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Short communication

Dating the Itabira iron formation, Quadrilátero Ferrífero of Minas Gerais, Brazil, at 2.65 Ga: Depositional U–Pb age of zircon from a metavolcanic layer

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ABSTRACT

Uranium–Pb dating of zircon from a metavolcanic layer within the Itabira iron formation, or Cauê Itabirite, Quadrilátero Ferrífero of Minas Gerais, Brazil, indicates that its deposition occurred at 2.65 Ga, i.e., considerably earlier than proposed by previous geochronological studies, which suggested deposition between 2.58 Ga (detrital zircon age from the underlying Moeda Formation) and 2.42 Ga (Pb–Pb isochron age from dolomitic rocks of the immediately overlying Gandarela Formation). The new age has major implications for the geology of the Quadrilátero Ferrífero and connects it with the Neoarchaean iron formation of the Carajás mineral province.

1. Introduction

The itabirite unit of the Quadrilátero Ferrífero of Minas Gerais (Fig. 1), Brazil, is a metamorphosed banded iron formation that encompasses world-class hematite deposits. The age of the itabirite unit, known as Itabira iron formation (Harder and Chamberlin, 1915) or as Cauê Itabirite (Dorr, 1969), is currently bracketed between 2.58 and 2.42 Ga. The 2.58-Ga age is based on U–Pb ion-microprobe ages of detrital zircon grains from the Moeda Formation of the underlying Caraça Group (Hartmann et al., 2006). The Caraça Group comprises the basal Moeda Formation, a metasedimentary clastic sequence with Witwatersrand-like conglomerate (e.g., Koglin et al., 2010), and the overlying Batatal Formation, a pelitic sequence that grades upwards into the Itabira iron formation. The upper part of the Itabira iron formation is transitional into the superjacent dolomitic rocks of the Gandarela Formation. The 2.42-Ga age refers to a Pb–Pb isochron determined on the dolomitic rocks (Babinski et al., 1995). A schematic summary of the pertinent stratigraphy and its age bracket is shown in Fig. 2.

Until now the depositional age of the Itabira iron formation is unknown. However, some authors, in particular Guimarães (1935, 1951, 1964), indicated the existence of metavolcanic rocks spatially associated with the Itabira iron formation (e.g., Harder and Chamberlin, 1915; Guild, 1957; Pires, 1983; Cabral, 2003). Such metavolcanic rocks, especially those occurring as concordant layers within the itabirite unit, have the potential of providing a definitive depositional age for the Itabira iron formation. Here we present the first U–Pb zircon age of one of the metavolcanic layers (Cabral, 2003), which places new constraints on the depositional age of the Itabira iron formation. This age has important implications not only for the geology of the Quadrilátero Ferrífero, but also for the global picture of the Earth's ocean–atmosphere system in Neoarchaean times.

2. Miguel Congo and sample material

Miguel Congo is an itabirite-hosted ferromanganese-ore deposit located in the eastern part of the Quadrilátero Ferrífero (Fig. 1), within the tremolite–anthophyllite metamorphic zone (Pires, 1995). The host itabirite shows a penetrative foliation, which is typical of the eastern domain of the Quadrilátero Ferrífero, resulting from thrust-and-fold tectonics during the Brasiliano orogeny at about 0.6 Ga (e.g., Chemale et al., 1994; Alkmim and Marshak, 1998; Rosière et al., 2008).

