Universidade do Porto - Faculdade de Ciências
Museu e Laboratório Mineralógico e Geológico
Memória nº4, p. 527-532, 1995 ISSN 0871-1607

METALLOGENETIC POTENTIAL OF THE VILARIÇA STRIKE-SLIP FAULT AT QUINTELA DE LAMPAÇAS (BRAGANÇA, PORTUGAL)

F.J.A.S. Barriga[1], A. Mateus[1], A. Ribeiro[1], W.S. Fyfe[2], F. Longstaffe[2]

[1] Departamento de Geologia da Faculdade de Ciências, Universidade de Lisboa, Ed. C2, Piso 5, Campo Grande, 1 700 Lisboa, Portugal

[2] Department of Earth Sciences, University of Western Ontario, London, N6A 5B7, Ontario, Canada

Abstract

At Quintela de Lampaças, the Vilariça fault zone clearly brings to contact rocks of the Parauthocthonous and Lower Allocthonous Units, and one of its branches may also reactivate the contact between the two volcanic sequences typical of the latter unit (greenschists and volcanic-siliceous rocks). The fault zone contains thick siliceous brecciated infillings (2 Km long, 0.5 - 20 m thick) which are lenticular in shape, and oriented according to the strike and dip of the fault. Detailed study (surface and in drillcore) of these hydrothermal polyphasic precipitates revealed that the outcropping breccias (oxide/hydroxide-rich) result from weathering of sulphide/carbonate mineralised breccias, found at depths of 75 m and deeper. Global evaluation of the available lithogeochemical data shows that economic abundances of precious metals were not found, but the mineralogy, textures and geochemical anomalies found in drill cores strongly suggest a precious metal precipitation system, in agreement with pre-drilling hypotheses.

In the Quintela de Lampaças area, the Vilariça Fault separates the *Parauthocthonous* (to the NW) and *Lower Allocthonous Terranes* of NE Trás-os-Montes (*e.g.* Ribeiro, 1974). The former is composed of quartz-pelites and psammites. The latter comprises greenschists and volcanic-siliceous rocks separated by an important fault, apparently reactivated during Late-Variscan tectonic activity (fig.1).

The fault zone contains thick siliceous infillings (0.5 to 20 m) in an extension of about 2 Km along the strike, comprising (a) tuffaceous ultra-cataclasites; (b) quartz (proto)-cataclasites; and (c) various quartz breccias, often oxide/hydroxide enriched (fig.2**A**,**B**). Comprehensive petrography of the latter two fault rock types enabled the distinction of 4 main quartz generations, and the establishment of a relative chronology between fracturing/sealing events (of the hydrothermal siliceous precipitates and metamorphic host lithologies) and development of the fault rocks; the main conclusions of the petrographic study are summarised in fig.2**C**. The quartz infillings are lenticular in shape, and oriented according to the strike and dip of the fault. This results from the tectonic style of the Vilariça fault (left lateral strike-slip with a vertical thrust component to the S-SE), and the consequent discontinuous nature of the infillings should not hinder the metallogenic potential of the fault (fig.2**B**). New lenticular bodies should be found at depth, after zones of severe necking or even absence of fault fills.

The development of the hydrothermal alteration assemblages is largely dependent of the intensity of brittle deformation, therefore rocks in the adjoining domains of the fault zone exhibit usually strong metasomatism. The main mineralogical changes involve partial or total saussuritization of pre-existing feldspars, partial destruction of calcic amphiboles, phyllosilicates, and primary Ti oxides and silicates, coupled with major quartz precipitation. Drilling at Quintela de Lampaças (370 m, with the co-operation of Instituto Geológico e Mineiro) confirmed the hypotheses made on the basis of the study of the outcropping oxidic breccias, and comparison with the mineralised and barren breccias observed in the França sector (N of Bragança; Mateus & Barriga, 1991, 1993; Mateus, 1995). The (hydr-)oxide aggregates that characterise the outcropping breccias are

