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The Urumieh Plutonic Complex (NW Iran): Record of the geodynamic evolution of the Sanandaj–Sirjan zone during Cretaceous times – Part II: Magnetic fabrics and plate tectonic reconstruction

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ABSTRACT

The Urumieh complex, to the north of the Sanandaj–Sirjan zone (NW Iran), belongs to a plutonic arc that took place above the northeastward dipping subduction of Arabia under Iran during Late Cretaceous times. Seven granitoid bodies occupying an area of ~300 km^2 can be sorted into three suites. According to the isotope chronology study of Ghalamghash et al. [Ghalamghash, J., Nédélec, A., Bellon, H., Vousoughi-Abedini, M., Bouchez, J.L., in press. The Urumieh Plutonic Complex: a magmatic record of the geodynamic evolution of the Sanandaj–Sirjan zone (NW Iran) during Cretaceous times – Part II: petrogenesis and 40K/40Ar dating. Journal of Asian Earth Sciences], the two first suites were emplaced during the same event at ~100 Ma, and the third one was emplaced ~20 Ma later: (1) the diorites form the largest bodies and comprise the Ghamishlu and Dourbeh stocks; (2) the biotite-granites are composed by the Sehkani, Nari and Doustak bodies, and (3) the younger bodies are represented by the Bardkish syenite and the Dourbeh granite. These bodies were subjected to systematic microstructural observations, and magnetic fabric measurements that yield information about their emplacement kinematics. The magnetic lineations of the diorites and biotite-granites (the early suites) call for a dominant NW-trending stretching during their intrusion, attributed to the transpressive deformation of the overriding Sanandaj–Sirjan microplate during the north-to northeastward motion of the subducting western branch of the Neo-Tethys. Oblique plate motion with ~20% of strain partitioning along a NNW-trending plate boundary accounts for the observed magmatic structures. Intrusion of the younger bodies took place after consumption of this western oceanic domain at about 80 Ma. The NW-trending lineations of the syenite suggest that the transpressive regime was continuing, while the steep lineations and the peculiar microstructures of the Dourbeh granite call for a forceful intrusion. Our study suggests that the motion of Arabia with respect to Central Iran was more northerly directed than estimated before, for the 100–80 Ma time interval during which plate tectonic markers are not available.

1. Introduction

The Urumieh Plutonic Complex (UPC), 700 km to the west of Tehran has already been studied in a companion paper (Ghalamghash et al., 2009) for its petrogenesis and $^{40}K/^{40}Ar$ dating. The UPC belongs to the northern extremity of the Sanandaj–Sirjan zone, a major geological boundary of Iran located in-between the Urumieh–Doktar magmatic arc and the Zagros fold and thrust belt (Fig. 1; Berberian and King, 1981; Sengör, 1989, 1990; Alavi, 1994). There, highly deformed metamorphic rocks, associated with abundant Mesozoic granitoid plutons and volcanic rocks (Mohajjel, 1997), result from the northeastward subduction of the Neo-Tethyan oceanic crust under the former Iranian continent and from the subsequent collision with the Afro–Arabian continent that took place in Late Cretaceous times (Berberian and Berberian 1981; Berberian and King, 1981; Alavi, 1994; Mohajjel, 1997).

To better document the incremental strain fields that took place into the emplacing Urumieh granitoids in relation with the Late Cretaceous regional tectonic stress/strain fields, a structural study of these magmatic rocks is performed. Consistency of the results is discussed at the light of the petrology and chronology data of Ghalamghash et al. (2009) and a tentative reconstruction is proposed. Since fabric measurements in granites are rather difficult to obtain directly in the field, the anisotropy of magnetic susceptibility (AMS) technique is used here (Borradaile and Henry, 1997; Bouchez, 1997).

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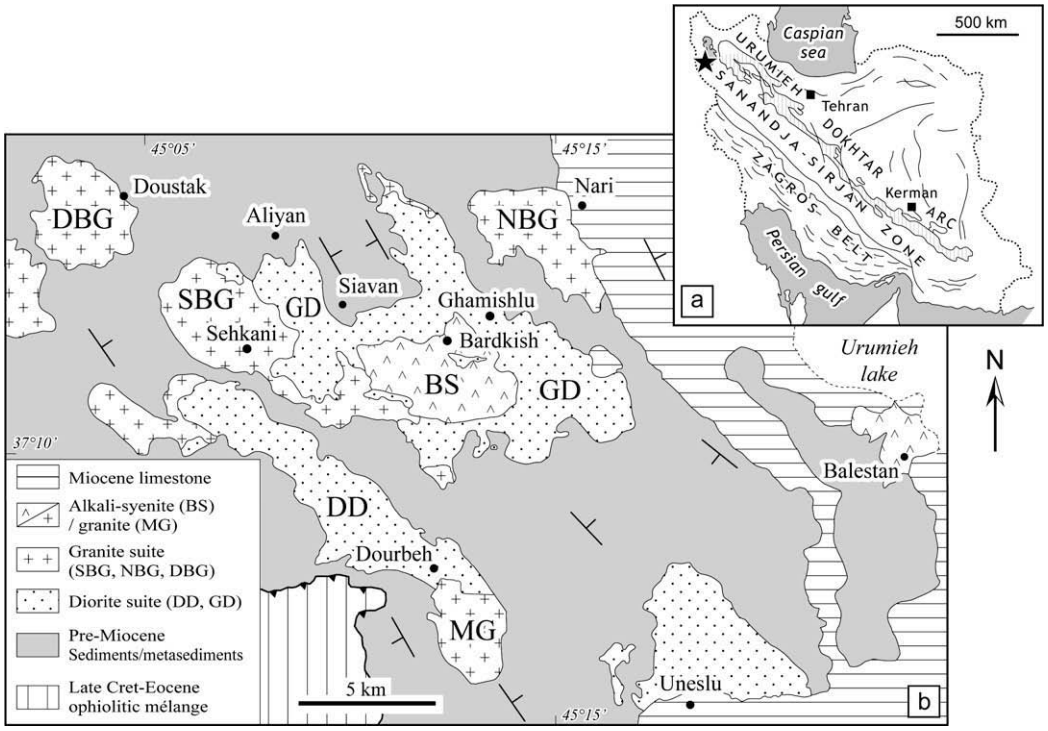

