# PLIOCENE EAST ANTARCTIC ICE SHEET INSTABILITY

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Warm climatic intervals during the Pliocene Epoch (5.33-2.58 Ma) are apt analogues with which to compare future climate scenarios, but there are currently no direct constraints on the dynamics of the East Antarctic Ice Sheet (EAIS) in potentially vulnerable low-lying regions during these times. Analyses of the isotopic provenance of multiple detrital marine sediment components can offer novel insights into the spatial and temporal response of the EAIS to climatic change, on both glacial-interglacial and longer-term timescales.

Here we present results of neodymium and strontium isotopic analyses of clay and silt sediment fractions (<63um), and argon isotope ages of individual hornblende grains from ice-rafted detritus (IRD) (>150um), from ODP Site 1165 (64˚22-77S, 67˚13-14E), Prydz Bay, and IODP Site U1361 (64˚24-57S, 143˚53-19E), Adelie Land. Both sites are ideally located to receive terrigenous sediments sourced from the Wilkes and Aurora Subglacial Basins, where large areas of the EAIS lie below sea level in direct contact with the Southern Ocean.

Pliocene clay and silt sediments from IODP U1361 reveal two distinct $\varepsilon_{Nd}$ and $^{87}Sr/^{86}Sr$ endmembers – the first matches Early Paleozoic terranes found to the east ($\varepsilon_{Nd}$:- -11 to -16 and $^{87}Sr/^{86}Sr$ values of 0.721 to 0.730), and the second displays a mixed signature between these same terranes and the Jurassic-Triassic Ferrar Large Igneous Province (FLIP) ($\varepsilon_{Nd}$: -4 to -7; $^{87}Sr/^{86}Sr$: 0.712 to 0.719). Sediments characterised as the latter endmember are consistently found during high productivity (warm) intervals as revealed by physical property and bulk geochemistry measurements in U1361, at 4.8-4.6, 4.3-4.2 and 4.05-3.9 Ma. These time intervals additionally appear to correspond to maxima in modelled solar insolation. In fact, FLIP strata have been inferred within the Wilkes Subglacial Basin by aero-geophysical surveys as far as 74.3°S, suggesting this area may be the most likely source for the endmember approaching FLIP composition identified in U1361, and implies that the Wilkes Subglacial Basin may be a source of EAIS destabilisation during warm intervals in the Pliocene.

Late Pliocene sediments (3.3-2.8 Ma) from ODP Site 1165 display an increase in IRD hornblende $^{40}Ar/^{39}Ar$ ages of 1100-1300 Ma during interglacial intervals. This signature has not been identified on-land proximal to the study site, but matches very well hornblende argon isotope ages in modern marine sediments offshore of the Aurora Subglacial Basin, some 2000 km away from Site 1165. A Wilkes Land IRD provenance signal is positively correlated to detrital $^{87}Sr/^{86}Sr$ and εNd signatures in the <63um fractions, implying that ice sheet destabilisation of the Aurora Subglacial Basin played an important control on bulk sediment composition in the Prydz Bay area in the Late Pliocene.

Overall, the radiogenic isotope compositions of multiple detrital marine sediment components at two locations in the Southern Ocean suggest significant destabilisation events of the EAIS in the vicinity of the Wilkes and Aurora Subglacial Basins in response to Pliocene climatic warmth, with significant implications for future sea level estimates.

# W isotopic composition of IVB iron meteorites

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## Introduction

The investigation of W isotope anomalies in meteorites is of interest because of the former presence of the short-lived isotope $^{182}$Hf, which decays to $^{182}$W. Thus, variations in $^{182}$W can be used to infer timescales of early solar system processes [*e.g.,* 1] However, the application of Hf-W chronometry relies on the assumption that W isotopes were homogeneously distributed in the solar nebula. This assumption appears to be valid for most meteoritic samples, but small deficits in s-process W isotopes have been observed in group IVB irons [2] and CAIs [3]. More recently, excesses in $^{180}$W have been measured in several magmatic iron groups [4]. These data seem to imply heterogeneity of W isotopes in the early nebula, but these results have been questioned [5]. We report new isotopic measurements for several IVB irons to examine the extent of nucleosynthetic W isotope anomalies in this group.

## Samples and Analytical Methods

We analyzed three IVB irons, and we processed two aliquots of the NIST W solution standard (SRM 3163) and one aliquot of a NIST Fe-Ni steel (SRM 361) using our chemical separation protocol for W. Isotopic measurements were made with a ThermoScientific Neptune *Plus* MC-ICPMS in low resolution mode. Signal intensities for both $^{180}$W and $^{178}$Hf were measured using $10^{12}$ Ohm resistors. The interference correction on $^{180}$W from $^{180}$Hf was tested by analyzing several aliquots of SRM 3163 doped with Hf.

## Results and Discussion

All three of the NIST samples of terrestrial W have $\varepsilon^{180}$W values within uncertainty of zero. These results demonstrate the accuracy of the method and do not suggest the presence of analytical artefacts on the W masses in low-resolution mode, which was recently suggested [5] to explain a previous report [4] of $^{180}$W excesses in magmatic iron meteorites. Furhermore, the results for SRM 3163 doped with Hf show that the interference correction on $^{180}$W is accurate for the range of Hf/W ratios of the samples. The $\varepsilon^{180}$W values for all three IVB irons agree within uncertainty; the data hint at a slight $\varepsilon^{180}$W excess, but this excess is not unambiguously resolvable at the current level of precision. All three IVBs exhibit small $\varepsilon^{184}$W deficits, consistent with previous results [2]. The $\varepsilon^{182}$W values of all three IVBs are below the CAI initial [3], indicating neutron-capture induced shifts in the W isotope abundances caused by cosmic rays. This process may also lower $\varepsilon^{180}$W values, but the magnitude of the effect is currently unknown. Efforts are underway to improve the precision of the measurements as well to perform analysis of additional samples.

[1] Kleine *et al.* (2009) *GCA* 73, 5150-5188. [2] Qin *et al.* (2008) *ApJ* 674, 1234-1241. [3] Burkhardt *et al.* (2008) *GCA* 72, 6177-6197. [4] Schultz & M nker (2010) *73rd Met. Soc.* #5116.
[5] Holst, Paton & Bizzarro (2011) *Workshop on Formation of the First Solids in the Solar System* #9065.