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Zircon U-Pb dating, geochemistry and evolution of the Late Eocene Saveh magmatic complex, central Iran: Partial melts of sub-continental lithospheric mantle and magmatic differentiation

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ABSTRACT

The Saveh magmatic complex is a composite intrusion of diorite to tonalite. It is part of the Urumieh-Dokhtar magmatic arc in central Iran. Zircon U—Pb dating indicates that emplacement and cooling occurred 37–40 Ma ago in late Eocene (Bartonian) time. Saveh igneous rocks define a continuous mafic-felsic continuum in terms of SiO_2 (55.4–70.8 wt%), Al_2O_3 (14.2–19.8 wt%) and CaO (6.4–17.1 wt%) contents. The initial values of $^{87}Sr/^{86}Sr$ and $\varepsilon_{Nd}(t)$ are 0.7048 to 0.7062 and + 2.6 to +3.4 (Mean = +2.9). Nd model ages (T_{DM} = 555 to 616 Ma) are consistent with derivation from Iranian continental crust and subcontinental lithospheric mantle of Cadomian age (500–600 Ma). Saveh igneous rocks are enriched in K, Cs and Pb and depleted in P, Nb and Ta, indicating that the magma source was moderately affected by slab-derived fluids, as expected for the Eocene tectonic environment. The continuum of rock types from diorite to graphic eutectic tonalite indicates that magmatic evolution was controlled by the F (FeO + MgO + MnO)-Anorthite (An)-Orthoclase (Or) cotectic with minor contamination by supra-crustal components. Similar initial ratios of $^{87}Sr/^{86}Sr$ and $^{143}Nd/^{144}Nd$ for all of the rocks and the slightly younger age of tonalitic rocks (2–3 Ma younger) further indicate that the crystallization of quartz and plagioclase with graphic texture occurred in the final stage of magmatic differentiation. Saveh magmas reflected partial melting of Iranian subcontinental lithospheric mantle due to extension above the Neo-Tethys subduction zone.

1. Introduction

Granitic rocks are essential components of the continental crust. Granitoids provide important clues to the growth and reworking of continental crust. They form in all Wilson Cycle tectonic settings such as convergent margin, continental rift, continental collision, post collision and even in oceanic spreading center (Eby, 1992; Martin and De Vito, 2005). We can't understand continental crust generation without understanding the origin, transport and emplacement of granitoids. Here, we contribute to this effort by reporting and interpreting new petrologic, geochronologic and isotopic data for an outstanding example of Cenozoic granitic magmatism from the Urumieh-Dokhtar Magmatic Arc (UDMA) of Iran.

Iran is part of the Alpine-Himalayan orogenic belt and includes the Zagros orogen. Iran crust is dominated by Cadomian (500–600 Ma) igneous rocks, interpreted to have been produced by arc magmatism above a S-dipping subduction zone on the north side of Gondwana (Honarmand et al., 2018; Moghadam et al., 2015a; Rossetti et al., 2015; Shahzeidi et al., 2017; Zanchi et al., 2015). This formed the continental block "Cimmeria" which rifted off Gondwana and accreted to Eurasia in late Paleozoic time (Hassanzadeh et al., 2008; Stampfli et al., 2001). Iran has been affected by N-dipping subduction of Neo-Tethys Ocean beginning in the Mesozoic (Alavi, 2007; Berberian and Berberian, 1981; Ghasemi and Talbot, 2006; Stöcklin, 1968). As the subduction zone and the overlying continental magmatic arc matured, igneous activity produced a broad belt of mostly Cenozoic volcanic and plutonic rocks now known as the Urumieh-Dokhtar magmatic arc (UDMA; Fig. 1a) which forms a distinct, linear intrusive-extrusive complex (Alavi, 2007; Berberian and Berberian, 1981; Chiu et al., 2013; Ghasemi and Talbot, 2006; Ghorbani and Bezenjani, 2011; Omrani et al., 2008; Shahabpour, 2007; Stöcklin, 1968; Verdel et al., 2011) located between the Sanandaj-Sirjan zone and central Iran (Fig. 1a). An important episode of extension and magmatic flare-up affected Iran from ~55 Ma (latest Paleocene-early Eocene) until ~37 Ma (late Eocene) (Verdel et al., 2011; Rossetti et al., 2014; Moghadam et al., 2015b, 2016: Lucci et al.,

