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Geochemical and Mineralogical Findings of Pertek (Tunceli) Fe-Skarn Mineralization: Preparation to Its Origin

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Abstract **–** The Southeast Anatolian Orogenic Belt (SAOB), one of the most important belts in Turkey, is located north of the Bitlis-Zagros Suture Zone. Major iron mineralizations are also observed along this belt. The Pertek (Tunceli) region is one of the dominant Fe-Skarn mineralisations. Keban Metamorphites of Permo-Carboniferous age forms the basement of the region. It is mainly represented by metacarbonates, marbles and schists, respectively. This unit is also cut by intrusive rocks from the Upper Cretaceous Elazığ Magmatic Complex (EMC). Tertiary volcanic rocks and sedimentary rocks also overlie both units with angular unconformity. Fe-Skarn was formed at the contact of carbonates belonging to Keban Metamorphites and diorites belonging to EMC. Macroscopically, magnetite crystals and garnet can be observed in the skarn formation, which is easily distinguished by its colour. Polarizing microscopy revealed quartz, calcite, garnet, pyroxene, chlorite and opaque minerals. X-ray diffraction (XRD) analysis revealed that the garnet is andraditic, and the ore minerals are magnetite and hematite. In the ore microscopy, it was determined that magnetite was first transformed into hematite and then hematite into goethite. Regarding the major oxide concentrations of the samples taken from the region, it was determined that the Fe_2O_3 value reached a maximum of 60% (average 21.94%), SiO_2 (average 38.20%) and CaO (average 23.58%) concentrations were high, and Al_2O_3 concentration was generally low. Al_2O_3 concentration reaches 17.96 % in the sample where clayification is common. The findings of this study provide a baseline for identifying the origin of the Pertek Fe-Skarn formation.

Keywords – Southeast Anatolian Orogenic Belt (SAOB), Fe-Skarn, Keban Metamorphites, Yüksekova Complex, XRD, Pertek (Tunceli)

I. Introduction

Skarn deposits can be identified as mineral museums that can develop in many geologic periods. In terms of mineralogy, it is a rock type dominated by minerals such as garnet and pyroxene [1-2]. Skarn formations generally develop due to contact and regional metamorphism and metasomatism of igneous intrusions by cutting carbonate rocks [3]. In order to investigate skarn formation, issues such as protolith rock properties, chemical properties of fluids, the temperature of the formation and the extent of magmatic participation should be clarified [3]. For the interpretation of these data, field and laboratory studies are interpreted together. The occurrence of seven main skarn types (Fe, Au, W, Cu, Zn, Mo and Sn) has been identified, and other metals are currently being investigated. The largest skarn deposits in the world are Fe skarns composed of magnetites and may contain small amounts of Cu, Co, Ni and Au [1-4]. For this reason, investigating Fe skarns and revealing their origin is very important for the mining sector.

The Southeast Anatolian Orogenic Belt (SAOB), one of the most complex parts of the Alpine-Himalayan system, is situated between the Anatolid/Tauride Platform and the Arabian Platform in Southeastern Anatolia. It extends from the Iskenderun Gulf in the west to the Turkey-Iran border in the east. There are records of many geologic periods in this belt. Thanks to its geological features, important skarn formations are observed near Elazığ and Tunceli [5-8].

II. MATERIALS AND METHOD

Samples were taken for mineralogical and geochemical analyses during fieldwork. Thin and polished sections and geochemical analyses of these samples were carried out at ITU-JAL. For geochemical analysis, major oxide analysis values were determined by the XRF method. XRD analysis was performed at ITU using BRUKER-binary V3 (RAW) device for detailed mineralogical identification. The results were evaluated in a High score program.

A. *Geological Background and Fe-Skarn*

The basement rocks in the vicinity of Pertek are Keban metamorphic rocks. It mainly consists of marble, dolomitic marble and greenschist facies rocks [9]. This unit is also cut by dioritic intrusions belonging to the EMC [10-13]. Skarn formation developed at the interface of these two units (Figure 1a). Macroscopic examination of this skarn zone shows quartz, magnetite crystals and limonite (Figure 1b). This skarn zone can be easily identified in the field by its colour.

