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PETROLOGICAL AND GEOCHEMICAL CHARACTERISTICS OF THE GRANITOID COMPLEX OF ASTANEH, WESTERN IRAN, FROM THE POINT OF BENEFICIATION

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ABSTRACT

The Granitoid Complex of Astaneh closed to Boroujerd belongs to the Sanandaj-Sirjan Zone (SSZ) in the western of Iran. It is elongated and parallel to the prevailing schistosity in the metamorphic rocks by the trend of NW–SE and consists of quartz diorites, granodiorites, monzogranites and acidic dikes (aplites and pegmatites). This complex is of sub-alkaline affinity; belong to the high-K calc-alkaline series, metaluminous to weakly peraluminous, and display features typical of I-type granites.

Trace and rare-earth elements distribution patterns for the Astaneh granitoid rocks indicate a distinctive depletion with respect to primitive mantle in Nb, Eu, Sr, Ba, P and Ti relative to other trace elements and a greater enrichment in LILE compared to HFSE. These geochemical characteristics suggest that these rocks derived from a crustal source.

The granitoid Astaneh has geochemical characteristics typical of arc intrusives and plot as volcanic arc granites on various discriminant diagrams. This granitoid is typical representatives of a volcanic arc environment, spatially related to an active continental margin. Probably, it is the result of the subduction of Neo-Tethyan oceanic crust below the Iranian microcontinent. All available data are compatible with the idea that these rocks represent the products of convergent margin processes during the Mesozoic.

Keywords: *Astaneh, REE, I-type granite, Continental arc.*

INTRODUCTION

The tectonic history of the Tethyan region has been studied by many authors,[2, 4, 10] among others. From Late Precambrian until Late Paleozoic time, southeastern Turkey, Central Iran, central Afghanistan, southern Pamir and Arabia were part of Gondwana, separated from the Eurasian plate by the Hercynian Ocean called Paleotethys. In the Middle to Late Triassic, during the closure of the Paleotethys in the north, rifting in the continental plate along the Zagros thrust zone occurred which resulted in the opening of a new ocean called Neotethys. During Triassic–Jurassic time with the closure of Paleotethys, the oceanic crust of the Neotethys started to subduct beneath the Eurasian plate. This led to an Early Cimmerian metamorphic event, recorded in the southwest Sanandaj-Sirjan Zone[4, 7] associated with Upper Triassic emplacement of intrusive bodies[9] within this zone. Finally, closure of Neotethys and collision of Arabia and Central Iran took place during the Neogene time.[4]

The Sanandaj-Sirjan Zone, which is the host of the Astaneh granitoid complex, has a length of 1500 km and a width up to 200 km from northwest to southeast of Iran. and separates the stable Central Iran block, from the Afro-Arabian plate.

The Astaneh complex is a NW-SE trending body covering an area of 600 km^2, approximately 40 km in length and 6 km in width, which lies between 33° 38'–34° N and between 48° 45'–49° 20' E (Fig. 1). The Astaneh area is characterised by the predominance of metamorphic rocks of Jurassic age[3] and the presence of the Boroujerd huge granitoid complex.

