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A-type volcanics in Central Eastern Sinai, Egypt

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Abstract

Alkaline rhyolitic and minor trachytic volcanics were erupted ~580–530 Ma ago. They occur with their A-type intrusive equivalents in Sinai, southern Negev and southwestern Jordan. At Taba-Nuweiba district, these volcanics outcrop in three areas, namely, Wadi El-Mahash, Wadi Khileifiya and Gebel El-Homra. Mineralogically, they comprise alkali feldspars, iron-rich biotite and arfvedsonite together with rare ferro-eckermannite. Geochemically, the older rhyolitic volcanics are highly evolved, enriched in HFSE including REE and depleted in Ca, Mg, Sr and Eu. The rhyolitic rocks of Wadi El-Mahash and Gebel El-Homra are enriched in K_2O content (5.3–10.1 wt.%) and depleted in Na_2O content (0.08–2.97 wt.%), while the rhyolites of Wadi Khileifiya have normal contents of alkalis. Their REE patterns are uniform, parallel to subparallel, fractionated [$(La/Yb)_n = 5.4$] and show prominent negative Eu-anomalies. They are classified as alkali rhyolites with minor comendites. The younger volcanics are classified as trachyandesite and quartz trachyte (56.6–62.9 wt.% SiO_2). Both older and younger volcanics represent two separate magmatic suites. The overall mineralogical and chemical characteristics of these volcanics are consistent with within plate tectonic setting. It is suggested that partial melting of crustal rocks yielded the source magma. Lithospheric extension and crustal rupture occurred prior to the eruption of these volcanics. The rather thin continental crust (~35 km) as well as the continental upheaval and extensive erosion that preceded their emplacement favoured pressure release and increasing mantle contribution. The volatiles of the upper mantle were important agents for heat transfer, and sufficient for the anatexis of the crustal rocks. A petrogenetic hypothesis is proposed for the genesis of the recorded potassic and ultrapotassic rhyolitic rocks through the action of dissolved volatiles and their accumulation in the uppermost part of the magma chamber.

Keywords: Alkaline volcanics; Taba-Nuweiba area; Mineral chemistry; Geochemistry; K-enrichment

1. Introduction

Two episodes of essentially calc-alkaline volcanic activity are recognized in the late Proterozoic or Pan-African belt in the Eastern Desert and Sinai, Egypt. The older episode, 800–700 Ma old, (Harris et al., 1984; Kröner, 1985; Stern et al., 1991) produced the island arc Younger Metavolcanics (Stern, 1981), metamorphosed within the greenschist facies. These metavolcanics are associated with volcaniclastics. The younger volcanic episode, 620–580 Ma old (Stern, 1981; Bielski, 1982, in Bentor, 1985; Ressetar and Monrad, 1983; Abdel-Rahman and Doig, 1987) occurred after the accretion of the island arc onto the East Saharan Craton. It produced the Dokhan Volcanics that are frequently associated and intercalated with molasse-type Hammamat clastic sediments (Gass, 1982; El-Gaby et al., 1984, 1988, 1989, 1990, 1991; Moussa, 2003). After the closure of the Pan-African orogeny, a third volcanic episode produced alkaline to peralkaline volcanic rocks known as Katherina Volcanics (Agron and Bentor, 1981). These alkaline magmas form minor occurrences but are widely scattered over the entire Arabian–Nubian Shield (ANS), although later erosion rendered the alkaline flows relatively rare (Harris, 1982). These alkaline volcanics and related alkali granites mark the transition to intraplate alkaline magmas, which prevailed during the Phanerozoic (Bentor, 1985; Stern et al., 1988; Black and Liegeois, 1993). Reported ages for the Late Precambrian alkaline rocks from Sinai, the Eastern Desert, southern Negev

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and SW Jordan, using the Rb-Sr whole rock isochron method range from ca 580 to 530 Ma (Bielski, 1982, in Bentor and Eyal, 1987; Hassan, 1998; Mushkin et al., 1999; Jarrar et al., 1992). However, Mushkin et al. (1999) extend the time span for the intrusion and extrusion of alkaline magmas in southern Negev to 600–530 Ma.

The alkaline volcanics were largely neglected in Egypt. In the Eastern Desert, Essawy (1972) recognized alkali rhyolites at Samadai–Tunduba area (CED). Abu El-Ela (2001) revealed that the felsites of Wadi Atalla (CED) pertain most probably to the Katherina Volcanics of South Sinai. In Sinai, there is only limited but conflicting data about the geology of these volcanics at Gebel Katherina type locality (Eyal and Hezkiyahu, 1980; El-Masry et al., 1992; Abdel Khalek et al., 1994; Eyal et al., 1994, 1995). Moreover the volcanics at Iqna Shar'a, central Sinai, were considered as a good example of Katherina Volcanics (Bentor, 1985; Bentor and Eyal, 1987; Mushkin et al., 1999). However, Samuel et al. (2001a,b) concluded that these volcanics, using petrological and geochemical data, represent the upper sequence of the Dokhan Volcanics (or Ferani Volcanics of Sinai).

