude and concentration of EC in both sites. In further study we need to investigate details of the source of EC during this period.

The belowground C balances in Alaskan boreal and tundra ecosystems: Insights from radiocarbon-based C accumulation rates and turnover times

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Keywords: Radiocarbon; permafrost; Tundra; boreal forest; accumulation rate; turnover time

High-latitudinal regions, where a particularly strong warming is expected, currently store large amounts of soil organic carbon (SOC) in active-layer soils and permafrost, accounting for nearly half of the global belowground organic carbon pool. In the arctic region, recent warming has promoted decomposition of the SOC, and releasing soil-originated CO_2 to the atmosphere. Therefore, the arctic terrestrial ecosystem may contribute to the positive feedback. Despite the importance of theses ecosystems in the global carbon cycle, our understanding of the sink/source strength of these systems and contribution of the heterotrophic respiration (Rh) to releasing CO_2 to the atmosphere is lacking. Accurate estimates of turnover times (TT) of SOC should be needed for accurate descriptions of present C balance of Arctic ecosystems. Here, we quantified C accumulation, and TT to evaluate the belowground C balance in Alaskan black spruce forest and tundra. C contents and ^{14}C of SOC were analyzed to evaluate (1) C storage in active-layer soils and near-surface permafrost (~ 80 cm), (2) net C accumulation (NCA) and the inputs (I) and decomposition rates (k, inverse of TT) using ^{14}C approaches, and then (3) the potential of permafrost thaw on post-thaw C loss from mineral soil horizons was evaluated. SOC stocks in the black spruce forest and tundra were 5.3 and 1.2, and 17.6 and 36.7 $kgCm^{-2}$ in the organic horizon (OH) and mineral soil of the active layer, and total SOC in the active layer and near-surface permafrost, respectively. The bomb-spike ^{14}C occurred into the OH in black spruce forest, which reflects the recent balance between C inputs from net primary productivity and decomposition rates. The NCA as 0.052 $kgCm^{-2}\ yr^{-1}$, I as 0.355 ± 0.037 $kgCm^{-2}\ yr^{-1}$, and k as 0.037 ± 0.089 yr^{-1} were estimated. According to SOC stocks and k, Rh was estimated 0.196 $kgCm^{-2}\ yr^{-1}$. The Rh occupied a substantial portion of total carbon exchange. On the other hand, the NCA were estimated nearly zero in mineral soil of the active layer and permafrost both black spruce forest and tundra, suggesting preaged C stabilization in deeper soil. The vulnerability of deep SOC stocks to future warming in changing Arctic environment may be higher in tundra than boreal forest.

Offset in radiocarbon ages between shell and plant pairs in the Holocene sediments around the Korean Peninsula

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Keywords: Radiocarbon dating; marine reservoir effect; coastal sediments; Korea

Since 2009, a research project to evaluate the marine reservoir effects of the coastal sites of Korean peninsula has been progressed by KIGAM. Estimating the reservoir effect around the coast of Korea is difficult because suitable sample pairs with marine and terrestrial ages are rare. In order to solve this problem, 61 sediment cores were collected with 1 m intervals by a percussion drilling tool from 52 coastal sites in the southern area of the Korean Peninsula. These drilling sites were roughly preselected by the interpretation of modern air photos of internet map services provided by the websites such as Daum and Google. Topographic maps in 1918-1926 with 1/50000 scale and old air photos were also used for the site selection. The length of each core was less than 5 m and the total length was 132 m. Based on analysis of lithology and mollusk assemblages, we collected marine shell and terrestrial plant pairs from same horizons. These samples were cleaned by physical and chemical pretreatments, and reduced by automatic graphitization system in KIGAM. The radiocarbon ages of the samples were measured by the AMS facility of KIGAM. This presentation will report interim results because this project is currently in progress.

Preliminary evaluation of fossil fuel pollution in Xi’an city

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Keywords: $\Delta^{14}C$; Fossil Fuel; Heavy metals

The evaluation of environmental pollution has been carried out in order to provide scientific data for policy makers, since CO_2 and some heavy metal elements derived from fossil fuel combustion in the cities are increasing dramatically with the economic development. Radiocarbon is an active tool for tracing and quantifying the emission of fossil fuel CO_2 in the atmosphere in one hand, and heavy metal elements from surface land may help us to differentiate pollution sources in the other hand. In 2010, we sampled annual growth grass *Setaria virid* for$\Delta^{14}C$ analysis and undisturbed surface soil for heavy metal elements measurement, the sampling locations ranged 3 areas (downtown, eastern suburbs & western suburbs) in Xi’an city. We chose the leaves of grass for the analysis of ^{14}C by 3MV multi-nuclides Accelerator Mass Spectrometry(AMS) in Xi’an AMS Center, and heavy metal elements (As, Be, Co, Cr, Cu, Ni, Pb, Zn) were determined by Inductively Coupled Plasma Atomic Emission Spectrometry(ICP-AES). The results show that the average $\Delta^{14}C$ of downtown, eastern and western suburbs were -33.237‰,-18.789‰ and -14.138‰, respectively. As for heavy metal elements, arsenic (As) could be considered as a marker of coal pollutant and the enrichment of lead (Pb) was mainly attributed to the vehicle transport, by correlation analysis with SPSS. The average Enrichment Factors (EFs) of As in downtown, eastern and western suburbs were 2.351, 2.205 and 2.493, respectively. The average EFs of Pb in downtown, eastern and western suburbs were 2.886, 1.691 and 2.078, respectively. In summary: Xi’an city is significantly affected by fossil fuel pollutions. Once we combine $\Delta^{14}C$ with heavy metal elements, we could distinguish pollution sources from coal or from petroleum oils.

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Depositional Environment Inference of the Large Streamside Sediments from the Radiocarbon Date

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ABSTRACT: In the large streamside area close to the Lower Hanriver, undisturbed core sediments (UD 1: depth 3.80 m) were obtained to interpret the depositional environments by radiocarbon (^{14}C) dates together with stratigraphy. Radiocarbon dates of the UD 1 reveal 31,000 yrBP to 1,700 yrBP, which belong to the sedimentation ages of Upper Pleistocene to Holocene. From the dates and its slopes, the sedimentation rates can be largely divided into five sections as the following core depths; they are (1) 1.19 m, (2) 0.76 m, (3) 0.48 m, (4) 0.87 m and (5) 0.20 m from the lower to upper altitude. In the (2), (4) and (5) sections, they show sedimentation rates of more or less steep slopes. Meanwhile, (3) section has very low rate of 0.48 m during the 24,400 yrBP to 8,750 yrBP, which might be caused by the channeling processes during the long hiatus of about 15,000 yrBP and explained as the followings. Because of the increasing rainfalls since the interglacial age, the area close to the large streamside was under the prevailing environments of channeling processes, and the large amounts of preexisting sediments were continuously eroded out under the increasing rainfall influences together with the monsoonal circulations. Meanwhile, distinctly increasing trends of (1) section could be the beginning of environment changes from the fluvial to the backswamp and continued to the upper altitude of (1) section, which are generally coincided with the stratigraphy of the UD 1.

