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Clues for unraveling metamorphic alteration on Kosturino (SE Bulgaria) chromitites

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Chemical variations of chromite from several different-size chromitite bodies in metamorphosed ophiolites from Kosturino (Rhodope Mountains, SE Bulgaria) show that metamorphic alteration took place in an open system, in three separate stages: 1) subsolidus equilibration of chromite with olivine, 2) mass loss of chromite under reducing conditions and 3) addition of magnetite. During the first stage, subsolidus equilibration between chromite and olivine promoted Fe2+ and Mg exchange giving rise to Fe2+-rich chromite and Mg-rich olivine. $Al2O_3$ and $Cr2O_3$ contents in chromite did not change during such evolution, preserving the primary igneous values. Fe2+ enrichment in chromite was favored by low chromite/silicate ratios, small size of chromitite bodies and high water/rock (W/R) ratio. Chromite from massive and thick chromitite bodies preserved their cores almost unaltered. During the second stage chromite reacted with olivine to form chlorite and ferrous chromite. The latter process formed Cr- and Fe2+-rich chromite (ferrous chromite) by loosing $Al2O_3$ and MgO. This reaction occurred under water-saturated conditions, decreasing SiO_2 activity and reducing conditions (as deduced from the Fe3+/(Fe3++Fe2+) ratio) (Gervilla et al. in press). Since chromite grain volume did not change, the $Al2O_3$ and MgO loss gave rise to significant mass loss from primary chromite to the secondary ferrous chromite resulting in the formation of pores. The third stage developed under moderately oxidizing conditions by the addition of magnetite component to the Al-poor, porous ferrous chromite giving rise to ferrian chromite. These Fe-bearing fluids partly dissolved chlorite in the pores, promoted diffusion of Fe2+ and Fe3+ in chromite and formed homogeneous rims in pervasively altered chromite. The amount of magnetite component in chromite was mainly limited by the pore volume. The absence of magnetite-rich rims overgrowing chromite-ferrian chromite grains suggest that such amount of magnetite component was low. Phase relations in the system (Fe2+,Mg)Cr2O4-(Fe2+,Mg)Fe3+2O4-(Fe2+,Mg)Al2O4 suggest that the aforementioned ferrian chromite homogeneous rims could have been formed at temperatures around 600ºC (Sack & Ghiorso, 1991). The different degrees of alteration evidenced at Kosturino chromitites suggest that chromite/silicate ratio, fluid (water) pressure and size of chromitite bodies strongly controlled the alteration processes of chromite during its retrograde metamorphic evolution and the extent of ferrian chromite formation.

References:
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