Journal of Economic Geology
Vol. 11, No. 4 (2020)
ISSN 2008-7306

زمین‌شناسی اقتصادی
جلد ۱۱، شماره ۴ (سال ۱۳۹۸)
صفحات ۵۹ و ۶۰

Mineral chemistry and geothermobarometry of metabasites of the Majerad igneous-metamorphic complex (SE of Shahrood)

Marzieh Veiskarami[1*], Mahmoud Sadeghian[1], Habibollah Ghasemi[1] and Minggou Zhai[2]

1) Department Petrology and Economic Geology, Faculty of Earth Sciences, Shahrood University of Technology, Shahrood, Iran
2) Department of Petrology, Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing, China

Submitted: June 22, 2018
Accepted: Jan. 01, 2019

Keywords: *Metabasite, Late Neoproterozoic, Mineral chemistry, Thermobarometry, Amphibole, Plagioclase, Shahrood*

Introduction

Thermobarometric models based on the chemical equilibrium among coexisting mineral-mineral or mineral-melts pairs are useful tools widely used to estimate the P-T path and chemical evolution during igneous processes. The high sensitivity of amphibole to physicochemical changes makes it a good tracer for thermobarometric models. Majerad Igneous-Metamorphic Complex with NE-SW trend, 40 kilometer length, and 10 kilometer width is located in the southeast of Shahrood in the northern margin of the Central Iran structural zone. Late Neoproterozoic sequence of Majerad metamorphic complex includes a wide range of metamorphic rocks with extensive compositional variety of metacarbonate, metapsammite, metapelite, metabasite and metarhyolite. Metabasites of the Majerad metamorphic complex consist of a greenschist to garnet amphibolite. Late Iranian Neoproterozoic complexes have been studied by numerous researchers, and a lot of papers have been published related to them (Rahmati Ilkhchi et al., 2011; Balaghi Einalou et al., 2014; Faramarzi et al., 2015; Hosseini et al., 2015; Malekpour-Alamdari et al., 2017). These complexes have cropped out in the different parts of Iran, except the Kopeh Dagh, Makran and the East Iran Flysch structural zones.

Analytical methods

The whole-rock major element compositions were determined by X-ray fluorescence using fused glass disks at the Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing, China. Trace elements were determined by ICP-MS (Agilent 7500a) at IGGCAS after more than 5-day acid digestion of samples in Teflon bombs. Compositional mineral analyses were performed at the State Key Laboratory of Continental Dynamics, Northwest University, Xian China, using a Cameca JXA-8230 instrument at an acceleration voltage of 15 KV, and beam current of 10 nA.

Results

In the metamorphic environment, aluminous hornblende-bearing assemblages are stable over a wide P-T field that extends from amphibolite to granulite, and high-T eclogite-facies conditions. At lower temperatures, the hornblendic amphibole is replaced by sodic-calcic amphibole at relatively high-P and by actinolite at lower-pressure greenschist-facies conditions (Spear, 1993; Ernst and Liu, 1998; Molina et al., 2015).

Amphibole formulas were calculated with the Amp-Excels spreadsheet using the 13 cations method (Leake et al., 1997). Amphiboles of metabasites are calcic, and Amphiboles of actinolite-schists are in the range of actinolite to magnesio-hornblende, and in amphibolites, they are plotted in the range of magnesio-hornblende to tschermakite. Plagioclase are usually oligoclase to

*Corresponding authors Email: veiskaramim@gmail.com
DOI: https://doi.org/10.22067/econg.v11i4.73682

bytownite.

Temperatures range of metamorphism events of amphibolites of the Majerad complex have been estimated by using the hornblende-plagioclase thermometer. This thermometer is based on the Ca and Na equilibrium exchange between plagioclase and amphibole (Holland and Blundy, 1994). The hornblende-plagioclase pair thermobarometer estimates temperatures of 450 to 690ºC and pressures of 4 to 11 Kb for the formation of the Majerad amphibolites. These temperature-pressure ranges correlate with P-T conditions of the greenschist and amphibolite facies in the typical Barrovian type metamorphism.

References

Balaghi Einalou, M., Sadeghian, M., Ghasemi, H., Zhai, M.G., and Mohajjel, M., 2014. Zircon U–Pb ages, Hf isotopes and geochemistry of the schists, gneisses and granites in Delbar Metamorphic-Igneous Complex, SE of Shahrood (Iran): implications for Neoproterozoic geodynamic evolutions of central Iran. Journal of Asian Earth Sciences, 92(13): 92–124.

Ernst, W.G. and Liu J., 1998. Experimental phaseequilibrium study of Al-and Ti-contents of calcic amphibole in MORB-A semiquantitative thermobarometer. American Mineralogist, 83(9–10): 952–969.

Faramarzi, N., Amini, S., Schmitt, A., Hassanzadeh, J., Borg, G., McKeegan, K., Razavi, S.M. and Mortazavi, S.M., 2015. Geochronology and geochemistry of rhyolites from Hormuz Island, southern Iran: A new record of Cadomian arc magmatism in the Hormuz Formation. Lithos, 236–237(1): 203–211.

Holland, T. and Blundy, J., 1994. Non-ideal interactions in calcic amphiboles and their bearing on amphibole-plagioclase thermometry. Contributions to Mineralogy and Petrology, 116(4): 433–447.

Hosseini, S.H., Sadeghian, M., Zhai, M. and Ghasemi, H., 2015. Petrology, geochemistry and zircon U–Pb dating of Band-e-Hezar Chah metabasites (NE Iran): An evidence for back-arc magmatism along the northern active margin of Gondwana. Chemie der Erde, 75(2): 207–218.

Leake, B.E., Woolley, A.R., Arps, C.E.S., Birch, W.D., Gilbert, M.C., Grice, J.D., Hawthorne, F.C., Kato, A., Kisch, H.J., Krivovichev, V.G., Linthout, K., Laird, J., Mandarino, J., Maresch, W.V., Nickel, E.H., Schumaker, J.C., Smith, D.C., Stephenson, N.C.N., Ungaretti, L., Whittaker, E.J.W. and Youzhi, G., 1997. Nomenclature of amphiboles: report of the subcommittee on amphiboles of the International Mineralogical Association Commission on New Minerals and Mineral Names. The Canadian Mineralogist, 35(1): 219–246.

Malekpour-Alamdari, A., Axen, G., Heizler, M. and Hassanzadeh, J., 2017. Large-magnitude continental extension in the northeastern Iranian Plateau: Insight from K-feldspar $^{40}Ar/^{39}Ar$ thermochronology from the Shotor Kuh–Biarjmand metamorphic core complex. Geosphere, 13(4): 1207–1233.

Molina, J.F., Moreno, J.A., Castro, A., Rodriguez, C. and Fershtater, G.B., 2015. Calcic amphibole thermobarometry in metamorphic and igneous rocks: New calibrations based on plagioclase/amphibole Al-Si partitioning and amphibole/liquid Mg partitioning. Lithos, 232(6): 286–305.

Rahmati Ilkhchi, M., Faryad, S.W., Holub, F.V., Kosler, J. and Frank, W., 2011. Magmatic and metamorphic evolution of the Shotur Kuh Metamorphic Complex (central Iran). International Journal of Earth Sciences, 100(1): 45–62.

Spear, F.S., 1993. Metamorphic phase equilibria and pressure-temperature-time paths. Monograph (Mineralogical Society of America), America, 799 pp.