Journal of Economic Geology
Vol. 9, No. 1 (2017)
ISSN 2008-7306

مجله زمین‌شناسی اقتصادی
جلد 9، شماره 1 (سال 1396)
صفحات 7 و 8

Magmatic-hydrothermal fluid evolution of the Dalli porphyry Cu-Au deposit; using Amphibole and Plagioclas mineral chemistry

Houshang Pourkaseb[1]*, Alireza Zarasvandi[1], Madineh Saed[1] and Ali Reza Davoudian Dehkordy[2]

1) Department of Geology, Faculty of Earth Sciences, Shahid Chamran University of Ahvaz, Ahvaz, Iran
2) Faculty of Natural Resources and Earth Sciences, Shahrekord University, Shahrekord, Iran

Submitted: Nov. 25, 2015
Accepted: Feb. 22, 2016

Keywords: *Plagioclas, Amphibole, Oxygen fugacity, EMPA, Dalli, Urumieh- Dokhtar Magmatic Arc*

Introduction

The formation of porphyry copper deposits is attributed to the shallow emplacement, and subsequent cooling of the hydrothermal system of porphyritic intrusive rocks (Titley and Bean, 1981). These deposits have usually been developed along the chain of subduction-related volcanic and calc-alkalin batholiths (Sillitoe, 2010). Nevertheless, it is now confirmed that porphyry copper systems can also form in collisional and post collisional settings (Zarasvandi et al., 2015b). Detailed studies on the geochemical features of ore-hosting porphyry Cu-Mo-Au intrusions indicate that they are generally adakitic, water and sulfur- riched, and oxidized (Wang et al., 2014). For example, high oxygen fugacity of magma has decisive role in transmission of copper and gold to the porphyry systems as revealed in (Wang et al., 2014). In this regard, the present work deals with the mineral chemistry of amphibole and plagioclase in the Dalli porphyry Cu-Au deposit. The data is used to achieve the physical and chemical conditions of magma and its impact on mineralization. Moreover, the results of previous studies on the hydrothermal system of the Dalli deposit such as Raman laser spectroscopy and fluid inclusion studies are included for determination of the evolution from magmatic to hydrothermal conditions.

Materials and methods

In order to correctly characterize the physical and chemical conditions affecting the trend of mineralization, 20 least altered and fractured samples of diorite and quartz-diorite intrusions were chosen from boreholes. Subsequently, 20 thin-polished sections were prepared in the Shahid Chamran University of Ahvaz. Finally, mineral chemistry of amphibole and plagioclase were determined using electron micro probe analyses (EMPA) in the central lab of the Leoben University.

Results

Amphibole that is one of the the main rock-forming minerals can form in a wide variety of igneous and metamorphic rocks. Accordingly, amphibole chemistry can be used as an indicator for characterizing the conditions involved during the evaluation of magma crystallization i.e., pressure, temperature, liquid water content and oxygen fugacity. Most recent studies on the porphyry copper intrusions in the Urumieh-Dokhtar magmatic arc by (Zarasvandi et al., 2015a), indicate that all of the mineralized porphyry systems (Dalli porphyry is included) consistently show high levels of La/Sm and Sm/Yb, with concave upward patterns in the rare earth elements' spider diagrams. Importantly, such features indicate high crustal assimilation in a relatively thickened crust and provide insight into the contribution of hornblende during the development of mineralized porphyry systems in the Urumieh- Dokhtar belt. The results of this study indicate that amphiboles of Dalli intrusions belong to the calsic group and range in composition from magnesio- hornblende, to edenite, magnesiohastingsite, and tschermakite. (Ridolfi et al., 2010), indicating that the alumina content of amphibole could be used for geobarometry. The calculations of geobarometry

*Corresponding authors Email: h.pourkaseb@scu.ac.i
DOI: 10.22067/econg.v9i1.51704

for quartz diorite intrusions of Dalli indicate that they formed in the pressure range of 136 to 287 (MPa). Also, calculation of magmatic water content using amphibole geochemistry indicates that the water content of quartz diorite intrusions in the Dalli were between 4.6- 5.7 (wt. %). The results of plagioclase chemistry indicate that there is a little zoning in this mineral. Also, the plagioclase composition varies from $Or_{0.01}$ to $Ab_{0.48}$, $An_{0.50}$, $Or_{0.018}$, $Ab_{0.62}$ and $An_{0.35}$. They mostly have Andesine and Labradorite compositions.

