New occurrence of Ag-Hg-Cu mineralization in the Tassafte area, NE edge of the Saghro inlier, Ediacaran-Cambrian transition (Eastern Anti-Atlas, Morocco)

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Abstract. The Tassafte Ag-Hg-Cu mineralization, located about 20 km to the East of Imiter Mine (Ag, Hg), at the NE edge of Saghro inlier, Eastern Anti-Atlas, represents a key zone to study and understand the mineralization history in the Anti-Atlas belt. It exposes E-W-oriented polymetallic mineralization veins hosted within Ediacaran formations and throughout Cambrian formations. The main metallic minerals are represented by argentite, amalgam of Ag-Hg and rarely native silver; copper minerals mainly comprise chalcopyrite, chalcocite, covellite, bornite, and copper oxides. The gangue minerals are mainly constituted by quartz and barite. Preliminary results of our finding show that the Ag-Hg-Cu mineralization in the NE of the Saghro inlier is presumably younger than what has been assumed previously. The mineralization is probably related to the Variscan to Alpine orogenies.

1 Introduction

The Anti-Atlas in Morocco consists of Paleozoic cover overlying Precambrian basement which is exposed within several inliers: Bas Draâ, Ifni, Kerdous, Tagragra-Akka, Agadir Melloul-Iguerda, Igherm, Zenaga, Siroua, Bou Azzer, Saghro and Ougnat (Fig. 1-A). These mountains are considered as a large metallogenic province for mineral exploration and exploitation (Bouchta et al. 1977; Mouttaqi et al. 2011), positioned at the NW margin of the West African Craton. Its evolution was related to a poly-phase tectono-magmatic history (from Eburnean to Alpine orogeny).

In the Eastern Anti-Atlas, the Saghro inlier is composed of meta-sedimentary Cryogenian basement that crops out in restricted areas know as Imiter-, Sidi Feleh-, Bou Skour-, Kelaa Megouna sub-inlier. The Ediacaran Ouarzazate supergroup consists of volcano-sedimentary successions overlying the basement (Gasquet et al. 2005; Tuduri et al., 2018). This supergroup itself is overlain by Cambrian sedimentary series. The Saghro inlier contains several ore deposits of precious and base metals, such as Imiter- (Ag-Hg), Tiouit- (Au-Cu), Thaghassa- (Au-Ag), and Bou Skour mine (Cu) (Mouttaqi et al. 2011; Tuduri et al. 2018). The mineralizations are hosted within Cryogenian meta-sediments and Ediacaran volcano-sedimentary rocks (Fig.1-B).

Previous studies argued that the mineralization events in the Eastern Anti-Atlas are linked to the extensional regime during late Ediacaran magmatic activities (Levresse 2001; Cheilletz et al. 2002; Gasquet et al. 2005; Bouabdellah and Slack 2016). However, recent data reported from the Imiter mine indicate a younger age for the silver mineralization and it is assumed to be related to the CAMP (Central Atlantic Magmatic Province; Triassic-Jurassic transition) magmatism during the opening of the central Atlantic ocean (Borisenko et al. 2014; Essarraj et al. 2016).

The current work reports for the first time on an Ag-Hg-Cu mineralization in the Tassafte mining district (Eastern Anti-Atlas belt), where the mineralization is hosted within both, Ediacaran and Cambrian formations.

2 Results

The Tassafte mining district is located at the NE edge of the Saghro inlier, about 25 km to the South of Tinghir city and 20 km to the East of the Imiter mine. In this area, two lithostratigraphic units were distinguished (Fig. 2), which correspond to the Ediacaran complex in the southern sector and to Cambrian formations in the northern part.