P-CA-10

Holocene coastal environment changes in the Boseong-Beolgyo area, southern coast of Korea: preliminary results from age dating and geochemical analyses

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Abstract

To understand past coastal responses to Holocene sea level change, we performed AMS radiocarbon dating and geochemical analyses of three sedimentary cores (BSL17, BSL18, and BSL21) recovered from the Beolgyo tidal flat in the southern coast of Korea. These coastal cores are characterized by high sedimentation rates during the early to mid Holocene, which generally correspond to Holocene transgression at each site. The $\delta^{13}C_{org}$ values displayed a long-term increasing trend from -27 to -21‰, suggesting an evolutionary series of fluvial to tidal and then shallow marine environments. Similar fluctuations observed in $\delta^{13}C_{org}$ values and C/S ratios on multi-centennial timescales seem to be linked to change in past fluvial sediment input or summer monsoon strength, suggesting that the geochemical characteristics of the coastal sediments have been highly sensitive to the freshwater input through the Beolgyo River. This study demonstrated that a rapid rise in sea level (> 5m) was possible between 8000 and 6000 cal yr BP, based on the dating of coastal sediments coupled with analyses of C/S ratios and carbon isotopes.

Preliminary radiocarbon dating results of Holocene alluvial deposits in Boseong River basin, South Korea

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Keywords: Holocene, alluvium, fluvial deposits, alluvial deposits, Carbon-14

In this study, we investigate the alluvial deposits in the upper part of Boseong River basin, south eastern part of the Korean peninsula in terms of sedimentology and geochronology and consider their implications for geomorphic evolution in the Boseong river basin. Over 15 sites along the Boseong river channel drilled and 150 radiocarbon dating samples in over 15 drilling cores were used.

As the results of this study, based on the preliminary dating results and the sedimentological and geomorphic characteristics of the alluvial deposits under study, a preliminary model of the geomorphic evolution of the upper Boseong river basin is proposed. The Holocene alluvial deposits vary, depending on the dominant factor of erosion and sedimentation induced by geomorphological setting (the gradient of river water level). Alluvial deposits in Boseong river basin were repeatedly subject to sedimentation and erosion during the Quaternary period, leading to the formation of slope deposits, fluvial terraces and old river deposits. Deposits along the Boseong River commonly consist of three fairly distinct phases: poorly sorted angular gravel mixed alluvial slope deposits, fluvial deposits dominated by sand and gravel, and overbank floodplain deposits that are composed of sand, silt and clay.

Radiocarbon dating of alluvial deposits at 15 sites in the catchment confirms that the majority of the sediment has been deposited during Holocene and probably connected Holocene climate change. The fine-grained sediments and overbank floodplain deposits (Old river terrace deposits) had been deposited during the early Holocene (8000 - 11010 cal yr BP). Steep gradient of slope lead to the sedimentation of alluvial slope deposits or mass movement deposits during 8000 - 4000 cal yr BP. Radiocarbon dates show that fluvial channel deposits overlying slope deposits in this basin was deposited around at 4000 cal yr BP to present, probably caused by a climatic shift. As the age of sand and gravel layer in the bottom of core is not clear, we need to consider to get the Optically stimulated luminescence (OSL) dating results for further study.

Robust statics: how do you omit outliers in ^{14}C wiggle matching dating?

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Keyword: Wiggle matching, robust statistics, Kawagodaira eruption, Tephra

The precision of single ^{14}C dates on the calendar timescale will be limited. An effective approach to overcome this limitation is to use wiggle matching method, for example which the tree-ring data series of unknown date can be compared against the constructed ^{14}C calibration curve built from known-age wood. In practice, some data were empirically or statistically rejected by obvious outliers. In general there are two procedures of dealing with outliers: manual and statistical rejections of outliers (Bronk Ramsey, *Radiocarbon* 51 (3), 1023-1045, 2009). Manual screening and rejection of outliers is probably the best way if the outliers are obviously identified by any observations or considerations before the wiggle matching is performed. However this procedure is subjective and it may be difficult to exclude minor outliers. In the procedure of statistical rejection, the model estimate (posterior probability distribution of calendar age) obtained by wiggle matching method were compared with original data (prior probability distribution), and then the outliers were identified with a statistical criteria. This is predictably-effective method in most cases. However, in the case of which the data number is limited for calculating the posterior probability distribution, the posterior probability distribution may be biased from true value in varying degree, resulting in the miss identification of outliers.

We propose an alternative procedure for rejection of outlines using robust statistics which provide a model describing the ‘good’ part of the data, but do not require us to identify specific observations and considerations. Robust statistics is a convenient modern way of summarizing results when we suspect that they include a small proportion of outliers (*Analytical Methods Committee*, 2001). In this presentation we show the effectiveness of the wiggle matching method using robust statistics.

A case study of robust wiggle matching: The Kawagodaira Volcano is located on the northwest slope of Amagi Volcano on the Ize Peninsula of central Japan. The fossil cedar tree excavated from the pyroclastic deposit at the pumice flow terminal of Kawagodaira Volcano was divided into 5-yr blocks from the outermost. The Bayesian wiggle matched age estimate obtained from the ^{14}C dates of 2 x 28 cellulose sample extracted independently from blocks showed no outliers (supported by high individual agreement index of OxCal 4.1 program, Bronk Ramsey et al. *Radiocarbon 46(2),* 325–44, 2004*;* Bronk Ramsey, *Radiocarbon 51(1)*: 337–360, 2009), and was 1210–1187 cal BC at the 95.4% confidence level (Tani et al., *Radiocarbon* 55, 748-752, 2013). Two of 28 data (weighted average of two ^{14}C data) form the fossil cedar tree was artificially biased by -160 years BP (with an assumption of modern carbon contamination) from original data on a random basis. We applied a Mont Carlo (MC) wiggle matching method to the biased data using a conventional (without the rejection of outlines) and two robust statistic methods (trimmed method with a function of the rejection for potential outliners and Huber’s method which a weighting factor were included (Huber, 1981)). As expected, the wiggle matching age from the biased data was apparently shifted to young direction. While the wiggle matching dates obtained by using robust statistics agreed with that of unbiased data within errors in the MC simulation. It is apparent that the influence of outliners was minimalized by wiggle matching age estimate using robust statistics. It is known that the robust model using Huber's method makes more use of the information provided by the data than that of trimmed method. We recommend using the robust model using Huber's method to deal with the several types of dataset.

POSTER PRESENTATIONS

4. APPLICATION OF LONG HALF-LIFE NUCLIDES

Long-term (10^3 to 10^5) denudation rates of watersheds along the east coast of Korea Peninsula emplying in-situ cosmogenic ^{10}Be and ^{14}C abundances

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Keywords : denudation rate, cosmogenic ^{10}Be, cosmogenic in-situ ^{14}C catchment-wide denudation rate,

To estimate catchment-wide denudation rate, many studies have observed basins periodically (one season to one year). However, short-term denudation rate has some problems. For examples Paulumbo et al. (2009) mentioned that the denudation rate may be biased by decadal-scale fluctuations in sediment yield due to the stochastic nature of storm events and transient sediment storage (e.g., Fuller et al., 2003) as well as the impact of humans on denudation (e.g., Brown *et al*., 1998; Hewawasam *et al*., 2003). To derive more precise, stable denudation rate on catchment, we need to constrain on much longer timescales.