Discussion

Amphibole minerals of the Dalli intrusions are calcic type and exhibit geochemical signatures of subduction zones. Also, characterizing the source of ore-hosting intrusions with amphibole chemistry indicate that parental magma of Dalli intrusion were generated from mixing of mantle melts with crustal materials. It seems that in an ongoing process of closure of Neo-Tethys, during compression and crustal shortening favourable conditions were provided for mixing of mantle melts with crustal materials. The geothermobaromerty calculations using amphibole and plagioclase minerals indicate conditions of 777 - 850 ^{o}C and 1-4 Kbar, representing magmatic stage of Dalli intrusions. Also, amphibole minerals are characterized by $Fe_{tot}/Fe_{tot} + Mg > 0.3$ and $Al^{IV} > 0.7$ which reveal the presence of primary oxidative magma in the Dalli porphyry Cu-Au deposit. Oxidative conditions seem to have prevailed during the onset of the hydrothermal stage of the Dalli porphyry deposit. This is because it has been confirmed by laser Raman spectroscopy analyses that the most primitive quartz veins in the potassic alteration of the Dalli deposit are characterized by the presence of anhydrite and hematite minerals (see Zarasvandi et al., 2015b). Also, microthermometry results on the most primitive barren quartz veins in potassic alteration represent temperatures as high as 620^{o}C which indicate the beginning temperature of hydrothermal conditions.

Acknowledgements

Many thanks are due to the office of vice-chancellor of the Shahid Chamran University of Ahvaz for valuable information concerning the field work and sampling.

References

Ridolfi, F., Renzulli, A. and Puerini, M., 2010. Stability and chemical equilibrium of amphibole in calc-alkaline magmas: An overview, new thermobarometric formulations and application to subduction-related volcanoes. Contributions to Mineralogy and Petrology, 160(1): 45–66.

Sillitoe, R.H., 2010. Porphyry Copper Systems. Economic Geology, 105(1): 3-41.

Titley, S.R. and Beane, R.E., 1981. Porphyry copper deposits. Part 1. Geologic Setting, Petrology, and Tectogenesis. In: J.W. Hedenquist, J.F.H. Thompson, R.J. Goldfarb and J.P. Richards (Editors), Economic Geologists, 75th Anniversary Volume. Society of Economic Geologists, U.S.A, pp. 214-234.

Wang, R., Richards, J.P., Hou, Z.Q., Yang, Z.M., Gou, Z.B. and DuFrane, A., 2014. Increasing Magmatic Oxidation State from Paleocene to Miocene in the Eastern Gangdese Belt, Tibet: Implication for Collision-Related Porphyry Cu-Mo ±Au Mineralization. Economic Geology, 109(7): 1943–1965.

Zarasvandi, A., Rezaei, M., Sadeghi, M., Lentz, D., Adelpour, M. and Pourkaseb, H., 2015a. Rare earth element signatures of economic and sub-economic porphyry copper systems in Urumieh–Dokhtar Magmatic Arc (UDMA), Iran. Ore Geology Reviews, 70: 407-423.

Zarasvandi, A., Rezaei, M., Raith, J., Lentz, D., Azimzadeh, A.M. and Pourkaseb, H., 2015b. Geochemistry and fluid characteristics of the Dalli porphyry Cu–Au deposit, Central Iran. Journal of Asian Earth Sciences, 111: 175-191.