2.1 Country rocks

In the Tassafte area, the ore veins are hosted within Precambrian to Cambrian formations. The Precambrian is presented by Ediacaran volcano-sedimentary succession in which different lithofacies are identified that comprise rhyolitic ignimbrite, basalt to andesite lava, fallout deposit and a hydroclastic complex. These rocks are unconformably overlain by Cambrian sediments. The lower Cambrian comprises the Igoudine Formation, composed of polygenic conglomerates, the Imouslek\Issafene Formations that consist of alternating carbonates and shales, and fine quartzite beds that represent the Asrir formation. The Middle Cambrian is

composed by greenish shale that represents the Jbel

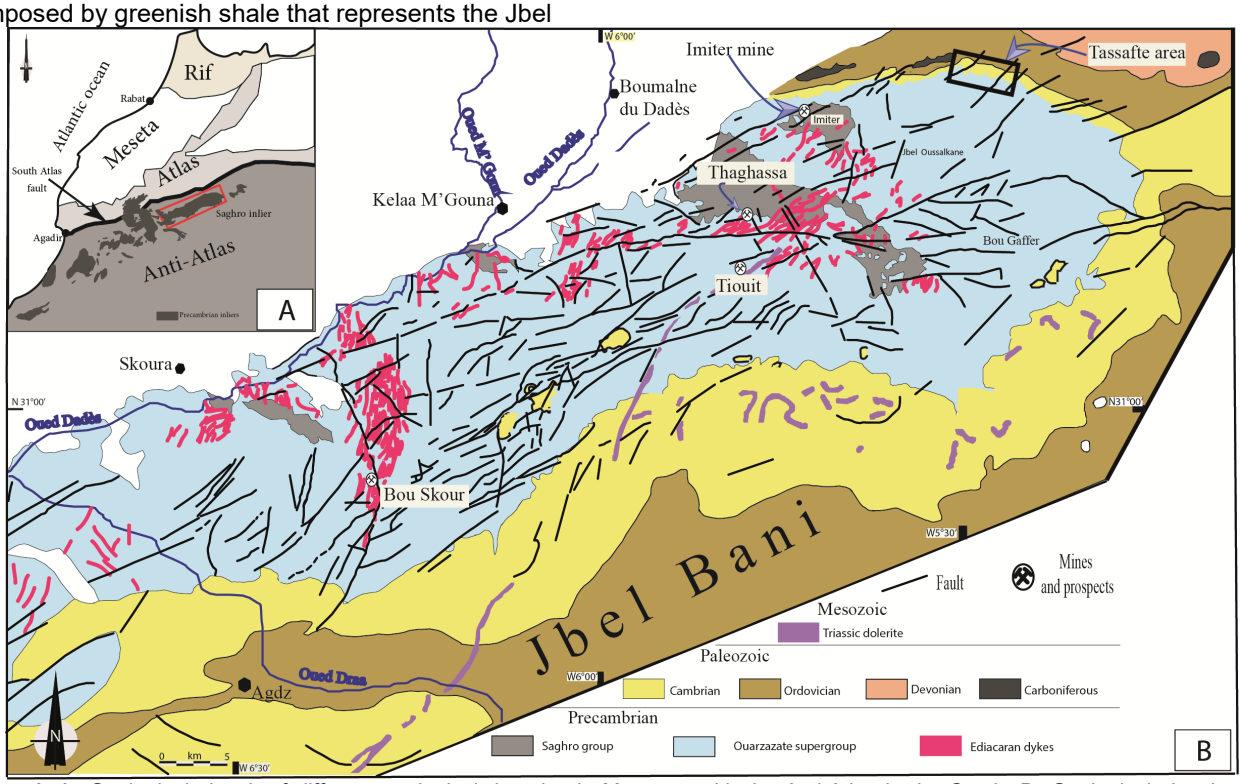

Figure 1. A- Geological sketch of different geological domains in Morocco, with the Anti-Atlas in the South. B- Geological sketch of the Saghro inlier with black box showing the location of the Tassafte mining area; updated after Tuduri (2005).

Wawrmast Formation showing interbedded lenses of carbonates and sandstone; the top is characterized by white massive quartzitic sandstones of Jbel Afrou Formation (Fig. 2).

2.2 Ore structures

In the Tassafte area, the ore deposits formed along an E-W shear system, in which the veins are oriented from N80 to N120. These ore structures are hosted in Ediacaran units and continuing within the Cambrian successions. The veins exhibit a thickness varying from some centimeter to decameter and they extend along 1 to 2 Km. They are generally dipping to the south about 55° to 90°, except the main major fault which marks the cartographic limit between the Ediacaran basement and the Cambrian cover and which is dipping to the North (85 to 70°N).