The present work deals with the study of the alkaline volcanics exposed at Taba-Nuweiba environs near the northwestern end of the Gulf of Aqaba. Three areas were selected for investigations namely, Wadi El-Mahash (W. M.), Wadi Khileifiya (W. Kh.) and Gebel El-Homra (G. H.). The aim of this work is to elucidate the nature of these volcanics, their tectonic environment, their magma source and modifying geological processes.

2. Geologic setting and field relations

The three studied volcanic occurrences (W. M., W. Kh. and G. H.) occur in Taba-Nuweiba district (Fig. 1a). These volcanics were mapped on the regional geologic maps of Sinai (edited by Eyal et al., 1980) and Egypt (edited by Klitzsch et al., 1987) as Katherina Volcanics. On the recent

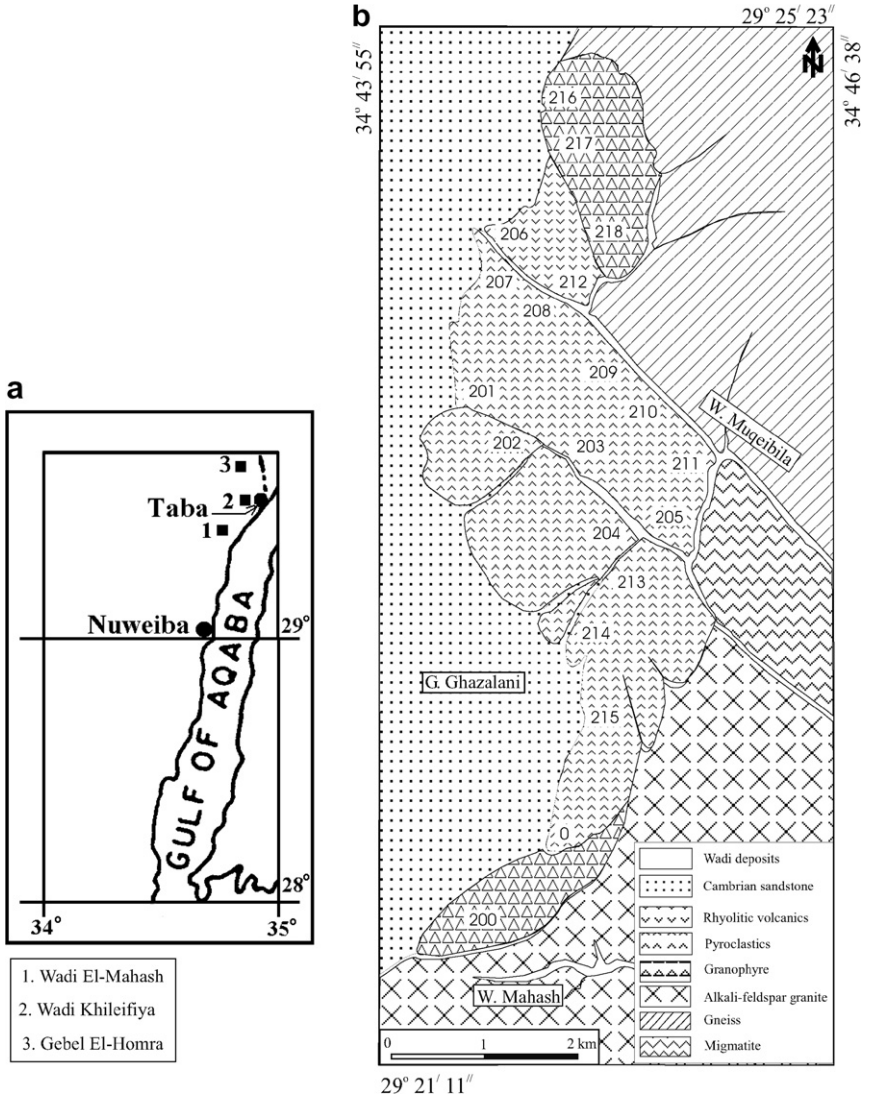

Fig. 1. (a) Location map of the studied areas; (b) photogeologic map of Wadi El-Mahash; (c) photogeologic map of Wadi Khileifiya and (d) photogeologic map of Gebel El-Homra.