

Geochemistry and genesis of the banded iron formations of the Cauê Formation, Quadrilátero Ferrífero, Minas Gerais, Brazil

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Abstract

The Cauê Formation of the Paleoproterozoic Minas Supergroup hosts banded iron formations (BIFs), locally called itabirites, deposited in shallow marine passive margin settings. Two major compositional types of itabirite, dolomitic and quartz itabirites, are found in the northwestern part of QF. The former consists of alternating dolomite-rich and hematite-rich bands, whereas the latter is formed with alternating quartz-rich and hematite-rich bands. Accessory minerals are chlorite, sericite, and apatite in both types.

Dolomitic and quartz itabirites have a very simple chemical composition. In the dolomitic itabirite, Fe_2O_3 plus CaO , MgO , and LOI range from 95.8 to 97.8%, while in the quartz itabirite, Fe_2O_3 plus SiO_2 range from 94.4 to 99.6%. Both itabirites are highly oxidized and present $\text{Fe}^{3+}/(\text{Fe}^{2+} + \text{Fe}^{3+})$ ratios higher than 0.98, by far superior than the average ratios of Paleoproterozoic BIFs. Trace element concentrations in itabirites are very low, ranging from <10 to 55 ppm. Dolomite shows negative $\delta^{13}\text{C}$ values varying from -2.5 to -0.8‰ versus PDB, while the oxygen isotope data display $\delta^{18}\text{O}$ values varying from -12.4 to -8.5‰ versus PDB. The $\delta^{13}\text{C}$ values of the dolomitic itabirite are in the same range of those of the overlying stromatolitic dolomites of the Gandarela Formation. C and O isotopes, REE signatures, and Y/Ho ratios suggest a marine origin for the sediments of the Cauê Formation. The HREE enrichment pattern exhibited by the itabirites shows a modern seawater REE signature overprinted by a hydrothermal pattern marked by positive Eu anomalies. Very low contents of Al_2O_3 and TiO_2 and a strong positive correlation between them indicate a minor terrigenous component in the chemically-precipitated marine sediments of the Cauê Formation. Differences in the HREE signatures of itabirites suggest that dolomitic itabirite precipitated in shallower waters receiving sediments from the continent, while quartz itabirite precipitated in deeper waters. Sea-level fluctuations caused by marine transgression–regressions possibly contributed to changes in the composition and varied input of the terrigenous sediments. These changes are expressed by the co-existence of dolomitic, quartz, and amphibolitic itabirites in the Cauê Formation, which represent lateral and vertical facies transitions of dolomitic, cherty, and shaly BIFs, respectively.

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1. Introduction

Banded iron formations have long been an object of interest because, apart from being the major source of iron ore, they are particularly important for the

understanding of atmospheric evolution, the chemical composition of the oceans, and the appearance of life on Earth.

The Cauê Formation of the Minas Supergroup is known for hosting giant iron ore deposits in the Quadrilátero Ferrífero (QF), in the state of Minas Gerais, located in southern Brazil (Fig. 1). About 16% (170 Mt) of the world's iron ore production in 2003 came from deposits hosted in the Cauê Formation (Tex Report,

