The Fortescue Group Basalts: The Source of Australia's Iron Ore?

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The genesis of the world-class BIF-hosted iron ore deposits of the Hamersley Group, Western Australia, is still highly debated. Models vary from gangue removal to iron addition, and from hydrothermal events to supergene processes. All models involving mass transfer require a source and/or sink for transported elements. Iron ore deposits of the Hamersley Group overlie mafic to intermediate lavas of the Fortescue Group, which forms the lowermost stratigraphic unit of the 100,000-km^2 Hamersley basin on the southern margin of the Pilbara craton. Widespread zones of intense metasomatism in the Fortescue Group are superimposed on a regional, north-south subgreenschist facies metamorphic gradient. Metasomatism is focused along lava flow tops, interpreted to represent zones of inherent permeability, and progressively produces a suite of pumpellyite-quartz and epidote-quartz–dominated assemblages. Whole-rock geochemical data indicate that metasomatism resulted in significant depletions in the alkalis, Mg, and the heavier first transition series metals (Mn-Zn). In particular, total Fe is extensively depleted, while net Fe^{3+}/Fe^{2+} ratio is increased. In contrast, large amounts of silica were added during alteration. Such mineralogical and geochemical trends have been documented elsewhere around the world in association with the circulation of highly saline fluids derived from sea water, such as in the Noranda district, Canada, and the in the Troodos Ophiolite, Cyprus. Thermodynamic modeling indicates uniform conditions for metasomatism across the basin of ~275°C, 10-km depth. This is interpreted as fluid flow occurring following basin burial and driven by Ophthalmian deformation to the south (ca. 2.1–2.2 Ga). As such, the regional-scale fluid flow and metasomatism will also have affected the BIF in the Hamersley Group. Specifically, we propose that the leaching of iron from the Fortescue Group lavas contributed, at least in part, a source of iron to the overlying BIFs, resulting in local upgrading to martite-microplaty hematite ore. Similarly, circulation of such fluids may have removed silica from the BIF and introduced it to the altered Fortescue Group lavas. Even if the formation of economic iron ore deposits occurred after this regional metasomatic event, the impact of this Paleoproterozoic regional metasomatism should not be ignored in any model of iron ore genesis in the Hamersley province.