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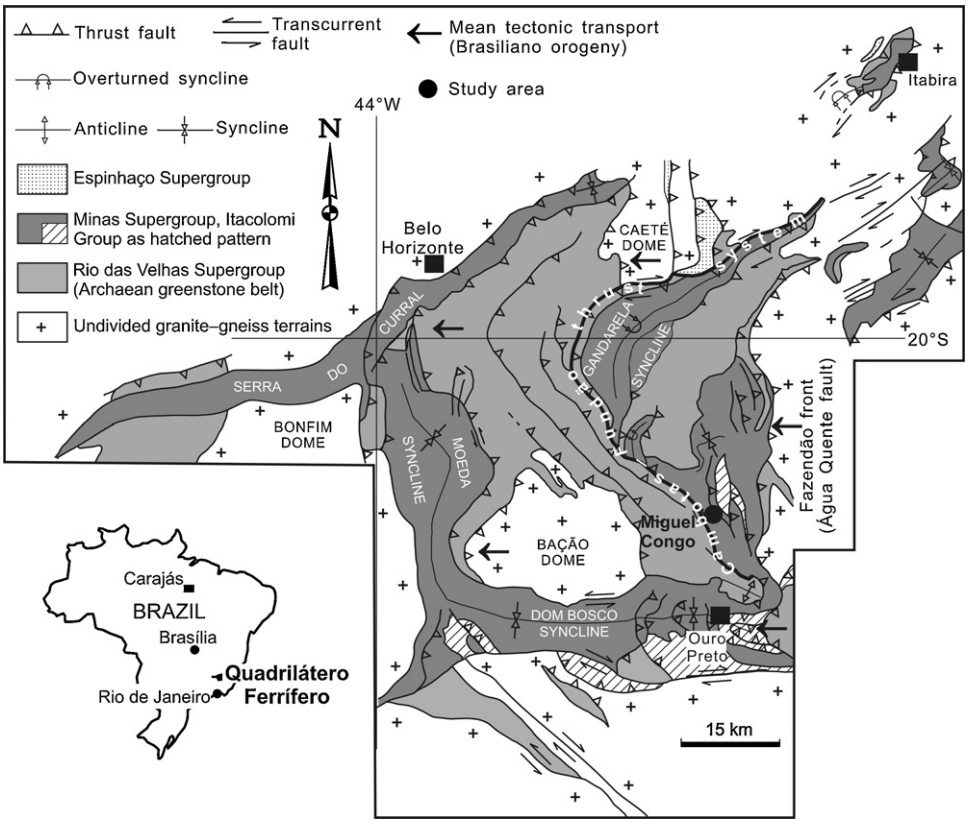

Fig. 1. Simplified geological map of the Quadrilátero Ferrífero (modified after Dorr, 1969, and Rosière et al., 2008), with the location of the study area, Miguel Congo.

The lowermost part of the itabirite sequence at Miguel Congo, close to its base, is made up of a ~10-m thick concordant layer of metavolcanic rock (Poppinga, 1984). Similar layers also occur further upwards in the sequence within ferromanganese orebodies, but these layers are only a few cm thick (Cabral, 2003). The layers are whitish and rich in clay, and lack noticeable quartz, but contain abundant tourmaline formed during a late- or post-tectonic hydrothermal overprint. Reconnaissance whole-rock chemical analyses of the metavolcanic layers indicate a basaltic protolith (Cabral, 2003; A.R. Cabral, unpublished data). Towards the

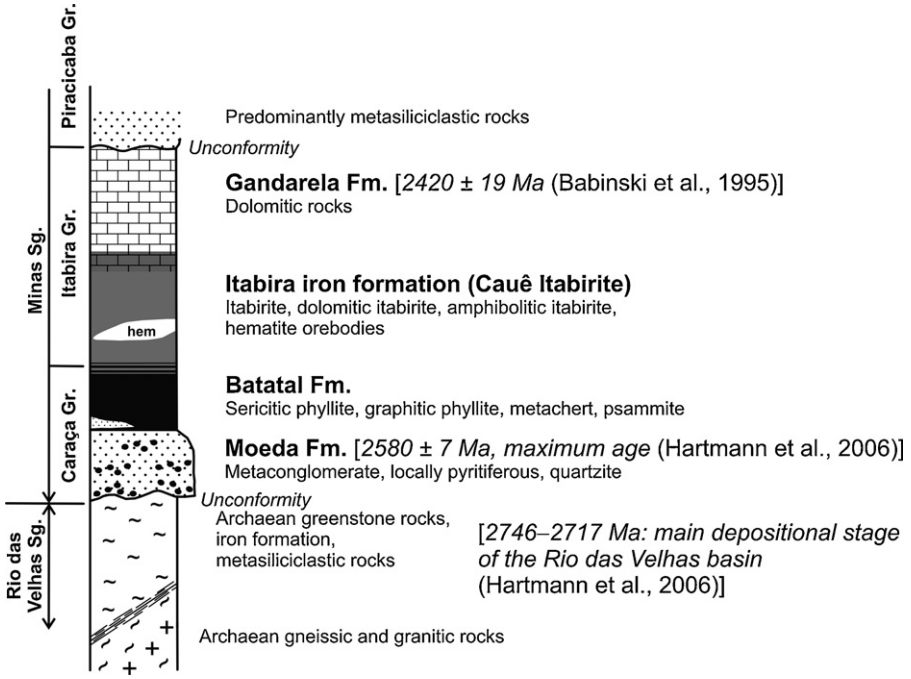

Fig. 2. Schematic lithostratigraphic column emphasising the Caraça and Itabira groups of the Minas Supergroup (adapted from Harder and Chamberlin, 1915; Dorr, 1969; Alkmim and Marshak, 1998).