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INFRARED MICROTHERMOMETRY OF SPECULAR HEMATITE-HOSTED FLUID INCLUSIONS FROM Au–Pd–Pt-BEARING QUARTZ–HEMATITE VEINS, QUADRILÁTERO FERRÍFERO, MINAS GERAIS, BRAZIL

LÜDERS, V.[1], CABRAL, A. R.[2]
[1] GeoForschungsZentrum Potsdam, Telegrafenberg, D-14473 Potsdam, Germany.
[2] Institut für Mineralogie und Mineralische Rohstoffe, Technische Universität Clausthal, Adolph-Roemer-Str. 2A, D-38678, Clausthal-Zellerfeld, Germany.
E-mail: volue@gfz-potsdam.de

The Quadrilátero Ferrífero is a world-class mineral province (Fe, Au, Mn) comprising a Palaeoproterozoic clastic-sedimentary sequence (Minas Supergroup), an Archaean greenstone belt sequence (Rio das Velhas Supergroup) and granite-gneiss domes. The Minas Supergroup hosts a thick itabirite unit (banded iron formation) with high-grade hematite ores. Presumedly, much of the primary (lode) gold from Minas Gerais came from itabirite-hosted, sulphide-free, specular hematite-rich, palladian gold-bearing (*jacutinga*) veins. Examples of this vein-style mineralization are found in the Gongo Soco and Itabira iron ore deposits, in which gold is mined as by-product. The *jacutinga*-style gold deposits are situated in the high-strain domain of the Quadrilátero Ferrífero, where the host rock (itabirite) shows a pervasive foliation commonly attributed to the 0.8–06 Ga Brasiliano Orogeny. The metamorphic grade increases eastwards from lower greenschist facies (Gongo Soco) to lower amphibolite facies (Itabira). In contrast, quartz-specularite veins from the western and south-western low-strain zone of the Quadrilátero Ferrífero are barren.

Quartz–iron oxide isotope thermometry in the foliated itabirite and iron ore (Hoefs et al., 1982) indicated higher temperatures than those suggested by the mineral assemblages. Both in Itabira and Gongo Soco, the *jacutinga* veins cross-cut the foliated itabirite. However, Olivo et al. (1995) considered that the Itabira *jacutinga* veins were synchronous with the peak metamorphic temperatures, with quartz–iron oxide model temperatures as high as 660°C. Fluid inclusions in quartz from quartz-hematite veins cutting Palaeoproterozoic itabirite in the Ouro Fino syncline area near Capanema, about 25 km south from Gongo Soco, have been studied in detail by Boiron et al. (1999) . These fluids have high sulphate, as well as high B, Li and F contents. They are oxidizing and characterized by low Na/K and Cl/SO_4 ratios. Only a few total homogenization temperatures were obtained in the range of 104 to 160°C for aqueous fluid inclusions, and between 250 and 280°C for aqueous-carbonic ones. Br/Cl ratios indicate an evolved seawater origin from which halite had precipitated (Boiron et al., 1999).

The fluids studied here originate from specular hematite veins from four iron ore deposits in the Quadrilátero Ferrífero: the barren veins of Córrego do Feijão and Fábrica, which are located in the low-strain zone, and the Au-Pd–Pt-bearing veins of Gongo Soco and Itabira.

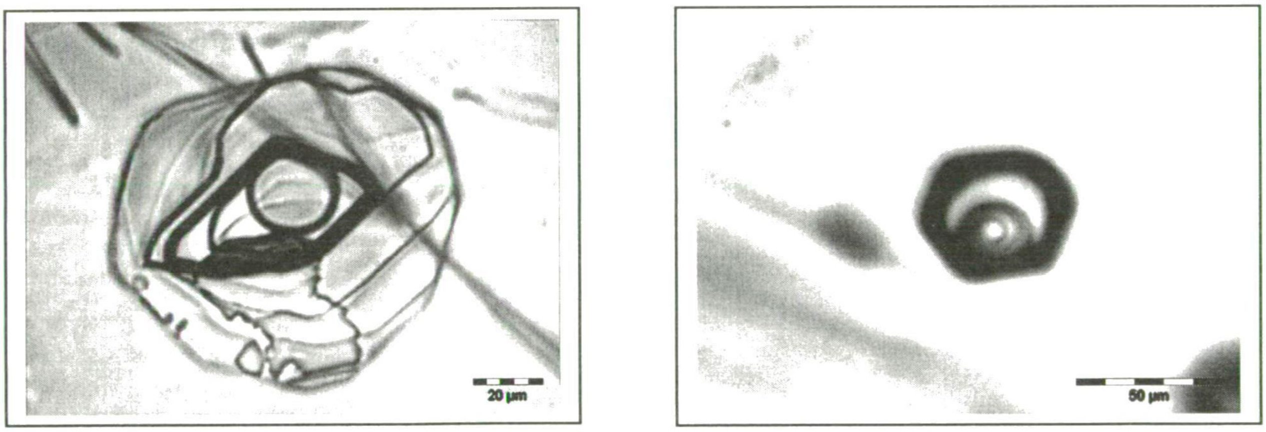

Fig. 1: Transmitted IR light microphotographs of fluid inclusions in hematite; left: two-phase aqueous type I inclusion with daughter crystals, Gongo Soco; right: aqueous carbonic type II inclusion, Itabira.

