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Tracing Metasomatic Processes in the Rio Grande Rift Through Nitrogen Isotope Analysis of Mantle Xenoliths

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The Rio Grande Rift, formed by the late Cretaceous to present-day geological processes, underwent significant metasomatism due to subduction, slab rollback, and asthenospheric upwelling, leading to crustal extension from the Eocene to the present. It is known that mantle xenoliths from the rift shoulder display an enrichment pattern in light rare earth elements (LREE) and higher water contents (~1 wt.% H_2O), indicative subduction-related metasomatism. Also, the intra-rift mantle xenoliths have been reported to show a depleted LREE pattern and lower water contents (~0.5 wt.% H_2O), reflecting asthenosphere influence [1, 2].

Here we report the first results of nitrogen isotopes of mantle xenoliths in the Rio Grande Rift to trace various metasomatic agents. Nitrogen isotopes are widely used to trace sources of volatiles, since subducted sediments and the depleted MORB mantle display distinguished $\delta^{15}N$ values (+7.2 ± 3.3 ‰ and -5‰, respectively) [3]. In this study, orthopyroxenes (OPX) of mantle xenoliths collected from the rift shoulder (Adam's Diggings) and the intra-rift (Potrillo and Elephant Butte) areas were investigated to unravel the effects of metasomatism associated with past subduction events and recent rift-related asthenosphere upwelling. The $\delta^{15}N$ values were measured by a modified mass spectrometer (VG 3600; GV Instruments Ltd.) with the single-step crushing method to release the N_2 from fluid inclusions in OPXs [4]. Our results display that the higher $\delta^{15}N$ values (+3.9 to +5.7‰) were observed in the rift shoulder samples, suggesting enrichment from subducted sedimentary sources. Conversely, the intra-rift xenoliths exhibit a broader and lower $\delta^{15}N$ range of -10.1 to +1.8‰, indicative of interaction with asthenosphere. In conclusion, the variable $\delta^{15}N$ values demonstrate metasomatism caused by a past subducted slab and subsequent mantle rejuvenation due to the extension of the Rio Grande Rift.

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