The cosmogenic nuclide ^{10}Be, which is produced by cosmic ray in minerals such as quartz (Lal, 1991), is increasingly applied (Bierman and Nichols, 2004); von Blanckenburg, 2006)). The ^{10}Be concentration of quartz in stream sediments provides a spatially-averaged denudation rate for river catchments, if the ^{10}Be production in the catchment equals the removal of 10Be by erosion and transport out of the catchment via stream channels (Brown et al., 1995; Granger *et al.*, 1996; Bierman and Steig, 1996).

In this study, ^{10}Be-derived denudation rates integrate over the period (commonly 10^3 to 10^5 years; ^{14}C holds effective shorter (10^3 to 10^4 years) than ^{10}Be) required to remove ~ 60 cm of bedrock surface (Granger *et al*., 1996) depending on the denudation rate (Palumbo *et al*., 2009). We investigate tens of catchments on the east coast of Korea Peninsula.

Estimating the catchment-wide denudation rate based on the cosmogenic nuclides needs (1) that quartz is distributed uniformly in the rocks present in the catchment, (2) that fluvial sediment is well mixed and its ^{10}Be concentration is representative for the denudation rate of hillslopes, and (3) that sediment transport in channels is fast compared to the residence time on hillslopes (Granger et al., 1996; Bierman and Steig, 1996). To satisfy the above-mentioned conditions, we analyzed the wastershed, which has 3rd to 5th order in stream order, and also avoided stream sediments contaminated by the human impacts such as the factory and golf club. Lastly we collect the sand size sample on the active flood plain. The measured ^{10}Be and in-situ ^{14}C concentrations will be converted into catchment-wide denudation rates (CWDR) after correcting size and shielding condition of each watershed. The induced denudation rates which can be considered as an indicator for the rate of surface uplift, will be discussed with other indicators of surface uplift rates as a perspective on long-term geomorphic evolution of intra-plate tectonic setting.

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Preliminary correlation of ^{10}Be content in the NW-SE transect from Chinese Loess Plateau

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Keywords: ^{10}Be; NW-SE transect; Chinese Loess Plateau

Paleoenvironmental and paleogeomagnetic tracing studies using Chinese loess ^{10}Be have progressed in recent years (e.g., Zhou et al., 2007a, 2007b, 2010). In these studies, the total measured ^{10}Be concentration or calculated flux signal from loess was commonly separated to 2 main fractions: the newly produced atmospheric ^{10}Be that was strongly related to the local rainfall and additionally modulated by geomagnetic field, and the dust contributed background ^{10}Be from the source area. Both the concept analysis (Zhou et al., 2007a) and our recent observation study on modern falling dust ^{10}Be (Xian et al., 2012) have indicated that the dust related ^{10}Be fraction should be "uniform" on centennial-millennial scale over time, so it leaves the atmospheric produced ^{10}Be precipitated by rainfall as the dominant component to explain the variations in loess ^{10}Be record, because the geomagnetic modulation effects on loess ^{10}Be is relatively weak compared with that of Monsoon precipitation changes exhibiting largest seasonal variability. To improve our understandings on the spatial distribution feature of ^{10}Be in loess, 4 representative reported ^{10}Be and magnetic susceptibility records spanning paleosol S_1 (corresponding to MIS 5) from the Xiagaoyuan (Sartori et al., 2005), Xifeng (Zhou et al., 2010), Houzhuang (Sartori et al., 2005) and Weinan sections (Gu et al., 1996), which are roughly along NW-SE transect with obvious rainfall differential are preliminarily correlated and investigated (Figure 1). All compared records clearly show the high similarity between the magnetic susceptibility and ^{10}Be content in loess, suggesting that the two proxies may experience similar climatic controlling process. As for the Xiagaoyuan section (annual rainfall ~350mm) located at the drier western Loess Plateau of higher accumulation rate, it clearly reveals three ^{10}Be concentration peaks of S_1SS_1 (MIS 5a), S_1SS_2 (MIS 5c) and S_1SS_3 (MIS 5e), with the mean value of ^{10}Be concentration about 2.75×10^8 atoms/g, while the similar ^{10}Be and magnetic susceptibility measurements on paleosol S_1 in the Xifeng (annual rainfall ~550mm), Houzhuang (annual rainfall ~650mm) and Weinan (annual rainfall ~700mm) sections can not be clearly subdivided as that of Xiagaoyuan partially attributed to the stronger pedogentic intensity resulting local "smoothing" effects. The mean value of ^{10}Be concentration are 2.94×10^8 atoms/g, 3.71×10^8 atoms/g and 4.55×10^8 atoms/g respectively. This may potentially suggest a gradual increasing changes in ^{10}Be content related to local rainfall changes, because the geomagnetic field condition and background ^{10}Be contribution are similar during the same MIS 5 stage. As for the Xiagaoyuan section, the inter-profile comparison also shows the asynchronous amplitude changes in ^{10}Be concentration and magnetic susceptibility. For example, ^{10}Be content in S_1SS_3 is identical to that of S_1SS_2, while the magnetic susceptibility is 2 times higher. This asynchronous amplitude variation indicates that the correlation between magnetic susceptibility and ^{10}Be is relatively complex in the Western Loess Plateau. Therefore, future in-depth tracing studies using the Western loess ^{10}Be records should be careful in data analysis.

