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A highly fractionated I-type granite as source of alkaline metasomatism (La Pedriza pluton, Iberian Variscan Belt)

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Alkaline metasomatism is mainly associated to residual alkali-rich fluids from alkaline and carbonatite intrusive complexes (fenite) or to devolatilization of metamorphic rocks (albitite, a generic name for quartz-bearing albite-rich rocks). Both types of rocks are composed mainly of K-feldspar (fenite), albite, alkaline pyroxenes and amphiboles, and accessory apatite, titanite and sometimes nepheline in fenites.

We have studied several discrete elongated bodies (metric size) of albite-rich metasomatic rocks, scattered within two Variscan peraluminous granites from the Spanish Central System (SCS) (Iberian Massif), outcropping in a limited area, close to the contact with a highly fractionated I-type granite (the La Pedriza pluton). The most outstanding features of these rocks are: (i) they are coeval with the magmatic activity of this sector of the Variscan batholith; (ii) high-T (500-650 ºC) and low-P (<3 kbar) estimated formation conditions; (iii) preservation of the main textural features of the host granites; (iv) extensive replacement of the parental granite mineralogy, with relic feldspar framework preserved (strongly albitized); (v) presence of uncommon solid solutions of Na-(and Li)-rich mafic minerals, mainly anhydrous, interstitial within the albite or quartz groundmass; (vi) highly oxidized conditions, deduced from widespread magnetite and Fe^{3+}-bearing silicates occurrence; and (vii) enrichment in Li, Be, Sn, Zn, Na, Mg, Mn, Fe^{3+}, Sc and F, and depletion in LOI, K, Rb, Cs, Ba, Sr, Pb, and Si. The original peraluminous granites are wholly transformed to alkaline syenitoid rocks. These characteristics strongly suggest an origin by alkaline metasomatism, but do not match those of fenite (e.g., they are associated to peraluminous granites; quartz hosts most of the metasomatic minerals) or metamorphic albitite (lack of associated ore mineralization; involvement of high-T water-subsaturated fluids). Moreover, fenite bulk chemistry is mainly enriched in HFS elements (REE, Th, U, Zr), which are slightly depleted in most of our studied metasomatic rocks.

We propose for the studied albitites an origin by metasomatic fluids expelled from the nearby highly fractionated I-type La Pedriza granite. This conclusion would be supported by the high Li (F, Be and Sn) contents, typically related to highly differentiated peraluminous magmatic sources, and the oxygen isotopic ratios, which indicate involvement of a magmatic melt/fluid agent mixed with minor external fluids. If the fluid agent were mainly hydrothermal, water-soluble cations (LILE) and hydrous minerals would be abundant in these albitites. Moreover, most of the elements enriched in these rocks are not those expected to be mobilized by hydrothermal, but are typical of magmatic fluids. Therefore, a highly reactive alkaline melt/fluid agent, rich in fluxing elements (Li, F, Be) and rare metals (Sn, Zn, Sc, Mn) was probably expelled (a second boiling?) by the La Pedriza I-type leucogranite. This magmatic fluid mixed with minor surrounding metamorphic/hydrothermal fluids, with this external component increasing towards the most distant outcrops. The high content of fluxing elements would explain the low density and high mobility of the “fluid”, thus behaving as a reactive metasomatic agent. The widespread solid solution shown by mafic minerals suggests that crystallization associated to metasomatism occurred within variable temperature and oxidation conditions.