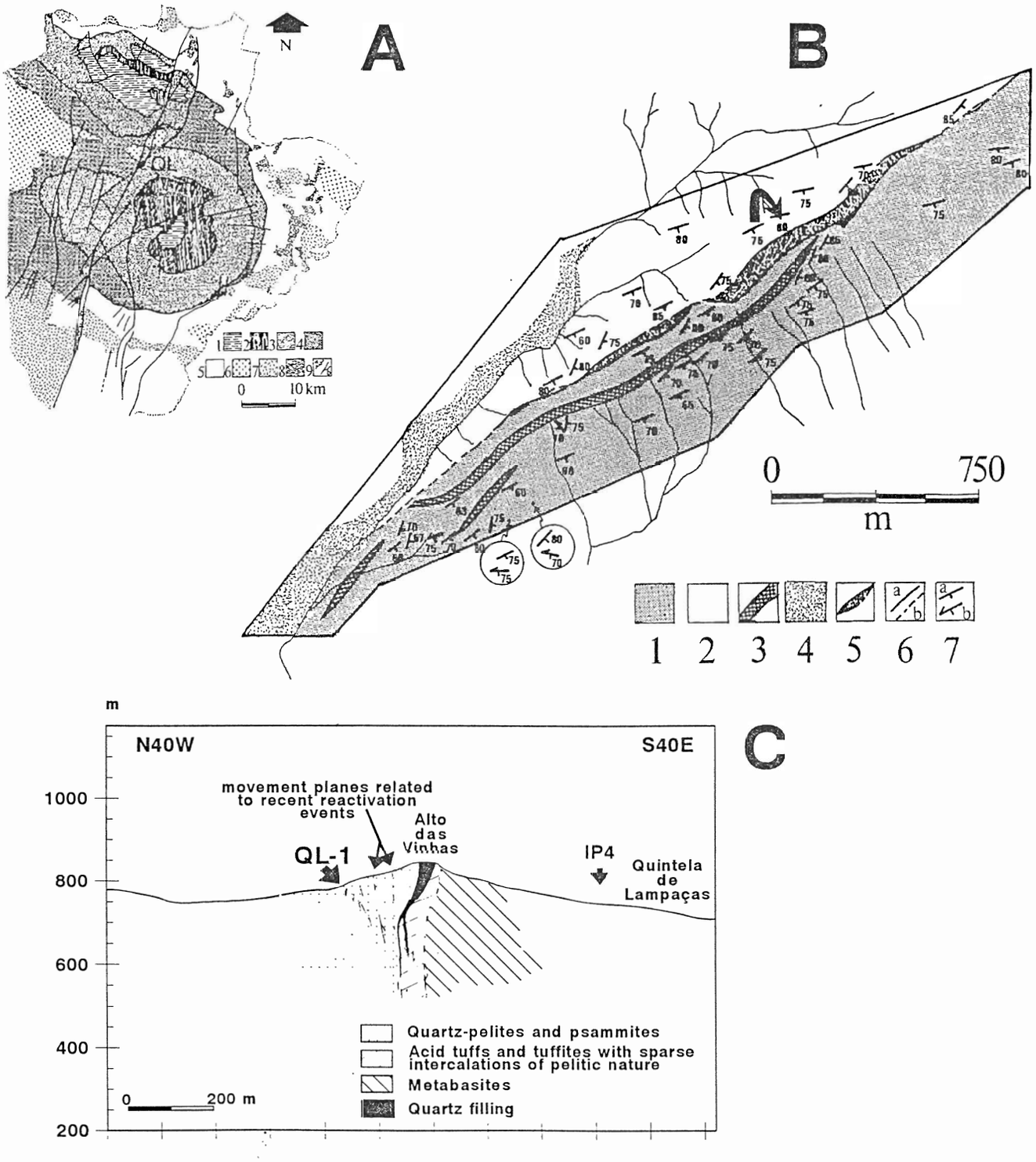

Fig.1 - A: Synthetic geological setting of the **VFZ** northern segment (simplified after Ribeiro, 1974) and localisation of the studied fault segment (**QL**). **1** - Upper Allochthonous Unit; **2** - Ophiolite Complex; **3** - Lower Allocthonous Unit; **4** - Para-autochthon; **5** - Autochthonous Domain; **6** - Late-hercynian granites; **7** - Hercynian granites; **8** - Cenozoic cover deposits; **9** - **a)** Major thrust plane; **b)** Main fault trace. **B**: Geological map of Quintela de Lampaças sector: **1** - Lower Allocthonous Unit : metabasites; acid tuffs, tuffites and alternating pelites; metagabbros (**3**); **2** - Para-autochthon: quartz-pelites and psammites; **4** - Alluvial sediments; **5** - hydrothermal siliceous fault precipitates; **6** - inferred (**a**) and well determined (**b**) fault trace; **7** - (**a**) S_1+S_2; (**b**) S_3. The arrow indicates the drilling QL-1; **C** - Interpretative geological cross-section according to the drilling results.

