



Application of Clinopyroxene Chemistry for Investigation of the physical conditions of ascending magma, a case study of volcanic rocks in the Aliabad area (Northwest of Nain)

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Introduction

The Aliabad area is located in the northwest of Nain. Volcanic rocks of the Aliabad area have andesitic to rhyolitic composition.

On the basis of petrographic investigations, porphyritic texture is the main texture of these rocks. Thus, they have experienced two crystallization stages. In these rocks, phenocrysts have been crystallized in the first stage, and in the second stage the cooling processes were fast, resulting in a groundmass of glass and fine crystals.

The second stage of crystallization in these rocks took place at (near) the earth surface. The composition of phenocrysts such as amphibole, biotite and pyroxene provide valuable data about magmatic series, pressure, and temperature history of the primary magma during crystallization. In this study, the clinopyroxene of these rocks was analyzed in order to estimate the physicochemical conditions of the parent magma.

Material and Methods

Field work in the Aliabad area was carried out to identify volcanic units and their relationships. About 65 samples were collected. Thin sections were prepared for petrographic studies to select suitable samples of the volcanic rocks for more detailed mineralogical and geochemical studies. The chemical composition of minerals was determined using a wavelength dispersive EPMA (Cameca-SX 100) at Iran Minerals Research and

Processing Center. Analytical conditions for the minerals were accelerating voltage of and a beam current of 15 nA. 15 kV. Also, the Minpet software package was used for processing the relevant data and calculating the structural formula of clinopyroxene minerals based on 6 oxygen atoms.

Results

The chemical compositions of clinopyroxenes were used to estimate the chemical evolution and P-T conditions of the magmas during crystallization. Microprobe analyses show that clinopyroxenes in the andesitic rocks are augite (En₄₃₋₄₅Wo₃₈₋₄₂FS₁₄₋₁₈).

According to the clinopyroxene thermobarometry calculations done by several methods, it was inferred that the clinopyroxenes are crystallized at temperatures of 1009-1200 °C and pressures of 2.5-7 kbar.

By noting the distribution of aluminum in clinopyroxenes, these phenocrysts were formed in a range of low to medium pressure that shows the crystallization of those during the ascending of magma in different depths of 9 to 18 km. According to the Helz diagram (1973), the amount of water is about 10 percent. Clinopyroxene composition along petrographic investigations in the studied rocks confirm that fO_2 is high.

Discussion

The Aliabad area is located in the Urumieh-

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Dokhtar volcanoplutonic belt, Northwest of Nain-Iran. In the Aliabad area, the exposed Cenozoic volcanic rocks are compositionally from andesite to rhyolite. These rocks show porphyritic, trachytic, and amygdaloidal textures under the microscope and they consist of plagioclase, clinopyroxene, sanidine, quartz, opaque and apatite.

The andesitic rocks of the Aliabad area are composed mainly of plagioclase and clinopyroxene phenocrysts in a groundmass of plagioclase microlites and fine crystals of pyroxene and opaque minerals along with glass. According to the ternary diagram of Wo-En-Fs (Morimoto, 1989), the studied clinopyroxenes are augite in composition. The physical (pressure and temperature) conditions of a magma during crystallization is recorded in the chemical composition of the clinopyroxene phenocrysts. Therefore, clinopyroxenes are representative of magma composition and usually are used for identifying the chemical condition i.e. magmatic series and physical conditions, temperature and pressure of a magma at the time when clinopyroxene was crystallized.

Several methods that are applied for this purpose are as follows:

1- The Soesoo (1997) method

Based on this approach, the pressure and temperature formation of the Aliabad clinopyroxenes are about 3.5-6 kbar and 1150-1200 °C, respectively.

2- The Sayari and Sharifi (2014) method

According to this method, the pressure and temperature formation of the studied samples are about 2.48-4.8 kbar and 1074-1094 °C, respectively.

3- The Nimis and Taylor (2000) method

Using this method, the temperature formation of clinopyroxenes in the Aliabad area is about 1009-1083 °C.

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References

- Helz, R.T., 1973. Phase relations of basalts in their melting ranges at $p_{H_2O}=5$ kbar as a function of oxygen fugacity, Part I, Mafic phases. *Journal of Petrology*, 14(2): 249–302.
- Morimoto, N., 1989. Nomenclature of pyroxenes. *The Canadian Mineralogist*, 27(1): 143–156.
- Nimis, P. and Taylor, W.R., 2000. Single clinopyroxene thermobarometry for garnet peridotites. Part I. Calibration and testing of a Cr-in-Cpx barometer and an enstatite-in-Cpx thermometer. *Contributions to Mineralogy and Petrology*, 139(2): 541–554.
- Sayari, M. and Sharifi, M., 2014. SCG: A computer application for single clinopyroxene geothermobarometry. *Italian Journal of Geosciences*, 133(2): 315–322.
- Soesoo, A., 1997. A multivariate analysis of clinopyroxene composition: empirical coordinates for the crystallization P-T estimations. *The Geological Society of Sweden*, 119(1): 55–60.