THE AUSTRALIAN-ANTARCTIC DISCORDANCE AS A LONG-LIVED MANTLE BOUNDARY: EVIDENCE FROM Hf-Nd-Pb ISOTOPE ANALYSES OF 14-28 Ma BASALTS FROM ODP LEG 187.

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Introduction: The AAD is an unusually deep (4-5 km) region of the global mid-oceanic spreading system centered on the Southeast Indian Ridge (SEIR) between Australia and Antarctica. Its anomalous depth reflects the presence of both unusually cold mantle, low melt supply and thin crust [1-2]. The topographic expression of the depth anomaly forms a shallow, west-pointing V-shape which cuts across the major fracture zones of the eastern AAD and implies that the depth anomaly has migrated westward at a long-term rate of ~15 mm/yr [3]. The AAD also encompasses an unusually sharp compositional boundary between Pacific MORB-source mantle (PMM) and Indian MORB-source mantle (IMM) isotopic domains [2], but the chemical boundary may be migrating at a different rate from the depth anomaly [4]. IMM and PMM have previously been distinguished largely on the basis of Pb isotopes. However, Pb isotopes are easily disturbed by alteration and/or low grade metamorphism; similarly, the most effective trace element ratios for discriminating IMM and PMM ratios (e.g. Ba/Zr) are alteration-sensitive and may additionally be complicated by partial melting and magma chamber processes. Here we present new high precision PIMMS Hf and Pb isotope data for basalts from the AAD: (1) to assess the utility of Hf-Nd isotopes as an IMM-PMM discriminant, (2) to extend the characterization of the mantle boundary from on axis to older (14-28 Ma) off axis crust, and (3) to address questions of the origin and evolution of the AAD.

Results: Consistent with the conclusion of Pearce et al., [5] our new data for basalts from Leg 187 show that combined Nd-Hf isotope systematics can be used as an effective disciminant for IMM vs PMM (Fig. 1). In particular, IMM is displaced to lower εNd and higher εHf ratios compared to PMM. As with Pb isotope plots, there is virtually no overlap between the two mantle types. The new boundary shown here has a slightly steeper slope than that proposed by Pearce et al. [5], i.e. $y = 2.56x - 8.46$. Similar to recent on-axis lavas erupted within and along the AAD [6], IMM basalts from Leg 187 have highly variable isotopic compositions, whereas PMM are more restricted in composition. Of the 13 sites drilled during Leg 187, seven appear to have sampled exclusively IMM and four exclusively PMM. At two sites (i.e. 1157 and 1158), basalts derived from both mantle domains have been recovered within close proximity. However, even at these sites the two mantle domains retain their compositional integrity, as IMM and PMM form separate and parallel arrays in a plot of $^{208}Pb/^{204}Pb$ vs εHf, with virtually no overlap between the two mantle types. Only one sample from Site 1157 appears to have a mixed mantle provenance, having PMM-like Pb, but IMM-like εHf, εNd and Nb/Y. A similar situation is observed for two samples occurring very close to the modern day boundary, one from the eastern end of Zone B5 and one from the western end of Zone A.

Discussion: Christie et al. [1] proposed two competing hypotheses to explain the tectonic and compositional characteristics of the AAD. Either the isotopic boundary migration is a localised perturbation of a geochemical feature associated with the eastern boundary of the AAD since the basin opened, or the migration is a long-lived phenomenon that has only recently brought Pacific mantle beneath the AAD. Our new Nd-Hf-Pb isotope data indicate that the boundary between IMM and PMM coincides with the eastern edge of the basin-wide arcuate depth anomaly that is centered on the AAD, consistent with the suggestion of Russo et al. [7] based on trace element data. Our data further indicate that although all the IMM sites have similarly low Pb isotope values (i.e. $^{206}Pb/^{204}Pb < \sim 18.1$), the westernmost drill sites (i.e. those thought to be from the extrapolation of present day Zones B4 and B5 off axis) tend to have lower εNd and εHf, but higher Nb/Y than those further east, indicating a slightly less depleted source for the latter. this may be due to incorporation of at least some plume component in the mantle source for these basalts. In addition, the data indicate that in spite of existing in close proximity in Zone A, both upper mantle domains have maintained their distinctive characteristics for at least 30 m.y.

References: [1] Christie et al. (1998) *Nature 394*, 637-644; [2] Klein et al. (1988) *Nature 333*, 623-629; [3] Marks et al. (1991) *EPSL 103*, 325-338; [4] Pyle et al. (1995) *JGR 100*, 22261-22282; [5] Pearce & Kempton et al. (1999) *J. Pet. 40* 1579-1611 [6] Hanan et al. (2000) *J. Conf. Abstr. 5(2)*, 478; [7] Russo et al. (2000) *EOS Trans AGU 81*, F1285

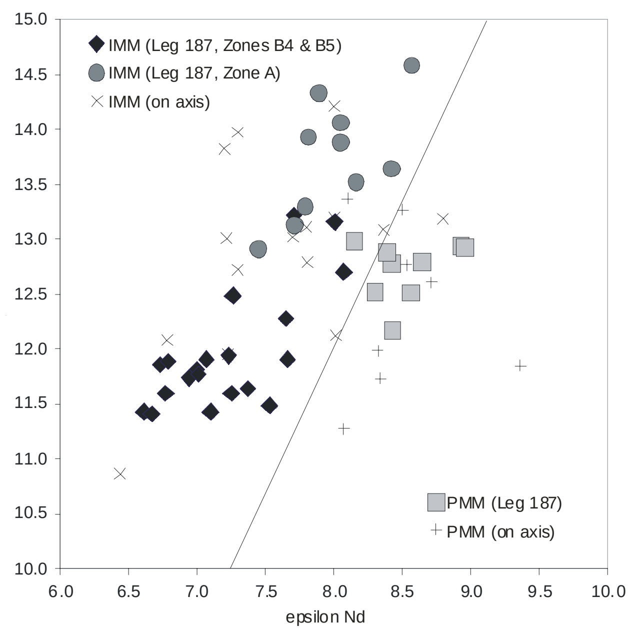

Fig. 1. Mantle provenance designation based on Pb isotopes. On axis samples kindly provided by D. Pyle and C. Langmuir..