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Cr-spinel compositions in serpentinites and their implications for the petrotectonic history of the Zagros Suture Zone, Kurdistan Region, Iraq

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Abstract

Accessory chrome spinels are scattered throughout the serpentinite masses in two allochthonous thrust sheets belonging to the Penjween–Walash sub-zone of the northwestern Zagros Suture Zone in Kurdistan. Based on field evidence, the serpentinites are divided into two groups: (1) highly sheared serpentinites (110–80 Ma), which occupy the lower contact of the ophiolitic massifs of the Upper Allochthonous sheet (Albian–Cenomanian age), and (2) ophiolitic mélange serpentinites of mixed ages (150 and 200 Ma) occurring along thrust faults on the base of the volcano-sedimentary segment (42–32 Ma) of the Lower Allochthonous sheet. The Cr-spinels of both groups show a wide range of YCr (Cr/(Cr + Al) atomic ratio) from 0.37 to 1.0, while the XMg (Mg/(Mg + Fe2+) atomic ratio) ranges from 0.0 to 0.75. Based on the Cr-spinel compositions of the entire dataset and in conjunction with back-scattered electron imaging, from core to rim, three spinel stages have been recognized: the residual mantle stage, a Cr-rich stage and a third stage showing a very narrow magnetite rim. These three stages are represented by primary Cr-spinel, pre-serpentinization metamorphosed spinel and syn- or post-serpentinization spinel, respectively. The chemical characteristics of primary (first-stage) Cr-spinels of both serpentinite groups indicate a tectonic affinity within a fore-arc setting of peridotite protoliths. The second stage indicates that Cr-spinels have undergone subsolidus re-equilibration as a result of solid–solid reaction during pre-serpentinization cooling of the host rock. Here the primary Cr-spinel compositions have been partly or completely obscured by metamorphism. During the third stage, the Cr-spinels have undergone solid–fluid re-equilibration during syn- or post-serpentinization processes. Both the second and third stages point to diachronous metamorphic paths resulting from continuous tectonic evolution influenced by either slow or fast uplift of mantle protoliths. In the fast metamorphic paths, the primary chrome spinels are flanked by a very narrow magnetite rim. The presence of two groups of distally separated serpentinites with different emplacement ages and fore-arc tectonic affinity could indicate that the closure of the Tethys Ocean culminated in two fortuitous subduction processes.