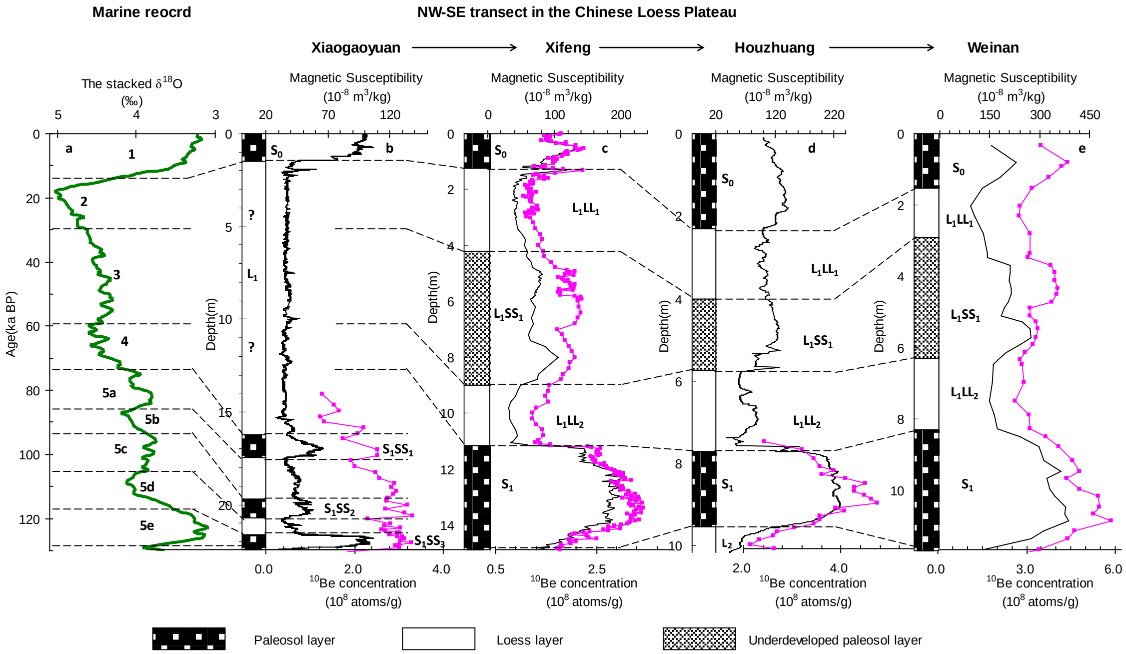

Figure 1 Correlation between the stacked marine $\delta^{18}O$ curve (Green line with numbered stages), stratigraphy, ^{10}Be concentration (Pink dotted line), and magnetic susceptibility (Black line) in the NW-SE transect from Chinese Loess Plateau. a. Marine $\delta^{18}O$ record (Lisiecki and Raymo, 2005); b. Xiagaoyuan (modified from Sartoria et al., 2005); c. Xifeng (Zhou et al., 2010); d. Houzhuang (modified from Sartoria et al., 2005); e. Weinan (modified from Gu et al., 1996). In the Xiagaoyuan section of Western Loess Plateau, both the ^{10}Be and magnetic susceptibility clearly reveal three peaks during paleosol S_1, which can be well correlated to the MIS 5a, 5c, 5e respectively. While the similar measurements on other compared sections can not be clearly sub-divided. This may basically attributed to the different pedogenic/weathering intensity and accumulation rate changes across the NW-SE transect in Chinese Loess Plateau.

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Erosion of a High-altitude Low-relief Area in the Korean Peninsula Considered as a Paleo-erosional Surface: Implications for Its Development Processes

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Keywords: AMS, terrestrial cosmogenic nuclides; Daegwanryeong; peneplain; soil production rate; catchment-wide denudation rate; Korean Peninsula

Over the top of the major mountain belts around world are high-altitude low-relief areas (HLAs) reported. HLAs have been generally interpreted as uplifted paleo-erosional surfaces such that provide the criteria to estimate the timing and the amount of regional uplifting. However this interpretation has generated some debate on the origin of HLAs, because it requires very long stable period and subsequent large magnitudes of uplift over a short time interval. Moreover recent studies argued that HLAs could be formed by the interactions among local lithology, surface processes under recent climate. With the advent of AMS technology, a few research used terrestrial cosmogenic nuclides to figure out the development process of the HLA. They gave insight to the evolution of HLAs considered as paleo-erosional surfaces, however, they concentrated on measuring the denudation rates of exposed bedrocks in each study area. Consequently they have a possibility to underestimate the denudation rates of each landscape and a limitation to understand the evolution of total landscape. Here, we attempt to quantify soil production and catchment-wide denudation rates as well denudation rates of bedrock outcrops to understand development process and evaluate the origin of a typical HLA in the Korean Peninsula, called the Daegwanryeong Plateau.

According to our result from measured ^{10}Be concentrations, soil production rate (SPR) (29~234 m Myr^{-1}) declines exponentially with the thickness of soil and the average denudation rate of tors (30 m Myr^{-1}) is similar to the smallest SPR. Exposure ages of tor surfaces (12.7~40.9 Ka) correspond to the Marine Isotope Stage II and III. Additionally catchment-wide denudation rate of each sub-catchment (52~120 m Myr^{-1}) is less than or close to the near-surface SPR (0~30 cm) in each sub-catchment. When compared with the data from other paleo-surfaces using ^{10}Be, our data is at least 3 times higher than those. The overall results indicate that the dominant geomorphic process in the Daegwanryeong Plateau might be a hillslope process like frost creep and the erosion is much more active than other paleo surfaces. Moreover it is probable that the Daegwanryeong Plateau has not been under morphological equilibrium and was affected by the processes related to the recent glacial period. Consequently the prerequisite conditions for the classic assertion that the Daegwanryeong Plateau is a paleo-erosional surface could not be satisfied. While the elevation of the study area has been affected by tectonic force explicitly, unique feature like low-relief hilly landscape with wide flat hilltops might result from the interactions between local lithology and surface processes under the recent climate. This study provides the insight to the actual development processes in HLAs that are composed of soil-mantled hillslopes and lie at mid-latitude humid region though the study area is confined to a typical HLA.

Cosmogenic ^{10}Be exposure age of the Jeongdongjin coastal terrace: the first numerical and reliable constraint on the penultimate interglacial (MIS 7) terrace surface

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Key words: cosmogenic ^{10}Be surface exposure dating, Jeongdongjin coastal terrace, Penultimate interglacial, spatio-temporal differential uplift

We firstly report the numerical and reliable age of the coastal terrace of Jeongdongjin (~70 m a.s.l.). Since the initial suggestion by Hwang (1968), the Jeongdongjin (JDJ) surface of coastal terrace has been a center of coastal terrace stratigraphy along the east coast.

However, the age of the surface has yet to be equivocally constrained because of its antiquity (older than the last interglacial), which is difficult to apply radiocarbon dating and OSL dating. Other indirect constraints on the sediments including amino-acid racemization and tephra chronology have been applied but their reliability is still in debate. Specifically, OSL dating doesn't provide successful result because the sediments are too old to be constrained due to the saturation of OSL signal. In order to overcome the fast saturation, new luminescence technique using feldspar (IRSL) has been tried on (Hong et al., 2013) but its reliability needs more consensus from OSL experts on the suitability of feldspar signal. Thus, we firstly applied to the conventional, cosmogenic surface exposure dating to constrain the age of the terrace surface. The surface exposure dating using cosmogenic ^{10}Be has been successfully on the coastal terrace and other geomorphic surfaces.

We dated three samples from paleo shore platform surfaces and another one sample from boulder deposited on the terrace using cosmogenic ^{10}Be surface exposure dating techniques. The ages range 170 ka to 240 ka. Based on our cosmogenic ^{10}Be ages, it may suggest that the Jeongdongjin terrace was formed during the penultimate interglacial period (MIS 7). Given the effect of surface erosion on the abundance of cosmogenic ^{10}Be, the surface could be a little older (i.e. MIS-9). However, the in-tact marks of boring shell on the dated surfaces help us believe that our ages suggest the real age of the surface formation. The boring shell can also be observed at the current shore platform along the sea level. Assuming that the result of the study is real, the pattern of surface uplift along the east coast has been spatio-temporally differentiated over the late Quaternary. The uplift rate in the Jeongdongjin is 0.35 mm/yr, using a paleo sea level of -18 m for MIS 7 (Dutton et al., 2009).

