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Vanadium Isotopes in TTGs and granitoids and nature of the Archean emerged crust

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The chemical composition of the emerged continental crust provides a boundary condition for climate, atmospheric chemistry, and biogeochemical cycles through Earth history and offers a window onto our planet's tectonomagmatic evolution. Reconstructions based on geochemical proxy analyses of detrital sediment archives disagree on the timing of a transition from dominantly mafic to dominantly felsic emerged crust [1–9]. We analyzed stable vanadium (V) isotopes in Archean granitoids, including tonalite-trondhjemite-granodiorite (TTG) rocks and show that these data can reconcile a late Archean shift in V isotopes in glacial diamictites [4] with a persistently felsic crust since 3.5 Ga, which is supported by titanium isotope and trace element evidence [1, 8]. We show that both modern and ancient granitoids deviate to lighter V isotopic compositions than the expected felsic endmembers of a previously reported island arc magmatic trend [4, 10]. It is likely that light V isotopes in Archean diamictites reflect dominant contributions from these granitoid magmatic sources rather than a dominantly mafic continental crust. We show that the diamictite V isotope record is not uniquely indicative of the balance between mafic and felsic continental crust, while other trace element proxies for magmatic differentiation in the diamictites do require the crust to have been persistently felsic. We suggest that the V isotope record is explainable through a felsic emerged crust that featured proportionally greater exposures of granitoids near Earth's surface than today, reflecting either lower volcanic eruption efficiency or more intense surface weathering in the Archean than today.

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