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Mantle Structure revealed through high Density Sampling of Ocean Ridges and Islands.

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Recent improvements in measurement techniques allow for more precise isotope analyses as well as higher sample throughput and allowing us to obtain a more detailed oicture through high density sampling. Consequently, we are now at the beginning of an era of discovery that follows from obtaining a higher resolution image. For example, for three decades Hf and Nd isotopic compositions in ocean island basalts have been very well correlated, but MORB have not show a good correlation between the two isotope systems. Is this a lack of correlation in MORB is related to sample density or are the Nd and Hf isotope systems are truly uncorrelated? Detailed investigations of the variations in Nd and Hf isotopic compositions in MORBs at normal ridges and from restricted geographic areas requires high precision data as the isotopic variations in N-type MORB are relatively small. For example, at the Mid-Cayman Rise the Hf-isotopic composition varies by 1.2 epsilon units. Our data from the Pacific, Atlantic and Indian Ocean show that, on a local scale, despite the limited variations the Nd and Hf isotopic compositions are well correlated. On a Hf-Nd isotope correlation diagram MORB from ridges far removed from hot-spots form parallel "local" arrays with similar slope as MORB from hotspot-influenced ridges, indicating that the nature of the heterogeneity that causes the local Hf-Nd isotope variation can be related to contamination by "enriched" OIB-type mantle. The parallel "local" arrays (differing Hf-isotopic composition) suggest a second larger scale length heterogeneity most likely related varying amounts of recycled oceanic lithosphere, which has a radiogenic Hf-isotopic composition.

Our detailed investigation along the East Pacific Rise provides evidence for asymmetric accumulation of low degree melts. Stepform crustal thickness variations at ridge discontinuities along the East Pacific Rise are proposed to be related to asymmetric melt accumulation as a consequence of the migration of the ridge. It is proposed that melts formed deep in the melting regime at the trailing end of a ridge segment will cross the discontinuity and accumulate on the other side of the discontinuity resulting in increased crustal thickness on the leading edge.

Thirdly, we resampled and reanalyzed a suite of basalts from Makapuu Head on Koolau volcano, the isotopically enriched endmember of Hawaiian lavas. In $^{208}Pb/^{204}Pb$ vs $^{206}Pb/^{204}Pb$ space our new data forms a steeper slope than the KSDP lavas, and extend towards more unradiogenic Pb ratios than previously published. In contrast to the KSDP lavas, the Makapuu lavas converge with the posterosional Honolulu volcanics and Salt Lake Crater pyroxenite compositions (our new data) in the unradiogenic Pb isotope end. In $^{208}Pb/^{204}Pb$ vs. Nd isotopes the Makapuu lavas also extent towards the isotopically depleted endmember of the Hawaiian plume compositions as this is defined by the Honolulu volcanics and the pyroxenites. These observations are consistent with the presence of an ancient depleted component within the enriched Koolau endmember. These data combined with other recent high precision isotopic data from other Hawaiian volcanoes reveals that each volcano requires distinct endmember isotopic compositions. These three examples show that detailed investigations at local scales are important in defining the components present in the mantle. In addition these local studies, done at high resolution and high precision, are now able to provide information on the length scales of the heterogeneities. It is expected that more of these high-resolution studies will redefine our view of the dynamics of the mantle.