Melting processes across ocean-scale mantle provinces: Insights from U-series disequilibria at the Australian-Antarctic Ridge

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The Australian-Antarctic Ridge (AAR) was one of the last remaining expanses of unexplored mid-ocean ridges on Earth. Since 2011, sampling by the IBRV *Araon* from the Korean Polar Research Institute have changed this. New isotope data indicate that the AAR is isotopically distinct from the Pacific and Indian ridge systems (Park et al., in revision). The existence of a new mantle province between the Indian and Pacific provinces, the Southern Ocean Mantle, has now been inferred. To compare the melting dynamics of this new mantle province to Pacific and Indian Ridges, we conducted U-series measurements on 35 basalts from the AAR. (^{230}Th/^{238}U) ratios range from ~1.3 to 1.7, and are the highest measured thus far in MORB. (^{226}Ra/^{230}Th) ranges from 1.0 to ~2.2. (^{226}Ra/^{230}Th) and (^{230}Th/^{238}U) are negatively correlated, consistent with mixing of deep and shallow melts to produce mid-ocean ridge basalts (Sims et al., 2002; Stracke et al., 2003). The high ^{230}Th excesses, which have low or equilibrium (^{226}Ra/^{230}Th), are hard to produce by simple models of melt genesis and magma migration. However, Hirth and Koldstedt (1996) have suggested that small melt fractions have high H_2O and are produced deep in the mantle, and channelized flow that could enable these melts to reach the surface from deep (Keller et al., 2017). We posit that the highest Th excesses in our samples represent these initial deep melts. Because they have near or equilibrium (^{226}Ra/^{230}Th) they have taken greater than 8 ka to migrate to the surface, consistent with the suggestions of Sims et al. 2002. In this work we also comapre U-Th-Ra disequilibria with major and trace element abundances and long lived radiogenic isotopes and show that the new Southern Ocean Mantle province has distinct sources and experiences unique melting processes. Thus our data indicate that compositional distinctions across ocean-scale provinces affect the physical melting process beneath mid-ocean ridges.