Spinel lherzolite xenoliths from the Agras volcano (Valencia, Spain)

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INTRODUCTION

Mantle xenoliths are wisps of the mantle carried up to Earth's surface by erupting magmas in volcanic systems. They are the most faithful samples for the upper mantle underlying both oceanic and continental lithospheres, especially for igneous processes (i.e., metasomatism or partial melting) entailing the formation of volcanic fields, associated with tectonothermal events such plate break-up, plume impacts or subduction. Mantle xenoliths are common in on-craton and off-craton regions, including those Neogene-Quaternary volcanic fields known in the Iberian Peninsula (Campos de Calatrava Volcanic Field in Ciudad Real, The Catalan Volcanic Field, Cabo de Gata-Cartagena Volcanic Belt and the Levante region in the Autonomous Community of Valencia). In the case of Levante region, the vulcanism are described in three areas being: Cofrentes, Picassent and Columbretes islands. In the Cofrentes region (Valencia province) crop out 3 volcanic centers, aligned following a NNW-SSE direction, known as Cerro de Agras (the largest), Los Frailes and Castillo de Cofrentes (Fernández Navarro and Sabater Diana, 1907; Ancochea et al., 1983). The volcanic rocks were described as limburgites (dark-coloured volcanic rock without feldspar) having geochemical affinity of olivine nephelinites (Ancochea et al., 1983; Ancochea y Huertas, 2004). In the region, the vulcanism was dated as late Pleistocene-Pliocene (2.6-1.0 Ma; Saez-Riduejo and Lopez Marinas, 1975). The mantle xenoliths described in the area are mainly dunites, harzburgites and spinel-bearing lherzolites (Seghedi et al., 2002; Ancochea and Huertas, 2004).

RESULTS AND DISCUSSION

This study targeted ultramafic xenoliths from the Cerro de Agras volcanic center, which is a monogenetic effusive cone of 1 km wide and approximately 100 m high. The eruption style was mainly strombolian and minor lava flow, producing alkali basalts. The rocks are aphanitic and show a porphyritic texture (Fig. 1A), mostly composed of olivine crystals, which developed alterations to iddingsite (Fig. 1B). The ultramafic xenoliths (n=20) are fragments up to 3 centimeters hosted in the alkali basalts. They are mostly unaltered, medium grained, spinel lherzolites exhibiting protogranular texture, characterized by large (2–3 mm) crystals of olivine and orthopyroxene, and smaller (200-300 µm) clinopyroxene and spinel (Fig. 1C). Locally, orthopyroxenes contain exsolutions of clinopyroxene. Noteworthy, almost all xenoliths studied contain interstitial glass, and in the rim, the pyroxenes develop a sieve (spongy) texture. These characteristics very likely evidencing interaction between the mantle rock and infiltrating host alkali basaltic magma (Fig. 1D) due to pyroxenes-magma chemical and/or thermal disequilibrium. Their origin are debated mainly by the significance in understanding the mantle processes like mantle metasomatism, partial melting, melt-mantle interactions. However, the petrographic features suggest mineral equilibrium in between these four minerals (olivine + orthopyroxene + clinopyroxene + spinel).

The semi-quantitatively mineral composition was determined using a Scanning Electron Microscope (JEOL IT500HR), operated at 20 kV, at the *Servicios Técnicos de Investigación* (University of Alicante). Olivine grains are homogeneous in composition, being rich in Mg and very low Ca contents, with their Mg# (Mg/(Mg+Fe)) ranging from 0.86 to 0.91. Orthopyroxenes are enstatites with Mg# varying from 0.86 to 0.90. Clinopyroxenes are augitic with Ca ranging from 0.82 to 0.94 apfu (atoms per formula unit) and Mg# from 0.91 to 0.92. Spinel are Al- and Mg-rich, with Al# (Al/(Al+Cr)) ranging from 0.80 to 0.84 and Mg# ranging from 0.70-0.76. Thermobarometric determinations using the mineral compositions indicate pressures ranging 17 to 20 kbar and temperatures between 1200 to 1260 °C.

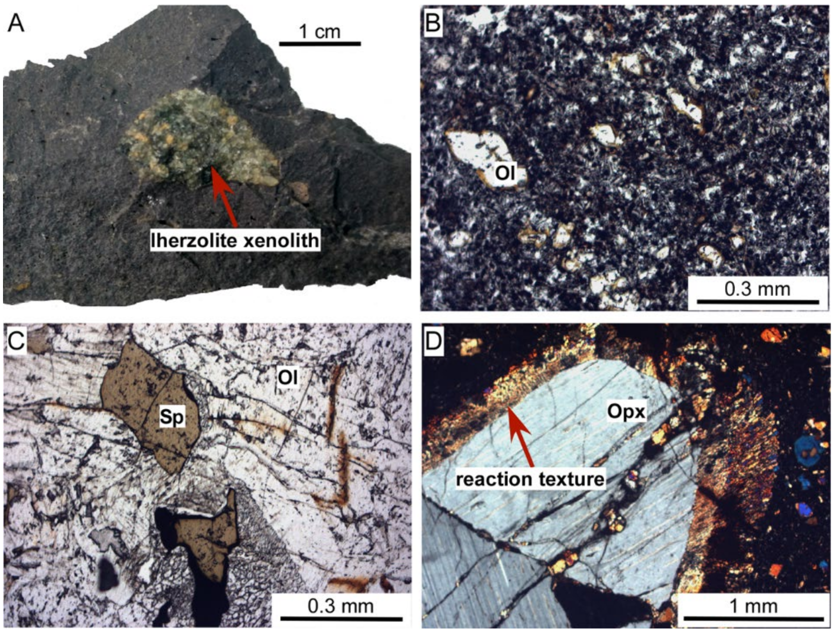

***Fig 1**. (A) spinel lhrezolite in volcanic rock; (B) olivine crystals in a glassy groundmass containing opaque minerals and olivine microcrystals partially altered by iddingsite; (C) spinel grains included in the xenolith; (D) pyroxene-rich corona in lherzolite xenolith.*

There is no consensus in the scientific literature relate to what triggered this magmatism, due to the lack of detailed study of many volcanic centers and their hosted mantle xenoliths. Although the most accepted interpretation relates it with intraplate alkaline magmatism, associated to intercontinental rifting. Current geology and tectonics features do not indicate that this magmatism can become active again, at least in the next thousands or millions of years. However, they constitute unique natural examples to characterize both the basalt (magmatic liquid) and the mantle from which this liquid comes.

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REFERENCIAS

Ancochea, E. (1983): Evolución espacial y temporal del volcanismo reciente de España Central. Tesis Doctoral, Universidad Complutense de Madrid, 487 p.

Ancochea, E. y Huertas, M.J. (2004). La región volcánica de Levante. En Vera, J.A. (Ed) Geología de España. SGE-IGME, 675-676.

Fernández-Navarro, L. y Sabater-Diana, G. (1907). Excursión al volcán de Cofrentes (Valencia). Boletín de la Real Sociedad Española de Historia Natural, 7, 368-384.

Sáenz-Ridruejo, C. y López-Marinas, J.M. (1975). La edad del vulcanismo del Cofrentes (Valencia). Tecniterrae, 6, 8-14

Seghedi, I., Brändle, J.L., Szakács, A., Ancochea, E. y Vaselli, O. (2002). El manto litosférico en el sureste de España: Aportaciones de los xenolitos englobados en rocas alcalinas del mioceno-plioceno. Geogaceta, 32, 27-30.