Comparative ages of pollen and foraminifera in the ODP 820 marine core

Patrick T Moss [1], Gavin Dunbar [2], Gerald Dickens [3] and Geraldine Jacobsen [4]

[1] *School of Geography, Planning and Architecture, The University of Queensland, Brisbane, QLD 4072.*

[2] *Antarctic Research Centre, Victoria University of Wellington, P.O. Box 600, Wellington, New Zealand.*

[3] *Department of Earth Science, Rice University, Houston, Texas, 77251, USA.*

[4] *ANSTO Institute for Environmental Research, ANSTO, PMB 1, Menai, NSW, 2234.*

This study discusses the results of using pollen concentrate for AMS C^{14} dating of sediments from the Ocean Drilling Program (ODP) 820 marine core and these dates are compared with existing AMS C^{14} dates derived from foraminifera for the same record. This will address the question of reworking, and consequent time lag between production and deposition of pollen in the Queensland Trough, as well as providing an additional age model from the terrestrial record (i.e. pollen) that can be directly compared with the existing age model derived from marine sediments (i.e. foraminifera). In addition, these results will contribute to our ability to interpret marine palynological records and provide additional insight into the sedimentological processes operating on the northeastern Queensland continental margin.

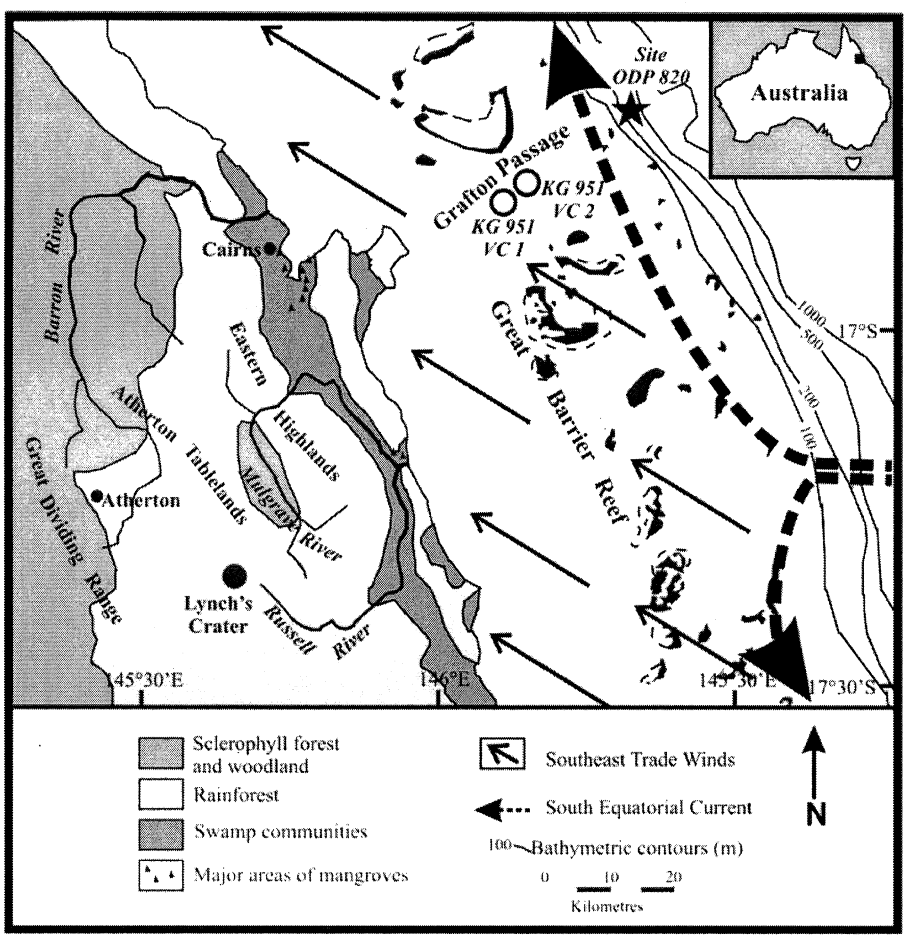

Figure 1: Location of study area in relation to the present vegetation of the humid tropics, the southeast trade winds and major marine current flows.

