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Petrologic and geochemical constraints on the origin of Astaneh pluton, Zagros orogenic belt, Iran

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ABSTRACT

The Astaneh plutonic complex consists of a series of granitoid rocks ranging in composition from quartz-diorites to monzogranites and evolving from metaluminous to weakly peraluminous compositions. They belong to the high-K calc-alkaline series, having features of typical Andean-type cordilleran granitoids. Trace and rare-earth elements distribution patterns for the Astaneh rocks indicate a distinctive depletion in Nb, Sr, Ba, P and Ti relative to other trace elements and a greater enrichment in LILE compared to HFSE. These geochemical characteristics suggest the participation of an important recycled (sedimentary?) component in the source region of the granitoids. They have Sr initial isotopic ratios in the range 0.7078–0.7084 and negative ε_{Nd} values of −5.39 to −6.13 for a time of generation of 170 Ma. There is a genetic link between quartz-diorites and granodiorites, the dominant rock types of the Astabeh intrusion. Direct melting or fractionation from a diorite source is very unlike. It is proposed that the Astaneh parental Qtd-diorite magmas were produced by the partial melting of a mixed source, dominantly composed of amphibolites and sediments, that was formed during subduction of Neo-Tethyan oceanic crust below the Iranian microcontinent during Middle Jurassic times.

1. Introduction

The Zagros orogenic belt resulted form the collision between the Arabia and Eurasia plates (Sengor, 1992; Alavi, 1994, 2007; Agard et al., 2005). It belongs to the large Alpine–Himalayan mountain chain, also referred to as the Tethysides orogenic belt (Sengor, 1987). In contrast with other sector of this huge collisional belt, the Zagros system is characterized for a long-lived magmatic activity developed along more than 150 Ma from the Mesozoic to the Plio-Quaternary (Omrani et al., 2008). This long-lived magmatic activity is widespread along two well-defined linear belts, namely the Sanandaj–Sirjan magmatic belt (SSMB) and the Urumieh–Dokhtar magmatic assemblage (UDMA), following the zonal division modified by Alavi (2007). Most of the magmatic rocks developed from the beginning of subduction at the Jurassic (Arvin et al., 2007) up to the collision-related magmatism with climax at the Eocene times (Mazhari et al., 2009; Omrani et al., 2008), have a common calc-alkaline affinity with geochemical and petrological features similar to those of Andean-type magmatism (Berberian et al., 1982). However, some alkaline (Mazhari et al., 2009) and shoshonitic magmas (Amidi et al., 1984) are associated in space and time with calc-alkaline batholiths and their extrusive equivalents. These have been described in both the SSMB and the UDMA, denoting the igneous complexity of the Zagros system (Ghalamghash et al., in press) that resulted from a complex plate convergence process (Alavi, 2007).

Some recent studies on the volcanic rocks in these two magmatic arcs (Omrani et al., 2008) revealed interesting data about the relation of magmatism and plate convergence in this region. The presence of two magmatic arcs separated in space and time, containing a wide variety of igneous rock series, makes the Zagros convergence system one of great interest to test petrogenetic models related to subduction and arc magma generation. Large plutonic bodies, still poorly known, are associated with volcanic rocks in both magmatic belts, SSMB and UDMA. One of these plutonic complexes is the Astaneh intrusion studied in detail here for the first time. It forms part of a linear belt of plutons distributed along the SSMB. Most of these plutonic associations display a varied spectrum of rocks from gabbros to granites, typical of active continental margins. Although the relation with a subducting slab is clear for the tectonic environment, the processes of magma production remains controversial. Whether granites represent fractionates from a parental mantle-derived diorite or gabbro or, by contrast, they are crustal melts produced from a mafic source is a matter of sample debate in calc-alkaline associations.

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The aim of this paper is to use geochemical features jointly with field and petrographic relations to determine the origin of magmas and tectonic environment for magma generation. The results of this study may help to understand the complex magmatic evolution of active margins in relation with subduction and collision. These results will shed light on this period of the Mesozoic history in Iran, an area for which little information has been available so far.

