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Geochemistry, Rb-Sr whole rock age and Sr-Nd isotopic constraints on the Variscan A_1-type granite from Azegour area in the Marrakech High Atlas (Moroccan Meseta) and their geodynamic implications

Mohamed Hadani[1]*, Maria do Rosário Azevedo[2], Rui Dias[3], Adil Saeed[4], Salah F. Awadelsied[4]

[1]Geodynamic and Geomatic Labrotory, Department of Geology. Chouaib Doukkali University, Route Ben Maachou, B.P.20, 24.000 El Jadida, Morocco
[2]Department of Geosciences, University of Aveiro, Campus de Santiago, 3810-193 Aveiro, Portugal
[3]Institute of Earth Sciences, Department of Geosciences, School of Science and Technology of the University of Evora, 7000-671 Evora, Portugal
[4]Department of Mineral Resources, College of Petroleum Geology and Minerals, Bahri University, Khartoum 1660, Sudan
*corresponding author, e-mail address: geohadani@hotmail.com

Abstract

In the northern part of the Marrakech High Atlas (MHA), along the southern Variscan segment of the Western Meseta, a Variscan granitic intrusion crops out, intruding metasediments and meta-volcanosedimentary rocks of Early Cambrian to Ordovician age. A new whole-rock Rb-Sr isochron age of 268 ± 9 Ma for the granite, combined with a previously published whole-rock Rb-Sr radiometric dating (271 ± 3 Ma), reveals a post-kinematic (tectonic) character with regard to the main Variscan deformational event, belonging within the tectonic context of the Moroccan Variscan orogenic belt. Geochemically, the Azegour intrusion is metaluminous to peraluminous and exhibits a calc-alkaline affinity with a ferruginous composition. The massif shows an extremely differentiated character (SiO_2 = 77.53–78.14 per cent), K_2O and high total alkali contents, $FeO_t/(FeO_t + MgO)$ and Ga/Al ratios, which have typical characteristics of an A-type granite. In addition, the granite contains high concentrations of LREE (La_N/Sm_N = 7.9–13.67) relative to HREE (La_N/Yb_N = 4.81–11.61) and a well-defined Eu negative anomaly (Eu/Eu* = 0.44–0.75). The granitic samples exhibit a strong enrichment of the most incompatible elements (Rb_N/Yb_N = 69.84–159.98) and a strong depletion of Ba, Sr, Eu, Nb, P and Ti. These characteristics are similar to those of A_1-type granites. The absence of mineralogy typical of an S-type granite, combined with its weakly peraluminous character [A/CNK (molar $Al_2O_3/CaO+Na_2O+K_2O$) = 1,013–1,045], suggest that there is little or no significant involvement of supracrustal sources in the petrogenesis of the intrusion studied. Despite the strongly differentiated character of Azegour granitic rocks samples, their multi-element patterns shows many similarities to those of I-type granitoids, which has led to postulate that the parental liquids of A_1-type were derived from partial melting of mafic magmas. The representative samples studied show less depleted $\varepsilon Nd_{(t = 270\ Ma)}$ values of –0.94 to –4.85 and lower positive to slightly negative $\varepsilon Sr_{(t = 270\ Ma)}$ values of –1.45 to 9.32. The isotopic data suggest that the Azegour granite was emplaced 270 myr ago, apparently generated by partial melting of a mafic/intermediate magma source in the lower crust as a result of the underplating of the asthenosphere mantle-derived Oceanic Island Basalt-like magmas. Alternatively, their isotopic signatures also can be attributed to the interaction and/or hybridisation of basaltic liquids derived from the mantle with these lower crust materials. The generated parental magma probably occurred at deep structural levels and involved fractional crystallisation processes by the separation of a mineralogical association composed of plagioclase + potassium feldspar ± biotite ± amphibole ± sphene ± apatite. The whole-rock Rb-Sr age of 268 ± 9 Ma, whole-rock geochemistry and Sr-Nd isotopic compositions of $\varepsilon Nd_{(t = 270\ Ma)}$ and $\varepsilon Sr_{(t = 270\ Ma)}$, combined with fieldwork data, suggest that the Azegour granite was emplaced during the later stage of compressional Variscan events in the MHA.

Keywords: Rb-Sr whole-rock geochronology, whole-rock geochemistry, post-collisional processes, magma underplating, Variscan orogeny, Morocco