Composition of the Archaean mantle and continental crust in the western Dharwar Craton, India

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The composition of the primordial mantle has a primary influence on the amount and composition of Earth's early continental crust. Studying the processes associated with ancient crust formation is complicated due to the limited exposure of Hadean-Archaean (>3.2 Ga) rocks. The western Dharwar Craton, India, (dominantly ~3.4 Ga) is one of the few well-accessible Paleoarchaean cratons that host both high temperature and pressure (deep) melts like komatiites and high to medium pressure (shallow) melts like TTGs. Detrital zircons yield a maximum $^{207}Pb/^{206}Pb$ age of ~3.6 Ga which defines the oldest crustal components of the craton (Guitreau et al., 2017). Based on trace element abundances ($^{147}Sm/^{144}Nd$ ~0.16; $^{176}Lu/^{177}Hf$ ~0.02) and Sr isotopes (Ravindran et al., 2020), this crust was dominantly mafic.

Hafnium and Nd isotopes of TTGs and greenstone mafic rocks of the western Dharwar Craton are well-correlated and support a mildly depleted mantle as their main source. In contrast, ultramafic rocks (komatiites, komatiitic basalts, cumulates) show a very strong depletion and 'decoupled' Hf-Nd isotope systematics. The initial εHf of these ultramafic rocks range from +3 to +20. Such extreme initial isotope ratios have also been observed in ultramafic rocks of other Paleoarchaean cratons (e.g. Hoffmann & Wilson, 2017). The whole rock Lu-Hf age of 3182±170 Ma agrees with the U-Pb zircon age (3228±22 Ma) of mafic rocks in that area which further clarifies that the Lu-Hf system has not been disturbed by late metamorphism. The komatiitic rocks could derive from deeper mantle sources that were modified by fractionation of garnet and/or perovskite (?) during early differentiation which resulted in decoupling of Lu-Hf from Sm-Nd. Thus, the ultramafic melts derived from deep mantle sources that preserved a memory of early mantle differentiation. The heterogeneous composition of the Archaean mantle significantly influenced the composition of the average continental crust in the Dharwar Craton.

References

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