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Method to derive geomagnetic signal from Chinese loess ^{10}Be record

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Key words: Loess ^{10}Be; Paleogeomagnetic intensity; Principal Component Analysis

The ^{10}Be records in Chinese loess can't be directly used for tracing the palegeomagnetic change because of the significant climate effect on them, thus it is necessary to separate the climate signal from the ^{10}Be records (Zhou et al., 2007, 2010). Here, we present a new method to reconstruct the geomagnetic relative paleointensities for the past 130 kyr from ^{10}Be records in Luochuan and Xifeng loess-paleosol sections. The high similarity (Fig.1) between the measured ^{10}Be concentration and magnetic susceptibility (SUS) sequences indicates both of those are related to climate factors (precipitation and dust flux) in the same manner. Therefore, a correction based on the correlation of ^{10}Be with SUS is used to remove the climatic "contamination" from the ^{10}Be records, and the Principal Component Analysis (PCA) is adopted to extract the common signal from the two loess sections, which we interpreted as variations of the global ^{10}Be production rate of the past 130 ka (Fig.2). And the latter is closely related to the geomagnetic variations.

Compared with the geomagnetic variability records from Luochuan and Xifeng respectively (Fig.3a and Fig. 3b), the PCA method synthesized the ^{10}Be production rate by extracting the common signal whose variance contribution is maximum (Christl et al., 2010). It is more intelligible and convincible to reflect the global consistency of the paleogeomagnetic field changes. And the reconstructed curve is better to reveal the Laschamp and Blake events, which agrees with other geomagnetic intensities reconstructions from ocean sediments (Fig.3) (Valet et al., 2005; Yamazaki and Kanamatsu, 2007).

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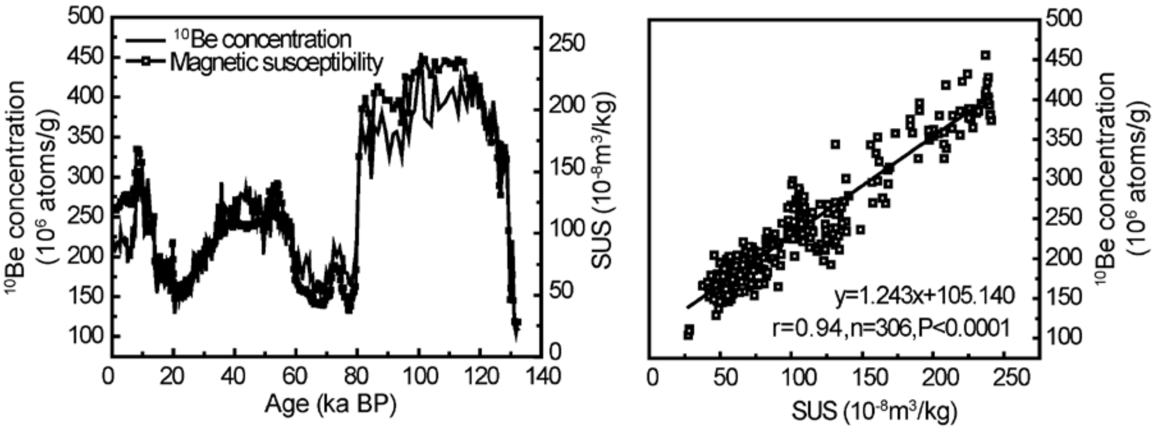

Figure 1 High similarity between ^{10}Be concentration and magnetic susceptibility. (a) ^{10}Be concentration and magnetic susceptibility from Luochuan section; (b) Significant linear correlations between ^{10}Be concentration and magnetic susceptibility.

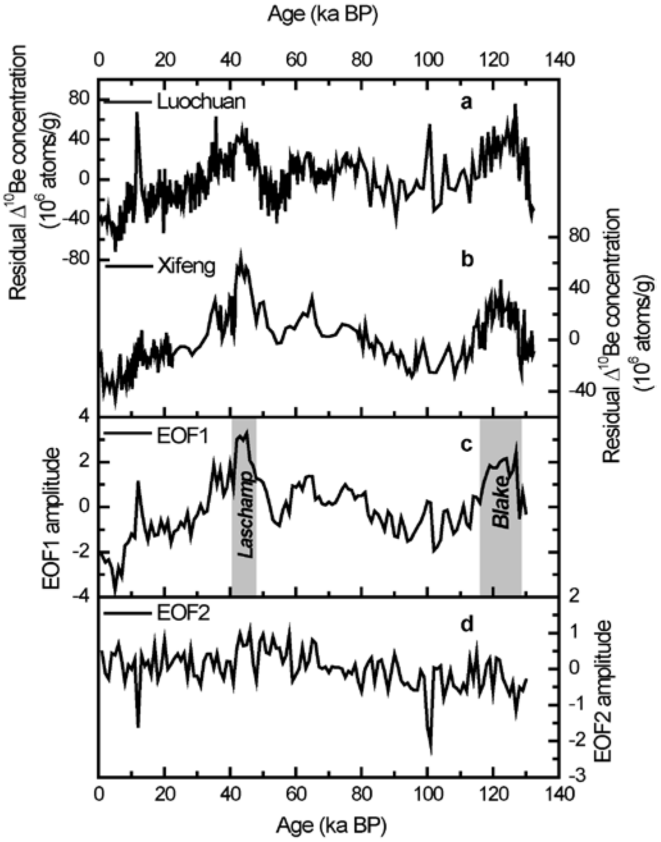

Figure 2 The residual ^{10}Be concentration from Luochuan (a) and Xifeng sections (b), and the amplitude time series of the first (c) and second (d) EOF modes.

