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The study of manganese deposits in rhyolites of chah-basheh mine, S Naein, Central Iran

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Abstract

These outcrops are composed of Paleozoic rhyolites that are rich from Manganese. These outcrops contain quartz, plagioclase and K-feldspar. This study area is located in the S Naein, E Isfahan and Central Iran. Petrological study and geochemical investigations suggest that rhyolites of Chah Basheh are similar to the high- subalkaline and K calc-alkaline series. Manganese mineralization consists of Iron and Manganese Hydroxids and Oxids specially Manganite and Pyrolusite. Mineralization fills in the cracks among the brocken tectonic rocks with specific and clear directions (NE and NW). Geochemical characteristic of manganese deposit indicate that they formed from hydrothermal solution with an igneous source. Manganese mineralization in the Chah Basheh mine is limited to two separate tectonic zones that one of these areas (area 1) is located in the 5 km from East Village Fakhrabad and the second (area 2) is in the SE of village Shureh. These areas are suitable for further exploration.

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Introduction

Central Iran zone is largest and most complication geological unit and it cover some parts of east Iran (north of Lut block). These deposits are located in Central Iran zone and its hydrothermal deposits are associated with paleozoic igneous rocks (Amidi *et al.*, 1979, Arian, 1997). Central Iran zone is largest and most complication geological unit. In this zone

Precambrian rocks are only in the eastern parts and includes gneisses, amphibolites, different schist, marble, mygmatite and granite anatexy. As geological division Naein area is located in central Iran zone (Emami, 1996, Davoudzaddeh & Schmidt, 1983, Nabavi, 1976, Nogole-Sadate, 1985). Geographic location of the study area is between 53°16 - 53°48 and 32°08-32°36. Some outcrops with Infracamprian age exists in the study area.

Oldest rocks of this area belong to Soltanieh formation which includes dolomite - rhyolite - shale - limestone with some chert layers. This formation is distinct from other region formations by a fault along Naein-Baft fault (Dehshir - Baft fault) (Emami, 1996). Limestone and shale formation are related to the lower Cambrian period and are containing fossils Trilobites and Konodont (vahabi Moghadam, 1993). Outcrops of Infracambrian are reported as the dome and dyke in the south-east of study area in south Naein. Lithology combination of them is porphyry rhyolites. Parts of this unit are as tuff.

These rocks from mineralogical composition are containing large crystals of quartz, plagioclase and alkali feldspar and from petrographic study are rhyolites. Manganese mineralization fills in the cracks among the brocken tectonic rocks and is in the form of veins along the fault and have two transportation system.

In this paper, we research about Manganese mineralization consists of Iron and Manganese Hydroxids in Rhyolites of Chah-Basheh Mine.

Materials and methods

Sampling

A total of 100 rock samples have been collected from various parts of the study area. After studying the manual sample, 80 thin sections and 10 polish sections preparation and was studied with polarizing microscope. 5 samples of rhyolite rocks were analysis by XRF method in central lab of Isfahan University (Iran) and 10 samples by ICP-MS method in ACME Labs in Canada (Table 1, 2).

Table 1. Chemical analysis data of Chah-Basheh Rhyolites by ICP-MS method.

Sample	1	2	3	4	5	6	7	8
SiO_2	70.8	69.21	68.14	69.13	70.56	70.79	68.68	69.51
Al_2O_3	12.69	13.34	13.66	11	14.18	12.9	12.84	13
Fe_2O_{3T}	2.58	3.79	4.31	2.89	3.24	2.6	2.65	3.3
MgO	0.32	0.2	0.4	0.15	0.34	0.33	0.33	0.37
CaO	1.75	0.7	1.62	1.06	0.86	1.76	3.03	1.59
Na_2O	0.14	0.27	0.39	0.15	2.59	0.14	0.93	0.14
K_2O	8.19	9.26	8.16	6.2	5.92	8.26	7.25	8.33
TiO_2	0.34	0.23	0.36	0.43	0.42	0.35	0.36	0.36
P_2O_5	0.08	0.16	0.07	0.19	0.08	0.06	0.07	0.06
MnO	0.09	0.03	0.24	0.25	0.14	0.09	0.18	0.1
LOI	2.6	4	2.3	6.9	1.5	2.3	3.4	2.9
Total	99.58	100.38	99.65	98.35	99.83	99.58	99.73	99.66
A/CNK	1.26	0.9	1.34	0.98	1.51	1.27	1.14	1.29
Na2O+K2O	8.33	9.53	8.55	6.35	8.51	8.4	8.18	8.47