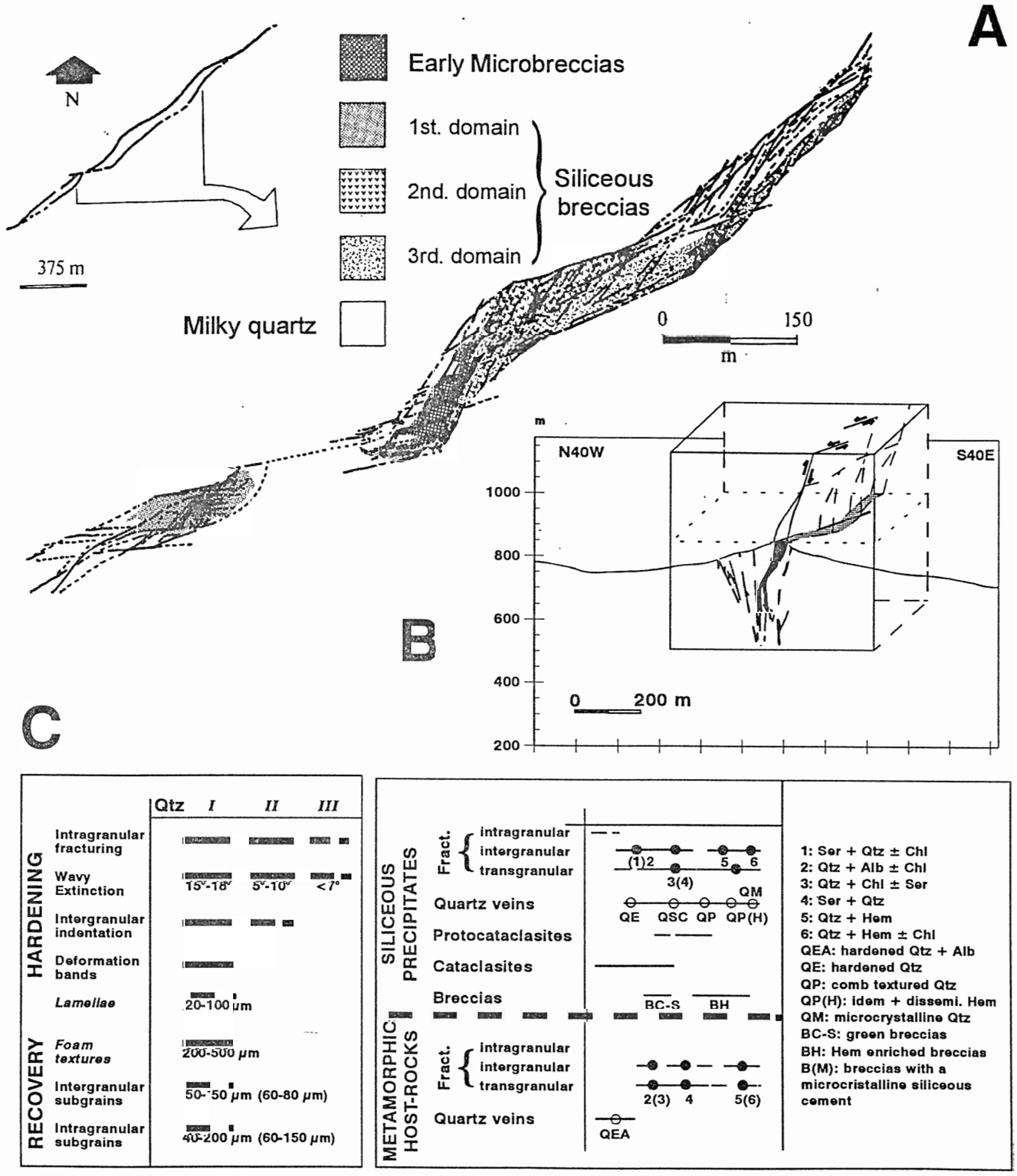

Fig.2 - A: Late fracture network exhibited by the hydrothermal siliceous precipitates of the Vilariça fault at Quintela de Lampaças and breccias distribution. **B**: Interpretative presentation of the siliceous fault infillings geometry according to the drilling results and surface mapping. **C**: Main microstructural characteristics of quartz generations I, II and III (the 4th do not show petrographic features resulting from plastic and/or semi-brittle deformation) and synthesis of the relative chronology between fracturing/sealing events (of the hydrothermal siliceous precipitates and metamorphic host lothologies) and fault rocks development.

