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Petrography of plutonic rocks in the late cambrian (rizu series), se-chahun iron oxide deposite, bafq mining district, Central Iran

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Abstract

The iron ore deposits of the Bafq district are associated with volcano sedimentary rocks and shallow depth intrusions. The Se–Chahun Iron Ore mine is containing two major groups of ore bodies called the X and XI anomalies. One of the important plutonic rocks in the study area is Narigan granites have two type; first type granite is white to gray leucogranite with a different grain size and second type granites are a pale-pink and have a medium-grained size. Second type of granite is intruded between first type granites and the study of textures show that first type granite is formed in deeper levels. Other important litho-type is Pyroxene gabbros, in the thin section this rocks contain plagioclase (Alb) anhedral pyroxene (augite). That is crystallized between plagioclase spaces and has an ophitic texture.

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Introduction

Most of the world iron ore production is from banded iron formations (BIF), magnetite-apatite deposits ("Kiruna-type"). An iron oxide copper–gold (IOCG) study widely for the Bafq district deposits (Barton and Johnson, 1996; Williams *et al*., 2005; Jami *et al*., 2007; Torab and Lehmann, 2007; Daliran, 2002; Bonyadi, 2010; Stosch *et al*., 2011).The Bafq mining district is in the Early Cambrian Kashmar-Kerman volcano-plutonic arc in Central Iran and hosts important "Kiruna-type" magnetite-apatite deposits (Torab, 2008). The Bafq district of Central Iran is the most important Fe metallogenic province in the region and a significant district on a worldwide basis (Jami, 2005). The iron ore deposits of the Bafq district are associated with volcanosedimentary rocks and high-level intrusions, and have a sulfide-poor mineral assemblage of low-Ti magnetite (hematite) with varying but characteristic amounts of fluorapatite and actinolite (Torab, 2008). Volcano sedimentary Unit is one of the important components in Cambrian and consists of shale, sandstone, limestone and dolomite. Within this sequence recognized the Saghand Formation and the Rizu to Dezu Series (Samani 1993, 1988).

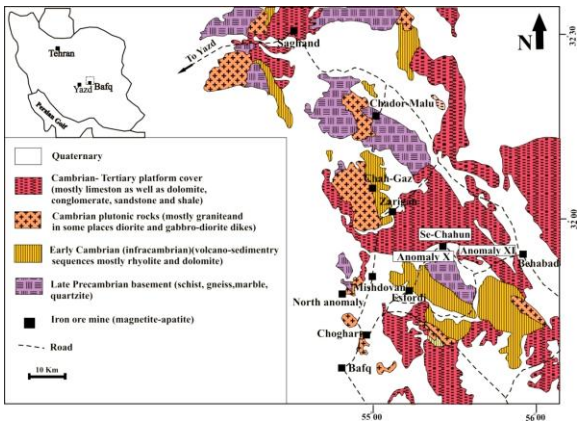

Fig. 1. Simplified geological map of the Bafq mining district and location Se-chahun ore deposits and igneous rocks (Modified from Torab, 2008).

The Se–Chahun Iron Ore mine is containing two major groups of ore bodies called the X and XI anomalies (NISCO, 1975). Anomaly XI located 3250 m northeast of Anomaly X (Fig. 1). Anomaly XI has been explored by geophysical methods and extensive drilling. The deposit is divided into two parts (north and south orebodies) with a total reserve of about 140 Mt low-grade iron ore with an average grade of 36% Fe (Torab, 2008). Although the massive magnetite-actinolite ore in Anomaly X has a higher grade, up to 67% Fe (Bonyadi, 2010).

The aim of this study is separated two types of Narigan granites with petrology and geochemical study.

Research Methodology

The area under study

Igneous rocks are spread in Central Iran. They divide to plutonic and volcanics of Late Precambrian, Infracambrian (recently Cambrian), Mesozoic and Tertiary age. The range of volcanic rocks is acid to basic. This group rocks contain rhyolite, dacite, andesite, basalt and other faceis such as lavas, tuffs, ignimbrites and volcanic detrital rocks (Haghipour *et al*., 1977).