Table 2.Chemical analysis data of Chah-Basheh Rhyolite rocks by method ICP-MS.

Sample	1	2	3	4	5	6	7	8
Sc	6	6.5	7	8	8	7	7	7
Mo	0.6	1.4	1.5	1.2	1.9	0.5	0.4	1.1
Cu	49.8	6.2	4.9	15	11.8	52	7.2	4.8
Pb	208.9	30.2	20.1	21.6	31.5	210	6	11.6
Zn	404	36	32	41.5	43	405	15	34
Ni	2.1	2.2	2.3	2.7	4.6	2.2	1.9	2.8
As	38.2	36	5143.5	38.2	39.3	39.4	32.9	2500.7
Cd	6.4	0.1	<0.1	0.1	<0.1	6	0.1	<0.1
Sb	0.5	0.6	29.7	2.2	3.5	0.5	2.1	19.1
Bi	0.2	0.2	0.1	0.1	<0.1	0.2	<0.1	0.3
Ag	0.3	0.3	<0.1	0.2	<0.1	0.3	<0.1	<0.1
Au	1.1	0.6	0.8	0.7	0.5	1.1	1.1	1.1
Hg	0.01	0.02	0.03	0.01	0.03	0.01	0.02	0.03
TI	<0.1	0.2	0.2	0.1	0.1	0.1	<0.1	0.2
Se	<0.5	<0.5	<.5	<0.5	<0.5	<0.5	<0.5	<0.5
Ba	2015.2	1526.2	2047.5	1409.3	1522.4	2133.3	1404.6	2012.9
Be	1	3	4	1	2	2	1	2
Co	2.8	2.6	4	2.8	2.5	2.8	2.9	3.1
Cs	5.4	10.5	19.2	12.2	13.1	5.5	11.1	16
Ga	10.2	10.5	14.5	11.9	11.8	10.4	12.1	11.1
Hf	4.9	5.4	5.3	4.8	5.7	5	5	5
Nb	9.1	9.7	9.1	9.5	9.9	9.6	9.6	8.6
Rb	290.1	231.1	347.2	277.3	229.5	288.5	282.9	354.2
Sn	1	2	1	1	2	1	1	1
Sr	48.7	71.3	67.4	45.6	183.2	49.2	72.4	40.1
Ta	0.8	0.7	0.7	0.8	0.7	0.7	0.8	0.7
Th	10.5	11.5	11.4	10.9	12.3	11	11.4	10.7
U	2.4	2.8	3	3.1	2.4	2.5	3	3.2
V	36	29	28	26	26	36	17	31
W	4	4.5	16.9	3.9	4.6	3.8	1.8	7.9
Zr	167.3	175.3	187.5	180.6	207.7	174.4	182.4	178.9
Y	22.8	21.9	22.1	24.8	26.7	23.4	21.5	25
La	21.2	18.5	11	16.3	19.4	22.5	16.9	15.9
Ce	46.6	43.6	27.4	50.3	51.7	48.1	44.4	38.7
Pr	5.12	4.5	3.25	4.01	5.07	5.25	4.21	4.08
Nd	19.2	16.8	13.6	18.6	20.9	19.3	15.8	16
Sm	4	4.1	3	3.8	4.3	3.9	3.5	3.9
Eu	0.75	0.71	0.61	0.76	0.89	0.73	0.68	0.69
Gd	3.34	3.25	2.82	2.64	4.03	3.37	3.13	3.39
Tb	0.6	0.64	0.56	0.72	0.74	0.63	0.59	0.67
Dy	3.32	3.51	3.14	3.88	4.01	3.48	3.46	3.66
Ho	0.69	0.74	0.68	0.71	0.82	0.69	0.69	0.76