Pollen records recovered from marine sediments offer the possibility of greatly extending knowledge of continental vegetation change and directly comparing these terrestrial alterations with marine environmental evidence, in particular oxygen isotope data. One such record is from ODP site 820 (16°38′S, 146°18′E, water depth - 280 m), which is situated seaward of the Great Barrier Reef on the continental slope, about 40 km from the coast and about 100 km from Lynch's Crater (Fig. 1.). This record was collected to examine the evolution and development of the Queensland plateau and investigate the formation of the Great Barrier Reef (Davies and McKenzie, 1993). The entire 400-m length of ODP site 820 is thought to cover the last 1.4 million years (Peerdeman et al., 1993). In addition, high pollen yields have been obtained from the ODP 820 sediments, which provide insight into late Quaternary terrestrial environments (Moss and Kershaw, 2000; 2007). The pollen and charcoal catchment of the ODP site 820 record, covering an altitudinal range from sea level to about 1600 m, includes areas now supporting lowland to montane rainforest (which occupies areas receiving about 1500mm to in excess of 4000mm of mean annual rainfall), sclerophyll vegetation (which dominates the landscape under mean annual rainfall levels of less than 1500mm), small patches of araucarian forest (occurs in areas receiving around 1500mm), coastal swamps (on poorly drained soils) and mangrove areas (mainly around Trinity and Mutchero Inlets) (Tracey 1982). Major components of pollen and charcoal are mainly derived from both the Russell/Mulgrave and Barron rivers systems (Kershaw, 1994; Moss et al., 2005). Both of these river systems drain a substantial part of the region.

Top (m)	Bottom (m)	ANSTO#	Age (14C years)	Error	This study	P+D 1993	P+D 1993	Difference (yrs) (foram-pollen)
					Cal BP	14C BP	Cal BP*	
2.43	2.48	OZJ311	5620	70	6380	4944	5269	1111
3.25	3.27	OZJ312	7350	80	8120	6304	6750	1370
3.65	3.67	OZJ313	7970	110	8860	6968	7485	1375
3.93	3.98	OZJ314	8140	80	9070	7396	7852	1218
4.25	4.27	OZJ315	8180	70	9090	7475	7927	1163
5.64	5.68	OZJ316	8570	70	9520	8954	9544	-24
6.05	6.07	OZJ317	9320	80	10510	9365	10162	348
6.93	6.98	Lost				14780	16969	-
7.2	7.27	OZJ319	15740	120	18950	31000	35991	-17041
7.4	7.47	OZJ320	18360	160	21860	41200	45451	-23591
7.9	7.97	No sample				43600	47526	25666

Table 1: Comparison between pollen concentrate and foram ages (AMS C^{14}). calibrations. Foraminfera: A reservoir correction of 375 years was subtracted from the reported age and the marine calibration of Fairbanks, et al., 2005 and the online calculator at http://www.radiocarbon.ldeo.columbia.edu/. *P+D = Peerdeman and Davies, 1993.

Previous palynological studies based on the ODP 820 marine core and the nearby Lynch's Crater record in North Queensland show there are important differences in pollen assemblage and timing of events between these two sites. This difference was, in part, attributed to the long, water-borne transport pathway between the primary source region for pollen and final depositional environment (Moss et al., 2005; Moss and Kershaw, 2007; Fig. 1). Therefore, we expect to find pollen ages similar to, or older than, foraminifera ages from the same core depth (as foraminifera have life spans of ~months and settle rapidly to the seabed after death), with the magnitude of the age difference being dependent on a number of factors, including sea level and fluvial discharge rates. If production and transport of pollen and foraminifera are the only mechanisms controlling the relative ages of each in the ODP 820 core, pollen can not be younger than foraminifera recovered from the same core depth. Table 1 shows that the Holocene ages for both the foraminifera and pollen are consistent with this theory. However, the Last Glacial Maximum (LGM)/Marine Isotope Stage (MIS) 3 ages are not, with the pollen ages being significantly younger than the foraminifera ages. Importantly, the age discrepancy is most pronounced during what has previously been interpreted as the period from MIS 4 through to MIS2. However, dating this interval at ODP site 820 has proved difficult due to ambiguities in oxygen isotope and biostratigraphic datum as well as large, abrupt, changes in sedimentation rate and composition (e.g. Peerdeman et al., 1993; Peerdeman and Davies 1993). Evidence of a significant vegetation change (decline in araucarian taxa, increase in myrtaceous taxa) occurred in the ODP record at 15 m and suggests that the terrestrial sediments in the ODP 820 record are providing a continuous record through the Late Pleistocene period, as this alteration is very similar to one seen in the Lynch's Crater record and has been dated to around 45,000 years BP (Turney et al. 2001). These results suggest that there is some unreliability associated with the initial foraminifera AMS C^{14} dates and there have been some reports that the foraminifera in the ODP 820 record may have undergone some diagenesis, which may have impacted the reliability of the foraminifera ages around 7 to 8 mbsf (metres below sea floor) (Peerdeman, 1993; Lawrence and Herbert, 2005). However, the generation of good age control through AMS C^{14} dating of the pollen concentrate provides the potential to extend radiocarbon dating through the deeper ODP 820 sediments and resolve uncertainty in the age model. This in turn will greatly improve our understanding of environmental change in the humid tropics region during a period of time that also likely included the arrival of people in North Queensland (e.g. David, 1993, Kershaw, 1994, Moss and Kershaw, 2000).

