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Magmatic occurrences in the Central Arava (southern Israel) based on Geology and Magnetometry

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ABSTRACT

The Eshet Ridge is located in the Central Arava near Wadi Paran. Geological data were collected using ground magnetic surveys and petrophysical measurements (magnetic susceptibility and density). The goal was to reveal the structure and nature of a concealed magmatic body under the ridge. Integrated gravity and magnetic interpretation together with seismic reflection data (including 2¾ modeling) indicated the presence of a deep-seated basic magmatic intrusion. Occurrence of Fe-mineralized rocks along the ridge supports subsurface data. The magmatic body was intruded in the hard Turonian rocks of the Eshet Ridge. Basic magmatic exposures dating from the Early Miocene were evident along Wadi Ashosh (in the eastern Negev) and its margins 18 km. to the north of the ridge. A new outcrop of basic magmatic intrusion was found southwest of the Tzukim settlement. Magnetic measurements indicated a similarity between their magnetic pattern and the Ashosh basic magmatics, which were dated to 20.4 ± 0.7 Ma. Volcanoclastic tuff pebbles (magnetic susceptibility of around 2–7 $*$ 10^{-3} SI) surrounded by conglomerate were discovered at two sites in Wadi Demma and Wadi Menuha (streams that drain near the Eshet Ridge and 2 km south of it, respectively). The conglomerates contained mostly limestone, chalk and chert fragments; not more than 5% of which were volcanic pebbles. Two pebbles were dated to 24.4 ± 0.7and 21.5 ± 0.5 Ma. The magmatic outcrops in Wadi Ashosh, the magmatic dyke near Tzukim and the volcanic purple and black pebbles near Wadi Menuha were all dated to the very Late Oligocene–Early Miocene. The magmatic body identified in this study under the Eshet Ridge was termed the *Eshet Intrusion* and is connected to, and even the source of, all these phenomena.

1. Introduction

Volcanism in Israel, Jordan, Syria and the Sinai took place between the Oligocene and the Pliocene in two cycles: (1) From the Late Oligocene to Middle Miocene (24–9 Ma) characterized by dykes, intrusive complexes and a few volcanic fields (Steinietz et al., 1978; Weinstein, 2000; Ilani et al., 2005). (2) During the Pliocene (6–2 Ma) and until the Pleistocene, characterized by volcanic fields and dykes (Shaliv, 1991, Ilani et al., 2001, Ibrahim et al., 2003, Steinietz et al., 2006).

The Harrat Ash Shaam volcanic province (HASV) is the largest volcanic field found on the Arabian plate. It developed during the Cenozoic close to the southern part of Dead Sea fault system, the major plate boundary separating the Arabian plate and the Sinai sub-plate (Fig. 1), and has been linked to the tectonic evolution of Red Sea rifting since the early Oligocene (Ilani et al., 2001; Shaw et al., 2003; Trifonov et al., 2011; Al Kwatli et al., 2012) (Fig 1). Al Kwatli et al. (2012) suggested the occurrence of two long periods of volcanism during the Cenozoic. The first period was synchronous with the early stage of Red Sea rifting, which started in the Late Oligocene and continued to the early-middle Miocene (~26 to ~16 Ma). The second phase has been active since ~13 Ma. A period of ~3 Myr of inactivity between ~16 Ma and~13 Ma suggests that compressive conditions prevailed in the HASV during this period.

Trifonov et al. (2011) suggested that Late Cenozoic basaltic volcanism began in Syria at the end of the Oligocene (26–24 Ma). During the Late Oligocene–Early Miocene, it was concentrated in a N-trending band. Based on their study conducted in Jordan, Ibrahim et al. (2003) suggested three phases of activity in the HASV starting from the oldest (around 23 Ma) to the youngest at around 1.7 Ma. During the Early Miocene, a pyroxene–iddingsite basalt (23%) was emplaced, which is characterized by a tholeiitic compo-