Sample	1	2	3	4	5	6	7	8
Er	2.13	2.21	2.16	2.12	2.68	2.29	2.13	2.5
Tm	0.35	0.31	0.32	0.38	0.4	0.35	3.34	0.39
Yb	2.36	2.61	2.24	2.59	2.78	2.43	2.35	2.71
Lu	0.38	0.37	0.35	0.41	0.44	0.38	0.38	0.43

Software

Also, different software's especially Excel, G CDKit, Igpet, Corel Draw 13 and Minpet programs were used for analysis and drawing charts.

Results and discussion

Mineralogy of Rocks

These rocks from mineralogical composition are containing large crystals of quartz, plagioclase and alkali feldspar and from petrographic study are rhyolites.

Within plagioclase can be seen red spots that are from decomposition of magnesium silicates and calcium, more of these spots are pine montite (Manganesy Epidote) with red and violet colour. Mineralization fills in the cracks among the brocken tectonic rocks with specific and clear directions (NE and NW) and some parts were scattered in the layers. Manganese and iron mineralization is limited to tectonic networks in the outcrops of rhyolite (Fig. 1).

Fig. 1. Fractures are filled by ore-bearing hydro-thermal solution.

Main mineralization of manganese consists of Manganite, Pyrolusite, Psylumelan, Rudkruzyt and Mangano calcite. Rudnit and Bravnyt is also detectable (Fig. 2).

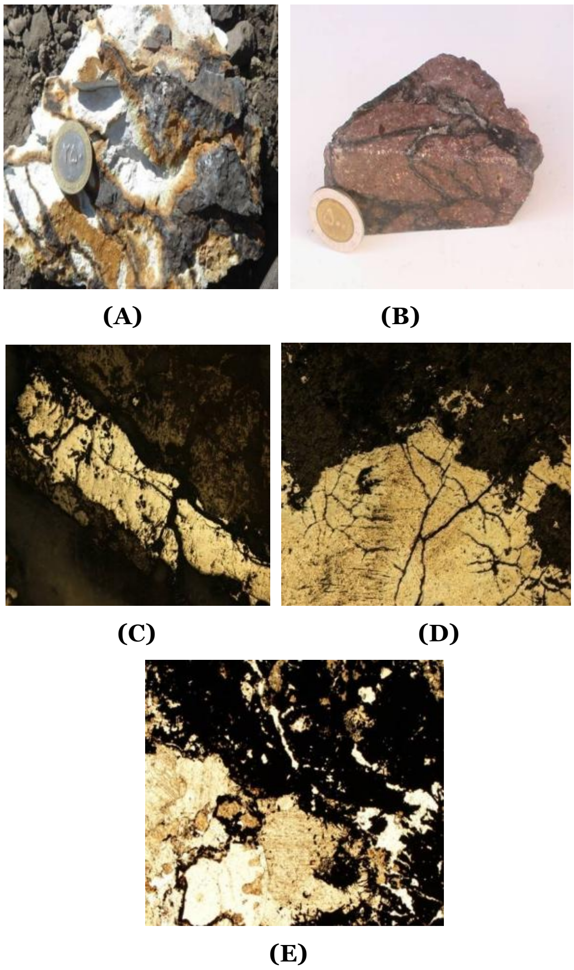


Fig. 2. A) The weathered manganese samples B) The shear tissue manganese samples C) Manganyt under reflected light, D) veins of Manganese in rhyolite under reflected light, E) solution of manganese ore in rhyolite (in light PPL).

