Re-evaluating the mantle structure underlying the southwestern US

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Previous assessments of the mantle structure underlying the southwestern US suggest the presence of highly geochemically heterogeneous mantle including depleted asthenosphere (≥100km) overlain by mantle lithosphere which grades from isotopically enriched at deep levels (>70km) to isotopically depleted at shallow levels (<70km). Along the Colorado Plateau-Rio Grande Rift-Basin and Range transition zone, alkalic basalts are thought to result from melting of isotopically depleted asthenospheric mantle at deep levels while tholeiites originate from melting overlying, isotopically enriched lithospheric mantle. Further work argued that the apparent absence of Th enrichment (i.e., melting occurring outside the presence of garnet) in tholeiitic basalts indicates that lithospheric mantle melting occurred at depths of <70km. In contrast, alkalic basalts, characterized by Th enrichment up to 20%, have been attributed to melting during asthenospheric mantle upwelling.

We present results from young (≤150ka) alkalic and tholeiitic basalts from the Zuni Bandera, Lucero, and Cat Hills volcanic fields (New Mexico, USA) that are characterized by Th enrichments. Results demonstrate that melting of both alkalic and tholeiitic basalt sources occurs in the presence of garnet at depths ≥70km, undermining previous structural and melting assessments of the mantle in this region of the US. In addition, the common presence of plagioclase in both alkalic and tholeiitic transition zone basalts, which implies staging and crystallization at crustal depths, suggests the possibility that enriched (and potentially depleted) isotope signatures in these basalts may indeed result from crustal contamination. Isotopic trends seen in tholeiites are similar to those observed in Mojave Desert basalts (e.g., Pisgah Crater, California), basalts that have assimilated mafic crustal components during residence at crustal depths. These results are inconsistent with current models and, if confirmed, undermine any assessments characterizing the melting regime and mantle structure underlying the mantle in this region of the western US.