Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.35072

A Bayesian Approach to the Generation of Archean Continental Crust

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The chemically evolved, andesitic bulk composition of Earth's continental crust is unique among the other rocky bodies of the Solar System [1]. The geochemistry of this crust has evolved through its 4.5 billion year history to reflect surface heat loss and the decrease in radiogenic heat-producing isotopes. Statistical analyses of the bulk rock record have shown a change in the major and trace element composition of continental crust over Earth history ([2], [3]). This change in crustal geochemistry from the Archean to modern continental crust is most prominently observed in the lithologies of Archean continental crust. Archean crust is compositionally distinct from post-Archean continental crust; its felsic components predominantly comprise the tonalite, trondhjemite, and granodiorite (TTG) rock suite, while its mafic components record geochemical evidence of secular mantle cooling. The mechanism that produced these felsic magmas remains contested due to uncertainty surrounding the dominant geodynamic regime of the early Earth. Here, a novel integration of parallel Markov chain Monte Carlo (MCMC) methods with the Perple_X thermodynamic forward model is used to invert for the starting H_2O content of magma and the possible range of P–T paths through which sequential fractionation and equilibrium melt differentiation may produce the observed differentiation trends preserved in Archean continental crust. Resulting P–T paths show a period of extended differentiation at 4-5 kbar (~14-18 km depth) with starting H_2O contents ranging from 3-4 wt%. These results are consistent with the depth and water content of mantle-derived mafic magmas in modern volcanic arcs, and point towards subduction as a potential tectonic setting for the production of these magmas.

References:

[1] Campbell & Taylor (1983), *Geophysical Research Letters* 10(11), 1061-1064.

[2] Condie & O'Neill (2010), *American Journal of Science* 310(9), 775-790.

[3] Keller & Schoene (2012), *Nature* 485(7399), 490-493.