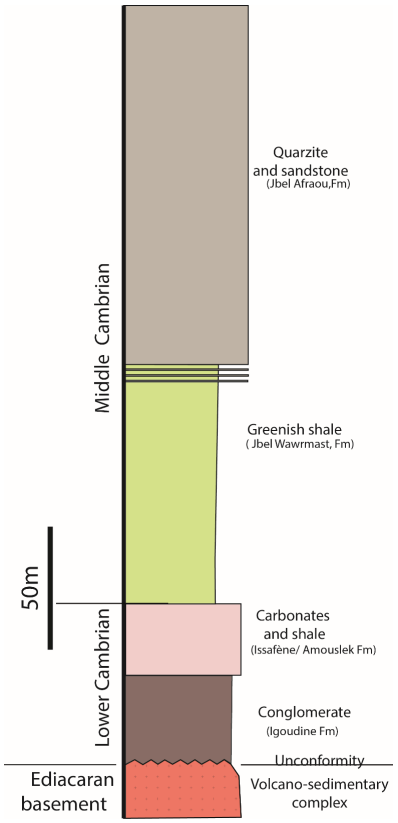

Figure 2. Schematic profile of the lithostratigraphic units that host the ore mineralization in the Tassafte area

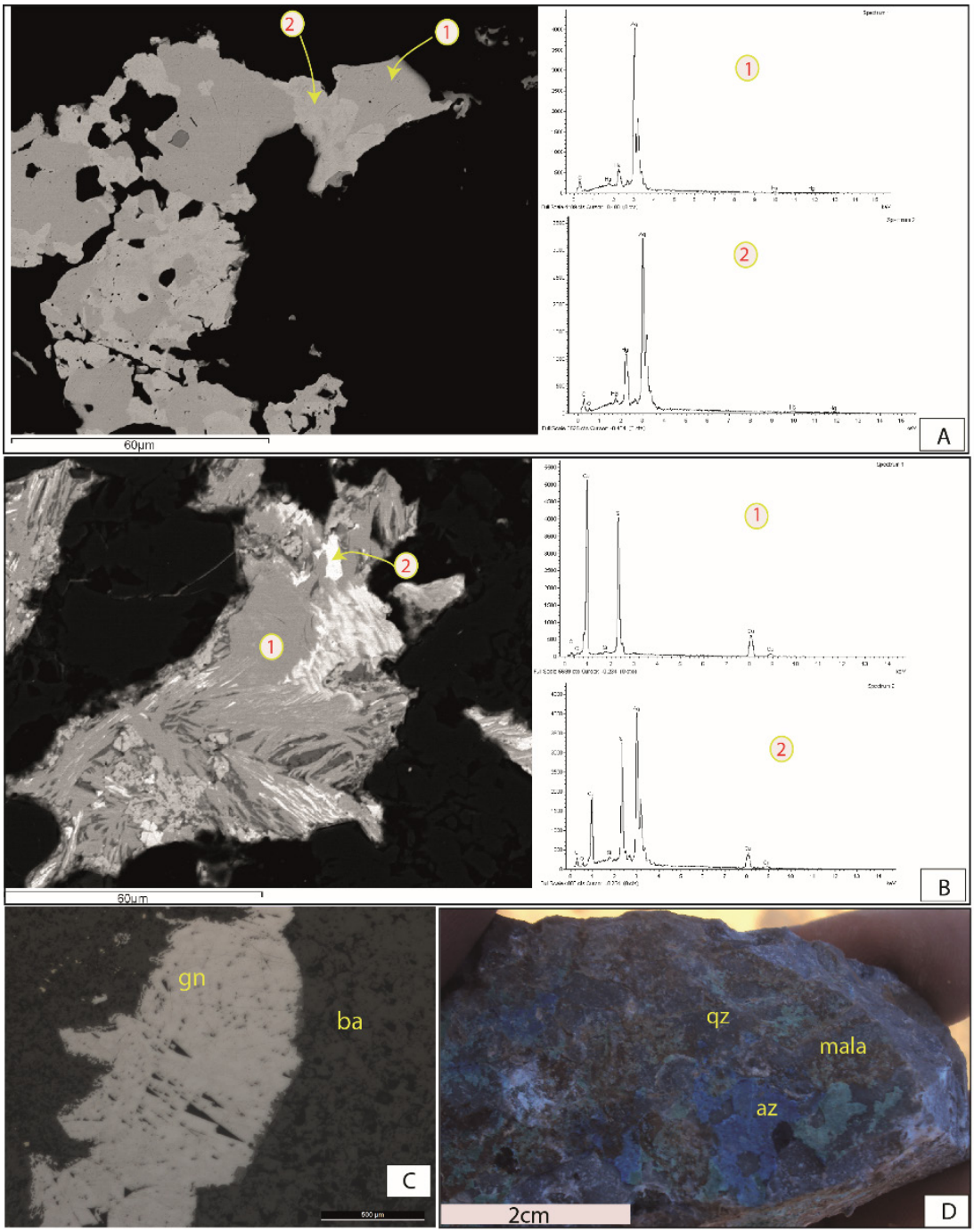

Figure 3. A- BSE image shows amalgam Ag-Hg mineral with different proportion of Ag and Hg that is confirmed byEDX analyses displayed on the right (Number 1 and 2 in circles). B- BSE image shows chalcopyrite and grey copper and their EDX analysis on the right. (Number 1 and 2 in circles). C- Thin section in reflected light image shows galena (gn) mineral within barite (ba) gangue. D- Malachite (mala) and azurite (az) mineralization within microcrystalline quartz gangue (qz).

2.3 Mineralization

Our preliminary results about the mineralization on the Tassafte mining area show a polymetallic mineralization within barite and quartz gangues. In the following, we present a brief description:

-Ag and Hg mineralization

The silver minerals are represented as argentopyrite, argentite, native silver and as an Ag-Hg amalgam (Fig. 3-A). The silver is also associated with grey copper.

-Cu mineralization

The copper minerals are largely present as copper sulfide (mainly chalcopyrite, chalcocite, covellite, bornite) or as a sulfosalt (grey copper) (Fig. 3-B, D). In addition, copper carbonate hydroxides are present as azurite and malachite.

-Zn mineralization

Is represented mainly by sphalerite or also within the

oxide stage in the form of zinc oxide.

-Pb mineralization

The Pb is present mainly as galena (Fig. 3-C).

-Gangue minerals

