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Silicate and oxide exsolution in pseudo-spinifex olivine from metaultramafic rocks of the Betic Ophiolitic Association: A TEM study

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ABSTRACT

Transmission electron microscopy (TEM) has been used to study submicroscopic particles in spinifex-like textured olivine from secondary harzburgites collected from the Cerro del Almirez locality in the Mulhacén Complex (Betic Cordillera, SE Spain). Three main types of submicroscopic oxides have been identified: (1) equidimensional Fe-rich spinel (magnetite), with average grain size in the order of 1–2 μm; (2) elongated Cr-bearing spinels (Fe-chromite to Cr-magnetite) with sizes ranging from 0.2 to 1 μm long and 0.01 to 0.1 μm thick; and (3) equidimensional Ti-rich particles from <0.01 to 0.1 μm and compositions ranging from ilmenite to Fe-Cr-Ti oxide. Chromite and ilmenite particles form parallel, chromite-rich and ilmenite-rich bands, extending along the **a**-axis of the host olivine. Both phases show a fixed orientation relationship with olivine, with the approximately hexagonal close-packed oxygen planes being parallel in both structures. These textural relationships indicate that both chromite and ilmenite were formed during a common exsolution process. Magnetite particles also are orientated preferentially relative to the olivine, but these particles are homogeneously distributed within the olivine, suggesting either a primary origin or an exsolution process that was not contemporaneous with formation of chromite and ilmenite.

Chromite particles commonly are accompanied by lamellae of talc and/or enstatite, both showing a consistent orientation relationship with olivine. Talc lamellae are twice as thick as the associated chromite crystals, whereas enstatite lamellae show a greater thickness and, moreover, form single enstatite particles, which consist of clino- and orthoenstatite intergrowths. Talc formation may be explained by exsolution, together with spinel, from olivine containing OH-groups, probably related to incomplete dehydration of serpentine during olivine formation. On the basis of these results and previously reported petrological data, we have concluded that exsolution of chromite-silicate and ilmenite occurred during the retrograde stage that followed the climax of the eo-Alpine metamorphic event.