Europlanet TNA Report

PROJECT LEADER

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Date of TNA visit:	October 2010 – March 2011
Host laboratory:	Vrije Universiteit Amsterdam (TNA2)

Project Title – ATOS2 Antarctic Terrigenous Oceanic supply

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

ATOS 2: The Europlanet project ATOS2 has been planned to complete our initial ATOS project and required to achieve the Nd and Pb measurements by TIMS and MC-ICP-MS analyses, using the TNA2 facilities at the Vrije Universtiteit (VU) Amsterdam. The sample dissolution was completed during ATOS1 and the Nd work requires one further column separation. The Pb chemical separation was also to be done.

Determining particles provenance is crucial, as the main objective of the study 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), taking part of the interhemispheric see-saw phenomenon between the north Atlantic and southern ocean (Barker et al., 2009).
Sedimentological analyses (clay mineralogy, grain-size distribution, elemental geochemistry) of a core collected off Wilkes land (Antarctica) revealed a major modification of terrigenous sedimentation during glacial intervals (Marine Isotopic Stage 2, MIS6, MIS8, MIS10) suggesting deep-currents reorganization. Sedimentological and geochemical data indicate that detrital sedimentation results from both proximal continental inputs (i.e. Wilkes Land Antarctica) and distal volcanic supplies during interglacial intervals (Holocene, MIS5, MIS7, MIS9 and 11). The volcanic contribution seems to disappear during glacial periods as the result of major alteration of deep circulation. The old continental crust characterizing the Wilkes Land results in low epsilon Nd (-12 to -20), and high Sr and Pb isotopic compositions

(Hemming *et al.,* 2007; Roy *et al.,* 2007; van de Flierdt *et al.,* 2007). By contrast, distal oceanic volcanic sources (as Kerguelen Plateau or Antarctic Peninsula) would provide rather different isotopic composition (low $^{87}Sr/^{86}Sr$, positive epsilon Nd values).

In summary, isotopic signatures (Nd-Sr-Pb) of fine-grained sediments deposited off Wilkes Land are the best tools to reconstruct the evolution of the circum-Antarctic current over the four last climatic cycles and to improve paleoceanographic reconstitutions.

The Sr results obtained during ATOS were really exciting. $^{87}Sr/^{86}Sr$ ranges between 0,72227 and 0,72786 stressing major changing provenance of the clay-size particles over the last climatic cycle with low Sr isotope ratios occurring during the Holocene contrasting with high ratio during the last deglaciation (termination I). 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. 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).

The Nd data obtained during ATOS2 agree with the $^{87}Sr/^{86}Sr$ record: the epsilon Nd varies between –11 and –16, with high values characterizing the interglacials (epsilon Nd> -13.5) whereas lower epsilon Nd characterizes the glacials (ca –15). The last climatic cycle displays a striking feature with lower epsilon Nd during MIS1 than during MIS2-4. This result confirms the major modification/reorganization of deep circulation during the last climatic cycle compared with previous climatic cycles evidenced by the $^{87}Sr/^{86}Sr$ record. The whole set of data samples plot on a mixing line between a “young” volcanic end-member and an “old” crustal end-member in the epsilon Nd vs. $^{87}Sr/^{86}Sr$ diagram, but define rather distinct domains. The IG samples plot near the “volcanic” enc-member whereas the G samples are located near the “crustal” end-member.

These results emphasized the need for constraining the southern ocean circulation over the last climatic cycles. In that frame, Sr and Nd data point out volcanic sources but Pb should definitively help us to discriminate between the different volcanic sources. Indeed Kerguelen Archipelago (KA) and Antarctic Peninsula (AP) are characterized by rather close $^{87}Sr/^{86}Sr$ (0.70269-0.70336 for AP vs. 0.704740-0.705060 for KA) and $^{143}Nd/^{144}Nd$ ratios (0.512830-0.512994 for AP and 0.512680-0.512728 for KA) but display rather distinct Pb isotopic ratios. Indeed the $^{208}Pb/^{204}Pb$ and $^{206}Pb/^{204}Pb$ ratios respectively range from 38.30 to 38.80 and from 18.79 to 19.28 in Antarctic Peninsula whereas these ratios vary between 38.81 and 38.97 for $^{208}Pb/^{204}Pb$ and 18.37 to 18.46 for $^{206}Pb/^{204}Pb$ in Kerguelen Archipelago (Hole *et al.,* 1993; Xu *et al*., 2007).

The Pb data obtained during ATOS2 are really peculiar. The $^{208}Pb/^{204}Pb$, $^{207}Pb/^{204}Pb$, $^{206}Pb/^{204}Pb$ display similar variations, exhibiting a larger range of variability over the older part of the record (MIS13 to MIS5) compared to the last climatic cycle. Interglacial periods are characterized by higher lead isotopic ratios ($^{208}Pb/^{204}Pb$ =38.78, $^{206}Pb/^{204}Pb$= 18.59) compared with glacial stages (($^{208}Pb/^{204}Pb$ =38.33, $^{206}Pb/^{204}Pb$= 18.33). The lower lead isotopic ratios characterizing glacial periods are consistent with a reduced contribution of old continental crust ($^{206}Pb/^{204}Pb$= 14.8-15 and $^{207}Pb/^{204}Pb$=14.5; Murphy *et al.*, 2003). The lead isotopic ratios do not show this G/IG variability but rather display decreasing ratios toward the present. The most recent sample is characterized by the lowest $^{208}Pb/^{204}Pb$ and $^{206}Pb/^{204}Pb$ (38.18 and 18.18 respectively) while both the epsilon Nd (-14.6) and $^{87}Sr/^{86}Sr$ (0.723) agree with previously published data (Hemming *et al*., 2007; Roy *et al*., 2007; van de

Flierdt *et al*., 2007). The lead isotopic data obtained during ATOS suggest that the Kerguelen Archipelago was potentially a source for detrital particles during previous IG periods, but could not explain the last climatic cycle specific trend (Kempton *et al.*, 2002). The comparison with previously published data (Abouchami & Goldstein, 1995; Weis *et al.*, 1993) indicates that the highest lead isotopic ratios measured during IG periods are consistent with values obtained for the SE Indian ridge ($^{208}Pb/^{204}Pb$ =38.7 to 38.8) but are lower than the ratios characterizing the Australian Antarctic Ridge ($^{208}Pb/^{204}Pb$= 38.7 to 39.2 between 3500 and 3674 meters depth, $^{208}Pb/^{204}Pb$>39 below 3950 meters depth).

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.

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- 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 Paleoceanography* (ICP10), August 29th - September 3, University of California San Diego (UCSD), USA.

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- Host approval

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