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MINERAL CHEMISTRY, GEOTHERMOBAROMETERY AND OXYGEN FUGACITY OF IGNEOUS ROCKS: NATANZ COMPLEX, CENTRAL IRAN

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The Oligo-miocene Natanz plutonic complex is part of a series of Tersiary intrusions in Cenozoic Orumieh – Dokhtar magmatic belt, south central Iran.

This complex is composed of gabbro, diorite, quartz-diorite, quartz monzonite, granodiorite and granite, which consist of different minerals such as plagioclase, quartz, hornblende, pottassic feldspar, biotite, pyroxene, apatite, zircone, titanite and Fe-Ti oxides. The geochemical data suggest that the Natanz granitoid rocks have characteristics of metaluminous, calc-alkaline, I-type granite formed in a volcanic arc setting.

Chemical composition of some mafic and felsic minerals such as, olivine, clinopyroxene, orthopyroxene, amphibole, biotite, chlorite, plagioclase and alkali-feldspar has determined by electrone – microprobe analyse.

The composition of olivines are Fo_{68} – Fo_{70} (crystal's cores have more Mg number than the rims). The value of Ca in rims is higher than cores indicating higher amounts of Na and lower $Mg^{\#}$ (Mg/Mg+Fe) in melt, while crystallizing olivine.

All of the pyroxenes in this area are Na-poor pyroxene and composition of them is in diopside – augite range. The composition of orthopyroxene is En_{65-69}. Ti, Cr and Na values in orthopyroxenes decrease with $Mg^{\#}$ (as fractional crystallization developed). As Fe^{3+} in pyroxenes depends to O_2 fugacity of melt, we can show in Al^{IV}+Na vs. Al^{VI}+2Ti+Cr diagram, that all samples will be above the line of Fe^{3+}=0. Therefore O_2 fugacity in melt crystallizing clinopyroxene, is relatively high. The composition of clinopyroxenes in Ti vs. Ca+Na diagram (Leterrier et al, 1982) indicates calc-alkaline characteria for parental magma. Gabbro pluton in this area doesn't represent parental magma because Cr_2O_3 values of pyroxenes are low suggesting differentiation of parental magma before gabbro formation. The equilibria temperature from clinopyroxene – amphibole thermometer (Anderson, 1997) is about 850 ˚C (in diorite). Since Al^{VI}/Al^{IV} ratio seems to be related to the crystallization pressure of clinopyroxene (Thompson, 1974; Wass, 1979), crystallization pressure of clinopyroxenes in gabbro and diorite (Al^{VI}/Al^{IV}= 0.04-0.39) is low.

Calcic amphibole with magnesiohornblende composition is one of the most mafic minerals in this complex. Amphiboles in granites show higher values of Na than ones in the other rocks. Application of Al in hornblende barometrery

(Anderson & Smith, 1995) indicates a pressure of ≈ 2 kbar for the intrusion. The maximum temperature from hornblende – plagioclase thermometer (Blundy & Holland, 1990) is 705.15 ˚C (for granodiorite), which probably reflect late-stage crystallization of the magma. In Na_2O vs. SiO_2 classification diagram for intra plate (I-Amph) and suprasubduction (S-Amph) Amphiboles (Coltorti, 2007), the analysed samples in all rocks are S-Amph type indicating these rocks are formed in a subduction zone (this result is also in agreement with calc-alkaline characteria of biotites and pyroxenes as well as rock chemistry). According to Wones 1989, the value of log fO_2 calculated for granodiorite is -16.37 (bars), which show oxygen fugacity in melt crystallizing amphibole.

Composition of plagioclase is An_{11} (minimum value in granite) to An_{92} (maximum value in gabbro), and in some samples, this mineral has normal zoning.

Micas are Mg – rich biotite and in classification of Abdel – Rahman, 1994, the biotites of Natanz complex indicate the composition of biotite in calc – alkaline orogenic rocks.

Chlorites show repidolite and picnochlorite composition, and based on Al^{IV} thermometery of chlorites (Cathlineau, 1988), the temperature calculated for chlorite formation is 128.4 ˚C, which may be related to the hydrothermal alteration of rocks.

The iron contents in mafic minerals are positively correlated with SiO_2 in whole rock chemistry.