Targeting Channel Iron Deposits in the Hamersley Province of Western Australia

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The Hamersley Province and the Pilbara Craton contain large, sedimentary, iron-rich deposits of Precambrian banded iron-formation (BIF) and their hosted bedded iron deposits, but also present are Cenozoic detrital deposits such as the channel iron deposits (CIDs). The latter reside in giant, meandering paleochannels chiseled into the matured Hamersley surface. The area consists of deposits varying from <1 to 100 m thick, with channel widths generally less than 1 km but varying up to 5 km. The CIDs represent more than 30% of Australia's iron ore production and are found in many locations, including the mining areas of the Robe Valley and the Yandicoogina area. The CID ore is characteristically ooidal and porous with minor peloids, with both commonly comprising a hematitic core, enveloped by a goethite-rich cortex cemented in a goethitic matrix. Goethitized and hematitized fossil wood is preserved in the matrix and in the nucleus, respectively, of the ooids and is a diagnostic and conspicuous feature of CID.

The genesis of these deposits is still much debated but the latest U-Th-He dating and petrological, sedimentological studies point toward the currently preferred model that involves sheetwash accretion of Fe-rich, pedogenic ooids derived from a deep ferruginous lateritic profile with cementation of the ooids as a late-stage event within the river beds. The occurrence of a magnetic ferric/ferrous oxide phase, such as kenomagnetite or maghemite within the cores and cortices of the ooids and peloids, is seen as evidence of wildfires before or during deposition in the channels. The combustion of vegetation during wildfire events is thought to result in the thermal reduction of surface iron oxyhydroxides which then partially or fully oxidize to kenomagnetite or maghemite. These phases are also perceived of as indicators of climate change to drier conditions.

Although numerous CIDs have been discovered, the majority of these are outcropping deposits. The possibility of the discovery of a buried CID was attempted by applying a 3-D forward numerical surface processes code (LECODE) to investigate iron-rich material dispersion such as the upper part of a lateritic profile developed on iron-rich rocks, including BIF and mafic rocks in the Hamersley Province. This code is modelling erosion, transport, and sedimentation based on the interaction of surface hydrodynamic flow markers and the surface geology. It has been used to assess laterite dispersion scenarios and to quantify proto-CID accumulation following the major Miocene climate shift and rapid sea-level variations. The model results were corroborated through comparison to known occurrences of CIDs. Geological scenarios were tested based on two climatic phases of the generally accepted genetic model: (1) a tropical phase by which in situ chemical weathering dominated physical weathering with rapid sea level change followed by (2) a semi-arid climate phase, at about 15 Ma, that stimulated physical weathering and erosion of the lateritic material derived from the weathering of BIF and mafic rocks on the valley floor. The results of this work suggest the presence of potential CID reserves under cover.