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A mixed seawater and hydrothermal origin of superior-type banded iron formation (BIF)-hosted Kouambo iron deposit, Palaeoproterozoic Nyong series, Southwestern Cameroon: Constraints from petrography and geochemistry

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ABSTRACT

The Kouambo iron deposit contains banded iron formations (BIFs) and is located in the northwestern margin of the Congo craton. The BIFs are hosted in Palaeoproterozoic Nyong series, a dominantly metasedimentary formations, which were metamorphosed into greenschist to granulite facies. The Kouambo BIFs are medium- to coarse-grained banded rocks consisting of alternation of Si-rich and Fe-rich mesobands, and belong to oxide facies iron formations. Geochemistry analyses reveal that these iron formations are composed of >96 wt% Fe_2O_3 and SiO_2 and have low concentrations of Al_2O_3, TiO_2 and trace HFSE, suggesting chemical precipitates of silica and iron. Moreover, these BIFs have low concentrations of Al_2O_3, TiO_2 and trace HFSEs (high field strength elements, e.g., Zr, Hf, Ta, Pb and Th), suggesting that terrigenous detrital materials contributed insignificantly to the sedimentation. The Post-Archean Australian Shale (PAAS)-normalized REE-Y patterns display seawater-like profile: minor LREE depletion and HREE enrichment, positive Y anomalies. However, they display positive Eu and negative Ce anomalies, and low Y/Ho ratio (average 29), which suggest the influence of the hydrothermal fluids. The weak positive $Eu/Eu^*_{(PAAS)}$ ratio (average 1.5), associated with the low V (17.5 ppm), Co (6.1 ppm) and Ni (27.5 ppm) contents similar to other Superior-type BIFs worldwide, are consistent with the deposition of the Kouambo BIFs in continental marginal sea or back-arc basin environment. In summary, the Kouambo BIFs show a seawater-like REE + Y signature, however, the positive Eu anomalies and reduced Y/Ho ratios relative to seawater indicates a possible mixing with hydrothermal fluids (~0.5%).

1. Introduction

Banded iron formations (BIFs) consist of alternating Si- and Fe-rich layers within an evaluated total Fe and Si content of 20–40 wt% and 40–60 wt% respectively, with the majority of BIF deposited from 3.8 Ga (billions of years ago) to 1.8 Ga (James, 1954; Klein, 2005; Li et al., 2014; Taner and Chemam, 2015). Planavsky et al. (2010) proposed the composition-based definition of Fe-formations as 'siliceous and Fe-rich sedimentary chemical precipitates with low levels of detrital siliciclastic or volcaniclastic material (<1% Al_2O_3) and greater than 10% total Fe, regardless of whether Fe is associated with a carbonate or oxide phase'. Gross and McLeod (1980; Gross, 1983) distinguished two main types of BIFs on the basis of the tectonic setting, associated lithologies and deposition age: (i) largely Archean volcanosedimentary Algoma-type usually distributed in greenstone belts, and (ii) Palaeoproterozoic Lake Superior-type associated with stable sedimentary basins and cratonic margins. The precursor iron minerals in BIFs are thought to have been ferric oxyhydroxide that precipitated directly from seawater. They are diagenetic and metamorphic by products and are typically hematite, magnetite, siderite, iron silicates and sulfides. There is a general consensus on the origin of both chert and iron-bearing minerals. For example, it has been demonstrated that silica in BIFs is of hydrothermal origin in the Eoarchean, with a higher and higher contribution by continentally-derived silica in the Proterozoic (Hamade et al., 2003; Allwood et al., 2010), while the iron in BIFs has been ascribed a seawater origin, with varying degrees of high-temperature (>350 °C) hydrothermal fluid input depending on age (higher in Eoarchean BIFs compared with younger BIFs) and degree of seawater mixing (Bau and Dulski, 1996; Bolhar et al., 2005; Alexander et al., 2008; Thurston et al., 2012). Because BIFs precipitated directly out from seawater, they are often regarded as reliable proxies for the composition of the

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