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Tectono-metamorphic evolution, quartz structures and fluid regime of the Vila Pouca de Aguiar region (Northern Portugal)

Evolución tectóno-metamórfica, estructuras de cuarzo y régimen de flujo de la Región Vila Pouca de Aguiar (Norte de Portugal)

M. A. RIBEIRO; A. DÓRIA & F. NORONHA.

GIMEF- Centro de Geologia da Universidade do Porto, Faculdade de Ciências, Praça Gomes Teixeira, 4099-002 Porto. Portugal. E-mail: maribeir@fc.up.pt/ adoria@fc.up.pt

Vila Pouca de Aguiar area (VPA) belongs to the Galiza-Trás-os Montes Zone and it is located along the southern border of the "Peritransmontano" domain [1]. The rocks in the area comprise an upper Ordovician to lower Devonian age metasedimentary sequence, and syn-to late and post-tectonic Hercynian granites. In this area two structural domains have been distinguished on the basis of different structural and lithostratigraphic features: Três Minas Structural Domain (TMSD) and Carrazedo Structural Domain (CSD) [2] (Fig. 1a). Both are characterised by the occurrence of C-rich lithologies within basal units: there are predominantly black shales in CSD and lydites in TMSD [3].

The VPA area has been affected by three tectonic ductile phases (D_1, D_2 and D_3), followed by later brittle phases. A sub-horizontal foliation (S_2) is the main foliation in CSD, and in TMSD the regional structure is marked by S_3 concordant with S1 foliation - N120º; sub-vertical.

The VPA area is affected by a low grade metamorphism (clorite + biotite ± andaluzite): biotite zone in the whole extension of CSD, and chlorite zone in the great extension of TMSD (biotite + andaluzite zones are restricted to narrow zones parallel to syntectonic granites) [2].

The metallogenic importance of this area is confirmed by the abundance of ancient gold mining and by several occurrences of gold indices [4] [5].

Tectono-metamorphic evolution

The P-T evolution of the regional metamorphism can be described as follows: during D_1 and D_2 phases the metamorphism occurred in prograde conditions, until a level of T= 350 to 450ºC and P= 350 to 400 MPa [2]. However in CSD, the upper structural domain, the D2 tangential phase induces an effect of tectonic overpressure, implying the formation of a well marked metamorphic banding in all lithologies: quartz-phyllites, acid volcanic rocks and calc-silicate rocks. In CSD the metamorphic banding erases the previous foliations (S_0 and S_1), while in TMSD the S0 layering is well preserved.

In both domains, a thermal peak of the metamorphism related to syntectonic granite emplacement, occurred during D_3 (T=500º to 550ºC and P = 300 to 350 MPa). After D_3, evidences of retrograde metamorphism were observed (Fig. 1b). In the proximity of the post-tectonic biotite granite of Vila Pouca de Aguiar a contact aureole was formed at T=500º to 550ºC (hornblende hornfels).

Quartz-structures and fluid regime

In the area a large number of quartz structures (barren and mineralised) occur into the metasedimentary units [6] (Fig. 1c). In CSD, the early quartz-structures (ante-D_3) are sub-horizontal barren quartz veins and veinlets concordant with previous anisotropies (S_0 and S_2), whereas in TMSD the ante-D_3 quartz-structures are sub-vertical, parallel to S_0 and S_1 [4].

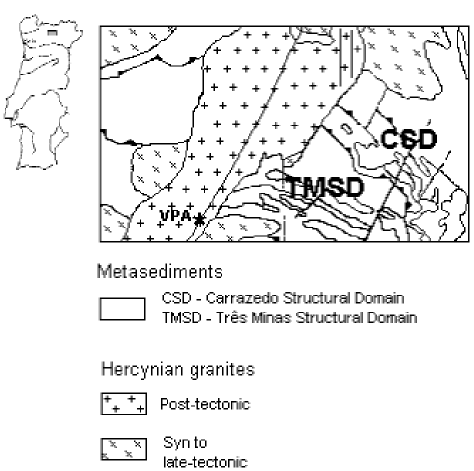
Au-mineralised quartz-structures are observed in both structural domains. In TMSD they are silicified structures essentially related to syn-D_3 shear zones (N120º to N130º, sub-vertical) that are concordant with previous anisotropies. In CSD the Au-mineralised quartz-structures are sub-vertical striking NE-SW and NW-SE, discordant with a previous regional sub-horizontal foliation (S_2). In these domain, D3 develops a crenulation with a soft foliation (N120º to N130º, sub-vertical), accompanied by brittle-ductile deformation expressed by N40º to N50º fracture system.

All these structures were reactivated during the brittle-ductile and brittle deformation events post-D_3, and due to this tectonic reactivation early milky quartz veins were repeatedly fractured and recrystallised.

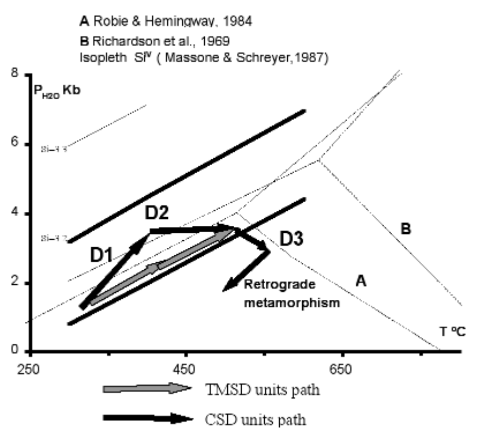
The fluids trapped in the successive quartz generations points out a lithological and structural control [4]. The fluids from the barren quartz in CSD were characterised by CO_2 being predominant in the volatile phase, whereas in TMSD the fluids are characterised by higher content of CH_4 and the presence of a solid phase (graphite). The fluids from ore bearing structures of both domains show a similar evolution evidenced by a decreasing of the volatile phase density, accompanied by a decreasing in CO_2, with a consequent enrichment in CH_4, and dilution combined with decreasing temperature.

Concerning the P-T conditions of fluid trapping the general trend correspond to decompression accompanied by temperature decrease. The early CO_2 richer fluids, were trapped in P-T conditions compatible with the syn-D_3 metamorphism. The decreasing P-T conditions (P=250 to 80 MPa and T<300ºC) are related to the basement uplift and/or pressure fluctuations from lithostatic to hydrostatic regime during retrograde metamorphism (post-D_3). In CSD the fluid evolution was essentially in lithostatic regime whereas in TMSD the fluid evolution was mostly in hydrostatic regime. The vertical structure of TMSD has made possible an hydrostatic regime at deeper levels than those of CSD where a lithostatic regime was observed [4].

a



b



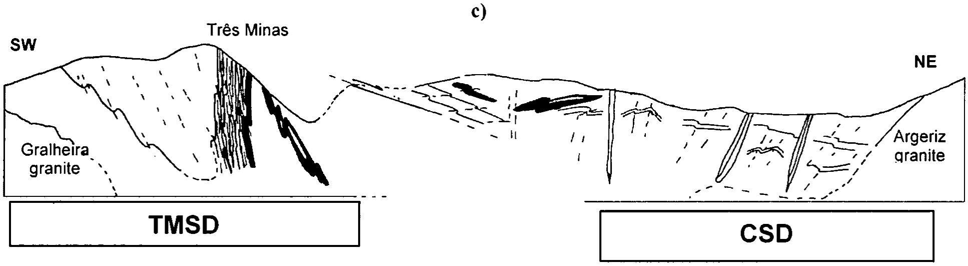


Fig. 1 – a) Geological sketch of VPA area; b) PTt path of TMSD and CSD; c) Schematic profile (section).

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