Fluid inclusions hosted in hematite from barren veins as well as from the Au-Pd-Pt-bearing veins of Gongo Soco are always two-phase aqueous and often contain multiple daughter minerals of unknown composition (type I inclusions) (Fig.1). These inclusions occur isolated within the studied samples and, therefore, they are assumed to be of primary origin. They show either rounded or irregular forms and size up to 100 (!) microns. Melting of ice was observed in this type of inclusions in the temperature range between -9.8 and -4.5°C (Fig. 2). First melting is approximately between -30 and -27°C. The homogenization temperatures (Th) range between 150 and 228°C. The lowest Th values were measured in samples from

Gongo Soco, whereas the highest Th values were measured in samples from a barren vein at Fábrica (Fig. 2). Melting of daughter minerals hosted in type I inclusions were not observed even upon heating to temperatures as high as 450°C.

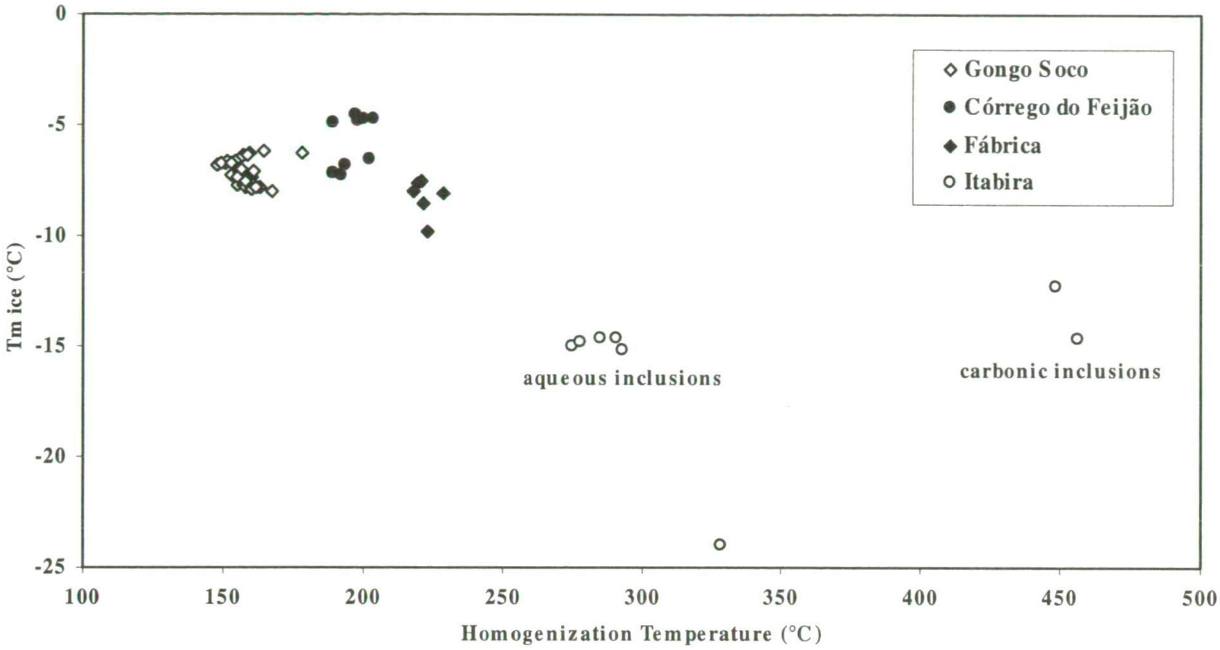

Fig. 2: Homogenization vs. Tm ice diagram of hematite-hosted fluid inclusions from iron deposits in the Quadrilátero Ferrífero, Brazil

Samples from Itabira host two different types of primary inclusions. Besides type I inclusions, aqueous carbonic inclusions (type II) are also very frequent in the studied samples (Fig. 1). Type II inclusions often show hexagonal or rounded shapes and sizes up to 35 microns. Type I inclusions hosted in hematite samples from Itabira have higher Th values and lower ice melting temperatures compared to samples from the other studied sites (Fig. 2). Type II inclusions show melting of solid CO_2 between -62.9 and -56.7°C and CO_2 homogenization temperatures to the liquid phase between 17.9 and 22.4°C, and often decrepitate prior to total homogenization. However, a few inclusions gave total homogenization temperatures as high as 450°C (Fig. 2).

Infrared microthermometric studies of specular hematite-hosted fluid inclusions from quartz-hematite veins in the Quadrilátero Ferrífero yielded distinct formation conditions in different parts of the study area. In the north-eastern part (Itabira), Au–Pd–Pt-bearing hematite-quartz veins, which crosscut the host itabirite, display a complex fluid chemistry. The presence of CO_2 and high homogenization temperatures let assume a retrograde metamorphic formation as suggested for similar veins from Ouro Fino (Boiron et al., 1999). In contrast, Au-Pd-bearing hematite-quartz veins at Gongo Soco seem to have deposited from saline formation waters at considerable lower temperatures. The fluids trapped in barren veins within the western and southern lower-strain zone are similar to those at Gongo Soco, but obviously did not transport Au, Pd and Pt. The reason for this is still unclear. It can only be speculated that in the high-strain domain, fluids could have had access (through faults and reactivated structures) to source rocks to leach them more effectively than in the low-strain zone.

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