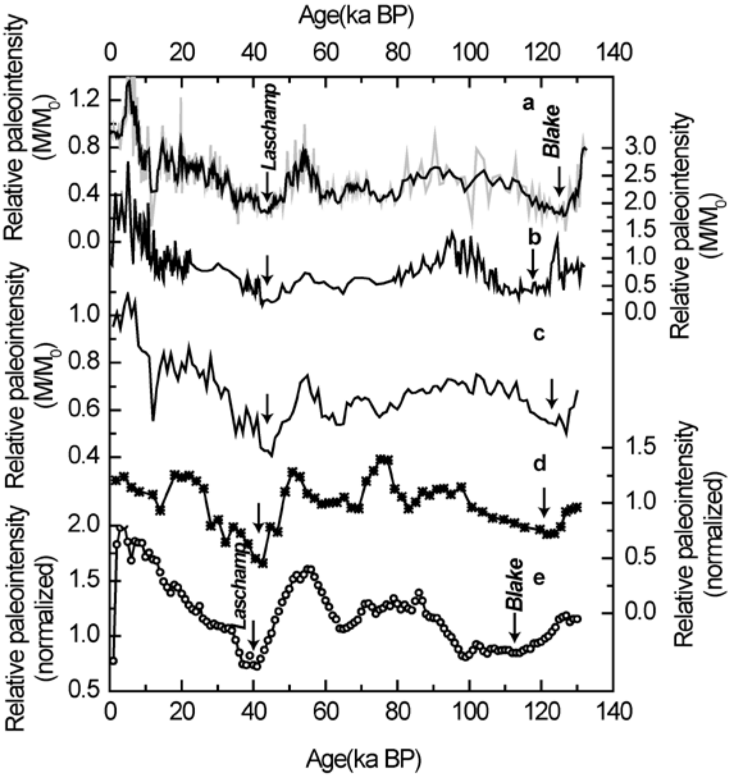

Figure 3 The reconstructed past 130-kyr geomagnetic excursion sequence from ^{10}Be in the (a) Luochuan and (b) Xifeng sections using the method in the Zhou et al 2010 paper, and comparison of the PCA result (c) with the records of (d) North Pacific (Yamazaki and Kanamatsu 2007), (e) SINT-2000 (Valet et al., 2005).

Preliminary study of ^{129}I dating tool in Chinese loess and red clay sequence

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Keywords: Iodine-129; Loess; Initial Value; Terrestrial; Prenuclear; AMS

Wind-blown loess-red clay sediments have been accumulating continuously for the last 25 Ma (Qiang et al., 2011; Guo et al., 2002). These sediments are a storehouse for the high resolution records of the variability of East Asian monsoon. Although the paleomagnetic stratigraphy dating was widely used for eolian sediments, it provides a relative dating. Here we try to develop an absolute dating tool for this study. The long half-life ^{129}I makes it possible with dating range from 2-80 Ma. The key point for this new method is to find the "initial value" of ^{129}I/^{127}I. That is the prenuclear ^{129}I/^{127}I ratio in the terrestrial environment. We chose two loess sections (Xifeng, 35.79°N, 107.59°E and Luochuan, 35.78°N, 109.44°E) from Chinese Loess Plateau (CLP) for this analysis, using newly developed carrier free iodine method by coprecipitation of AgI and AgCl (Hou et al., 2010). Our results showed that a roughly consistent ^{129}I/^{127}I atomic ratio of 2.0×10^{-11} was observed below 1.5 m and 0.4 m in two sections, respectively, approximately one order of magnitude higher than the initial value (1.5×10^{-12}) in marine system (Moran et al., 1998). Possible explanation is that the marine evaporation transported into the CLP from the long distance (>800 km) led to a small proportion of ocean-origined iodine (low ^{129}I/^{127}I atomic ratio) into the loess iodine while the eolian dusts of relatively high flux might bring more ^{129}I to the CLP compared to the common atmospheric deposition. The question is how to find and derive the "initial value" of ^{129}I/^{127}I from both geological reality and theoretically calculation. We have selected 5 known age red clay samples from CLP for this aim. They are from 2 to 25 Ma range. By fitting with the measured ^{129}I/^{127}I ratios in limited red clay samples versus their paleomagnetic ages, we deduced a decay curve of ^{129}I/^{127}I ratio with an initial value of ~5.3×10^{-12} which is about half the prenuclear ratio measured from loess sections, but still approximately 4 times that in marine system. Therefore there is still a long way to go for ^{129}I study as a dating tool. Since loess may be unsuitable for "initial value" study, we have to test lake sediments in the next step to improve our understanding of the mixing process of natural iodine isotopes in different types of terrestrial sediments.

Acknowlegements

This study was funded by the National Science Foundation of China (No. 41271512), the Ministry of Science and Technology of China (No. 2012IM030200), and by the Chinese Academy of Science (Grant No. KZCX2-YW-147). The authors are grateful to Luyuan Zhang and Yunchong Fu for their help to this work

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POSTER PRESENTATIONS

5. ARCHAEOLOGY AND GENERAL APPLICATION

An attempt to use iron rust for age dating

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Keywords; Agedating, AMS, iron rust, radiocarbon

Radiocarbon has become one of the most important absolute age dating isotopes for archaeological artifacts since it was first suggested by Libby [1]. Even though 1 mg of carbon is generally enough for carbon age dating using accelerator mass spectrometry, because of their scarcity, sampling the volume of many iron artifacts is often avoided. However, oxidation is inevitable when dealing with iron artifacts and the carbon content is known to be about 1 w. %. Up to 0.8 w. % of the carbon is in an eutectic solution. The remaining carbon exists in a thermodynamically stable carbide state, which means that radiocarbon ratios from this portion could be used for age dating. As archaeologists are much less reluctant to sample the rusted areas of iron artifacts than the pristine sections, this presents a solution to the sampling problem. A comparison of age dating using a rusted and un-rusted portion from the same sample has already been performed by A.C. Cook, and showed good correspondence [2]. Given the long and continuous history of Korean iron artifacts, this technique is being developed at KIST. A description of the pretreatment techniques under development and some preliminary results will be presented.

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Radiocarbon dating of charcoal remains excavated from the Tang-e Sikan cave in Arsanjan, southern Iran

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Keywords: ^{14}C age; charcoal; Arsanjan; Southern Iran; Middle-Upper Paleolithic period

Modern humans (*Homo-sapiens*) evolved in East Africa around 200,000 years ago, started migration out of Africa to West Asia about 130,000~60,000 years ago, and subsequently spread to Europe and West Asia, replacing earlier Neanderthals (e.g. Foster and Matsumura, 2005; Armitage *et al.*, 2011). Therefore, the West Asia area, especially southern Iran, is very important to elucidate the evolution of modern humans. The Iran-Japan archaeological research group has started excavation of the Arsanjan archeological sites in southern Iran since 2011. The Tang-e Sikan cave, one of the largest limestone caves in the Arsanjan area, has thick Paleolithic cultural sequences, and has produced many stone implements from the middle to Epi-Paleolithic periods (Tsuneki and Mirzaye, 2012). The trenches of E5 and B3 dug inside the Tang-e Sikan cave in 2012, revealed continuous six and ten reconstruction layers, respectively, as seen from excavations. We tried to estimate ^{14}C dates of charcoal remains collected from the layers using AMS-^{14}C method to reveal the transition dates of these layers.

The charcoal samples of trench E5 were dated at 300–115 BP at Layer 1, and 26,750–26,370 BP for Layer 2. One sample from Layer 3 and samples from Layer 4 were older than 50,000 BP, which is over ^{14}C-detection limit. On the other hand, the charcoal remains of trench B3 were dated at 36,500–35,300 BP for Layer 2, and 36,890±190 BP for Layer 3. Coupled with the ^{14}C dates of charcoal remains and the type of lithic artifacts (e.g. the presence of micro-blades) in Layers 2–4 of trench B3, the Layers 2 and 3 could be dated to the transition from Middle Paleolithic to Upper Paleolithic period, while Layer 4 could be dated to the Middle Paleolithic period. Conard and Ghasidian (2011) reported that another prehistoric site of Ghar-e Boof in Dasht-e Rostam area located in about 200 km northwest of Arsanjan was dated at 36,030–33,060 BP for Layer AH IV. The Layer AH IV also contains many micro-blades, and is considered to correspond with the Layers 2 and 3 of trench B3 of the Tang-e Sikan cave in Arsanjan. From the results in this study, it is obvious that the culture of micro-blades was present at about 37,000 BP in Arsanjan. This is the oldest finding in Iran, and indicates that the Tang-e Sikan cave can give important information about migration of modern humans out of Africa. It is needed to further determine dates of older than 50,000 BP for deeper layers than Layer 4 using the other methods except ^{14}C dating, such as U series dating, amino acid racemization dating, and luminescence dating.