Fig. 1. Tectonic frame of the study area, with respect to the Arabia–Iran plate boundary (a) after Alavi (1994, modified), and (b) simplified geological map the Urumieh area (after Ghalamghash, 2002) at the northwest extremity of the Sanandaj–Sirjan zone.

2. Geological setting

The Urumieh plutons intrude Paleozoic to Early Cretaceous sedimentary rocks, mainly limestones and shales, and are overlain by Early Miocene formations. To the southwest of the study area (Fig. 1), amphibolites and schists define a metamorphic complex of Mesozoic age that, along with an ophiolitic mélange made of serpentinized pyroxenite, mafic volcanic rocks, radiolarites and Late Cretaceous-Eocene pelagic limestones, form the remnants of the western Neo-Tethys ocean (Shahrabi, 1994; Khalatbari-Jafari et al., 2004; Naghizadeh and Ghalamghash, 2005).

The country-rocks of the plutons are folded with NW–SE trending axes (Fig. 2). The bedding of the Mesozoic formations is locally strongly tilted and even overturned, particularly in-between some of the granitoid bodies where the country-rocks were dragged. Although part of the folding is clearly attributable to the emplacement event, as indicated by the wrapping of the bedding or foliation around the plutons contours, crosscutting relationships, particularly to the south of the Dourbeh diorite (Fig. 2), attest that folding began before the intrusions. After the intrusions, evidence of tectonic activity is locally attested by dips up to 20° with the same NW-trends of the Miocene sediments that cover the granitoids.

Three sets of faults cross-cut the plutons. According to Mohajjel (1997) the main set consists in NNW–ESE dextral faults such as the Siavan fault (Fig. 2) and ductile-brittle deformation along some of these faults has been reported (Borzouii, 2001). A second set of faults (not represented in Fig. 2) is apparently conjugate with the latter and dominantly sinistral with a minor thrust component. The latest faults of the area have E–W strikes and a thrust component to the SW. To the south of the study area, these faults separate the amphibolites and ophiolites from the other rock units.

3. The granitoid plutons, their chronology and field structures

The Urumieh plutons occupy an area of about 300 km^2 and consist of seven different stocks which can be sorted into three suites, namely (i) dioritic suite, (ii) granitic suite and (iii) younger stocks (Fig. 1b), and whose petrographic features are reported in Ghalamghash et al. (2009).

The diorites form two large bodies, locally cross-cut by dykes of granite and syenite, but which do not contain enclaves or xenoliths. To the east, the Ghamishlu diorite (GD; ~70 km^2) intrudes Late Triassic to Early Jurassic sediments and is covered by the Oligo-Miocene conglomerates. To the southwest, the Dourbeh diorite (DD; ~35 km^2) is a 12 km-long and 3 km-wide, NW-elongate body.

The granite suite comprises four separate bodies. The Sehkani biotite-bearing granite (SBG; ~30 km^2) intrudes Permian limestones. To the east of the village of Sehkani, this pluton is in contact with the Ghamishlu diorite (GD). The Nari (NBG; ~25 km^2) and Doustak (DBG; ~50 km^2) biotite-bearing granites outcrop to the northeast and northwest of the area, respectively. They also intrude Permian limestones, themselves covered by conglomerates around the village of Nari. Xenoliths of metasedimentary rocks are observed in Sehkani, Doustak and Nari granites. To the west of Nari, up to 50 m-long and NW-elongate xenoliths of metasediments contain lenses of granitic material derived from the partial melting of their host.

Finally, the younger stocks are composed by the muscovite-biotite and garnet bearing Dourbeh granite (MG; ~50 km^2) that outcrops to the south of the area, and by the Bardkish syenite (BS; ~25 km^2) in the center of the study area, which intrudes with sharp contacts both the Ghamishlu diorite and the Sehkani granite. Dykes of microgranite to microsyenite and pegmatites intrude the Bardkish syenite (BS).

K/Ar isotope dating of amphiboles and biotites, performed by Ghalamghash et al. (2009), clearly indicate the existence of two distinct events. Due to the high level of emplacement of the plutons into the sediments, the K/Ar dates are believed to closely represent the emplacement ages of the plutons. The older ages, spanning from 100 to 93 Ma (±2 Ma), concern the diorites (GD, DD) and the biotite-granites (SBG, NBG, DBG). They suggest that the corresponding bodies were emplaced during a ~7 Myrs-long