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Westward prograding metamorphism in mantle peridotites from the Eastern Desert of Egypt: clues to the subduction polarity of the Arabian Nubian Shield intra-oceanic arc ophiolite

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Neoproterozoic arc mantle beneath the Arabian Nubian Shield (ANS) in the Eastern Desert (ED) of Egypt exhumed due to intra-oceanic upthrusting are represented mainly by exposed ophiolitic peridotites serpentinized to different degree. Metamorphism is related to the Pan-African collision and the subduction of oceanic lithosphere. However, polarity of the Pan-African intra-oceanic subduction is still questionable. We here trace the variation of the degree of serpentinization and regional metamorphism of six serpentinite masses, widely distributed in the ED (from the east to the west: W (Wadi). Alam, W. Igla, W. Mubarak, G. El-Maiyit, W. Um El Saneyat and W. Atalla). This is based on their mineralogy, textures and mineral chemistry. The studied rocks have harzburgite composition and they all formed in oceanic mantle wedge in the fore-arc setting, except those from W. Atalla that formed in MOR-arc transition setting.

Much difference in the degree of serpentinization is obvious among these rocks. They are mainly partly serpentinized containing primary olivine and orthopyroxene at W. Alam and W. Igla, while they are completely serpentinized in the other localities. With the increased degree of metamorphism, textures were transformed from the pseudomorphic to the non-pseudomorphic. The most common retrograde assemblage is composed of lizardite $\pm$ chrysotile$\pm$ brucite$\pm$ magnetite. The serpentine prograde textures can be viewed as a continuum from retrograde lizardite pseudomorphic textures, to very fine-grained transitional texture of lizardite and chrysotile, to chrysotile-antigorite interlocking texture and finally to antigorite interpenetrating texture. These textures appear to represent successive stages in a recrystallization event. In late subduction-related metamorphism and early collisional emplacement stage, mylonitic-antigorite serpentinites formed and antigorite became the major phase in G. El-Maiyit, Um El-Saneyat and W. Atalla. The polygonal units of the hourglass texture and the penetrative fabric of the serrate veins in all serpentinized peridotites indicate that fracturing of these rocks was developed in a dynamic regime. The late emplacement of veins of brucite, carbonates and oxides were most probably formed during the final stage of exhumation and under a stress regime in the brittle-ductile transition.

As the grade of metamorphism increases Fe released from olivine and orthopyroxene and Cr released from chromite are accommodating in antigorite-rich serpentinites. Serpentine in veins also tends to have less substitutions, which is consistent with the fact that Al, Cr and Ni are relatively immobile during alteration and therefore remain in their original microstructural site. Compositional zoning in spinel grains in all serpentinites reflect variation in the degree of alteration. The biggest variation of spinel compositions are among serpentinites from Um El-Saneyat and W. Atalla. With increasing the degree of alteration, size of the aluminian chromite core decreases while width of the intermediate Fe^{3+}-rich aluminian chromite to ferrian-chromite zone and the outer Cr-magnetite to magnetite zones increase. The alteration zones were formed in a temperature < 400 $^{\circ}$C to 550 $^{\circ}$C corresponding to the low green-schist to the lower amphibolite facies.

We propose that this is concordant with a westward polarity of the subducting oceanic lithosphere, associating the intra-oceanic arc ophiolite during the closure of the Mozambique ocean.