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OPHIOLITES FROM THE EGYPTIAN SHIELD: A CASE FOR A POSSIBLE INTER-ARC BASIN ORIGIN

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The pyroxene and whole-rock chemistry of the ophiolitic metavolcanics of Wadi Um Seleimat (WUS) and Muweilih (MU) areas in the central Eastern Desert of Egypt are presented. WUS ophiolite suite seems to be intact where it comprises (from bottom to top): serpentinites, pyroxenites, metagabbros, massive diabases and pillowed metavolcanics. MU metavolcanics, about 10 km to the southeast of WUS area, consists predominantly of metabasaltic-metadiabasic pillowed and massive lava flows together with the corresponding pyroclastics. These metavolcanics, together with their associated metagabbros and serpentinites, can be considered as a part of a dismembered ophiolite sequence.

The mineral assemblage in WUS rocks is: albite, chlorite, epidote, titanite, calcite and quartz, which indicates a low greenschist facies (230–320°C) metamorphism. The mineral assemblage of MU metavolcanics includes: albite, actinolite, hornblende, epidote, chlorite, titanite, calcite, quartz and ilmenite that reflects a transitional greenschist-amphibolite facies metamorphism. Few samples of WUS contain plentiful clinopyroxene phenocrysts in plagioclase-free glassy groundmass. These features are typical of rocks of boninitic affinity.

Whole-rock and pyroxene chemistry demonstrate that the metavolcanics of both areas are mainly andesitic basalts with tholeiitic affinity. The boninitic affinity of some samples from WUS area is shown on TiO_2-SiO_2/100-Na_2O diagram of pyroxenes (Fig. 1). On the other hand, clinopyroxenes from metavolcanics associated with the boninitic rocks plot mostly in the island-arc tholeiites and mid-ocean ridge basalt fields. Clinopyroxenes from Muweilih area plot in island-arc tholeiitic-MORB overlap area.

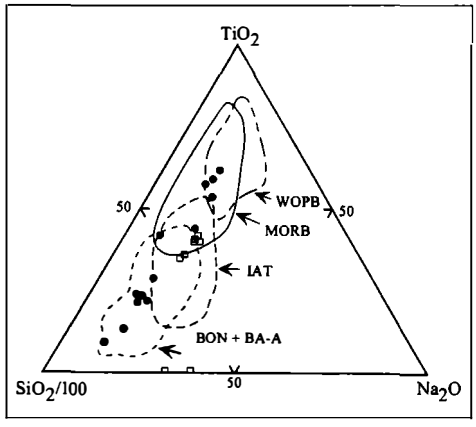

Fig. 1
TiO_2-SiO_2/100-Na_2O diagram of pyroxenes [1]. MORB: mid-ocean ridge basalts; WOPB: within ocean plate basalts; IAT: island-arc tholeiites; BON+BA-A: boninites+basaltic andesites and andesites from inter oceanic fore-arc regions. Closed circles: Wadi Um Seleimat; Open squares: Muweilih.

The studied boninitic samples are classified as intermediate-Ti boninites [2]. On the TiO_2-Zr diagram (Fig. 2) WUS rocks fall in volcanic-arc field and the area shared between MORB and volcanic-arc basalts, with high affinity to the latter. On the other hand, MU metavolcanics plot mostly in the volcanic-arc MORB overlap area, which may refer to their back-arc basin affinity. In agreement with most of the above discussed discrimination diagrams, WUS metavolcanic MORB normalized patterns (Fig. 3) are generally similar to those of the immature island-arc tholeiites, with relative low HFSE and high LILES than those of MORB. In contrast, MU metavolcanics have MORB-normalized patterns with HFSE value close to unity and relative enrichment in LILE (Fig. 3). These features may imply a transitional MORB-island-arc (i.e. back-arc basin) affinity of these rocks.

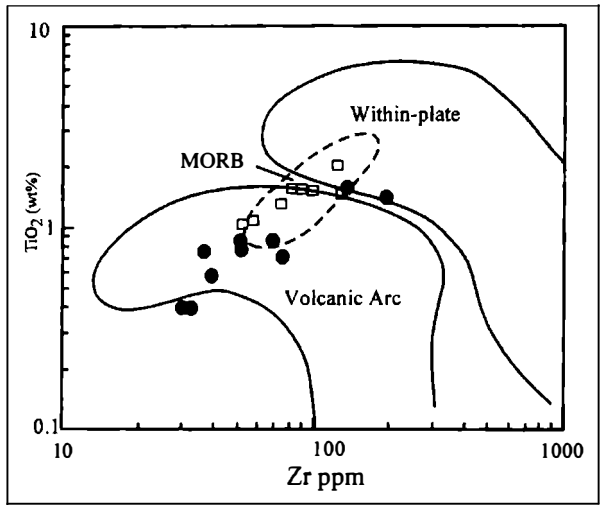

Fig. 2
TiO_2 vs. Zr discrimination diagram [3]. Symbols as in Fig. 1.

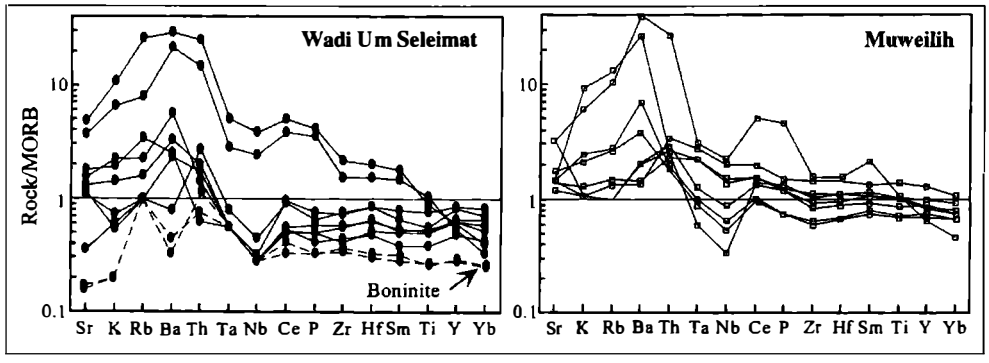

Fig. 3
MORB-normalized incompatible element spidergrams [3].

As modern boninites are found only in supra-subduction zone settings, it is inferred that ancient boninites also formed above a subduction zone. In the case of WUS metavolcanics, the previous geochemical studies [4] recognized their supra-subduction, i.e. fore–arc environment. However, the available data in the present study do not support such a model for the following reasons: a) the boninites overlie the arc-tholeiites; b) the absence of the sheeted dykes, which indicates incomplete extension; c) the thin volcanic section of this ophiolite and d) the little pyroclastics associated. These criteria may represent primary features of ophiolite formation in an incipient or rifted island-arc setting where arc volcanics are separated by thinner marginal basin crust [5].

Consequently, WUS tholeiites-boninite sequence appears to reflect the transgression from arc-style to (incipient) back-arc style volcanism. If the present interpretation is correct, MU meta-volcanics, which lie about 10 km to southeast of WUS ophiolite sequence and display a back-arc geochemical characteristic, may represent a more advanced stage of this inter–arc basin while those of WUS represent their embryonic stage. The association of WUS and MU metavolcanics with ophiolitic mélange, which comprises ophiolitic dismembers of serpentines and metagabbros within the island-arc metavolcanics and volcanoclastic metasediments [6] are compatible with the above suggestion.

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