Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.27885

Triple Oxygen Isotope Classification and Discrimination of Granitic Rocks

ILYA N. BINDEMAN

University of Oregon

Oxygen is the major element on Earth, and its isotopes, together with SiO_2 and other indices such as Al-saturation, should provide the most robust constraint on magma genesis. Following the initial classification by Chappell and White [1], Harris et al. [2] offered to use $\delta^{18}O$ to discriminate largely coeval S, I, and A-type Cape Town granites, with heavy $\delta^{18}O$ values strongly characterizing the supracrustal S-type group. Large isotopic differences strongly favor their protolithic source characteristics rather than assimilation. I will present new measurements of $\Delta'^{17}O$ in granites worldwide to explore how $\Delta'^{17}O$, along side with $\delta^{18}O$, can be used as an additional classification tool. Closed system igneous differentiation increases $\delta^{18}O$ by ~1‰ without change in $\Delta'^{17}O_{0.528}$ and most I- and A-type granites form a narrow range in $\delta^{18}O$-$\Delta'^{17}O$ space around the mantle values. Most granites follow, however, the 0.523 slope on $\delta^{17}O$ vs $\delta^{18}O$ diagram, which we here call "crustal $\Delta'^{17}O$ array". Such shallow slope is characteristic of low-temperature processes and shales, suggesting that S-type granites inherit ^{17}O and ^{18}O atoms in proportions from materials that once equilibrated with surface waters at low temperatures and thus shallower isotopic slope. Subsequent metamorphism and anatexis preserve these signatures. Granites that plot around the $\Delta'^{17}O_{0.523}$-$\delta^{18}O$ diagram have different sources: shales (plotting below), and cherts (plotting above). Two other groups stand out: low-$\delta^{18}O$ type with mostly high $\Delta'^{17}O$ values, characteristic of seawater-altered source, and high to slightly lower than the mantle $\Delta'^{17}O$ values, for meteoric water-altered source, explained by the detail of water-rock interaction (equilibration-mixing). Adakites, produced by partial melting of subducted slabs, plot close to the mantle values. Archean granites are lower-$\delta^{18}O$ but generally plot along the crustal array as compared to post-Archean granites. Assimilation of diverse supracrustal materials by mantle-derived A-type magmas is responsible for connecting $\delta^{18}O$ and $\Delta'^{17}O$ end members on the triple O diagram, explaining the transitions between different isotopic groups.

[1] Chappell, 1999, Lithos, 46, 535

[2] Harris et al. 1997 Chem. Geol. 143:95

[3] Bindeman, JPet, 2024, 65: egae55