ALBITIZATION PROFILES RELATED TO THE VARISCAN BASEMENT; A CASE STUDY OF THE CATALAN COASTAL RANGES AND EASTERN PYRENEES (NE IBERIA)

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Widespread albitization has been recorded on Variscan granitoids of the Catalan Coastal Ranges (CCR) and the Eastern Pyrenees. Field observations suggest that albitization display a profile-like shape beneath Triassic, Cretaceous and Paleocene unconformities, decreasing in intensity forward the internal areas of the pristine granitoids. Petrographic, cathodoluminescence, SEM, microprobe and geochemical analyses show that albitization of Ca-plagioclase occurs as a pseudomorphic dissolution-reprecipitation mechanism and is mainly accompanied by biotite chloritization and Fe-oxides precipitation, giving a characteristic red-pink colour to the Na-metasomatized rock. Palaeomagnetic data suggest a Triassic age for the Fe-oxides and so for albitization. Triassic severe environmental conditions are characterized by high atmospheric and oceanic CO₂ levels and global warming, besides acidification and salinisation of marine waters. All these features, possibly coupled with the granitoids long-lasting exposure due to smooth palaeoreliefs, could have played a major role in the development of these unusual shallow albitization profiles during Triassic times.

Key words: albitization; paleoalteration profile; Triassic environment

1. INTRODUCTION

Albitization of feldspars is a long-time recognized Na-metasomatic process that occurs in a pervasive manner on a wide variety of geological settings (Perez and Boles, 2005). It has been extensively reported in ore deposits and igneous and sedimentary rocks as the result of hydrothermal alterations or burial diagenesis (Engvik et al., 2008; McFarlane et al., 2011).

More recently albitization has been explained as a shallow process related to the Permo-Triassic paleosurface (Ricodel et al., 2007; Thiry et al., 2009; Parcerisa et al., 2009, 2010a, 2010b; Franke et al., 2010). The geometrical arrangement of albitized rocks is very illustrative, showing maximum albitization linked to the paleosurface which progressively disappears towards the internal parts of the massifs. Observations made on albitization profiles developed on the Variscan basement of the Catalan Coastal Ranges and Eastern Pyrenees coincide with a hypothetic shallow origin.

2. GEOLOGICAL SETTING

In northeastern Iberia, syn- and late Variscan granitic rocks crop out largely along the Catalan Coastal Ranges (CCR) and the Eastern Pyrenees (Fig.1).

In the CCR granitoids are partly covered by a thin Triassic sedimentary cover that disappears progressively towards the north. In the Pyrenees the Variscan basement is mainly covered by Cretaceous sedimentary rocks. The western edges of the CCR and the southern part of the Pyrenees are bordered by Paleocene sediments of the Ebro Basin.

In addition, the CCR have been affected by a Miocene extensional event with the formation of several graben structures filled by Miocene sediments.

Geomorphologically, some pene-plain structures can be recognized on the Variscan basement being attributed to the Permo-Triassic paleosurface (Parcerisa et al., 2010a).

Fig.1. Location of the albitized profiles in a schematic geological map of NE Iberia (MG=Montseny-Guilleries Massif, AB=Albera Massif, RF=Roc de Frausa Massif; CCR=Catalan Coastal Ranges).

