# Relations between Au / Sn-W mineralizations and late hercynian granite: Preliminary results from the Schistose Domain of Galicia-Trás-os-Montes Zone, Spain

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## ABSTRACT :

Au and W-Sn mineralization of the Schistose Domain of Galicia-Trás-os-Montes are spatially related to late hercynian granites. The Bruès (Au) and the Mina Soriana W-(Sn) deposits are studied. Both show some similarities and are assumed to form in the same tectonic and metamorphic context, on top of the granites. The role of the granite as a source for mineralizing fluids and rheological control for vein emplacement is re-adressed and discussed.

## 1 INTRODUCTION

Au and W-Sn Hercynian mineralization are frequently found close to granites thus questioning the eventual link between the emplacement of the intrusions and the mineralization. Classical models attribute a genetic link between W-Sn mineralization and granites (Derré, 1983; Lerouge et al., 2000) whereas the relationships between gold and magmatism are still debated (e.g. Vallance, 2001; Lang & Baker, 2001; Bouchot et al., 2000). This study presents a case-study of two Au (Bruès) and W-(Sn) (Mina Soriana) ore systems both associated in time and space with upper carboniferous Hercynian granites. This preliminary work re-addresses the problem of the role of granites in determining the nature and the location of the inferred mineralization.

## 2 GEOLOGICAL SETTING

The Bruès (Au) and Mina Soriana W-(Sn) deposits are located in the Galicia-Trás-os-Montes Zone (GTM zone, Figs. 1a, 1b) (Julivert et al., 1972; Farias et al., 1987), a part of the Iberian Hercynian massif. The GTMZ belongs to the internal zone of the Variscan belt and is composed of a relative autochthonous / parautochthonous unit overthrusted by allochthonous crystalline nappes (Ribeiro et al., 1990). The allochthonous basal units are constituted by schists, amphibolites, ortho- and paragneiss (Marquínez, 1984; Farias et al., 1987) whereas the parautochthonous (GTM Schist Domain, Julivert et al., 1972) is represented by a sequence of deformed and metamorphosed rocks. This domain mainly consists of Palaeozoic schists with sparse quartzite levels affected by low to medium grade metamorphism. They exhibit a well developed regional schistosity related to nappes emplacement and are affected by NS-trending crenulation and folds. Both parautochthonous and allochthonous units are intruded by synkinematic G3-type carboniferous plutons (Capdevila, 1969). These granites are separated in three facies with respect to the presence or absence of micas. Later G4-type plutons are emplaced during Stephanian-Permian times (Dallmeyer et al., 1997).

## 3 THE BRUES GOLD DEPOSIT

The Bruès gold deposit takes place on the top of the two-mica Boborás G3 granite intrusive in the Palaeozoic micaschists (Fig. 1c). The set of parallel ENE-WSW trending gold bearing veins is focused on the west dipping granite-micaschist contact. The set of gold-bearing veins is spatially associated with a regular network of granitic to aplito-pegmatitic dykes and connected sills, also intrusive in the micaschist. These dykes trend N60°E in the vicinity of Boborás granite and turn gradually to N90°E with distance to the granite (Figs. 1c, 2).

### 3.1 *Vein geometry*

Magmatic dykes and sills are frequently bordered and/or crosscut by two types of gold bearing quartz veins interpreted as: i) vertical tension gashes filled by quartz and sulphides (Fig. 3); ii) laminated and/or brecciated mineralized quartz shear veins (Fig. 4). Vertical E-W trending tension gashes are frequently en echelon disposed. They are either hosted within dykes and sills, along the dyke/micaschist contact, or isolated within micaschists. N70 to 90°E trending shear veins are quite systematically associated with the dykes. This spatial relationship suggests a strong rheological control by the dykes during vein formation. Moreover, kinematic criteria on shear veins, and vertical north-stepping en echelon tension gashes, are everywhere consistent with a northverging normal motion.