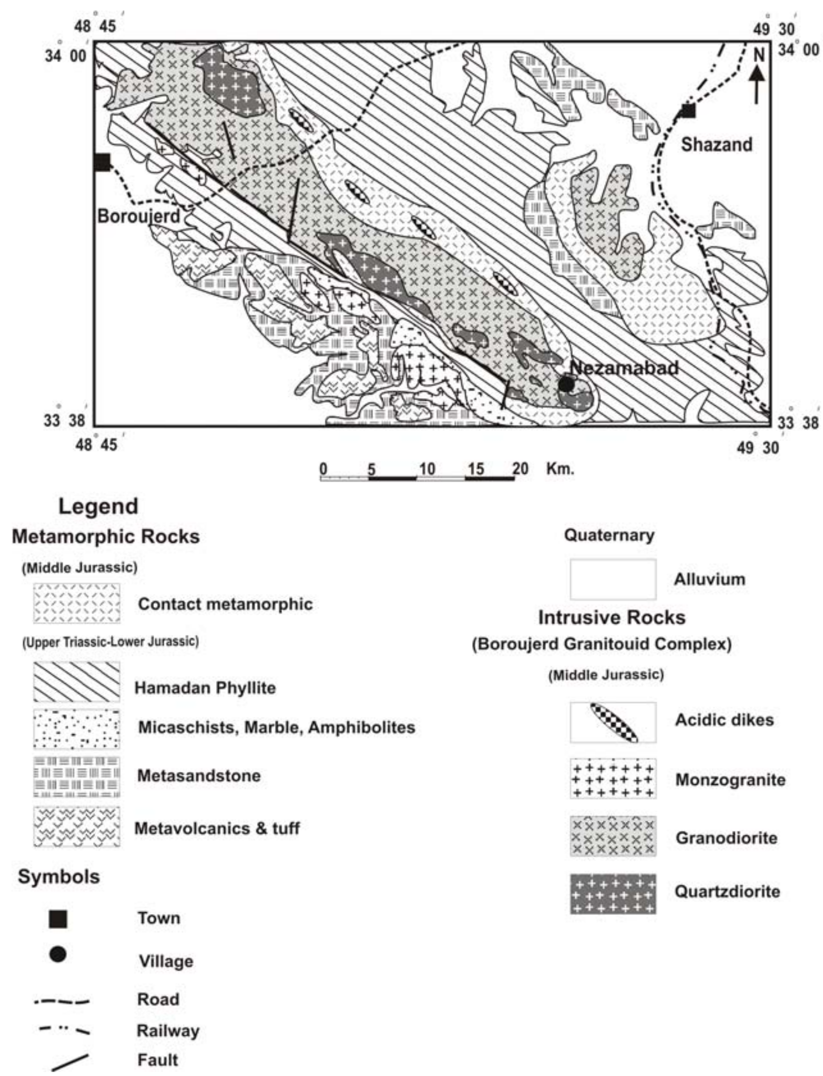

Fig. 1: Geological map of Astaneh Granitoid Complex closed to Boroujerd.

MATERIALS AND METHODS

A total of about three hundreds rock samples from different facies, including granodiorite, quartzdiorite, monzogranite, acidic dikes and enclaves were collected. Two hundreds thin sections and thin polished sections of these samples were prepared and studied by optical microscope. Representative samples (34 samples) were then selected for whole rock geochemistry. Sample weights were 1–1.5 kg before crushing and powdering. Major, minor, and trace element abundances were determined by inductively coupled plasma atomic emission spectrometry (ICP-AES) and inductively coupled plasma-mass spectrometry (ICP-MS) at the ALS Chemex laboratories in Vancouver, Canada. . The analytical processes are described in Cotten *et al.*[6] Relative standard deviations were ≤ ±2% for major elements and ≤ ±5% for trace elements.

RESULTS AND DISCUSSION

The investigated granitoids show wide compositional variations, especially in their silica content. The samples exhibit a wide range in SiO_2 content from approximately 52 to 63 wt% for the quartz diorites, 58 to 71 wt% for the granodiorites and 70 to 75 wt% for the monzogranites. Most samples form near-linear to curvilinear trends of decreasing Al_2O_3, Fe_2O_3*, MnO, TiO_2, MgO, CaO and P_2O_5, and increasing K_2O and Na_2O with increasing SiO_2. The patterns of these in the TiO_2 versus SiO_2 and P_2O_5 versus SiO_2 diagrams show marked inflections at approximately 60 wt% SiO_2 and provide a slightly convex curve in the Al_2O_3 versus SiO_2 diagram. These patterns suggest that fractionation of hornblende, a Ti-bearing phase, and apatite may have played roles in these rocks.

The trace elements behave in a similar way when plotted versus increasing SiO_2 content: decreasing trends for Ba, Sr, V, Cr, Ni, Co and Zn and increasing trends for Rb, U, Ta and Nb. Transition elements (Ni, Cr, Co, V) decrease with increasing SiO_2 content, in agreement with their incorporation into early-crystallized ferro-magnesian silicates. Average Nb contents are always low (<20 ppm) as it is usual in calc-alkaline rocks.

In the molecular $Al_2O_3/(CaO + Na_2O + K_2O)$ *versus* $Al_2O_3/(Na_2O + K_2O)$ [A/CNK *vs.* A/NK] diagram the composition of quartz-diorites plot into the metaluminous field, while the granodiorites and the monzogranites plot into the peralminous domine. Nevertherless, the ratio of the molcular A/CNK of the quartz-diorites as well as the most of the granodiorites and the monzogranites are in the 1–1.1 interval of A/CNK, hence the rocks are of I-type in the sense of Chappell and White.[5] All samples are of subalkaline affinity and belong to the calc-alkaline series on the basis of the Irviane and Baragar[1] and low Sr, P and Ti values are compatible with typical crustal melts.

CONCLUSIONS

The Astaneh Granitoid Complex is typically formed of a high-K calk-alkaline suite, in which granodiorite, quartz diorite and monzogranite are the dominant rock types. Regarding field relations, petrography and geochemistry these rocks show similarity to intrusions typical of the active continental margins. Numerous studies suggest that trace elements can be used to discriminate between the different tectonic settings of granitoid magmas, although they must be used with caution as they could represent the formation of the protoliths rather than those of the derived magma. The Astaneh granitoids in the geotectonic classification of Pearce *et al.*[8] are classified as volcanic arc granites. Furthermore, as discussed earlier, granitoids of the Boroujerd area are enriched in LILE such as Cs, K, Rb, and Th with respect to the HFSE, especially Nb and

Ti. Magmas with these geochemical characters are generally ascribed to the subduction-related environments. High Th/Yb ratios correlated with high values for La/Yb are consistent with continental arc magmas.

The Astaneh Granitoid Complex is made of three units including quartz diorite, granodiorite and monzogranite.[1] The geochemical characteristics, mineralogy and petrography of these rocks are comparable with the typical I-type granites. The Complex belongs to metaluminous to slightly peraluminous, a high-K calc-alkaline series, and displays geochemical characteristics typical of volcanic arc granites related to an active continental margin. This conclusion is in good agreement with the general model of Shahabpour[11] which assumed that the Sanandaj-Sirjan calc-alkaline magmatic arc formed over a high angle subducting oceanic slab in the Neotethyan subduction zone during Late Triassic to Late Cretaceous time.

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