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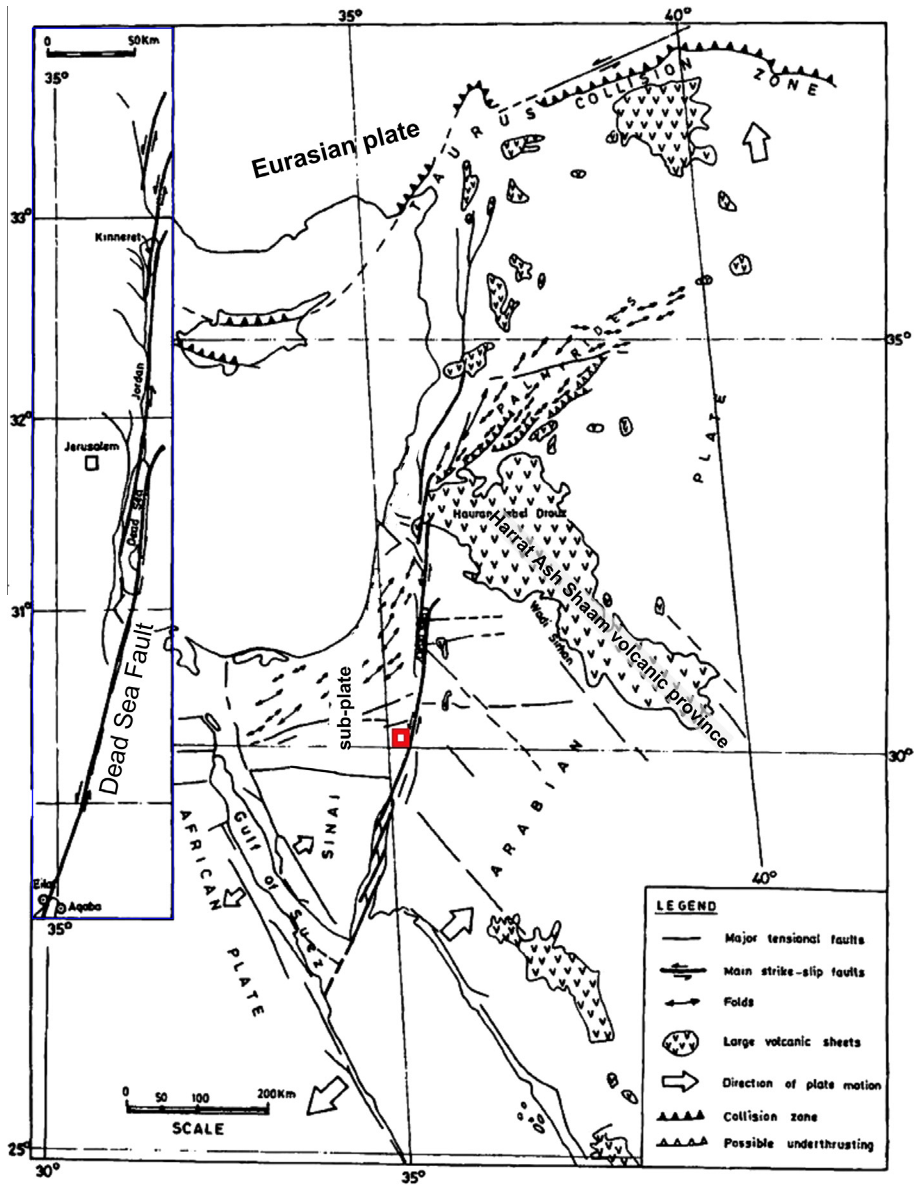

Fig. 1. Tectonic setting of the Dead Sea fault system (after Kashai and Crocker, 1987). Red rectangular denotes the study area. *Inset:* Enlargement of the DSF (Dead Sea Transform). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

sition. Dykes that are part of the HASV, trend NE–SW, parallel to the Dead Sea fault. Emplacement of the dykes was part of the same volcanic phase and regional tectonic regime associated with the phases of volcanic activity of the Red Sea System (Ibrahim et al., 2003).

Based on K–Ar radiometric dating methods, Steinietz et al. (1978) recorded four volcanic phases: (A) 24.8 ± 1.5 Ma in Central Sinai. (B) 20.4 ± 0.7 Ma of intrusions in Central Sinai and the Arava along NE–SW trends. (C) 14.5 ± 0.3 to 4.3 ± 1.3 in Eastern Galilee and along the Coastal plain and (D) 6.7 ± 0.3 to 2 ± 0 producing the dykes of the Central Arava (updated by Steinietz et al., 2006). Ilani et al. (2005) described 20 Ma basalts from western Galilee and suggested that this magmatism was related to NW trending faults. They also described detailed basalt flows, tuff and basalt intrusions as part of Miocene volcanism in the Western Galilee coastal plain dated to 15 Ma. Weinstein (2000) described middle Miocene (17–9 Ma) volcanic rocks in northern Israel, which migrated from eastern Lower Galilee to the southwest until reaching the western Galilee coastal plain. This phase of magmatism occurred mainly in response to the formation of the Dead Sea fault (DSF) (that is also define as Dead Sea Transform (Fig. 1) and consequent motion along it (Ibid).

Miocene magmatic exposures along the western margins of the Arava valley (see below) were found in Wadi Ashosh (Wadi is the Arabic word for a stream), Tzukim and Wadi Demma (Fig. 2). The exposure in Wadi Ashosh was identified by Shaw (1947) and first studied by Bentor and Vorman (1957). A more detailed description was carried out by Levite (1966). Steinietz et al. (1978) dated the Ashosh Magmatic rocks to 20.4 ± 0.7 Ma by K–Ar methods.

Numerous outcrops of strongly localized iron oxide mineralization and dolomitization along the Paran fault zone on the Eshet Ridge (Fig. 2) were reported by Grosz et al. (2006). These rocks were one of the targets for the geological, magnetic and petrophysical study presented here.

New magmatic outcrops were found in the eastern Negev near the settlement of Tzukim and in Wadi Menuha, south of Wadi Paran (Fig. 2). Basaltic dykes and caldera are exposed in the research area near Ein Yahav and were dated by Steinietz et al. (2006) as Pliocene exposures (6.7 ± 0.3 to 2 ± 0 Ma) and therefore not connected to Miocene volcanics.