Chemie der Erde 76 (2016) 529–541

Contents lists available at ScienceDirect

Chemie der Erde

journal homepage: www.elsevier.de/chemer

Strongly peraluminous leucogranite (Ebrahim-Attar granite) as evidence for extensional tectonic regime in the Cretaceous, Sanandaj Sirjan zone, northwest Iran

Hossein Azizi[a,*], Keivan Mohammadi[b], Yoshihiro Asahara[c], Motohiro Tsuboi[d], Narges Daneshvar[e], Behzad Mehrabi[e]

[a] Mining Department, Faculty of Engineering, University of Kurdistan, Sanandaj, Iran
[b] Earth Sciences Department, Faculty of Basic Sciences, University of Kurdistan, Sanandaj, Iran
[c] Department of Earth and Environmental Sciences, Graduate School of Environmental Studies, Nagoya University, Nagoya, 464-8601, Japan
[d] Department of Applied Chemistry for Environment, School of Sciences and Technology, Kwansei Gakuin University, Sanda, 669-1337, Japan
[e] Geochemistry Department, Faculty of Earth Sciences, Kharazmi University, Tehran, Iran

ARTICLE INFO

Article history:
Received 26 January 2016
Received in revised form 26 August 2016
Accepted 27 August 2016
Editorial handling - H.S. Moghadam

Keywords:
Peraluminums leucogranite
Post orogenic granite
Nd model age
Sr-Nd isotope ratios
Sanandaj Sirjan zone

ABSTRACT

The Ebrahim-Attar (EBAT) leucogranite body is intruded within the Jurassic metamorphic complex of the Ghorveh area, located in the northern part of the Sanandaj Sirjan zone (SaSZ) of northwest Iran. The granite comprises alkali feldspar, quartz, Na-rich plagioclase and to a lesser extent, muscovite and biotite. Garnet and beryl are also observed as accessory minerals. Additionally, high SiO_2 (71.4–81.0wt %) and Rb (145–440 ppm) content; low MgO (<0.12wt %), Fe_2O_3 (< 0.68 wt.%), Sr (mainly < 20 ppm), Ba (<57 ppm), Zr (10–53 ppm) and rare earth elements (REEs) low content (3.88–94.9 ppm with an average = 21.2 ppm); and flat REE patterns with a negative Eu anomaly characterize these rocks. The chemical composition and mineral paragenesis indicate that the rocks were formed by the partial melting of siliciclastic to pelitic rocks and can be classified as per-aluminous leucogranite or strongly per-aluminous (SP) granite. The Rb-Sr whole rock and mineral isochrons confirm that crystallization of the body occurred at 102.5 ± 6.1 Ma in Albian. The $^{87}Sr/^{86}Sr(i)$ and $^{143}Nd/^{144}Nd(i)$ ratios are 0.7081 ± 0.009 and 0.51220 ± 0.00005, respectively, and $\varepsilon_{Nd(t)}$ values range from −5.8 to −1.6. These values verify that the source of this body is continental crust. The Nd model ages (T_{DM2}) vary between 1.0 and 1.3 Ga and are more consistent with the juvenile basement of Pan African crust. Based on these results, we suggest that the upwelling of the hot asthenospheric mantle in the SaSZ (likely during the Neo-Tethys rollback activity) occurred after the late Cimmerian orogeny. Consequently, we suggest that this process was responsible for a thinning and heating of the continental crust, from which the SP granite was produced by the partial melting of muscovite rich in pelitic or felsic-metapelitic rocks in the northern SaSZ.

© 2016 Elsevier GmbH. All rights reserved.

1. Introduction

Granitoid bodies are a primary component of continental crust and as such, are key to understanding continental evolution. Granitoid rocks of different groups have been generated in various tectonic regimes such as active margin, continental rifts, collision and post collision and to a lesser extent, within oceanic ridges (e.g., Whalen et al., 1987; Barbarin, 1990; Eby, 1992; Brown, 1994; Förster et al., 1997; Kusky and Polat, 1999; Martin and De Vito, 2005). Because of this, the source of the granites has been the subject of many studies. In addition, the classification of granite is based on the tectonic context, with sources identified by many researchers (Pearce et al., 1984; Whalen et al., 1987; Eby, 1992; Frost et al., 2001 and many others) that are widely recognized. However, a persistent challenge in this field is understanding the origin of peraluminous leucogranite within orogenic belts. Strongly peraluminous granite (SP granite, Sylvester, 1998) or peraluminous leucogranite are characterized by a low content of mafic minerals (Less than 5%), high A/CNK (≥1.1) and high Rb/Sr (>1), Rb/Ba(>0.3)and Al_2O_3/CaO (>7)ratios. Additionally, the dominant minerals within SP granite are alkali feldspars, sodic-plagioclase, quartz, muscovite and biotite, along with a limited amount of garnet and cordierite. The source of this type of granite, however, is not well understood. Strongly peraluminous granite is considered to be