Plutonic bodies contain granite to gabbro rocks in Early Cambrian ("Infracambrian"). The characteristics of some of the more important plutonic rocks in the Se-chahun mining district are described here (Fig. 1).

Research method

During the field observations was collected of 150 rock samples from all parts of the study area. After studying the manual sample, 125 thin section preparation and was studied with petrographic polarizing microscope.

Results and discussion

Narigan granites

Narigan Granite is in the north-east and south of the Se–Chahun deposit. These granites are highly silicic, marginally peraluminous trondhjemites (Ramezani, 1997) although alkaline character may be derived from Na–K alteration (Torab and Lehmann, 2007).

In the field these granites have a two type (Fig. 2). First type granite is white to gray leucogranite with a different grain size (Fig. 3). In the thin section this rocks have a granular and *poikilitic* texture. K-feldspar tends to form subhedral to euhedral crystals, and consist of microcline and pertitic orthoclase. This minerals contain smaller mineral such as biotite,hornblende and plagioclase.

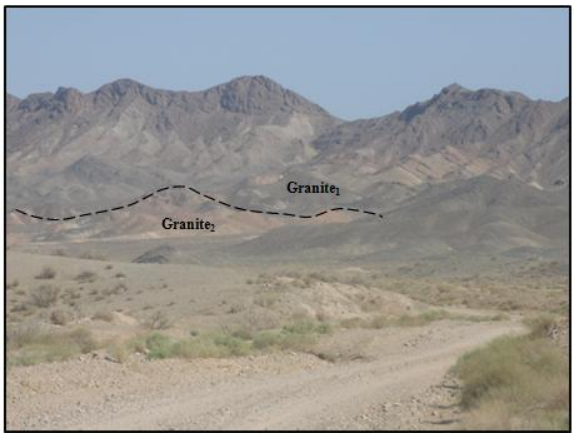

Fig. 2. Outcrop of Narigan Granite, near the De-chahun mine.

Fig. 3. Hand sample of first type granite.

Plagioclases (oligoclase- andesine) are euhedral to subhedral shapes. These minerals developed to clay mineral, sericite and cholorite. Plagioclases have a two generation, first generation have not alteration or have a less alteration, second generation have a alteration in center or alteration all of it. This mineral developed to calcite, chlorite, sericite and epidote assemblage.

Biotite and opac minerals are also present in minor amounts and tend to form subhedral to euhedral crystals. These minerals have a two generation, in first generation biotites are flat shape and altred to chlorite, titanite and opac minerals. Second generation is euhedral assemblage biotites. This minerals are seen in the veins and have a low grade alteration and developed to chlorit, epidote and titanite (Fig. 4).

Anhedral to subhedral quartz along with fine-grained alkali feldspar and plagioclases, occupy intergranular spaces and some quartzes contain smaller crystals of this minerals.

Second type granites are a pale-pink and have a medium-grained size (Fig. 5). These rocks tend to alkali granites and have a granular and pertitic texture. It consists of quartz (39%), orthoclase (35%), plagioclase (oligoclase) (25%), biotite and chlorite (~ 1%) (Fig. 6). Second type of granite is intruded between first type granites and the study of textures show that first type granite is form in deeper part.