mainly the result of primary sulphide and carbonate weathering. These lie presently 75-100 m below the surface, controlled by the fault fill; the assemblage comprises ***quartz*** + ***siderite*** ± ***dolomite*** + ***chalcopyrite*** + ***pyrite*** ± ***bornite*** ± ***sphalerite*** ± ***arsenopyrite*** ± ***galena***. The metasomatism of the host rocks is then characterised by more or less intense sericitization, chloritization and silicification, together with frequent disseminated pyrite. Economic abundances of precious metals were not found, but the mineralogy, textures and geochemical anomalies found in drill cores strongly suggest a precious metal precipitation system, in agreement with the pre-drilling hypothesis. The Quintela de Lampaças site has become a significant exploration target that should be investigated thoroughly.

Since the alteration took place under conditions compatible with those inferred for precipitation of the main fault minerals, one may conclude that the main seismic cycles responsible for the propagation of Vilariça fault at Quintela de Lampaças occurred in a transitional brittle-ductile regime, under a decreasing thermal gradient (350 to 250°C, pressures lower than 2 kbar). Analysis of the hydrothermal mineral parageneses coupled with fluid inclusion and stable isotope data further indicate that, during the semi-brittle/brittle transition, the circulating fluid evolved from reducing, CO_2-bearing, to oxidising, slightly alkaline, and loose progressively the CO_2. The final tectono-hydrothermal activity took place in a brittle regime. Much oxidising, alkaline, low temperature fluid (<200°C), was pumped into intensely fractured host rocks. Detailed examination of fig.3 (**A** to **C**) enables a more precise evaluation of available data.

There is an overall trend of decreasing $\delta^{18}O$ values, from cycle ***I*** to cycle ***III***. This is interrupted by peaks of high $\delta^{18}O_{Qtz}$ values obtained in quartz separates of the same generation where the homogeneization temperature differs less than 25°C (fig.3**C**). Another interesting feature, compatible with the available microthermometry, results from the division of the general evolving $\delta^{18}O_{Fluid}$ trend in two main segments. The first comprises the deposition of the earlier quartz generations (with a relatively narrow range of $\delta^{18}O_{Qtz}$ values, < 2‰) according to a continuous cooling path between ≈350 to 250°C (fig.3**C,D**). The $\delta^{18}O_{Qtz}$ range obtained for quartz ***II*** concentrates might, therefore, be explained by the presence of immiscible fluids generated via system depressurisation induced by seismic yielding (the most saline and CO_2 enriched fluids were in equilibrium with the isotopically enriched quartz). The second segment, which begins at the third deformation cycle, took place under temperatures lower than 200°C. Considering the $\delta^{18}O_{Mineral}$ average values for calcite, siderite, dolomite and the subsequent quartz generations, there is a gradual $\delta^{18}O_{Qtz}$ increase from 9.57‰ (quartz coexistent with siderite) to 19.79‰ (euhedral late-quartz crystals) - corresponding to calculated $\delta^{18}O_{Fluid}$ from -2.63 ‰ to 0.82‰ in fig.3**C**; the trend is interrupted by the $\delta^{18}O$ values of both the quartz veins ***iii*** and the carbonates. This is strong independent evidence corroborating the importance of seismic events on the mechanisms that constrain the chemical evolution of the fluid during a given deformation cycle. The isotopic signature of carbonates also is consistent with this conclusion. Thus we interpret carbonate deposition as a result of CO_2 loss and an accompanying increase in pH. In this perspective, the fact that fluid salinity during quartz vein ***iii*** formation is lower than in fluids related to quartz ***III***

