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The Fish Canyon Tuff an erupted pluton? – Insights from Fe isotopes

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The Fish Canyon Tuff an erupted pluton? – Insights from Fe isotope

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How are silicic plutons and volcanos (P-V) connected? Petrology, geochemistry, geophysics, geochronology and field observations show many similarities and differences between the two systems, making a clear interpretation of the P-V relationship difficult. An ideal way to study this connection are large, super eruption forming caldera systems since they are thought to represent erupted crystal-rich mush. One of these large caldera systems is the Fish Canyon Tuff (FCT) in CO. FCT is the largest known eruption (5000 km^3) and has pluton-like characteristics: homogeneous, phenocryst-rich dacitic composition with a near-solidus mineral assemblage similar to a granodiorite. Pristine hydrous minerals and resorbed anhydrous minerals suggest that heat and H_2O were added to a crystal-mush prior to its eruption [1]. Is the FCT a remobilized pluton? We test this hypothesis by measuring $\delta^{56}Fe$ of FCT minerals. Our previous work (Goldschmidt 2020) on $\delta^{30}Si$ of FCT minerals imply similarities between FCT and granodioritic plutons. New results on Fe isotopes ($\delta^{56}Fe$) of FCT minerals support this link. The global $\delta^{56}Fe$ trend for igneous systems shows a hyperbolic increase to heavier values at high SiO_2 content (>70 wt.%). Magnetite is the main phase controlling the Fe budget and therefore, offers the best insight into $\delta^{56}Fe$ systematics. The crystallization of magnetite removes heavy $\delta^{56}Fe$, suggesting that the observed trend is not a simple Rayleigh fractionation process [2]. Furthermore, $\delta^{56}Fe$ of magnetite is heavier for silicic plutons than for volcanos [3]. Our data reveal that the $\delta^{56}Fe$ of FCT magnetite is among the heaviest of those found in volcanic rocks and that it falls in the range of plutonic rather than volcanic magnetite. These results support the idea that the FCT is an erupted crystal mush and offer a direct link between silicic P-V rocks.

[1] Bachmann *et al.* (2002) *J. Petrol.* **43**, 1469-1503. [2] Zambardi et al. (2014) Earth Planet. Sci. Lett. **405**, 169-179. [3] Heimann *et al.* (2008) *Geochim. Cosmochim. Acta* **72**, 4379-4396.