Acknowledgements

We would like to thank the support of the Integrated Ocean Drilling Program (IODP) for suppling samples. ANSTO dated the pollen concentrate samples through an AINSE Grant to P.T. Moss, G Dunbar & G. Dickens (# 06-129).

References

David, B., 1993. Ngarrabullgan cave: preliminary results from a pre-37,000 year old rockshelter, North Queensland, Arch. Oceania 28, 50-54.

Davies, P.J., McKenzie, J.A., 1993. Controls on the Pliocene-Pleistocene evolution of the northeastern Australian continental margin. Proc. ODP, Sci. Results 133, 755-762.

Fairbanks, R.G., Mortlock, R.A., Cao, L., Kaplan, A., Guilderson, T.P., Fairbanks, T.W., Bloom, A.L., Grootes, P.M., Nadeau, M-J. 2005. Radiocarbon calibration curve

spanning 0 to 50,000 years BP based on paired $^{230}Th/^{234}U/^{238}U$ and ^{14}C dates on pristine corals. Quat. Sci. Rev. 16-17. 1781-1796.

Kershaw, A.P., 1994. Pleistocene vegetation of the humid tropics of northeastern Queensland, Australia. Palaeogeogr., Palaeoclimatol., Palaeoecol. 109, 399-412.

Lawrence, K.T., Herbert, T.D., 2005. Late Quaternary sea-surface temperatures in the western Coral Sea: Implications for the growth of the Australian Great Barrier Reef. Geology 33, 677-680.

Moss, P.T., Kershaw, A.P., 2000. The last glacial cycle from the humid tropics of northeastern Australia: comparison of a terrestrial and marine record. Palaeogeogr., Palaeoclimatol., Palaeoecol. 155, 155-176.

Moss, P.T., Kershaw, A.P., Grindrod, J., 2005. Pollen transport and deposition in riverine and marine environments within the humid tropics of northeastern Australia. Rev. of Pal. Pal 134, 55-69.

Moss, P.T., Kershaw, A.P., 2007. A late Quaternary marine palynological record (oxygen isotope stages 1 to 7) for the humid tropics of northeastern Australia based on ODP Site 820. Palaeogeogr., Palaeoclimatol., Palaeoecol. 251, 4-22.

Peerdeman, F.M., 1993. The Pleistocene climatic and sea-level signature of the northeastern Australian continental margin., unpublished PhD thesis, Australian National University, Canberra, Australia.

Peerdeman, F.M., Davies, P.J., 1993. Sedimentological response to an outer-shelf, upper-slope sequence to rapid changes in Pleistocene eustatic sea level: Hole 820A, northeastern Australian Margin. Proc. ODP Sci. Results 133, 303-313.

Peerdemann, F.M., Davies, P.J., Chivas, A.R., 1993. The stable oxygen isotope signal in shallow-water, upper-slope sediments off the Great Barrier Reef (Hole 820A). Proc. ODP Sci. Results 133, 163-173.

Tracey, J.G., 1982. The vegetation of the humid tropical region of north Queensland. CSIRO, Melbourne; Australia.

Turney, C.S.M, Kershaw, A.P., Moss, P., Bird, M.I., Fifield, L.K., Cresswell, R.G., Santos, G.M., Di Tada, M.L., Hausladen, P.A., Youping, Z., 2001. Redating the onset of burning at Lynch's Crater (North Queensland): implications for human settlement in Australia. J. Quat. Sci. 16, 767-771.