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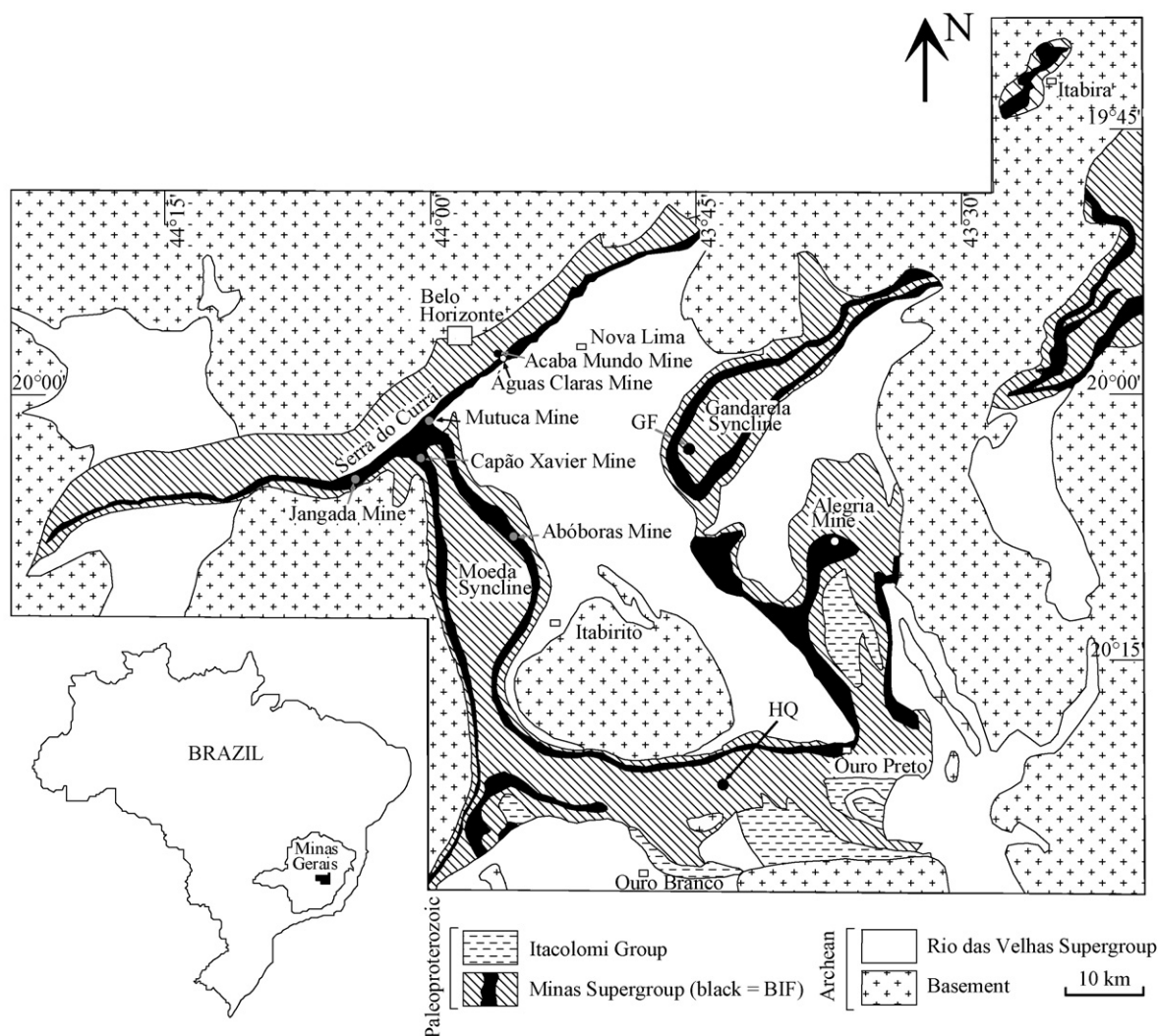


Fig. 1. Location and geological map of the Quadrilátero Ferrífero region (after Dorr, 1969).

2005; Companhia Vale do Rio Doce—CVRD, internal reports). The Cauê Formation is a classical Proterozoic BIF deposited on the continental shelf (Dorr, 1969) and classified a Superior type BIF, according to the scheme of Gross (1980).

Several geological processes have obliterated primary characteristics of the original sediments of the Cauê Formation, resulting in metamorphosed and oxidized BIFs called itabirites in Brazil. Two major compositional types of itabirite occur at the QF: quartzitic, and dolomitic; amphibolitic itabirite is also present, albeit in small amounts (Dorr, 1969; Rosière et al., 1993). The origin of this compositional diversity and the genesis of itabirites are still debated. Can this diversity be accounted for by

different original sedimentary facies within the Minas Basin or is it due to post-sedimentary processes? Dorr (1969) correlated the quartz and dolomitic itabirites with the oxide facies BIFs of James (1954) and considered the amphibolitic itabirite a product of contact metamorphism of dolomitic itabirite by adjacent granitic rocks. Beukes et al. (2002) attributed the genesis of the dolomitic itabirite to the hydrothermal metasomatism of the original cherty BIF during a hypogene enrichment stage of the iron ore. Veríssimo (1999) and Veríssimo et al. (2002), however, interpreted compositional variations as representing original sedimentary facies. These authors described the quartz and amphibolitic itabirites at the Alegria Mine, east of the QF (Fig. 1), and corre-

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