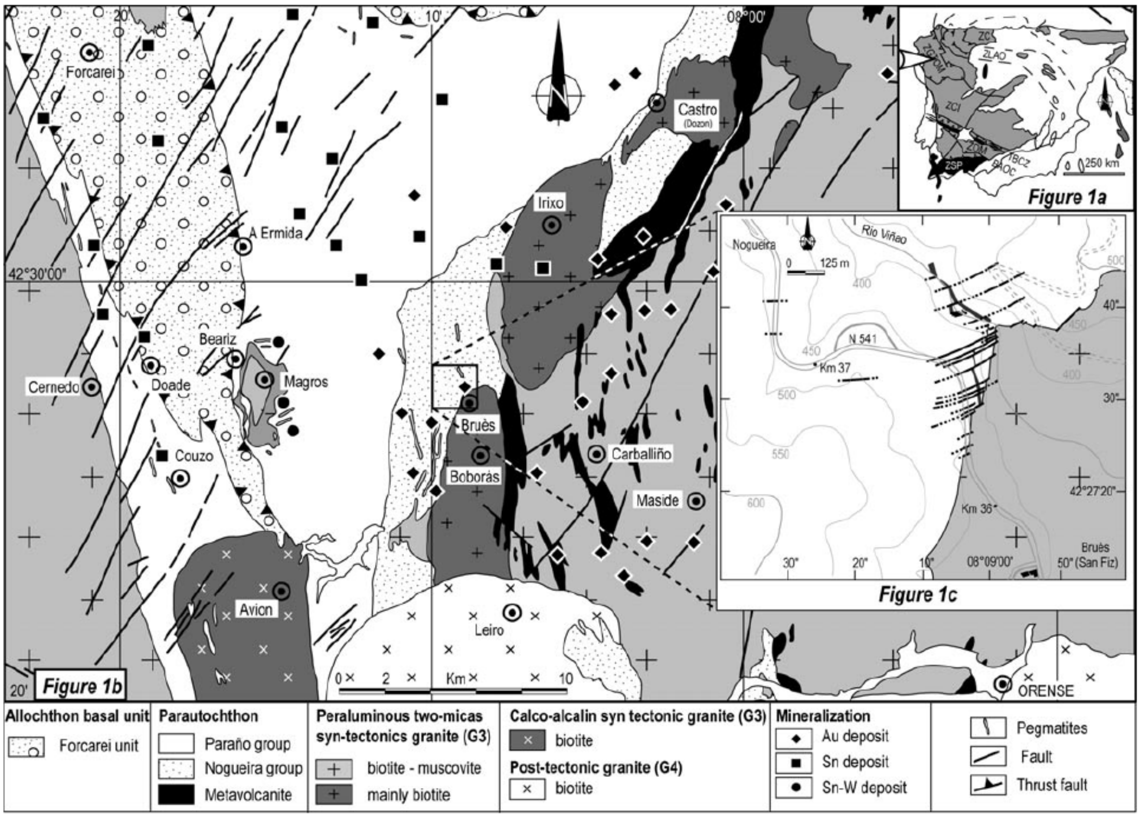


Figure 1. a) Structural map of the Hercynian Iberian massif (modified from Ribeiro & Sanderson, 1996) ; ZC : Cantabrian zone; ZLAO: Léon and Asturian zone; ZGTOM : Galicia-Trás-os-Montes zone; ZIC : Centro-Iberian zone; ZOM : Ossa-Morena zone; ZSP : South-Portuguese zone; b) Geological map of the study area, after the geological map of España, scale 1:200.000 (Orense), second edition; Ore deposits after metallogenical map of España, scale 1:200.000 (Orense); c) Boborás granite and Bruès dykes network.

### 3.2 *Mineralogical study and internal texture*

Petrostructural analyses show that both quartz veins and tension gashes present the same paragenetic evolution. Like for the classical orogenic veins type, they are composed of polyphased and complex quartz generations (Gerbeaud, 2002). The first quartz (Q1a) is characterized by large grains containing scheelite inclusions and forming the main filling of the veins.

Q1b corresponds to late growth developed around and inside Q1a grains. The Q2a quartz has two habits: within shear veins, it corresponds to elongate grains; within tension gashes, Q2a appears as subhexagonal undeformed grains with tourmaline inclusions. The latter minerals are crosscut by little fractures filled by the microcrystalline Q2b quartz. The Q3 undeformed quartz is located within arsenopyrite geodes or within late fractures. Q1 and Q2 quartz generations exhibit numerous evidences of internal deformation (i.e. undulose extinction, recrystallized sub-grains).

The presence of elongate Q2 grains within shear veins argues for a syn-tectonic quartz crystallisation. Arsenopyrite forms large infillings (up to 10 cm wide) with the quartz veins and is intercalated between the Q2a and Q2b. Bismuthinite is found within arsenopyrite as infillings of cavities and is associated with phengites. Gold (electrum Ag0.15 Au0.85) mostly occurs within arsenopyrite as grain (from 1 to 50 µm in size) mostly within fractures affecting arsenopyrite, and is associated with bismuth, maldonite and Bi-tellurides. Boulangerite has only been observed within late quartz veinlets.