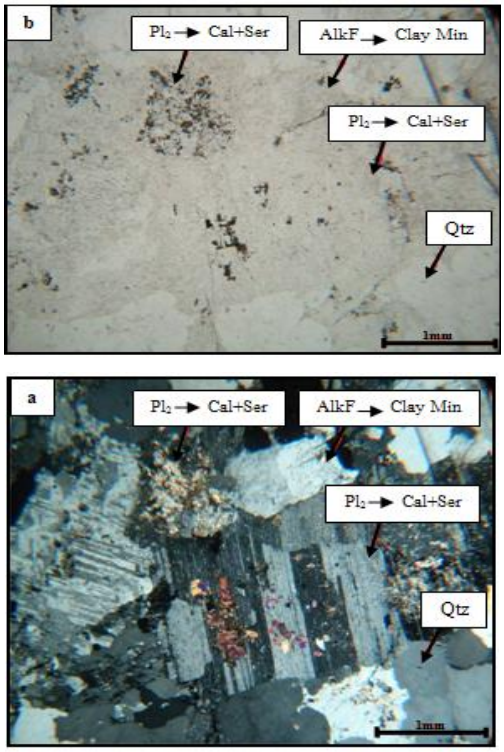

Fig. 4. Photmicrographs of (leuco) Granite Narigan, (a, XPL and b, PPL).

Fig. 5. Hand sample of second type granite.

The result of major element analyses of Narigan Granite samples are listed in Table 1. The alumina saturation index values (Shand, 1927) are plotted in (Fig. 7) and show that the least altered Narigan granites are both Al-oversaturated (peraluminous) and Al-undersaturated (metaluminous) but most samples plotting in the peraluminous region. These felsic plutonic rocks of the region plot in the granite and alkali granite field of the plutonic rock classification diagram (Tas, Middlemost, 1994) (Fig. 8). To distinguish between alkaline and subalkaline suites, the samples have been plotted in a diagram of total alkalis (Na_2O+K_2O) versus silica (SiO_2) (Fig. 9). In this diagram, granites mostly plot in the subalkaline field (Fig. 9).

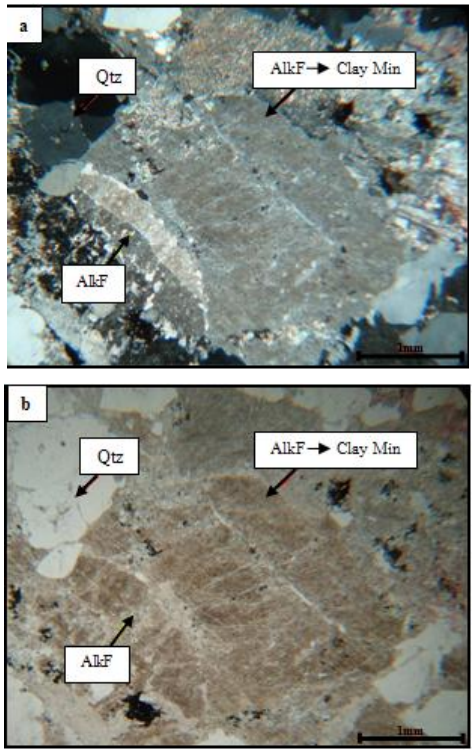

Fig. 6. Photmicrographs of (alkali) Granite Narigan, (a, XPL and b, PPL).

Table 1. Major element composition of the Narigan Granite (XRF).

Sample	SiO_2	Al_2O_3	Fe_2O_3	K_2O	CaO	MgO	Na_2O	MnO	TiO_2	P_2O_5	L.O.I	Sum
G1	73/45	15/02	0/72	0/22	0/36	0/099	8/32	0/01	0/38	0/03	0/4	99/009
G2	76/23	12/8	1/5	4/92	0/5	0/16	3/28	0/01	0/18	0/01	0/3	99/89
G3	76/5	12/54	0/95	4/1	1/1	0/22	4/1	0/01	0/13	0/01	1/01	100/7
G4	76/3	12/35	1/01	4/5	0/96	0/19	4/62	0/01	0/15	0/02	0/4	100/51
G5	76/45	13/58	0/75	3/25	1/05	0/2	4/45	0/02	0/24	0/01	0/92	100/92
G6	76/75	13/75	0/69	0/8	1/25	0/35	4/93	0/04	0/22	0/01	1/19	99/98

