HIGH-GRADE IRON ORES IN THE AMERICAS: PAST IMPORTANCE, FUTURE PROMISE

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ABSTRACT: The discovery of direct-shipping or 'natural' iron ores in the Lake Superior region of the U.S. in the mid-1800s coincided with the industrial revolution and literally provided the backbone for the development and expansion of industry and population from the Atlantic to the Pacific. Approximately 3.4 billion tons (Gt) of iron ores containing >50 percent Fe were produced from U.S. mines in the region from 1848 until they were exhausted 20-30 years ago. The Vermilion 'Range' in Minnesota produced nearly 100 million tons (Mt) of this ore from Archean greenstone belt hosted Algoma-type iron formation. The remaining production came from Proterozoic Superior-type strata including 2.3 Gt from the Mesabi Range in Minnesota while Michigan and Wisconsin contributed 850 Mt from the Marquette, Menominee, and Gogebic Ranges. Iron mining over the past several decades has by necessity required recovery from largely un-enriched, metamorphosed, magnetic BIF, generally referred to as taconite.

Brazil became a major producer/exporter of iron ore in support of the Allied effort during WWII and iron mining and exports for the last 70+ years have recovered high-grade (>60% Fe) ores from both the Iron Quadrangle (IQ) (Minas Gerais) and, since 1984, the Carajas area (Para). Analogous to N. America, both Proterozoic Superior-type (IQ) and Archean Algoma-type (Carajas) parent iron formations have been naturally enriched to the direct shipping ores. In recent years Brazil has ranked 2nd or 3rd in world iron ore production.

The protore (parent) of these direct-shipping ores are carbonate- or oxide-facies iron formation that contained 25 to 35% Fe prior to undergoing leaching (de-silicification), oxidation, and volume loss. The conventional model ascribing these changes to supergene processes has recently been challenged by research showing that hypogene fluids (basinal brines? magmatic? meteoric?), channeled by faults into structurally favorable horizons and settings have played an important role in producing some of the high-grade (>60% Fe) deposits that are presently providing much of the world's iron ore.

Except for some spectacular hard hematite ores on Baffin Island in the Canadian Arctic, the best chance for further discoveries of high-grade iron ores in N. America would be at depth in one or more of the historic districts. This would likely require that the hypogene hydrothermal fluid hypothesis have indeed been the cause of some/much of the leaching documented by the past production in the Lake Superior region. Descriptions of the North American iron ores, starting with the U.S.G.S. monographs published at the beginning of the 20th century provide many tantalizing clues suggesting that hypogene fluids have indeed played an important role in the evolution of some of these districts.

Published estimates of the reserves in the IQ and Carajas areas are 29 Gt of ore containing 16 Gt of iron at an average grade of >55%; 75 years of production at current rates. Additional resources surely exist in the immediate Carajas area and beyond – perhaps the biggest challenge will be to continue to find a balance between resource recovery and responsible ecological stewardship in the fragile Amazonian region.

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