The unchanging composition of Earth's emerged continents

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The chemical and lithological compositions of Earth's continents are surface expressions of Earth's geodynamic regime. They also influence weathering feedbacks, the long-term evolution of free O_2 in the atmosphere, and the flux of nutrients to the oceans. It is thus of utmost importance to accurately reconstruct how the chemical and lithological composition of Earth's continents evolved over time. Until recently, the idea prevailed that Earth's crust was dominated by mafic lithologies until approximately 2.5 to 3.0 Ga. The shift from mafic to felsic continents was interpreted to reflect the onset of plate tectonics at 3.0 Ga and it was further suggested that this change in the chemical composition of the emerged continents initiated the Great Oxidation Event. However, a re-evaluation of the arguments used as a basis to reason for basaltic Archean continents shows that the proxies used can be affected by surface weathering and can record instead the disappearance of komatiites from the rock record.

We will present a novel approach based on the Ti isotopic composition (δ^{49}Ti) of shales to decipher the chemical and lithological compositions of Earth's emerged crust over time. This proxy is based on the observation that the δ^{49}Ti value of igneous rocks increases with increasing SiO_2. Therefore, by measuring the δ^{49}Ti values of shales with continental provenance, the SiO_2 content of the emerged crust can be estimated, providing constraints on the proportion of mafic to felsic rocks. The average δ^{49}Ti value of shales is almost constant over the last 3.5 Ga and always heavier than that of mafic rocks. A three-component mixing model shows that this can only be explained with emerged continents that contain ≥55 wt% felsic rocks. This results is supported by a compilation of over 1400 Al/Ti and Zr/Ti ratios in shales. Important changes in the composition of the crust (lower P, higher Ni in the pre-Archean) could have influences the rise in atmospheric oxygen. Our results also suggest that plate tectonics was already active at 3.5 Ga.