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Titanium isotopic insights into peralkaline magma differentiation

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Understanding the mechanisms responsible for the production of peralkaline magmas is important as these are at the source of economically important ore deposits and their formation is tied to the production of carbonatites. Possible drivers of compositional variability include partial melting of both mantle and lower crustal rocks, as well as fractional crystallization, water content, and oxygen fugacity. The titanium (Ti) isotopic composition of terrestrial magmatic rocks is a useful tool to understand how differentiated magmatic rocks form (1,2), because different pathways to produce silicic rocks are associated with different Ti isotopic fractionation trends. Titanium isotopes thus provide insights into (i) the water content/oxygen fugacity of parental magmas, and (ii) distinguish between partial melting and fractional crystallization. Here we report whole-rock Ti isotopic measurements from a bimodal basalt-trachyte-pantellerite suite located in Pantelleria, Italy, in the Strait of Sicily Rift Zone, with an aim to better understand their formation conditions. Panelleritic rocks are highly alkali- and iron-rich trachytes and rhyolites that frequently include aenigmatite ($Na_2Fe_5TiSi_6O_{20}$) as an important Ti-bearing phase. The origin of trachyte and pantellerite at Pantelleria and other similar peralkaline systems has long been debated as the result of either protracted fractional crystallization from alkali basalt or partial melting of alkali basalt or gabbro. We find that basalts, trachyte and pantellerites have d^{49}Ti ranging from +0.03 to +0.09 ‰ (n=2), +0.86 ‰ (n=1), and +1.31 to +2.05 ‰ (n=13), respectively. The extremely fractionated d^{49}Ti values of pantellerites can only be explained by fractional crystallization. Moreover, we see no marked difference in the extent of melt-mineral Ti isotopic fractionation when aenigmatite, which hosts Ti in six-fold coordination, crystallizes compared to the Fe-Ti oxides (*e.g.*, ilmenite) crystallization.

[1] Johnson et al. (2019). *GCA* 264

[2] Aarons, et al. (2020). *Science advances*, *6*(50)