Case Study of Radiocarbon Dating of a Painting on Silk

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Keywords: radiocarbon, dating, silk, painting, AMS

One of the major issues in dating a painting on silk is effective elimination of all unknown carbon-containing foreign materials from silk. This carbon comes from the natural contamination like microorganisms growing on silk during the period of conservation and the artificial contamination such as mineral dye of painting which may contain dead carbon and the paper which is attached on the back side of the painting.

For this case study, we acquired two pieces of silk, old and modern. The modern one to make a preceding examination was material for clothes which was imparted violet color by means of a dye. The old one was obtained from an old painting, Avalokiteshvara Bodhisattva with the Moon on Water, Suwolgwaneumdo. The painting was estimated to be a work of the Goryeo Dynasty (918 – 1392 AD) of Korea.

To set up the pretreatment procedure of a painting on silk for radiocarbon dating, we pretreated the modern silk. The pretreatment procedure to get protein from modern silk for radiocarbon dating was as follows: wash with de-ionized water and organic solvent; heat at 80°C for 20 hours in 6N HCl to separate the silk into fibers; remove dye or undecomposed remains by passing through 1.2 μm glass fiber filter; classify the proteins into three portions by their molecular weights of x>10,000 daltons, 3,0000<x<10,000 daltons and x<3,000 daltons using Millipore Centriprep® centrifugal filter 10 and 3. The centrifuging process was carried out twice with an old filter and a new filter to check the influence of the conserving time of the filters. All the proteins were dried and combusted followed by reduction to measure their ages by AMS. The painting on silk was treated by the same pretreatment procedure after removing paper attached on the back side of the sample.

Table 1. The results of radiocarbon dating for modern silk treated with an old filter and a new filter

Molecular weight	Modern silk treated with an old filter			Modern silk treated with a new filter		
	Sample code	Age (BP)	pMC (%)	Sample code	Age (BP)	pMC (%)
x<3,000	TWd120487	940±30	88.9±0.2	TWd120498	-230±20	102.9±0.3
3,000<x<10,000	TWd120488	140±30	98.3±0.3	TWd120499	-240±20	103.1±0.3
x>10,000	TWd120489	-190±20	102.4±0.3	TWd120500	-270±20	103.4±0.3

Table 2. The results of radiocarbon dating for a painting on silk

Molecular weight	Painting on silk		
	Sample code	Age (BP)	pMC (%)
x<3,000	TWd120490-1	740±30	91.1±0.3
3,000<x<10,000	OWd120422	540±35	93.4±0.4
x>10,000	TWd120491	-	-

The radiocarbon ages of modern silk and the painting on silk were summarized in the tables. As shown in Table 1, the ages of the modern silk obtained with old and new filters are different. The old Millipore Centriprep® centrifugal filters had been conserved for more than one year, and the new filters were purchased just before the treatment. It is seemed that the age difference was due to dissolving of the degraded part of the old Centriprep® centrifugal filters containing dead carbon.

The painting on silk was treated with new centrifugal filters. In Table 2, the ages of all the portions of painting on silk are older than modern. The age of the silk protein portion with $x<3,000$ daltons was measured older than the other portion in this work because the contaminants from the mineral dye of painting might remain at the silk protein with $x<3,000$. This is in a good agreement with a previous work(K. J. Kim et al), which reported that the mass distribution of protein in silk is in the range of $3,000<x<10,000$ daltons. The age of silk protein portion with $x>10,000$ daltons could not be determined because the CO_2 gas was lost. However, K. J. Kim et al also reported that the silk protein portion with $x>10,000$ daltons had a chance to be contaminated by submicron materials, which pass through the microfiber filter but don't pass the Centriprep® centrifugal filter 10.

The age of the silk protein portion with $3,000<x<10,000$ daltons was measured to be 540 ± 35 BP and it was calibrated to AD 1310-1360 (34.0%) and AD 1390-1440 (61.4%). In conclusion, it was thought that Suwolgwaneumdo was painted in the late Goryeo Dynasty or the early Joseon Dynasty (1392 – 1910 AD) of Korea. These results are in a good agreement with the ages by the historical estimation of the painting and with the ages of similar Buddhist paintings such as a Goryeo Suwolgwaneumdo (AD 1310 or 1323) in Japan.

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POSTER PRESENTATIONS

6. STUDY ON ANTHROPOGENIC NUCLIDES

^{14}C activities in terrestrial plants in the vicinity of Hanbit NPP, Korea

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Keywords: AMS; Carbon-14

It is known that ^{14}C is released from a Nuclear Power Plant (NPP) during routine operation as gaseous effluents. And it is emitted more predominantly as the hydrocarbons of $^{14}C_2H_6$ and $^{14}CH_4$ in Pressurized Water Reactor (PWR) than the form as ^{14}CO and $^{14}CO_2$ in Boiling Water Reactor (BWR) and they are converted to $^{14}CO_2$ by mixing throughout the atmosphere. Then, the $^{14}CO_2$ is easily assimilated by plants through photosynthesis. A large NPP, Hanbit is located at Yeongggwang, Jeollanam-do province, South Korea (35°24′54″N 126°25′26″E). It has 6 PWRs and produces electricity of around 6,200 MW. In order to see to what degree and to what extent the ^{14}C anthropogenic signals show in the proximity of Hanbit nuclear power plant, we have collected leaves and silver grass samples at several locations in the vicinity of Hanbit. They are (1) the NPP's front gate (~ 0 km), (2) solar energy facility around the front gate, (3) the places of 1.0 km and 1.5 km, apart from the gate, (4) a motorway rest area (Baegyangsa rest area), 30 km distant in east direction, (5) a country lane toward national neutrino research laboratory around the NPP, (6) the road beside the coast at the NPP's rear side, and (7) the seashore between the NPP and Beobseongpo (a tourist region). The samples have been pretreated to extract α-cellulose and the results of ^{14}C AMS measurement will be discussed.