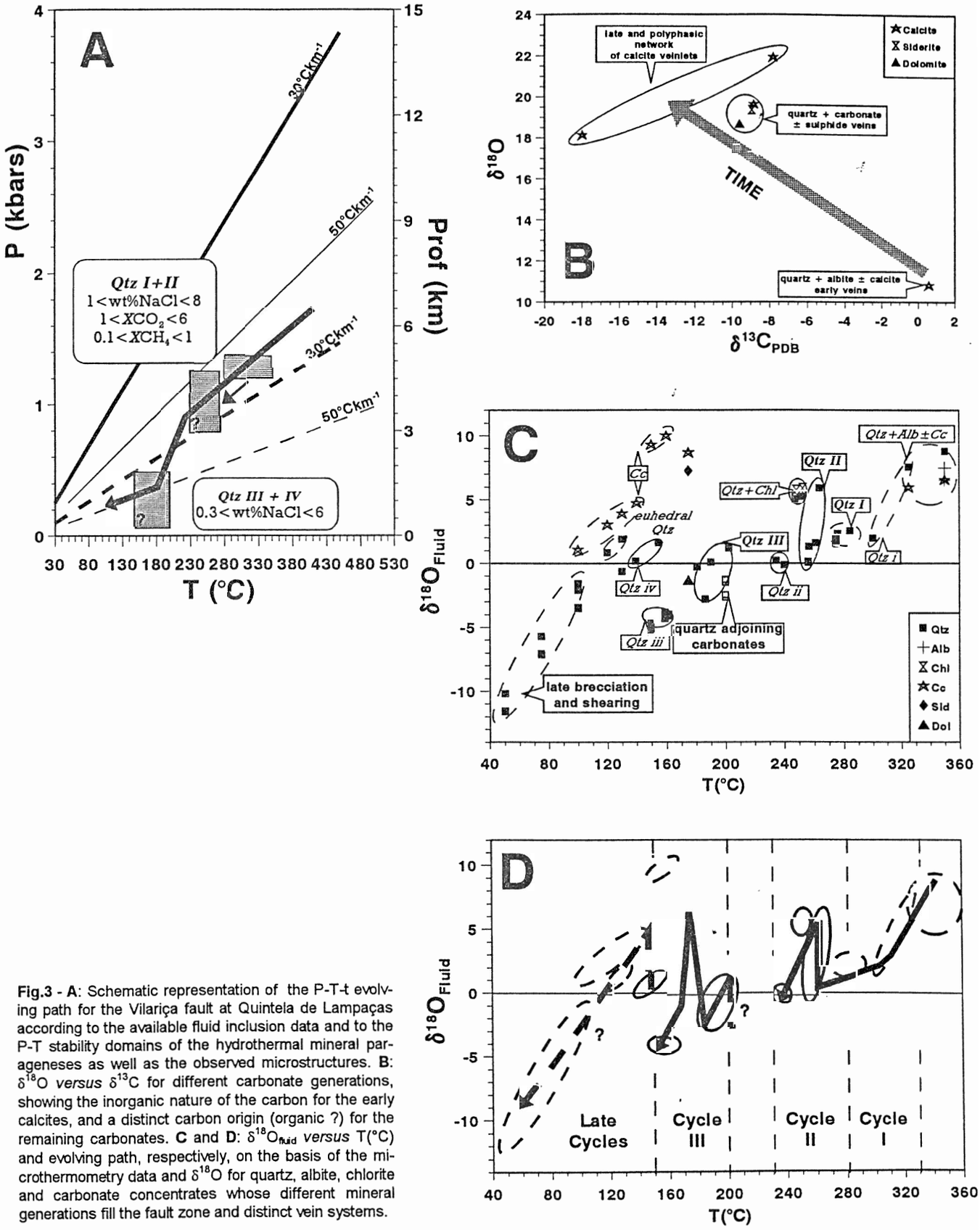

Fig.3 - A: Schematic representation of the P-T-t evolving path for the Vilariça fault at Quintela de Lampaças according to the available fluid inclusion data and to the P-T stability domains of the hydrothermal mineral parageneses as well as the observed microstructures. **B**: $\delta^{18}O$ *versus* $\delta^{13}C$ for different carbonate generations, showing the inorganic nature of the carbon for the early calcites, and a distinct carbon origin (organic ?) for the remaining carbonates. **C** and **D**: $\delta^{18}O_{fluid}$ *versus* T(°C) and evolving path, respectively, on the basis of the microthermometry data and $\delta^{18}O$ for quartz, albite, chlorite and carbonate concentrates whose different mineral generations fill the fault zone and distinct vein systems.