* Corresponding author.
E-mail addresses: Azizi1345@gmail.com, hazizih2001@yahoo.com (H. Azizi).

http://dx.doi.org/10.1016/j.chemer.2016.08.006
0009-2819/© 2016 Elsevier GmbH. All rights reserved.

produced during or after collision and is thought to result from the partial melting of metapelitic and meta pesammitic rocks within the collision zone (e.g., Pitcher, 1983; Miller, 1985; Sylvester, 1989, 1998; Chappell et al., 1988; Patino Douce, 1995; Searle et al., 1997). For instance, Sylvester (1998) considered two principle orogeny models for SP granite. The first is the Alpine-Himalayan collision type. In this type, the thickness of the continental crust in the collision zone strongly increased and sometimes extended to 70 km. In this zone, heat is produced from the decay of radioactive elements such as Rb, K, Th and U, and as a result of a long production period, it produced small bodies of SP granite (Le Fort et al., 1987; Zen, 1988; Sylvester, 1998 and references in therein). Generally, the SP granite contained within the Alpine-Himalayan collision type is rare and is related to high-pressure metamorphic rocks. The second collision type is characterized by high temperature, such as within the Hercynian and Lakhlan orogeny belts. In this type of collision, the thickness of the continental crust does not increase more than 50 km. In this process, an upwelling of the hot asthenosphere occurs, which is related to basaltic magma, due to the heat conductivity of the continental crust. The SP granite shows some similarity to S-type granite, but the S-type granite is much richer in high Al-minerals such as cordierite and occasionally orthopyroxene, which is produced mainly by dehydration melting of felsic metapelitic rocks that have abundant muscovite. During adiabatic upwelling, either in the collision or post collision regime, muscovite becomes unstable and melted, releasing a product similar to peraluminous leucogranite. In contrast, the melting of biotite would produce granites that are richer in FeO and MgO than peraluminous leucogranite (Patino Douce, 1999).

In the northern SaSZ, northwest Iran Jurassic granitoid bodies and Jurassic metamorphic host rocks are widely distributed and cut by many aplite and pegmatite dikes (Fig. 1a–c). The largest pegmatite crops lie in the Ebrahim-Attar (EBAT) mountain to the southwest of Ghorveh (Fig. 1c; Fig. 2a, b). The pegmatite is mined for feldspar and silica and to a lesser extent, mica and beryl. The mining activity is centered on two major sections called EBAT-MINE 1 and EBAT-MINE 2. EBAT-MINE 1 is currently active while EBAT-MINE 2 is under construction. Our field and microscopic observations confirm that the EBAT rock is not a typical pegmatite. Indeed, much of the body of the rock has a granular and graphic texture, while in other parts, it has a pegmatite texture. This finding is consistent with a cone shape of the EBAT body, which is buried under the metamorphic complex and is partly exposed because of erosion. Recent excavations demonstrate that the EBAT-MINE 1 and EBAT-MINE 2 are a part of a small granitic body; therefore, we consider the EBAT rock to be of leucogranite stock rather than a pegmatite dike, as previously thought.

The limited availability of published research on EBAT granite underscores that little is currently understood about this type of rock. Even so, previous studies have proposed that the EBAT body represents the final stage of Moshirabad granite, which is consolidated in the host metamorphic rocks (Salami et al., 2013). In this geochemical study, Sr-Nd isotope ratios and radiometric ages based on the whole rock and mineral isochrons are presented, focusing on the origin of the rock and its affiliation with the host rocks. The samples were collected from the quartz feldspar mines located along the length of the granitic body. We discuss the whole rock chemical compositions and isotope ratios and propose a geodynamic model for the origin of the EBAT granite in the SaSZ.

