

Europlanet TNA Report

PROJECT LEADER

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COLLABORATORS

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Date of TNA visit:	15/03/2010-26/06/2010
Host laboratory:	Vrije Universiteit Amsterdam (TNA2)

Project Title – ATOS Antarctic Terrigenous Oceanic supply

- Report on the outcomes of the TNA visit (approx 1 page)

The Europlanet project ATOS planned to analyze two sets of 20 samples for Sr, Nd and Pb chemistry (plus blanks and standard), using TIMS facilities (MAT 262) and MC-ICP-MS for Nd and Pb. We did attempt to analyze these two sets of samples within two weeks, but it was far too optimistic, as indicated by the host institution when they were approached, even working 12 hours per day including week-ends. For instance, the HF digestion already takes 4 days. However, I managed to analyze Sr isotopic composition of the whole set (40 samples) and achieved part of the Nd chemistry (REE extraction). The Nd separation still needs to be completed.

Multiproxy analyses of a core collected off Wilkes Land (Antarctica) revealed major modifications of terrigenous sedimentation during glacial intervals, suggesting deep-currents reorganization: detrital sedimentation results from both proximal continental inputs and distal volcanic supplies during interglacial intervals. The volcanic contribution seems to disappear during glacial periods as the result of major alteration of deep circulation. The isotopic signatures (Nd-Sr-Pb) of detrital fine-grained sediments allow reconstructing the provenance of oceanic terrigenous supplies over the last 500 kyr. The old continental crust characterizing the Wilkes Land results in low epsilon Nd and high Sr and Pb isotopic compositions (Hemming *et al.*, 2007; Roy *et al.*, 2007; van de Flierdt *et al.*, 2007) while distal oceanic volcanic sources would provide rather different isotopic composition (low $^{87}\text{Sr}/^{86}\text{Sr}$, positive epsilon Nd values).

The Sr results are really exciting as it was expected. $^{87}\text{Sr}/^{86}\text{Sr}$ ranges between 0,71709 and 0,73559 stressing major changing provenance of the clay-size particles over the last 500 kyr, with low Sr occurring during interglacial periods (MIS 1, MIS5, MIS7, MIS9 and MIS11) contrasting with high ratio during glacial (MIS2, MIS6, MIS8, MIS12). The lowest Sr compositions clearly reflect distal oceanic supply from volcanic areas during the deglaciation while the highest Sr ratios is directly related with prominent proximal inputs from the adjacent Wilkes Land old continental crust during glacial (Bout-Roumazelles et al., 2010). According to regional geology and previously published Sr isotopic ratios distribution around Antarctica, the less radiogenic Sr characterizing the Holocene may result from volcanic supply from either the Kerguelen Plateau; via the Antarctic Circumpolar Current (ACC) or the Antarctic Peninsula, via the westward flowing currents south of the ACC (Hemming *et al.*, 2007; Roy *et al.*, 2007; van de Flierdt *et al.*, 2007). Determining particles provenance is crucial, as the main objective is to document the glacial/interglacial variability of oceanic circulation around Antarctica and to compare its past evolution with the paleoclimate record from Antarctica ice-core (EPICA, 2004). Previous studies around Kerguelen Plateau evidenced modifications of the ACC during the last glacial period compared with the Holocene (Dezileau *et al.*, 2000; Mazaud *et al.*, 2007; Mazaud *et al.*, 2010), taking part of the interhemispheric see-saw phenomenon between the north Atlantic and southern ocean (Barker *et al.*, 2009). Moreover, maximum $^{87}\text{Sr}/^{86}\text{Sr}$ ranges (0,73559 to 0,71709) are observed during the oldest part of the record during the MIS12-MIS11 transition (424 ka) and the MIS10-MIS9 transition (337 ka), whereas the $^{87}\text{Sr}/^{86}\text{Sr}$ minimum range (0,72786 to 0,72320) characterizes the last termination (MIS2-MIS1 transition, 14 ka). These results evidence that the deep circulation was submitted to much stronger variations during former climatic cycles compared to the last one. The dataset indicates that the relative contribution of advected material through deep-water masses vs. proximal inputs was enhanced during interglacial stages 5, 11 and 13, while deep advection was drastically reduced during glacial stages 10 and 12. The isotopic results suggest varying intensity of deep water-masses reorganization at glacial-interglacial timescale over the last climatic cycles.