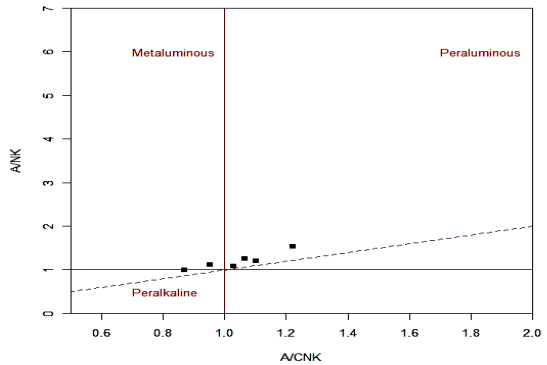

Fig. 7. Al-saturation plot for narigan granites (Shand, 1943).

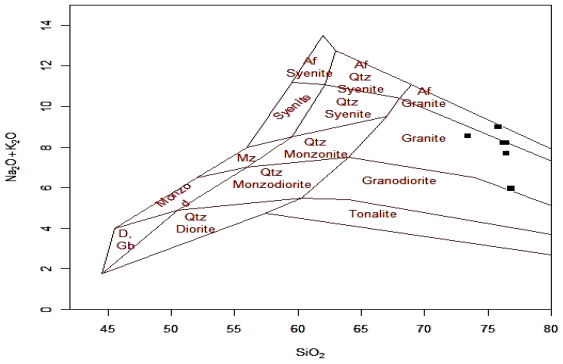

Fig. 8. Classification of narigan rocks (Tas, Middlemost, 1994).

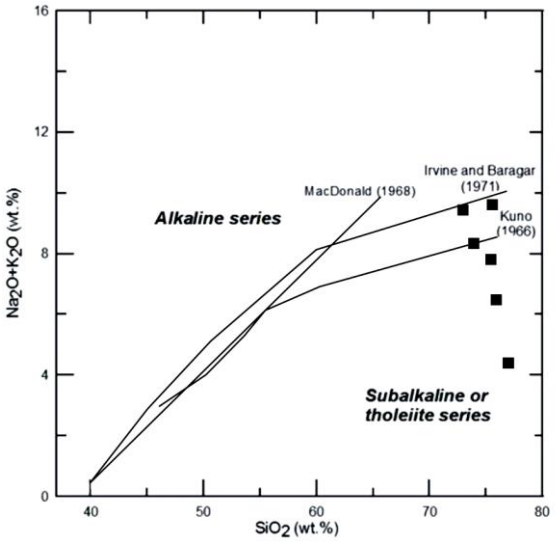

Fig. 9. Discriminant diagram between alkaline-subalkaline series of granitic rocks of the Se-Chahun district.

Pyroxene gabbros

Pyroxene gabbros are in the Se-Chahun mine and collected rock samples of the core drilling boxes. In these rocks in the hand sample pyroxenes convert to chlorite and amphibole and this assemblage are shown very good (Fig. 10). In the thin section this rocks contain plagioclase (Alb) with euhedral to subhedral crystals and have a carlsbad and pericline macles. This mineral has a high grade alteration and developed to epidote, chlorite and sericite.

Anhedral pyroxenes (augite) are between the plagioclase spaces and has an ophitic texture (Fig. 11). These minerals convert to chlorite and amphibole and opac minerals are also present in minor amounts (Fig. 12).

Fig. 10. Hand sample of Pyroxene gabbros.

