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Quartz nanocrystals in the 2.48 Ga Dales Gorge banded iron formation of Hamersley, Western Australia: Evidence for a change from submarine to subaerial volcanism at the end of the Archean

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Abstract

Banded iron formations (BIF) have recently been used as proxies for tracking the chemical changes associated with the transition from an anoxic to oxic atmosphere around 2.45 billion years ago, known as the Great Oxidation Event (GOE). The timing of the GOE has been ascribed to both the collapse of a methane greenhouse and a decreased overall demand for oxygen due to the production of more oxidizing gases associated with greater subaerial volcanism. The latter is a byproduct of a period of high mantle plume activity and the formation of new continental crust between 2.51 to 2.45 Ga. Here we report unique mineral evidence for momentary subaerial volcanism recorded in hematite-rich layers of the 2.48 Ga BIF from Dales Gorge, Hamersley of Western Australia. The BIF contains euhedral quartz nanocrystals (QNC), which only occur on the surfaces or in cavities of hematite breccias exhibiting soft-sediment features and an exogenous source. These QNCs with an average size of 170–100 nm are distinct to the amorphous chert in the BIF mineral assemblage and have the smallest crystal sizes of well-crystallized quartz ever reported. We suggest that QNCs represent pyroclastic materials that were transported as dust particles to the BIF depositional setting. Although the analysis of one specific BIF unit does not provide proof of changing modes of volcanism during the Archean-Paleoproterozic transition, this high-resolution petrological study does confirm that subaerial volcanism existed at that time.

Keywords: Banded iron formation, chert, quartz nanocrystal, subaerial volcanism, rise of atmospheric oxygen