The Influence of ^{129}I Global Precipitation on Chinese Background Level

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KeyWord:^{129}I; global precipitation; background level; AMS

Introduction

A number of radioactive wastes, which have been produced by nuclear weapon tests, accidents, reactors and reprocessing plants since 1945 with the advent of the nuclear age, are released into environment and result in a regional or global distribution[1]. The concentration of ^{129}I, one of the long-lived radionuclides in the waste, has been increased by two or three orders of magnitude due to the release from reprocessing facilities. In this work, 48 soil samples, 5 water samples and 6 plant samples collected from Chinese non-nuclear districts, and 8 soil samples, 41 water samples and 3 plant samples collected around Daya Bay nuclear power plant were analyzed in Xi’an AMS center. The investigation demonstrates that the^{129}I inventory in China is strongly influenced by global precipitation. The ratio of ^{129}I/^{127}I determined in this work could be recorded as the background level in China.

Result and Discussion

The measurement results of ^{129}I in various samples collected in China are presented in Table 1. As seen, the measured ^{129}I/^{127}I ratio in soil samples from non-nuclear districts falls in the range from 1.54×10^{-11} to 1.12×10^{-8}. It is in the same order as those of soil samples in other countries at similar latitude. For example, it is reported that the ^{129}I/^{127}I ratio in Japanese soil samples collected from background areas before Fukushima Dai-ichi Nuclear Power Plant (FDNPP) accident is varied from $3.9\times10^{-11}$to 2.2×10^{-8}[2]. The ^{129}I/^{127}I ratio in soil samples around Daya Bay nuclear power plant falls in the range of 4.54×10^{-10} to 7.86×10^{-10}. It is much smaller than the ^{129}I/^{127}I ratio in soil samples near FDNPP, which has been increased to $3.8\times10^{-9}\sim5.9\times10^{-6}$ after FDNPP accident[3]. So the ^{129}I/^{127}I ratio will be significantly affected by nuclear accidents.

Both the ^{129}I/^{127}I ratio of soil and water samples around Daya Bay nuclear power plant falls within the range of ^{129}I/^{127}I ratio in soil and water samples from non-nuclear districts. This indicates that there is no significant ^{129}I released from Daya Bay nuclear power plant. Its normal operating has little influence on the ^{129}I level in surrounding environment.

Through comparison, one can obtain that the ^{129}I level in most regions of China are not affected by native nuclear activity. The present ^{129}I is mainly result from global precipitation. The obtained ^{129}I/^{127}I ratio in soil, water and plant samples can be employed as a background level in China before FDNPP accident.

We thank the finical supports by the National Natural Science Foundation of China (Grant No. 11275147)

Table 1 AMS measurements of soil, water, plants samples in China

Sample type	**Range of ^{129}I concentration**	**Average concentration of ^{129}I**	**Range of ^{129}I/^{127}I ratio**	**Average ratio of ^{129}I/^{127}I**
Soil in non-nuclear district	3.07×10^{5}～1.30×10^{8} atoms/g	2.04×10^{7} atoms/g	1.54×10^{-11}～1.12×10^{-8}	1.99×10^{-9}
Water in non-nuclear district	9.80×10^{6}～7.35×10^{7} atoms/l	2.92×10^{7} atoms/l	3.91^{-11}～7.86×10^{-8}	6.07×10^{-10}
Soil in daya bay	2.59×10^{6}～2.63×10^{7} atoms/g	8.34×10^{6} atoms/g	4.54×10^{-10}～7.86×10^{-10}	2.10×10^{-10}
Water in daya bay	1.24×10^{6}～2.32×10^{7} atoms/l	1.51×10^{7} atoms/l	1.94×10^{-11}～9.78×10^{-11}	6.85×10^{-11}
Plant in daya bay	4.41×10^{6}～2.22×10^{7} atoms/g	1.37×10^{7} atoms/g	3.36×10^{-10}～4.62×10^{-10}	3.99×10^{-10}

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POSTER PRESENTATIONS

7. BIO AMS

Mass Distribution of Phosphatidyl Inositol Derivatives in Cells: Second Messenger-Dependent Quantitative Biomarkers for Diagnostics

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keywords : AMS, Phosphatidyl inositol, Cell signaling, TLC

A highly sensitive detection and quantitation method based both on the conventional thin layer chromatography (TLC) and the ultrasensitive accelerator mass spectrometry (AMS) for the determination of the intracellular mass distribution of phosphatidyl inositol derivatives is reported. Intracellular phosphatidyl inositol derivatives are a class of phospholipids and derived from a parental molecule of inositol. They play important roles as precursors or second messengers for cell signaling processes such as hormone-dependent signal transduction. Their various and unique roles in cell signaling processes are mainly dependent on the locations and/or the number of phosphate groups. In this study, cells were dosed with ^{14}C-inositol under different conditions, and phosphatidyl inositol derivatives and other lipid components were obtained from the cells through biochemical process, followed by the conventional TLC and AMS measurements. ^{14}C/^{12}C ratio of the allocated areas of the TLC plate could reveal the mass distribution of the phosphatidyl inositol derivatives under the given conditions. In principle, this method is an alternative or superior to the conventional ^{32}P-based method for quantitation of phosphatidylinositol derivatives in cells.

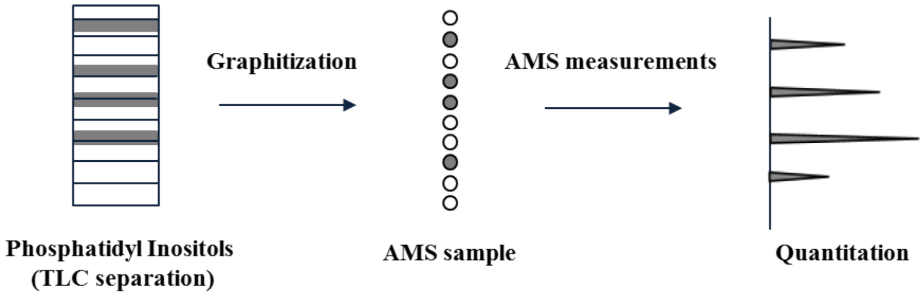

Figure. Mass Distribution of Phosphatidyl Inositol Derivatives in Cells: Second Messenger-Dependent Quantitative Biomarkers for Diagnostics

A step forward in BAMS sample treatment at SFT-AMS

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C-14 AMS for biomedical samples such as plasma or urine provides an ultra-precision quantitative analysis method. The simple analysis of the isotopic ratio of carbon, however, leaves some ambiguities unanswered. The elemental fraction of carbon of the original sample may vary for the cases of biomedical samples, but the method to measure such fraction for each samples has not been developed; instead, a number that is expected from an average fraction replaces a measured value. Nevertheless, the BAMS analysis has successfully provided various useful information for pharmaco-dynamics or pharmaco–kinetics. If more realistic data become available, the contribution may extend the area of applications.

We developed a BAMS sample treatment method that can measure the carbon elemental fraction of the original sample. Because the conventional Y-tube treatment cannot cope with such necessity, we adopted the E/A combustion followed by the reduction on Fe catalyzer method. One disadvantage of the method may be the relatively slow reduction rate that causes longer time compared to Y-tube reduction using Co-Cu catalyzer. The loss of speed is partially compensated by gaining the effectiveness in the procedure. We found that a 4-hours combustion & reduction process is sufficient for a single sample.

Details of the sample preparation and treatments are presented in the contribution.

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