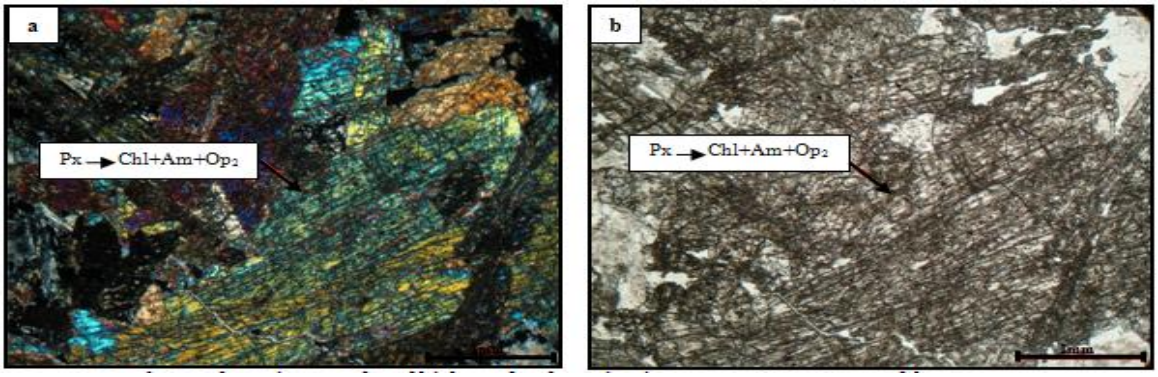

Fig. 11. Photmicrographs of high grade alteration in pyroxenes, (a, XPL and b, PPL).

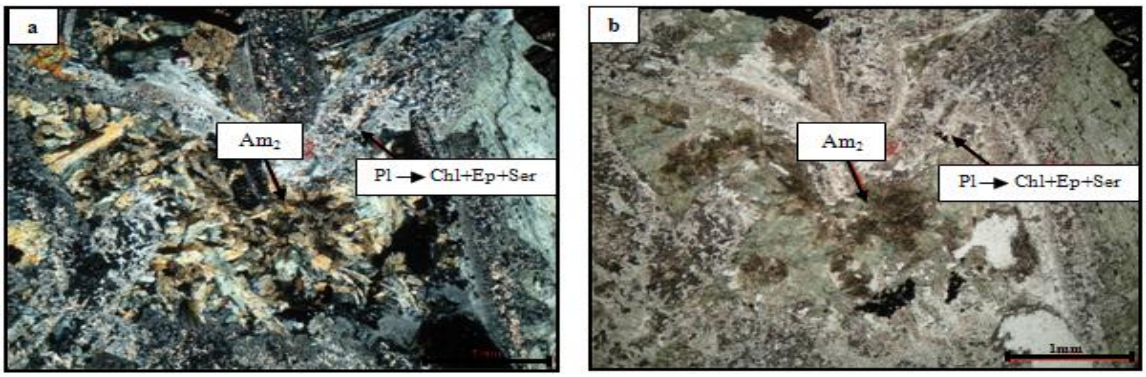

Fig. 12. Photmicrographs of metasomatic amphiboles in the space of plagioclases and plagioclases with high grade alteration, (a, XPL and b, PPL).

Conclusion

Igneous rocks are spread in Central Iran. They divide to plutonic and volcanics of Late Precambrian, Infracambrian (recently Cambrian), Mesozoic and Tertiary age. One of the important plutonic rocks in the study area is Narigan granites have a two type; First type granite is white to gray leucogranite with a different grain size and second type granites are a pale-pink and have a medium-grained size. Mineral assemblage in these rocks is quartz, K-feldspar, plagioclases, biotite, chlorite and opac minerals. Second type of granite is intruded between first type granites and the study of textures show that first type granite is formed in deeper parts than first one. The alumina saturation index values (Shand, 1927) show that the least altered Narigan granites are both Al-oversaturated (peraluminous) and Al-undersaturated (metaluminous) and these felsic plutonic rocks of the region plot in the granite and alkali granite field of the plutonic rock classification diagram (TAS, Middlemost, 1994).

Other important group is pyroxene gabbro, In the thin section this rocks contain plagioclase (Alb) anhedral pyroxene (augite) is in the plagioclase spaces and has an ophitic texture. These minerals convert to chlorite and amphibole and opac minerals are also present in minor amounts.

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