Volcanic stratigraphy and geochemistry of the VS complex in the northern Iberian Pyrite Belt

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INTRODUCTION

The northernmost Iberian Pyrite Belt (IPB) hosts several massive sulphide orebodies aligned in a major E-W belt located just south of the regional thrust that limits the South Portuguese Zone with the Pulo do Lobo Unit. These massive sulphide bodies, except Aguas Teñidas, have small tonnages but high base and precious metal grades that contrasts with the absolute dominance of pyrite in the most of the other IPB deposits.

The massive sulphides are hosted by a deformed and only slightly metamorphosed sequence of volcanic and sedimentary rocks (Volcanic Sedimentary Complex, VS Complex), here dominated by felsic volcanic rocks of Tournaisian-Visean age. Mafic volcanic rocks are scarcer and dominantly occur in independent tectonostratigraphic units, apparently unrelated to the massive sulphides.

Most of the studies on the volcanology of the IPB are focused on the south and central parts; only some few works deal with the northern area (e.g., Bobrowicz, 1995; Sánchez España, 2000)

This contribution presents a summary of the geology of the northern IPB with special emphasis on the geochemistry and the facies interpretation of the volcanic units. The results allow the definition and characterization of the several volcanic units existing in the area and a proposal of the reconstruction of the stratigraphic sequence and the environment in which volcanism occurred and the massive sulphides formed.

GEOLOGICAL SETTING

The northern IPB is characterized by a complex Variscan structure in which several superimposed tectonostratigraphic units crop out in narrow and elongated domains of ca. 10-15 km long and up to 1-3 km thick steeply dipping to the north or moderately to the NNE; they are limited by major NW-SE to WNW-ESE south-verging thrusts and shear zones. In detail, these tectonostratigraphic units represent structurally dismembered parts of the VS Complex.

In this area, more than 95% of the cropping out VS Complex consists of volcanic rocks; shale accounts for less than 5%. The most common volcanic rocks are felsic and include well variegated facies ranging from coherent facies, which have been interpreted as domes, crypto-domes and sills to volcaniclastic rocks such as autoclastic breccia (hyaloclastite) and rocks rich in pumice and glass fragments that are the product of the resedimentation of the massive rocks. Some of them could have a primary pyroclastic origin. Epiclastic facies and shale are less abundant. Andesite is especially abundant in the northernmost part and shows the same types of facies. Mafic rocks occur in minor proportions as coherent lavas that laterally pass to monomictic and polymictic breccia.

Lithostratigaphic analysis

Detailed geological analysis of the Volcanic Sedimentary Complex allows differentiation of six principal lithological units that usually occur in independent tectonic domains (Fig. 1):

(1) Footwall Felsic Unit (FFU), with feldspar-quartz-phyric rhyodacite (crypto)-dome complexes including coherent facies and associated hyaloclastite breccia and epiclastic sedimentary equivalents alternating with volcaniclastic siltstone and pumice and glass-rich breccia beds at the top and on the lateral margins of the dome complexes.
(2) Volcano-Sedimentary Unit (VSU), dominated by vesicular basaltic lava and associated mafic epiclastic sandstone and siltstone, intercalated with thin beds of shale.
(3) Hanging Wall Felsic Unit (HFU), formed by coherent rhyolite domes and associated volcaniclastic rocks intercalated with polymictic epiclastic sedimentary rocks, cut by numerous felsic and mafic sub-volcanic intrusions.
(4) Sedimentary Unit (SU): intensely deformed unit grey siltstone with interlayered shale and fine-grained epiclastic sedimentary rocks. Mylonitic fabrics are widespread.
(5) Upper Felsic Unit (UFU): dacitic to rhyolitic dome complexes with similar characteristics to the Footwall Felsic Unit. Locally, there are pumice-rich breccias associated to the domes.

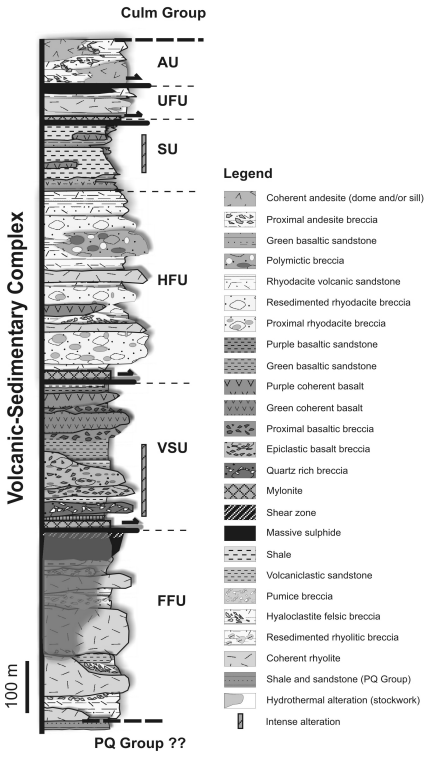

Fig. 1. *Simplified stratigraphic column of the volcano-sedimentary sequence in the northern part of the IPB (San Telmo-Aguas Teñidas area).*

