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Evidence of colder ambient mantle condition during the Archean; Implication from the calculation of mantle potential temperature (Tp)

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Mafic magmas indicate the physicochemical conditions e.g., pressure, temperature, and fluid availability during melt generation and its evolution in the continental or oceanic lithosphere. Here we present the mantle potential temperature (Tp) values from Indian cratons, assuming mantle melting and generation of mafic melt by keeping the redox condition Fe^{+2}/Fe_{Total}=0.9 at the magma source [1] and compared the result with previously published Tp values across the globe [2]. The calculated Tp values (1628°C-1525°C) during the Archean eventually overlap with that of the previously published data. However, the ca. 2.8 Ga basalt [3] from Mauranipur-Babina greenstone belt of the Bundelkhand craton yield a significantly lower Tp value (1473°C) than previously published literature. Trace element ratios e.g., La/Yb, Th/Ta, Nb/Y, and Zr/Y indicate MORB or Oceanic Plateau Basalt (OPB) signature, suggesting a depleted mantle source of origin for the samples. Similarly, in a Ta-Tb-Th triangular plot, the samples show the tholeiitic basalt signature. Aulbach and Arndt (2019) [4] calculated a Tp value <1500°C for the protoliths of mantle eclogite. The lack of direct evidence of low Tp producing basaltic crusts during the Archean from other cratons might indicate sample alteration, sampling biases and limitations in Tp calculation methodology. However, the direct evidence of lower Tp from this study indicates a relatively colder ambient mantle condition and suggests rigid plate motion towards the end of the Mesoarchean if not earlier.

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