Journal of Economic Geology
Vol. 7, No. 2 (2015-2016)
ISSN 2008-7306

مجله زمین‌شناسی اقتصادی
جلد ۷، شماره ۲ (سال ۱۳۹۴)
صفحات ۷ و ۸

Mineral chemistry of garnet in pegmatite and metamorphic rocks in the Hamedan area

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Submitted: June 14, 2014
Accepted: Oct. 25, 2014

Keywords: *Hamedan, metamorphic, garnet, zoning.*

Introduction

The area of this study is located near Hamadan within the Sanandaj - Sirjan tectonic zone. In the Hamadan area, consisting mainly of Mesozoic plutonic and metamorphic rocks, aplites and pegmatites locally contain garnets.(Baharifar et al., 2004, Amidi and Majidi, 1977; Torkian, 1995. Garnet-bearing schists and hornfelses in the area are products of regional metamorphism shown by slate and phyllite (Baharifar, 2004). In this investigation the distribution of elements in garnet in different rock type was studied to determine their mineral types and conditions of formation. Garnet samples from igneous and metamorphic rocks were analyzed by electron microprobe (EMPA), the results of which are presented in this article.

Materials and methods

Thirty-five samples were selected for thin section preparation and twenty thin-polished sections were prepared for mineralogical and microprobe analysis. Thin sections of garnet-bearing igneous (pegmatite) and metamorphic rocks (schist and hornfels) were studied by polarizing microscope. Chemical analysis was performed on the garnets (38 points) using a Caimeca SX100 electron microprobe at an acceleration voltage of 15 kV and electric current of 15 nA in the Mineral Processing Research Center, Iran. Separation of iron (II) and Fe (III) was calculated by Droop's method (1987) and the structural formulas of the garnets were calculated using 24 oxygens to determine the relative proportions of the end-members using the mineral spreadsheet software of Preston and Still (2001).

Results

Based on the analyses, almandine (Fe - Al garnet) and spessartine (Mn - Al garnet) are the principal types of the (Kamari) metamorphic and (Abaro) pegmatitic garnets, that belong to the well-known pyralspite garnet group. Chemical zoning patterns of the garnets in the metamorphic rocks (schists) differ from those in the igneous rocks (pegmatite), showing different compositions from core to rim. Petrographic evidence such as: co-existing tourmaline with pegmatite garnets and andalusite with schist garnets; zoning in garnets (oscillatory zoning of Al in pegmatite garnet, Mn increasing in the cores of schist garnet contrasted with Mn decreasing in the cores of pegmatite garnets; the decrease of Mg in the cores of pegmatite garnets, contrasted with the increase of this element in the cores of schist garnets; and the linear trends of Al and Ca in hornfels garnets) Pyrope garnet composition in schist indicates a closed system for garnet formation condition in schist and a magmatic source for pegmatites.

The compositions of garnets from schists change from $Alm_{0.63}$, $Prp_{0.07}$, $Sps_{0.24}$, $Grs_{0.05}$ in the cores, to $Alm_{0.71}$, $Prp_{0.09}$, $Sps_{0.13}$, $Grs_{0.05}$ in the rims. Garnets from pegmatites show a change from $Alm_{0.73}$, $Prp_{0.015}$, $Sps_{0.24}$, $Grs_{0.07}$ in the cores, to $Alm_{0.71}$, $Prp_{0.011}$, $Sps_{0.28}$, $Grs_{0.00}$ in the rims. Garnets from hornfelses showed changes from $Alm_{0.79}$, $Prp_{0.14}$, $Sps_{0.06}$, $Grs_{0.07}$ in the cores to $Alm_{0.8}$, $Prp_{0.13}$, $Sps_{0.05}$, $Grs_{0.01}$ in the rims.

Discussion

The percent of almandine and spessartine in the garnets of the schists and pegmatites are higher than that of garnets in the hornfelses. Almandine

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and spessartine in the pegmatite garnets from core to rim show a completely reversed trend. In the schist garnets from core to rim, the almandine trend is decreasing outward– increasing inward, while the spessartine trend is increasing – decreasing. In the hornfels garnets no specific trend could be determined, there is no zoning. This difference in trend between pegmatite garnets from that in schist garnets and hornfels garnets shows differences in their origin. Texture homogenization, rich in potassium, metaluminous to peraluminous magma of Hamedan granitoid intrusion (Aliani et al., 2012), Peraluminous biotite in this intrusion and lack of garnet zoning show that garnet pegmatites have been formed directly from granitic melt crystallization.

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