palabras clave: Faja Pirítica Ibérica, litoestratigrafía, geoquímica

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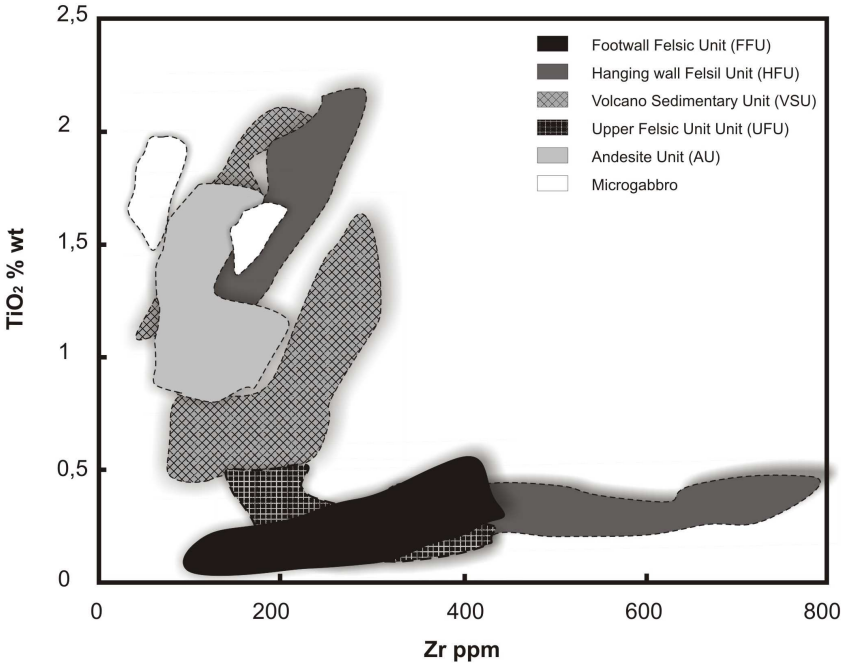

Fig. 2. *TiO_2 vs. Zr plot showing the distribution of the main igneous rock units from the northern IPB.*

(6) Andesite Unit (AU), forming the tectonically uppermost unit. It comprises andesitic dome complexes, rich in hyaloclastite breccias and equivalent volcaniclastic sedimentary rocks.

The massive sulphides are dominantly hosted by the Footwall Felsic Unit (Aguas Teñidas) with only some orebodies related to the Upper Felsic Unit (Lomero Poyatos, San Telmo and El Carpio).

GEOCHEMISTRY OF THE VOLCANIC ROCKS

The geochemistry of the VS Complex is dominated by andesitic to rhyolitic calc-alkaline magmatic rocks with subordinate tholeiitic basalt. Overall, the rocks of the VS Complex define a continuum of silica content ranging from basalt to rhyolite, with a significant proportion of dacite and andesite. The Footwall Felsic and Upper Felsic Units are geochemically identical and probably represent dismembered parts of a single volcanic felsic complex. This volcanic unit is characterized by Zr contents below 200 ppm, significantly lower than those of the more evolved Hanging Wall Felsic Unit (200-750 ppm) (Fig. 2); these two felsic units are interpreted as independent batches of magma derived from the same deep magma chamber.

DISCUSSION

The Aguas Teñidas, Castillejito and Cueva de la Mora deposits occur at the top of the Footwall Felsic Unit. The massive sulphide orebodies of the old Aguas Teñidas, San Telmo and El Carpio deposits occur either in the Upper Felsic Unit or along its tectonized footwall contact with the Sedimentary Unit. The Lomero Poyatos deposit occurs in volcaniclastic rocks of the Upper Felsic Unit, but is sandwiched in a small tectonic window within the overlying Andesite Unit. If the Upper Felsic Unit correlates with the Footwall Felsic Unit, then all the massive sulphides are contemporaneous and formed on top of domes that are likely to be the youngest volcanic rocks of the area. These orebodies are hosted in hyaloclastite or pumice-and-glass-rich breccia that exhibit intense hydrothermal alteration and are interpreted as replacive, formed below the seafloor by replacement of permeable and reactive units such as the pumice-and-glass-rich breccias (Tornos, 2006). However, the chemical analyses show that the ore-bearing domes are not the most "fractionated" of the northern IPB, which is the barren Hanging wall Felsic Unit. The fertile unit is characterized by low Zr contents that may be the result of a unique history of magmatic assimilation of previous primitive rocks.

Cross-cutting relationships, structural analysis and the geochemical study suggest that the volcanic sequence is tectonically inverted, with the youngest units located at the lowest structural position. The proposed reconstructed stratigraphic sequence comprises an andesitic footwall, overlain by the felsic complexes of the Hanging wall Felsic and Footwall-Upper Felsic Units. Mafic rocks and related sediments apparently occurred interbedded with the felsic rocks.

CONCLUSIONS

The VS Complex of the northern Iberian Pyrite Belt is dominated by felsic volcanic rocks with minor amounts of andesite, basalt and shale. These rocks are grouped in six tectonostratigraphic units, of which five have distinctive geological and geochemical characteristics. However, two of them (Footwall Felsic Unit and Upper Felsic Unit) are probably dismembered parts of the same volcanic complex. These late ones, despite not being the most fractionated felsic rocks of the area, seem to be the host rocks of the massive sulphides.

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