In zones 1 and 2, due to cracks and joints in many different directions, green tuffits are made along the cracks and joint Dykes. tuffits and andesite are seen in all directions with different thickness. Mostly very thin (a few centimeters) veins containing minerals, so the chances for dyke to containing manganese ore are weak.

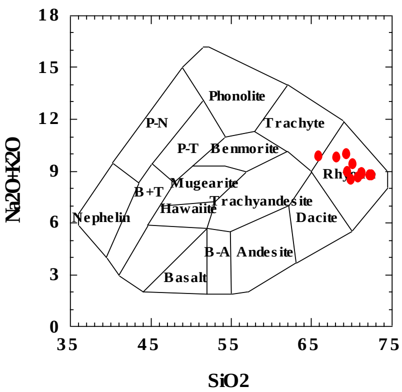
Rocks in Zone 1 and 2 are rhyolite, rhyodacite and andesite which rarely include tuffs, semi-volcanic dacite and quartz porphyric. These series rocks have a slope angle of 15 to 25 degrees to the West. Volcanic activity of this region is rhyodacite lava and then combination is intermediate that intermediate volcanic rocks (andesite) are important. Rhyolite lava has seen as domes in this area. Mineralization is exposed in the rhyolite domes. Manganese mineralization is carbonate oxide and added to hydrothermal and tectonic altered rocks (Fig. 3).

Fig. 3. Minerals filling the cracks.

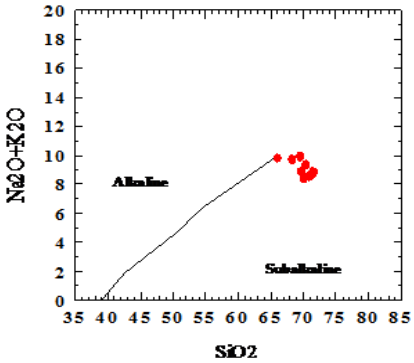
Manganese mineralization fills in the cracks among the brocken tectonic rocks and is in the form of veins along the fault and have two transportation system. First system of charged zones is characterized by north-east trend (N 25 E) and rapid slope to the south-east and the second system filled the broken with ore with north-west trend (N 10 W) that is cut off the granodiorite dyke. Two trends have 35 degree angle together. Veins thickness is variable between 1 mm to 5 cm. Manganese Mineralization is limited to two separate tectonic zones in the Chah Basheh mining region that one of these areas (area 1) is located in the 5 km from East Village Fakhrabad and the second (area 2) in the SE of village Shureh. The structure of both zones is the same. Tissues of ore deposit including shearing, tape, hole and mass.

Geochemistry of Rocks

Chemical characteristic of ore is the high amount of silica. Increasing amounts of immigrants such as Ba, Cu, Ar and Sr can be used in deeper zones. Region 1 and 2 is characterized by ore rich of manganese and is limited to the tectonic zone.



(A)



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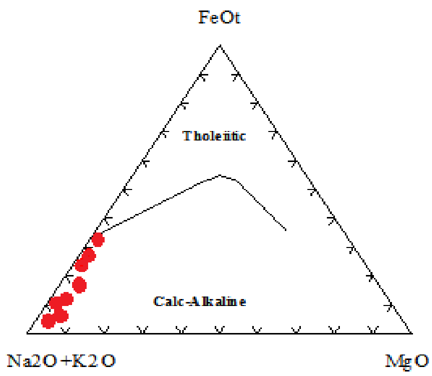


(C)

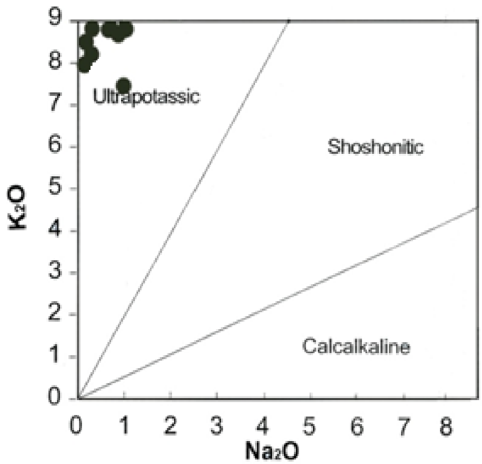
Fig. 4. A) Middlemost (1985) for volcanic rocks, B) the alkali vs. silica (Le Maitre *et al.*, 1989), for separation sub-alkaline and alkaline series, C) AFM triangular shape in which calc-alkaline series are separated from tholeiitique (Irvine & Baragar, 1971).