The gangue is represented by quartz that formed within several generations. They are microcrystalline quartz and geodic ones. Second gangue mineral is barite that show different texture such as massive and colloform.

Conclusions and prospective

The Tassafte mining area is located at the NE part of the Saghro inlier, about 20 km to the East of the Imiter mine. In this district the mineralization are formed in veins with centimetric to metric thickness. They are E-W-trending and they are hosted within Ediacaran and Cambrian successions. The mineralization is represented by copper minerals in the form of sulfide (chalcopyrite, chalcocite, covellite, bornite) or as carbonates hydroxide (malachite and azurite). In addition, the Ag mineralization forms an amalgam of Ag and Hg, or it is present as argentite and argentopyrite. This mineralization is also associated with galena and sphalerite.

Previous studies about the Ag-Hg-Cu mineralization specifically in the Imiter mine considered the mineralization to be restricted to the late Ediacaran age (Levresse 2001; Gasquet et al. 2005; Bouabdellah and Slack 2016). We present data indicating that at least part of the Ag-Hg-Cu-Pb-Zn mineralizations are younger and probably related to Variscan to Alpine orogenies.

Our prospective concerning the mineralization of the Tassafte area, consist of a deep study of the mineralization including fluid inclusions, isotopes, in order to understand the source and the genetic model of this mineralization. A comparison with Imiter mine and similar mining areas in the Anti-Atlas will be also carried out.

Acknowledgements

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