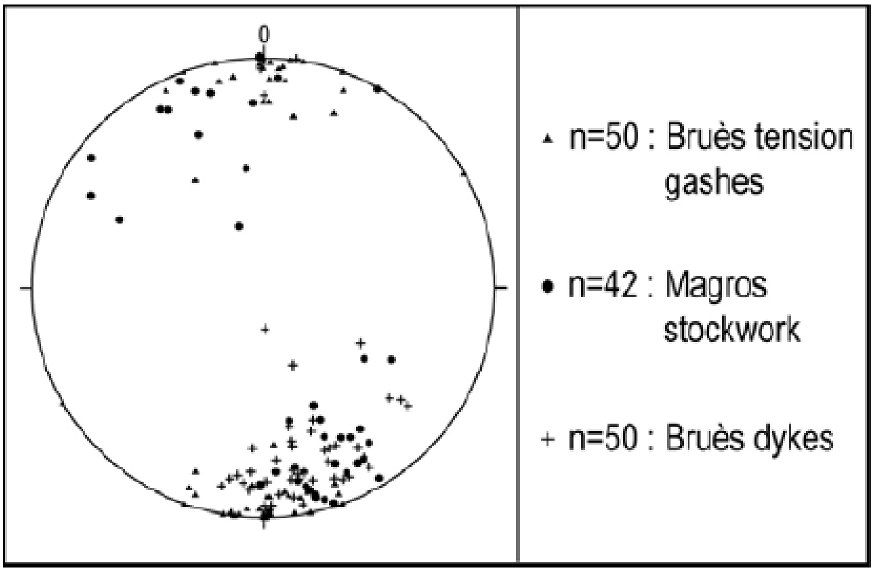


Figure 2. Stereonet diagram of tension gashes and dykes from Bruès deposit and from Magros stockwork, Schmidt diagram, lower hemisphere.

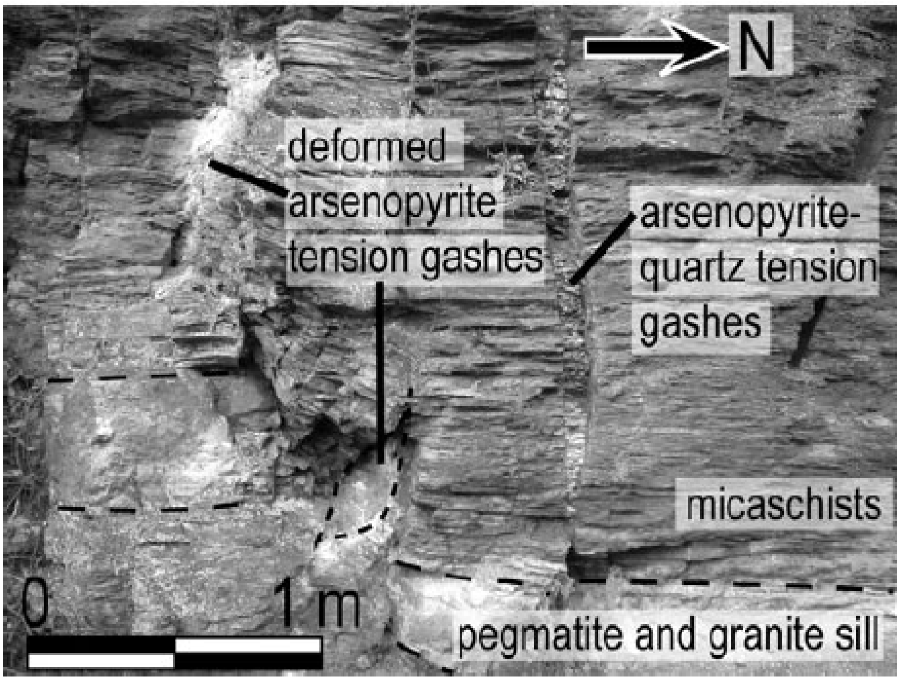


Figure 3. Deformed arsenopyrite tension gashes, quartzarsenopyrite tension gashes, intrusive sill in micaschistes.