Average values of the main oxides in these samples are matched with general combining of rhyolite rocks. In these rocks K2O/Na2O is more than one (with the average value 11) and it indicate that the overall combination of rhyolite is potasic. One of the best and nomenclature geochemical diagrams for volcanic rocks is oxide – oxide for classify samples. In the Condie (1989) and Le Bas (1986) charts, samples placed in the rhyolite region (Fig. 4A).

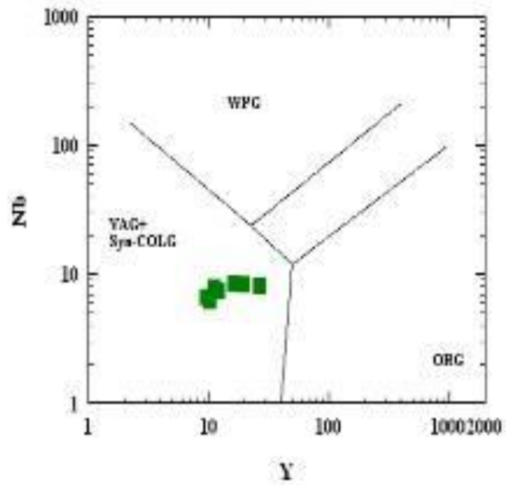
Le Maitre *et al.*, (1989) were proposed graphs total alkali to silica for separation alkali rock series from semi-alkaline or sub-alkaline (Fig. 4 B). Samples of region is showing semi-alkaline or sub-alkaline behavioral. Diagram of AFM (Irvine and Baragar, 1971) was used to determine the process of igneous series and for separation calc-alkaline magmas from tholeiitique. Samples show calc-alkaline properties (Fig. 4 C).

Determination of potassium by Middlemost (1985) provided that rhyolite samples are located in the high-potassium to ultra potassic range (Fig. 5A). To determine the tectonic environment of rhyolites, a variety of graphs based on the sub-elements are presented by the researchers. One of the most common tectenomagmaee charts is provided by Pearce *et al.*, (1984). In these diagrams, rhyolite samples show volcanic arc features (VAG) (Fig. 5 B,C). However, the high Rb in the samples is due to the large role of crust in the process of producing their original magma.

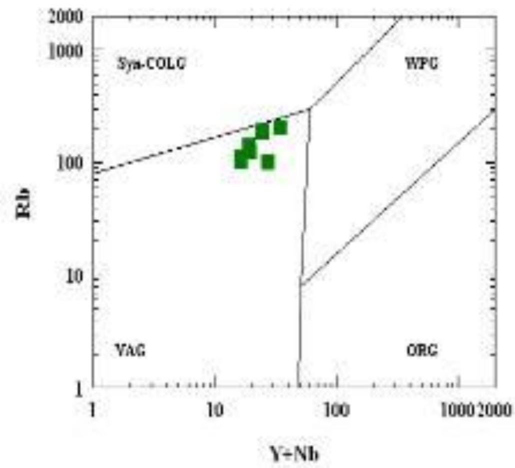
Harris *et al.*, (1986) can be classified granitoid magmas in terms of the tectonic environment by using minor elements. In these diagrams the samples located in an active continental margin and thus the ocean subduction page is below the continental page (VA) (Fig. 6). Brown *et al.*, (1984) shows a chart for separation of various active volcanic arc, in this diagram rhyolite rocks are within the continental arc (Fig. 6 C).



