

Dating oxygenation events in the Archean Keonjhar Palaeosol, India, using the ^{138}La - ^{138}Ce chronometer

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Growing evidence from various geochemical proxies suggests intermittent oxygenation before the Great Oxidation Event (GOE). Nonetheless, it often remains ambiguous whether post-depositional processes have altered these proxy signals. In this context, the ca. 3.0 Ga old Keonjhar Palaeosol in the Singhbhum Craton in India has received significant attention as the detected Ce anomalies in this Archean palaeosol have been interpreted to reflect oxic surface weathering conditions during the Mesoarchean, significantly before the GOE. Cerium anomalies are commonly used as a redox proxy because Ce anomaly formation requires oxidation of Ce^{3+} to highly immobile Ce^{4+} and subsequent removal of the remaining REE^{3+} . Thus, the La-Ce chronometer enables direct dating of oxygenation and Ce anomaly formation as it dates REE^{3+} (including La^{3+})- Ce^{4+} decoupling. Therefore, we performed combined ^{138}La - ^{138}Ce , ^{147}Sm - ^{143}Nd , ^{176}Lu - ^{176}Hf and trace element measurements to elucidate the time at which the geochemical patterns of the palaeosol were formed. Major and trace element analyses conducted in our study only showed minor or no Ce anomalies, and depletion of mobile elements and depleted rare earth element (REE) patterns compared to the protolith. Importantly, ^{138}La - ^{138}Ce chronometry indicates a ^{138}La - ^{138}Ce age of <620 Ma, which precludes earlier claims [1] of Archean atmospheric oxygenation preserved in the Keonjhar Palaeosol. In addition, the corresponding ^{147}Sm - ^{143}Nd data yields an isochron age of 1765 ± 180 Ma, while the ^{176}Lu - ^{176}Hf data did not yield an isochron. In line with clear field evidence indicating later deformation and hydrothermal overprint of the palaeosol [2] we suggest that element depletion and REE mobilization is rather linked to post-depositional fluid flow along the unconformity plane which separates the former palaeosol-surface and the overlying quartzites. Altogether, these findings suggest post-Archean mobilization of REE during multiple alteration events and emphasize the need to combine palaeo-redox proxies with radiogenic isotope data to evaluate their significance.

[1] Mukhopadhyay et al., *Geology*, 2014, 42, 10, 923-926.

[2] Hofmann et al., *Earth Science Reviews*, 2022, 228, 103994.