3. ALBITIZATION FEATURES

On the Montseny-Guilleries Massif (northwest CCR), albitization displays a profile shape (>200m depth) beneath the Triassic and Paleocene unconformities (Parcerisa et al., 2010a). The profile extends about 20km in a
NNE-SSW direction (Fig. 1) and albition became more intense towards the upper parts of the profile, close to the sedimentary cover. At outcrop scale the rock displays a typical red-pink colouration directly related with the occurrence of Fe-oxides. Progressively to the lower parts, this pink/red-staining affects only the wall-fractures and the closer rock in a diffused transition to the pristine granites (Parcerisa et al., 2010b). At the southern edge of the Eastern Pyrenees granitoids (Albera and Roc de Frausa Massifs) albition profiles have been observed in a parallel way beneath Triassic and Cretaceous south-dipping unconformities. As in the case of the Montseny-Guilleries Massif (CCR), albited outcrops show a massive red-pink colour that progressively became restricted to fractures and finally disappears towards the pristine granites, away from the unconformities. Petrographically, the initial albition process takes place along microfractures and intercrystalline boundaries. As albition evolves and penetrates into crystals, patches of pristine plagioclase became isolated among secondary albite areas (Fig. 2). SEM images of secondary albite surfaces show abundant micro-size porosity which sometimes contains Fe-oxides (Fig. 3). The Fe-oxides have been characterized as haematite and maghemite by magneto-mineralogical analyses (Franke et al., 2010). Chloritization occurs coupled with albition and is usually accompanied by an increment of apatite inclusions inside the chlorite crystals.

Fig. 2. Cathodoluminescence image of green luminescent pristine plagioclase partially replaced by non-luminescent secondary albite. Image width: 3 mm.

Fig. 3. SEM image of a microprobe tested albited plagioclase showing widespread micro-scale porosity partially filled by Fe-oxides.

5. GEOCHEMISTRY AND ELEMENT MOBILITY

Averaged whole-rock analyses of pristine and albited granites of the Montseny-Guilleries Massif show significant geochemical changes as well as both mass transfer and relative element immobility during albition (Fig. 4). Major elements Al and Si can be considered as immobile at whole-rock scale, despite fine-scale mobility can have occurred. Mn, P, Ti and Fe display a slight loss, versus the important loss of K and the small gain of Mg. The behaviour of K and the decrease of Fe / (Fe+Mg) ratio can be related with the widespread chloritization of biotite. Na gain versus Ca loss fit very well with the petrological observations and microprobe data of the overall albitionization process. Trace elements display variable behaviors. Th can be assumed as immobile at whole-rock scale, despite it could display mobility at crystalline scale. V, Rb, Zr and Sr display slender losses in front of the significant misses of Nb and Pb. Y records a slight gain whereas Co, Ni, Cu, Ni and Zn show notable gains.

Fig. 4. Log-log isocon diagram (Grant, 2005) of Montseny-Guilleries samples showing averaged whole-rock geochemical changes during albitionization. The slope a=1 represents zero change. Major elements in wt.% and trace elements in ppm.

6. DISCUSSION AND CONCLUSIONS

Widespread albitionization occurs in the Variscan granitoids of the Catalon Coastal Ranges and the Eastern Pyrenees. This large Na-metasomatic event shows a profile-like shape respect to the Permian-Triassic palaeosurface. Haematite occurrence, dated as Triassic, is coupled with albitionization and decreases towards the inner parts of the granitoids. Similar Triassic albitionization profiles have been described on Variscan granitoids of the Morvan Massif (French Central Massif) by Ricod et al. (2007) and Parcerisa et al. (2009), as so as another ones have been observed stretching the Triassic base from Morocco to Scandinavia (Parcerisa et al. 2009).

Presently, albitionization occurs in groundwater deep systems (Boyce et al., 2003) and not as a shallow process. During Triassic times it seems that albitionization was a common process linked to shallow environments and several reasons played a role in this atypical process:

1. Triassic times were characterized by a remarkable rise of atmospheric CO2 (Schmitt 1999; Korte et al. 2010), global warming, acidification and salinisation of oceans (Woods 2005). These conditions enhanced geochemical reactions promoting the development of paleoweathering profiles in continental areas.

2. The paleogeography was dominated by smooth landscapes with extensive endorreic marine basins and long-lasting exposure of the Variscan basement (Bourquin et al. 2011). In this context, saline aerosols can be taken into account as a Na source at regional scale, as it has been showed by Foltescu et al. (2005) in present day aerosols.
All these features, could have promoted the development of these unusual shallow albization profiles during Triassic times.

REFERENCES


Fig. 3

Fig. 4