(A)

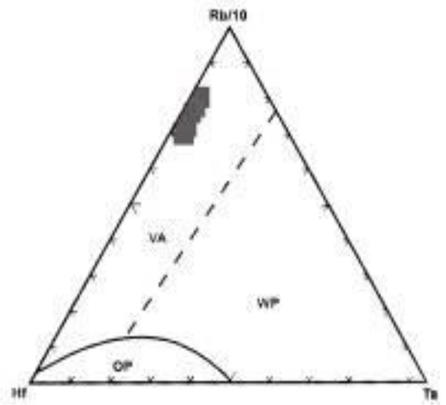


(B)

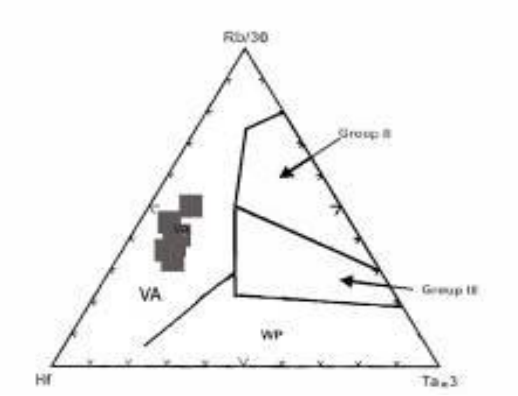


(C)

Fig. 5. The determination of potassium (Middlemost, 1985). B) Rhyolite graphs (Pearce *et al.*, 1984) based on Nb-Y (C) Based on Rb-Yb.



(A)



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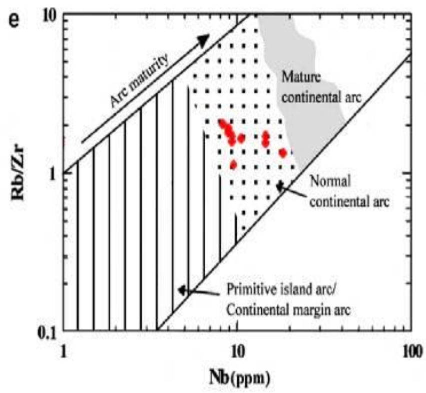

(C)

Fig. 6. Diagram of Hf-Rb/10-Ta × 3 (Harris *et al.*, 1986) (A) Diagram of Hf-Rb/30-Ta × 3 (B). Diagram of Rb / Zr versus Nb (Brown *et al.*, 1984) (C).

Conclusion

Manganese felsic volcanic rocks of Chah Basheh mine are classified in rhyolite groups. Phenocrysts features such as corrosion Gulf in quartz, quartz resorption and plagioclase corrosion indicate a chemical imbalance of magma and rapid reduction in pressure. This shows the continental crust origin of magma or magma mixing. Felsic rocks of sub-alkaline geochemical nature are calc-alkaline. Wilson (1989) believes that rhyolite in the subduction regions are sub-alkaline, high potassium (K> 4 percent by weight), riched in iron (FeO / MgO> 4.5) and silica. Enriched in incompatible elements in felsic volcanic rocks can be explained by influence and important role of crust.

Tectenomagmatic charts show an active continental margin environment for Chah Bashe rhyolites. Manganese mineralization consists of Iron and Manganese Hydroxids and Oxids specially Manganite and Pyrolusite. Mineralization fills in the cracks among the brocken tectonic rocks with specific and clear directions (NE and NW). Geological and geochemical characteristic of manganese deposit indicate the formation from hydrothermal solution with an igneous source. Mineralization is of low temperatures epithermal style. Manganese Mineralization is limited to two separate tectonic zones in the Chah Basheh mining region that one of these areas (area 1) is located in the 5 km from East Village Fakhrabad and the second (area 2) is in the SE of village Shureh. The structure of both zones is the same. Tissues of ore deposit including shearing, tape, hole and mass. Chemical characteristic of ore is the high amount of silica. Increasing amounts of immigrants such as Ba, Cu, Ar and Sr can be used in deeper zones.

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