Barker, S., Diz, P., Vautravers, M., Pike, J., Knorr, G., Hall, I.R., Broecker, W.S. 2009. Interhemispheric Atlantic seesaw response during the last deglaciation, *Nature*, 457, 1097-1102. Doi:10.1038/nature07770.

Dezileau, L., Bareille, G., Reyss, J.L., Lemoine, F. 2000. Evidence for strong sediment redistribution by bottom currents along the southeast Indian ridge, *Deep-Sea Research 1*, 01899-1936.

EPICA community Members, 2004. Eight glacial cycles from an Antarctic ice core, *Nature*, 429: 623-628.

Fagel, N., Innocent, C., Gariépy, C. and Hillaire-Marcel, C. 2002. Sources of Labrador Sea sediments since the Last Glacial Maximum inferred from Nd-Pb isotopes. *Geochimica Cosmochimica Acta*, **66**: 2569-2581.

Hemming, S. R., T. van de Flierdt, S. L. Goldstein, A. M. Franzese, M. Roy, G. Gastineau, and G. Landrot 2007, Strontium isotope tracing of terrigenous sediment dispersal in the Antarctic Circumpolar Current: Implications for constraining frontal positions, *Geochem. Geophys. Geosyst.*, 8, Q06N13, doi:10.1029/2006GC001441.

Mazaud, A., Laj, C., Kissel, C., Sicre, M.A., Michel, E., Turon, J.L. 2007. Variations of the ACC-CDW during MIS3 traced by magnetic grain deposition in mid-latitude South Indian Ocean: connections with the northern hemisphere and with central Antarctica, *Geochem. Geophys. Geosyst.*, 8: Q05012, doi:10.1029/2006GC001532.

Mazaud, A., Michel, E., Dewilde, F., Turon, J.L. 2010. Variations of the Antarctic Circumpolar Current during the past 500 ka, *Geochem. Geophys. Geosyst.*, 11: Q08007, doi:10.1029/2010GC003033.

Roy, M., van de Flierdt, T., Hemming, S.R. and Goldstein, S.L. 2007. $^{40}\text{Ar}/^{39}\text{Ar}$ ages of hornblende grains and bulk Sm/Nd isotopes of circum-Antarctic glacio-marine sediments: Implications for sediment provenance in the southern ocean. *Chemical Geology*, **244**: 507-519.

van de Flierdt, T., Goldstein, S.L., Hemming, S.R., Roy, M., Frank, M. and Halliday, A.N. 2007. Global neodymium-hafnium isotope systematics -- revisited. *Earth and Planetary Science Letters*, **259**: 432-441.

- Publications arising/planned (include conference abstracts etc)

Bout-Roumazeilles V., Bory A., Beucherie A., Crosta X., Schmidt S., Presti M. 2010. Glacial - interglacial change in detrital supplies off Wilkes Land - Antarctica= paleoceanographic implications. *10th International Conference on Paleooceanography (ICP10)*, August 29th - September 3, University of California San Diego (UCSD), USA.

Bout-Roumazeilles V., Bory A., Beucherie A., Crosta X., Schmidt S., 2010. Glacial-interglacial terrigenous changing provenance off Wilkes Land - Antarctica. *Geophysical Research Abstracts*, vol.12, 8062, 2010.

Bout-Roumazeilles V., Davies G., Bory A., Beucherie A., Crosta X., Presti M, Michel E., Schmidt S. Isotopic evidence of glacial -interglacial changing sediment provenance off Wilkes Land (Antarctica): paleoceanographic implications. *Quaternary Science Reviews*, in prep.

- Host approval The host is required to approve the report agreeing it is an accurate account of the research performed.

Dear Dr Bout,

this note is to acknowledge that I have seen and approved the report that you submitted with respect to your Europlanet funded visit to VU Amsterdam. I am also delighted that you have shown the initiative and determination to undertake a more detailed study and obtained funds for a further visit to Amsterdam. I look forward to our continued discussions and helping you produce a publication in the near future.

Gareth Davies

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