SEG 2024 Conference: Sustainable Mineral Exploration and Development

Reassessing the Bulk Geochemistry and Origin of Hematitic Iron Ores from the Northern Cape Province of South Africa

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Massive hematite iron ores from the Northern Cape Province of South Africa display a geographical distribution controlled by a regional unconformity contact separating chemical sediments (BIF, carbonates) of the Paleoproterozoic Transvaal Supergroup from shales and associated siliciclastic sedimentary rocks of the younger Olifantshoek Supergroup. This stratigraphic framework has been widely used in support of an ancient lateritic origin for these ores. We performed bulk geochemical (major-minor and trace elements, including REE) and iron isotope ratio analyses of 30 representative iron ore samples from across the Northern Cape region, to constrain the composition of likely protoliths to the ores and test the paleolateritic model of ore formation. Results were assessed against average bulk-rock compositions of Transvaal BIF and Olifantshoek shale as end-member precursor candidates to iron ore geochemistry.

Ore textures vary from massive to laminated and breccia-like. The ores are dominated by hematite (>90% modal Fe_2O_3 in most samples), with minor Si, Al, K and/or Mn making up the remainder. PAAS-normalized trace element spidergrams occupy the entire compositional space defined by the two chosen end-member protoliths (BIF and shale). Similarly, REE spidergrams generally mimic the seawater-like average BIF pattern at low REE abundances, while samples with higher REE concentrations show flatter, shale-like patterns with slight relative depletion in heavy REE. Trace elements that appear to show atypical relative enrichments include Ba, Sr, Pb and less so Cu and Zn. Selected detrital proxy ratios (K/Rb, Ti/Nb) compare closest to those of shale rather than of BIF. Iron isotope data exhibit narrow variability ($d^{57}Fe$: -0,2±0.3‰) with only six samples registering values below -1‰. Collectively, our results do not support a common origin of the iron ores from geochemically conservative lateritic weathering of BIF, but instead point to a possible hydrothermal replacement origin involving variable contributions of shale as key additional precursor material.