MOHAMED METWALY Abu Anbar, 2015. The Pan-African Ophiolites and Related Mineralization in Egypt. *Acta Geologica Sinica* (English Edition), 89(supp. 2): 65-68.

The Pan-African Ophiolites and Related Mineralization in Egypt

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Precambrian ophiolites are abundant in the Arabian-Nubian Shield of NE Africa and Arabia and range in age from 690 to 890 Ma. In Egypt, they are widely distributed in the central and southern Eastern Desert and occur as nape complexes along sature zone or dismembered masses in metavolcano-sedimenatry assemblages. The ophiolite succession includes ultramafic rocks, mafic rocks, plagiogranite, sheeted dykes, metabasalts, and pillow lavas (Fig.1).

The distribution of the Neoproterozoic ophiolites in Central Eastern Desert (CED), Egypt (Fig. 2) includes: -1- Gabal El-Rubshi as dismembered ophiolite dominated by serpentinites, in addition to peridotites, pyroxenites, chromitites, and talc-carbonate rock. 2-Qift-Quseir Ophiolites (Fawakhir ophiolite) consists of basal serpentinized harzburgite, pyroxenite lenses, gabbros, minor bodies of trondhjemite, massive diabase, and pillowed basalt. 3-South Quseir Ophiolites include Esel

Fig 1. a) Esel pillow lavas, b) disseminated chromite in serpentinites, c) Sheeted dikes, d) Serpentinites with talc carbonate

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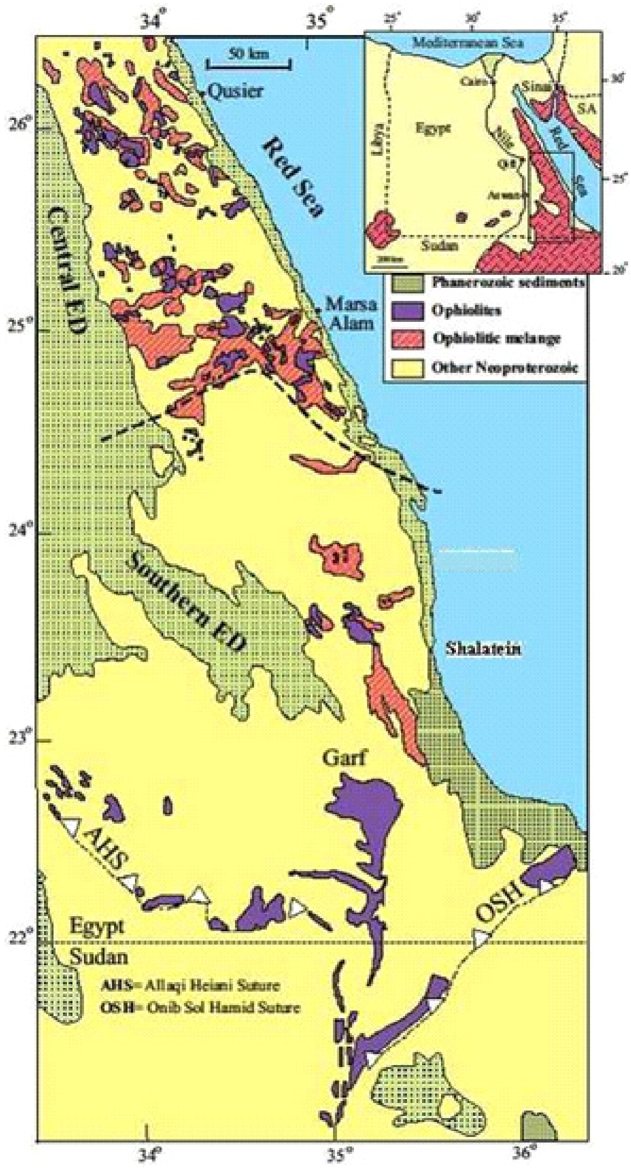

