Titanium isotopes as a new tool to fingerprint the tectonic setting of continent formation?

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Determining the tectonic setting in which continents are formed is paramount in order to understand Earth evolution. Recent studies have hinted that the mode of continent formation transitioned from oceanic plateau to subduction zone environments at around 3 Ga. However, testing this model is difficult due to the lack of unambiguous geochemical tracers able to directly link portions of juvenile continental crust to a specific geodynamic setting. Part of the reason why may be due to the little attention paid to tracers of rutile (TiO_2) involvement in this process. Ti stable isotopes have been show to be sensitive to oxide-melt equilibrium and thus have the potential to bring new insights into this question. Here we investigate the potential of Ti isotopes as tracers of the conditions of formation of juvenile continental crust.

In order to test this hypothesis, we carried out ultra-high precision (±0.02‰) Ti isotope measurements in modern-day equivalents of the two proposed settings of continent formation (Iceland rhyodacites and adakites for oceanic plateau and subduction zone models, respectively). Results show that all samples are consistently enriched in heavy isotopes of Ti relative to the mantle (+0.08‰<δ^{49}Ti<+0.30‰ vs. +0.005±0.005‰), consistent with a role for rutile in their formation, followed by evolution by fractional crystallisation. Interestingly, adakites and rhyodacites plot along two distinct trends in δ^{49}Ti vs. SiO_2 diagram, with the rhyodacites consistently plotting at lower δ^{49}Ti at a given SiO_2 content, thus outlining a potential discriminating tool between these settings of continent formation.

Application of this method to TTGs from the Pilbara (3.1 to 3.4 Ga) and Yilgarn craton (2.8 to 2.9 Ga) show that the Pilbara samples systematically plot on the Iceland rhyodacite trend whereas the Yilgarn samples plot on the adakitic trend, thus indicating that they might have been formed in different geodynamic settings.