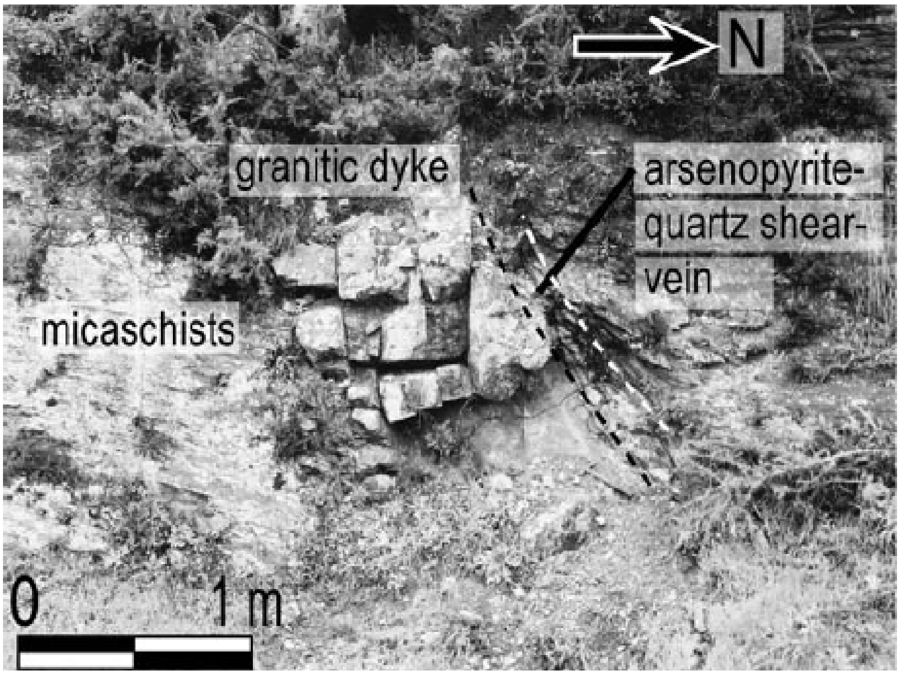


Figure 4 Granitic dyke in micaschist with arsenopyrite-quartz shear vein.

3.3 *Microthermometric study*

Microthermometry and Raman spectrometry were carried out on fluid inclusions of different quartz of the Bruès deposit (Pourraz, 2002). H2O-CO2-rich and CO2-fluid inclusions (with minor or significant CH4 and N2 contents) are present within all quartz generations. Presence of significant amounts of volatiles both in fluids from quartz veins and metamorphic lenses indicate that fluids have deeply reacted with the C-rich metamorphic series. H2O-salt inclusions are also recognized in fluid inclusion planes crosscutting all quartz generations. The P-T path highlights: i) an isothermal (around 400°C) decompression from 250 MPa (probably a lithostatic pressure indicative of around 10 km depth) down to 100 MPa, followed by ii) an isobaric cooling probably at rather low pressure, which is synchronous with the main metal and gold deposition.

## 4 THE MINA SORIANA W-(SN) DEPOSIT

The Mina Soriana tungsten-bearing veins network takes place on top of the Beariz-Magros granite, assumed to belong to the G3-type (Fig. 1b). Vein system is hosted by micaschists, on the eastern side of the granite exposure. The granite is composed by two distinct facies: the centre of the intrusion exhibits a two-mica coarse facies whereas the edge is a fine-grained leucogranite. In places, important quartz stockwork affects this leucogranite. This stockwork is particularly well developed in the leucogranitic eastern part, close to the Mina Soriana mineralizations. Structural observations and data show that (Fig. 2): i) quartz veins are oriented N60°E to N120°E with an average direction close to N70°E; ii) locally, networks of en echelon veins are related to a north-verging normal motion; iii) veins are restricted to the granite; iv) quartz veins contain traces of arsenopyrite.

The surrounding micaschist exhibits disseminated tourmaline grains and pegmatitic dykes and sills. These magmatic intrusions provide an important hydrothermal alteration illustrated by massive tourmalinite haloes around dykes and sills. The Mina Soriana W- (Sn) deposit is related to a similar geological context. This old mine is one of the numerous W-Sn deposits of the Magros district (Fig. 1b). It consists of a few N60°E trending quartz veins, 10 cm to 2 m-thick, hosted within micaschists. These veins contain the mineralization expressed by wolframite, arsenopyrite, pyrite and sphalerite. Micaschists are marked by a well-developed sub horizontal schistosity affected by a N-S crenulation. Some outcrops present a well-defined N-S stretching lineation. Numerous magmatic sills intrude the micaschists developing surrounding tourmalinites halos. Associated with this event, late N60°E to N90°E trending quartz-tourmaline-muscovite veinlets are developed, crosscutting tourmalinites levels and parallel to the major W-(Sn)-bearing veins (Fig 5).

