Banded Iron Formation deposits from the Tiris region (Western Sahara): structure, mineralogy and textures

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Many important showings of iron oxide deposits have been reported since the 1950's in the Tiris region, SE of Western Sahara. These deposits are located in the same Precambrian belt which hosts the world-class iron deposits of Quidiat Iyil in Mauritania, which are close to the border with Western Sahara. Unfortunately, the iron deposits of Western Sahara have not been characterized until the present, mainly because of the political conflicts in the area. Hence, the occurrence of these outcrops in Western Sahara defines new and interesting metallogenetic targets. Therefore, the aim of this work is to provide new data on the mineralogy of the main deposits, as well as their textures, paragenesis and origin.

Most of these deposits have been intensively deformed, in particular, by folds at macro, meso and micro-scale. On the other hand, most of these deposits have been affected by medium to high-grade regional metamorphism, and coarse-grained textures have been widely developed. This aspect could favour the benefit of the ores.

According to the age of the deposits, three main groups can be established:

1) Southern group. It is found in the Jneifisat zone, and it is hosted by the migmatitic units of the Lower Archaean. They are affected by high grade regional metamorphism, and all display a lepidoblastic texture. Magnetite can reach up to 35% modal of the rock. The rest is made up of quartz, which occurs in small bands or metamorphic rods.

2) Central group. These deposits are hosted in the highest part of the Archaean series, comprising paragneiss, metabasites and some marble beds, metamorphosed in amphibolite facies. The most important deposit of this type is found at El Farfarat, NW of Miyec, although there are many other mineralized units in different levels of the series. Some noticeable outcrops can be distinguished in Galb Leazib, Galb Fula and several outcrops in the vicinity of Miyec. The thickness of these BIF can vary a lot, being less than 3 m in all cases. These deposits have a modal content of magnetite which is slightly higher than the above mentioned, up to 50%; the content in quartz ranges from 30 to 50%. However, some outcrops can consist of massive magnetite, as in Galb Fula (more than 75 %), accompanied by small amounts of quartz and siderite. Other minerals, as siderite and grunerite, may appear in small amounts, as in Galb Leazib or Galb Laana. All these minerals have been formed by medium-grade regional metamorphism.

3) Northern group. These deposits are interbedded with Eburnean volcanosedimentary series. These BIF are the thickest in Western Sahara (more than 10 m in some points). In addition, they are massive, as in the Bu Daira Ranges, and the content in magnetite may reach 75% in volume. However, although the texture is also lepidoblastic, the fine grained textures (in the range 500 μm-1 mm) are not as suitable for the benefit of the ore as in the above-mentioned cases. Quartz is the only gangue mineral found there up to date.

In all these deposits, magnetite has been partially replaced on surface by fine-grained supergenic hematite.

The potential for magmatic metal sources in the Iberian Pyrite Belt

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The Iberian Pyrite Belt (IPB), located in southern Portugal and Spain, hosts several giant volcanic-hosted massive sulfide (VHMS) deposits within a bimodal - siliciclastic volcanic-sedimentary succession of Late Devonian to Lower Carboniferous age [1]. Felsic volcanic centres display a complex architecture of lava domes, pyroclastic units and intrusions defining lava cryptodome pumice cone volcanoes [2]. Although current knowledge indicates that the direct contribution of metals of magmatic origin may have not been predominant in typical IPB deposits [3], the exceptional nature of the ores in some giant VMS deposits are best explained by a magmatic – hydrothermal model [3,4]. Volcanic successions in the Neves Corvo and Serra Branca areas are mineralized and Neves Corvo is a world-class giant high Cu and Sn grade VHMS deposit [1,3]. Conversely, Albernoa quartz-feldspar-phyric volcanics have no known sulfide mineralization or ore-related hydrothermal activity. Exposed melt inclusions hosted in quartz phenocrysts in felsic rocks from these three distinct volcanic centres were analysed by SEM/EDX [5] and LA-ICP-MS. EDX showed that melt inclusions present in Albernoa samples contained metallic precipitates with Sn, Cu, Cl and S suggesting that the magmatic source beneath the volcanic centre had high contents in these elements. LA-ICP-MS analyses on the unexposed melt inclusions determined the bulk composition. Quantification of element concentrations followed Halter et al's [6] methodology in which mass ratio was determined using whole rock differentiation trends. In clear contrast with their host rock compositions, melt inclusions from Serra Branca and one Albernoa sample showed higher concentrations of mafic-related elements (e.g. FeO, MgO, Co, Ni, Cu and Zn) and low Na_2O. The remaining rhyolite and rhyodacite rocks from Albernoa have melt inclusions with a composition similar to those of their hosts. The high-silica melt inclusions found in the Neves Corvo samples are depleted in Cu and have low Sn (12 ppm Sn). Sn concentrations are higher in the melt inclusions than in their host rocks. Serra Branca and Albernoa melt inclusions can contain up to 35 ppm Sn, much higher than in melt inclusions from Neves Corvo. Preliminary results of contrasting concentrations in particular elements observed in the melt inclusions and their host rocks suggest mixing of magmas. On the other hand, it is puzzling to observe that higher concentrations of ore-metals (e.g. Cu, Sn) are found in melt inclusions hosted in volcanic rocks from volcanic centres without known mineralization and not in the Neves Corvo volcanic rocks. On-going research should provide additional arguments for this discussion. Nevertheless, these observations have strong implications for the understanding of the pre-eruptive processes that occurred beneath the IPB volcanic centres and the on the evaluation of the role of magmatic-hydrothermal processes in the formation of high-grade Cu (±Sn) mineralization in this remarkable province.

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