Fig. 2 Location map of ophiolites in Egypt

ophiolite as complete ophiolitic sequence, Wizr and Um Gheig highly dismembered suites 4-Mubarak Ophiolitic Mélange incorporates allochthonous blocks and sheets of various sizes in a matrix of highly deformed metasediments and sheared serpentinite.5-El-Barramiya Ophiolite are located in the westernmost part of the Precambrian rocks, north and south of Idfu-Marsa Alam road. It consists of ophiolitic mélanges of the Ashayir-Suwayqat area and Wadi Dungash area. 6-Ghadir Ophiolite exposes an almost complete ophiolite sequence in Wadi Ghadir and its tributary valleys. The ophiolite sequence consists of serpentinized peridotites, layered gabbro, massive rosette-structure gabbro, microgabbro, sheeted diabase dykes, and pillowed basalts. Also occur in Wadi Igla, Ras Shait, Um Khariga, El Gemal and North G. Zabara.

The South Eastern Desert (SED) ophiolites include: 1-Atshan Ophiolite, 2-Zarget Naam–Rahaba Ophiolite Belt which occurs as dismembered incomplete sequences of ultramafic-mafic association and widely disseminated in metasediments, 3-Gerf Ophiolite occurs at Gabal Gerf (Fig. 3), Gabal Harga Zarga, and Gabal Heiani areas, it contains a metamorphosed dismembered ophiolite sequence thrust over a low- to high grade volcano-sedimentary association, 4- Allaqi Ophiolite is located NE of Wadi Allaqi at Wadi Murra-Wadi Abu Had area and represented by allochthonous dismembered blocks, fragments, and matrix. The blocks include meta-peridotites, metapyroxenites and serpentinites, metagabbros, pillowed metabasalts, and amphibolites. The matrix includes highly foliated metasediments and highly sheared ultramafics, 5-Um Radam Ophiolite is located in the extremely southern part of SED, east of Wadi Allaqi. The ophiolite is composed of serpentinites, metagabbros, deformed pillow lavas, and amphibolites. It is thrust over a WSW-vergent dome structure of Pan-African metasedimentary schists and associated, in places, with quartzite and marble bands.

The mantle rocks in Garf ophiolites in SED, Egypt (Fig. 3) as largest Neoproterozoic (~750 Ma) ophiolite in the Arabian Nubian Shield are composed mainly of harzburgitic serpentinized peridotite and serpentinite masses and minor olivine websteritic pyroxenite with thin selvages of tremolite anthophyllite schist and chloritite. The serpentinized peridotites are LREE-depleted with flat MREE; the HREE are negatively fractionated, with small positive Eu anomaly indicates the influence of cumulation process. The serpentinites have flat REE pattern, with wide ranges in total REE contents and degree of depletion. The pyroxenites are enriched in LILE and LREE but depleted in HFSE, indicate their slight fractionation. They have slightly convex-upward MREE patterns, reflecting the dominance of clinopyroxene; their HREE patterns are negatively fractionated, similar to the serpentinized peridotite counterpart. Mineral compositions of primary clinopyroxenes and Al-spinels together with the whole rock chemistry are all similar to those of modern forearcs. High Cr# in the relict Al-spinels (0.8-1.0) and Fo (98 to 99) in the primary olivines of serpentinites and serpentinized peridotites indicate that they are residual melt after extensive partial melting peridotite. Geochemical evidence of the podiform Al-spinels suggest a greenschist up to lower amphibolite facies metamorphism (at 500-600°C), which is isofacial with the host rocks. Clinopyroxenes from pyroxenites have a boninitic affinity, suggesting a local importance of pervasive melt–rock reactions in the mantle wedge, driven by the infiltration of subduction-related silica-rich melts and/or fluids. Their magmas appear to have been derived from a depleted (transition MORB-boninitic) mantle source and their geochemical