2. Geological setting

From Late Precambrian until Late Paleozoic, South Eastern Turkey, Central Iran, Central Afghanistan, Southern Pamir and Arabia were part of the Gondwana supercontinent. This was separated from the Eurasian plate by the Hercynian Ocean called Paleotethys. During Middle to Late Triassic, coeval with the closure of the Paleotethys in the north, a rifting episode along the Zagros belt

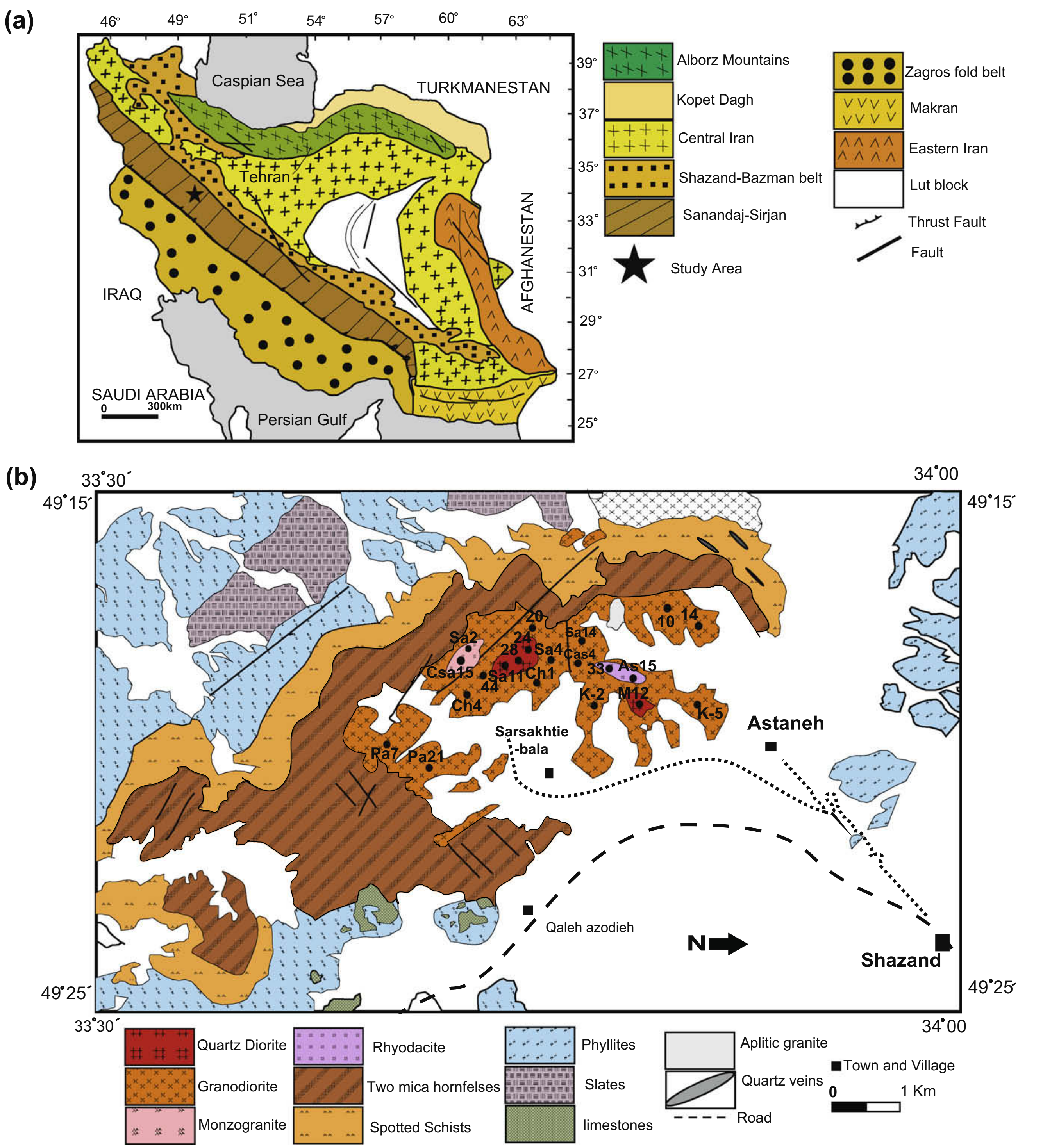

Fig. 1. Geological map of the Astaneh intrusion and location of analyzed samples. Inset shows the location of the Astaneh area in the Iran geological map (modified from: Stöcklin and Setudinia (1972)).