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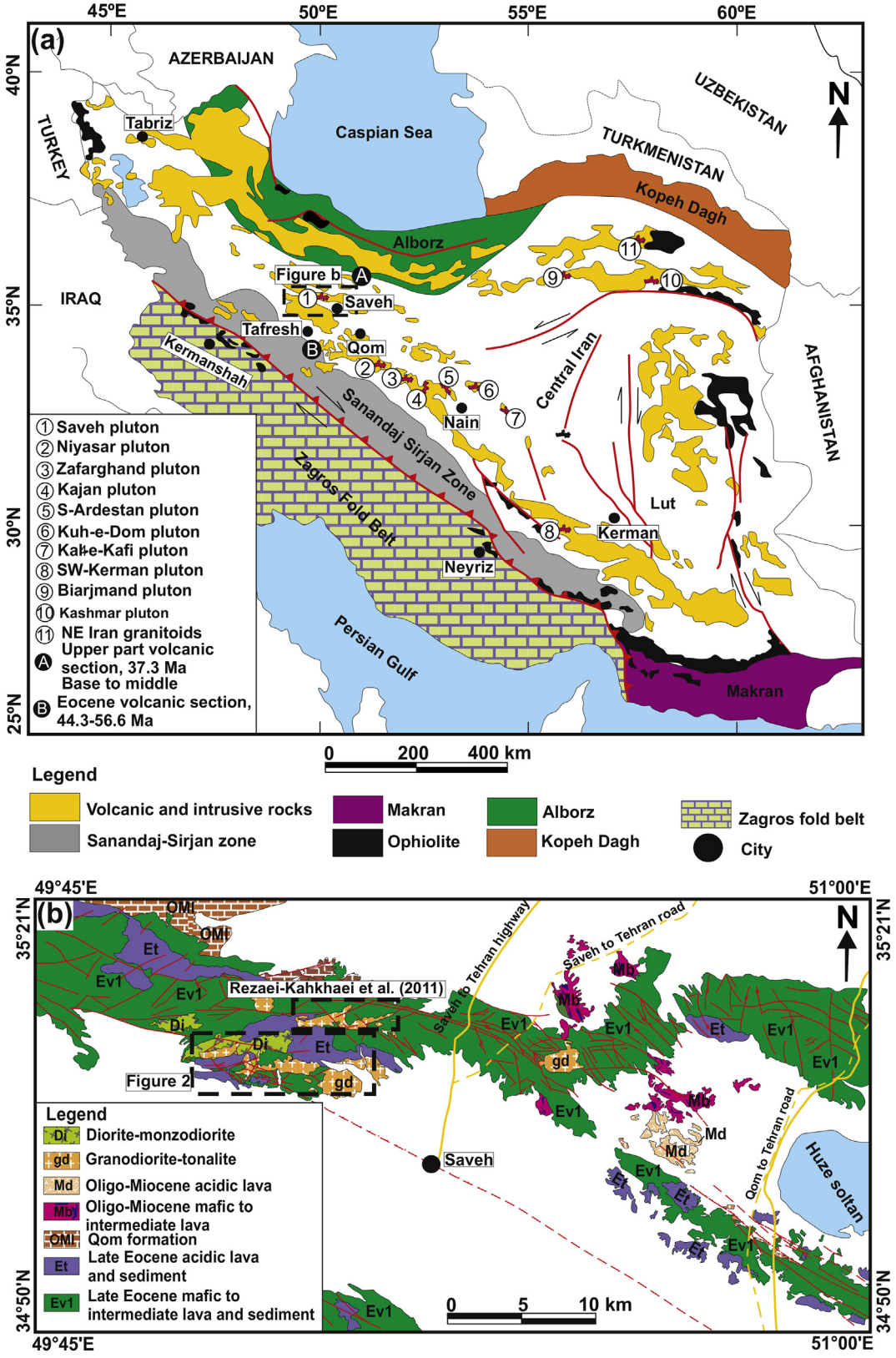

Fig. 1. (a) Simplified geological map of Iran (modified from Stöcklin, 1968). (b) Geological map of the center part of UDMA: Saveh map from Ghalamghash (1998), Zaviyeh map from Amidi et al. (2004); Qom map from Zamanni and Hossaini (1999). The field for Kashmar granitoids (40.1 ± 0.53 Ma) from Moghadam et al. (2015b), S-Ardestan granitoids (24.6 ± 0.1 Ma) from Babazadeh et al. (2017), Niyasar granitoids (18.9 ± 0.9 Ma) from Honarmand et al. (2014), SW-Kerman (33 ± 1 Ma) from Dargahi et al. (2010), Kuh-e-Dom granitoids (47 Ma) from Kananian et al. (2014), Zafarghand granitoids (24.6 ± 1 Ma) from (Sarjoughian et al., 2018), Kajan granitoids from Golkaram et al. (2016) and Kal-e-Kafi granitoids from Ahmadian et al. (2009). Data for Iran Cadomian gneisses and granites is from Moghadam et al. (2015a).Age data for Saveh and Tafresh volcanics is from Verdel et al. (2011).