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Serpentinized Peridotites at the North Part of the Wadi Allaqi District (Egypt): Implications for the Tectono-Magmatic Evolution of Fore-arc Crust

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Abstract: The Neoproterozoic Allaqi-Heiani suture (800-700 Ma) in the south Eastern Desert of Egypt is the northernmost linear ophiolitic belt that defines an arc-arc suture in the Arabian-Nubian shield (ANS). The Neoproterozoic serpentinized peridotites represent a distinct lithology of dismembered ophiolites along the Allaqi-Heiani suture zone. The alteration of peridotites varies, some contain relicts of primary minerals (Cr-spinel and olivine) and others are extremely altered, especially along thrusts and shear zones, with development of talc, talc-carbonate and quartz-carbonate. The fresh cores of the chromian spinels are rimmed by ferritchromite and Cr-magnetite. The fresh chromian spinels have high $Cr^{\#}$ (0.62 to 0.79), while $Mg^{\#}$ shows wider variation (0.35–0.59). High $Cr^{\#}$ in the relict chromian spinels and Fo content in the primary olivines indicate that they are residual peridotites after extensive partial melting. The studied ophiolitic upper mantle peridotites are highly depleted and most probably underwent high degrees of partial melting at a supra-subduction zone setting. They can be produced by up to ~20%–22% dynamic melting of a primitive mantle source. The mineralogical and geochemical features of the studied rocks reflect that the mantle peridotites of the north part of the Wadi Allaqi district are similar to the fore-arc peridotites of a supra-subduction zone.

Key words: Neoproterozoic, serpentinite, Arabian-Nubian Shield, Egypt, Chromian spinel, olivine, fore-arc

1 Introduction

The oceanic crust forms in a variety of tectonic settings, including oceanic spreading centers, back-arc basins, fore-arcs, arcs, and extensional settings, such as in association with plumes (Moores, 1982; Gass et al., 1984; Dilek, 2003), but ophiolite formation (i.e. obduction of the oceanic lithosphere) takes place in a compressional regime. Ophiolites are tectonically transported assemblages of peridotite and other ultramafic rocks, gabbro, diabase, and pillow basalts. Geochemical data from these rocks and their constituting minerals constrain mantle processes such as melting, melt extraction and melt-mantle interaction (e.g. Parkinson and Pearce, 1998; Takazawa et al., 2003; Wu et al., 2013), and contribute to our understanding of lithosphere generation (Pearce et al., 2000).

The basement rocks of Egypt form the western part of the Arabian-Nubian Shield (ANS) (Fig. 1). The ANS is a collage of well-preserved tectono-stratigraphic terranes, with suture zones that are decorated by ophiolites (Johnson and Woldehaimanot, 2003). The ANS is the northern continuation of the Mozambique belt, and together, they have been referred to as the East African Orogen (Stern, 1994). The ANS represents an excellent example of the Pan-African orogenic cycle that has long been recognized as a period of major crustal accretion (Kröner, 1984), where continental, island-arc, and oceanic terranes were brought together (e.g. Kusky et al., 2003) to form the crystalline basement of the African continent as part of the late Neoproterozoic supercontinent Gondwana. The ANS may be representing the largest tract of juvenile continental crust of Neoproterozoic age on Earth (Patchett and Chase, 2002). Ophiolitic rocks of the ANS are mostly nappes that form distinct belts between arc sequences and older cratons and microcontinents (Abdelsalam and Stern, 1996). Not all the ophiolites

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