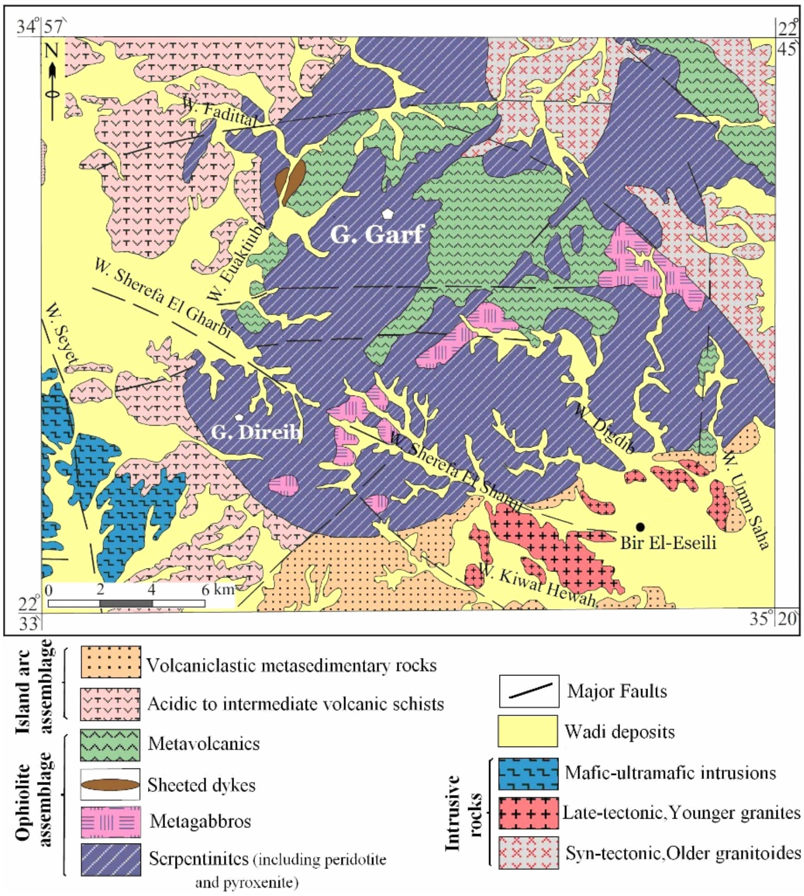

Fig. 3 Geological map of the Garf ophiolite, SED, Egypt

characteristics are comparable to those of the modern forearc oceanic crust formed during the initiation of an intra -oceanic subduction zone. Therefore, the ophiolitic ultramafic rocks of Gabal Garf represent fragments of an oceanic lithosphere that formed in a forearc regime, which belongs to an ophiolitic mantle sequence formed in a suprasubduction zone.

The whole rock Al_2O_3 composition for Arais peridotites in SED indicate partial melting (>20 % melt which possibly formed in a sub arc setting (mantle wedge) during subduction and closing of the Mozambique Ocean. Also, the chromian spinels in Arais peridotites are low in TiO_2, 0.05 wt. % and $Fe^{\#}$ [Fe^{3+}/(Cr + Al +Fe^{3+})], ~0.06 on average. They are similar in chemistry to spinels in forearc peridotites (Khedr & Arai, 2013).

Mineral chemistry and whole rock composition of pillow lavas in many ophiolite suites indicate suprasubduction zone (SSZ) settings and the high Cr# in ophiolitic harzburgites suggests a forearc environment.

The ophiolite belt in Egypt contains mineral deposits such as chromites, PGE, talc, chlorite, marble, magnesite deposits and gold in some areas. The podiform chromitite deposits occur in serpentinites (after harzburgite and dunite) and well-preserved mantle sequence consisting of lherzolite-harzburgite with abundant lenses of olivine dunite. They are common as small and irregularly shaped masses and show massive, disseminated, and nodular texture in the South Eastern Desert (SED) of Egypt. They exhibit a wide range of compositions from high Cr to high Al varieties. The Cr of chrome spinel ranges from 0.67 to 0.88 in olivine-dunite, quite similar to that of the high-Cr chromitite, whereas it is around 0.62 in lherzolite-harzburgite. Petrographic and geochemical evidence suggests that podiform chromitites in the SED of Egypt were formed as a result of crystallization of mafic melts, probably of boninitic composition; the boninitic parental magmas were probably produced by a second stage of melting above a subduction zone (arc–marginal basin) environment. Three types of chromite ores can be distinguished within the SED of Egypt: (a) sulphide-poor podiform ores; (b) brecciated ores; and (c) sulphide-rich ores (Saleh, G.M., 2006).

The tectonic model and the direction of subduction and subduction zone as well as age dating is still a matter of debate and it needs a lot of work and discussion.

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