2. Geological setting

The SaSZ is located in western Iran (Fig. 1a), having a width of 50–150 km and a length of 800 km. It is situated between the Zagros suture zone in the west and Urmia Dokhtar magmatic arc (UDMA) in the east (Stocklin, 1968; Falcon, 1974). Due to scattered outcrops of the Precambrian basement, most studies have considered the SaSZ a western section of the Iranian micro-continent, cut by many granitoid bodies in the Jurassic and younger (Hassanzadeh et al., 2008; Azizi et al., 2011a, b; Hosseini et al., 2015) as well as in Mesozoic rock (Shahbazi et al., 2010; Mahmoudi et al., 2011; Azizi et al., 2011a; Azizi and Asahara, 2013; Azizi et al., 2015a, b; Shahbazi et al., 2015; Yajam et al., 2015). The principle occurrences of granitic bodies in the Iranian plate belong to the Late Jurassic (Fig. 1a, b). Some bodies are A-type granites, which were generated within an extensional basin in the Late Paleozoic (Alirezaei and Hassanzadeh, 2012). Further, the granitoid compositions transition from diorite to granite, including limited amounts of alkali granite, which were primarily generated during the Zagros orogeny as a consequence of the Neo-Tethys oceanic subduction beneath the SaSZ (Berberian and King, 1981; Shahbazi et al., 2010, 2015) and/or the island arc-continental collision (Azizi and Asahara, 2013; Azizi et al., 2015a). For example, Hunziker et al. (2015) studied several granitic rocks from the Makran area, which is located south of the SaSZ. Based on the age of the rocks, the granite was assigned the ages of 170-145 Ma and classified according to three time periods. Based on the results of the study, it was proposed that this granite formation occurred within an extensional basin during the Jurassic without any affiliation to subduction activities.

The Ghorveh area, which is part of the northern SaSZ, includes a Triassic–Jurassic metamorphic complex with marble, green schist, amphibolite, meta-arkose and quartzite, which were deformed and show poly-deformation structures (Fig. 1b). The metamorphic rocks are cut by granitoid bodies with ages of 180–140 Ma (Mahmoudi et al., 2011; Azizi et al., 2011a, b; Azizi and Asahara 2013; Maanijou et al., 2013; Azizi et al., 2015a, b; Shahbazi et al., 2015; Yajam et al., 2015). The geodynamics of these bodies are not well defined, but the new findings confirm both an active continental margin and island arc setting. In the eastern part of Ghorveh, the granitoid bodies are overlaid by Late Miocene to Pliocene shallow basin sediments (Fig. 1b) including limestone, shale, siltstone and sandstone, which are cut by younger adakite and high-Nb basalt (Azizi et al., 2014a, b).

The EBAT mountain, which is characterized by a rough topography, contains marble, schist and metabasites that are cut by two granitoid bodies in the north and south; they are known as Moshirabad and Ghalaylan granites, respectively (Fig. 1b). The Moshirabad granitoid has a sigmoid shape, containing medium-to-coarse grained rocks of diorite and having a sharp contact granitic composition, although in some locations, there is mixing and mingling of textures and cross-cutting by different types of dikes (e.g., diorite and granite). The latter rocks were dated using the U-Pb technique on zircon grains. It was determined that the Moshirabad body crystallized at 157 Ma (Yajam et al., 2015). The southern Ghalaylan body includes two main groups of porphyric granite and granite (Azizi et al., 2015a). The chemical composition, mineralogy and isotope ratios of this body are significantly different from the other bodies in the Ghorveh area. Indeed, Azizi et al. (2015a) considered these rocks to be adakite to Tonalite-Trondhjemite-Granodiorite (TTG) formed during the arc and continental collision in the late Jurassic. In addition, the contact aureole metamorphism in northern Ghalaylan is overprinted during the granite intrusion. The EBAT mountain mainly includes metamorphic rocks with some poly-deformed textures (Fig. 2a–c); these rocks are cut by the EBAT granite. The slender contact aureole was found to have developed around the main body as a dolomitization and skarn zone with some minor Sn and W mineralization (Salami et al., 2013). Lastly, field observations show that the dikes are fresh, coarse-grained, white in color (Fig. 2g-h) and are cut by young faults with the development of cataclastic textures.

Download English Version:

https://daneshyari.com/en/article/5745656

Download Persian Version:

https://daneshyari.com/article/5745656

Daneshyari.com