## 5 CONCLUSION

Two types of mineralized quartz veins have been analysed. The Bruès (Au) and Mina Soriana W-(Sn) deposits present several similarities that are: i) both occur within micaschists, spatially related with N-S elongate shape granitic intrusions (Fig. 1b); ii) N60°E to N90°E trending mineralized quartz-veins are spatially associated with granitic and/or aplitopegmatite dykes and sills; iii) both Bruès veins and Magros stockwork show evidences of formation controlled by north-verging normal motion. This necessitates to be demonstrated for the mineralized veins of the Mina Soriana.

All these elements can suggest that both mineralizating events occurred in the same tectonic context, characterized by a north-verging normal motion. In both cases, veins localizations are controlled by rheological discontinuities constituted by granitic and aplito-pegmatitic dykes and sills. If these assumptions are confirmed, this study provides a remarkable example of a dual hydrothermal system in which sectors are gold-enriched (the Bruès deposits) whereas others show W-Sn mineralizations (the Magros district). In the future, the role of the granite in this kind of mineralization distribution and segregation will be studied in detail.

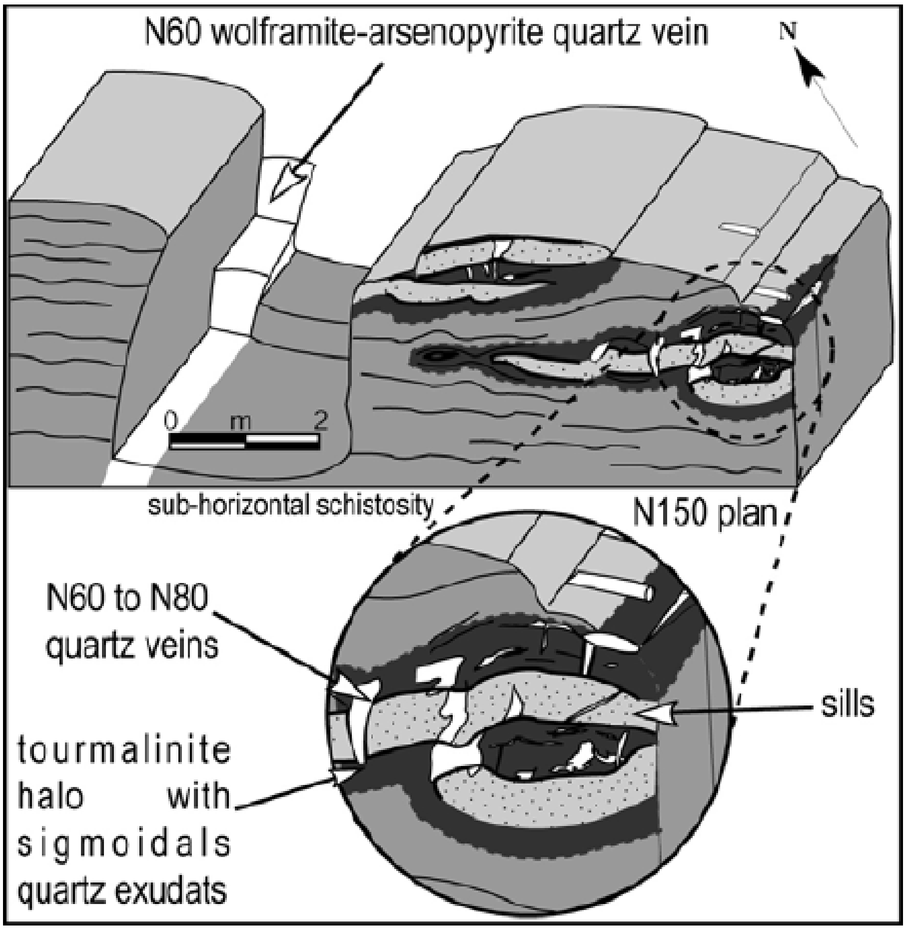


Figure 5. Relationship of mineralized features and magmatic sill within the Mina Soriana deposit.

## ACKNOWLEDGEMENTS

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