III. MINERALOGY AND GEOCHEMISTRY

In the thin section studies of the samples collected from the skarn zone, opaque garnet minerals quartz and calcite are observed (Figure 2 a-b). Garnets with very coarse crystals and opaque minerals around them are commonly observed. In another zone of skarn formation, pyroxene, quartz, calcite and opaque minerals are observed (Figure 2c-d). Chloritization is quite common in these rocks. The XRD study conducted to support the mineralogical identification revealed that the garnet type is andradite and that magnetite, hematite and goethite minerals are present along with the gangue quartz (Figure 3).

The ore mineralogy studies determined that the common ore mineral is magnetite (Figure 4). It was noted that magnetite turned into hematite (Figure 4a), and then hematite turned into goethite (Figure 4b).

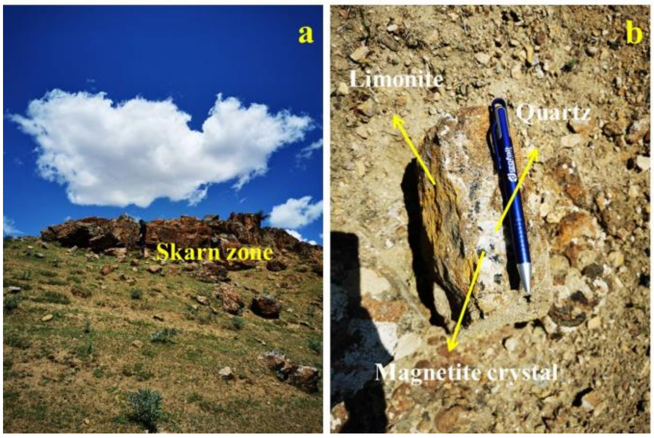


Fig. 1 General view of Pertek Fe-Skarn Zone.

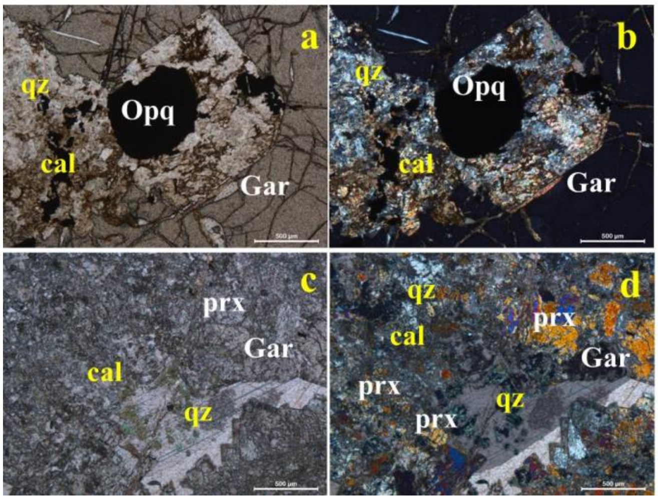
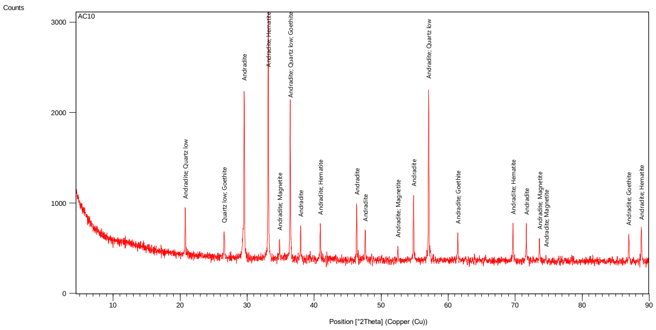


Fig. 2 Polarizing microscope images of skarns. Abbreviations: (Gar) Garnet, (prx) pyroxene, (cal) calcite, (qz) quartz, (Opq) opaque mineral.

Table 1 represents the major oxide concentrations of the samples. The Fe_2O_3 value is 6.24-60.50 % (average: 21.94), the SiO_2 value is 25.50-67.44 % (average: 38.10), and the CaO value is 0.27-39.51 % (average: 23.58) (Table 1). While Al_2O_3 values are generally poor, a value of 17.96 % was obtained in the sample with clayification.

IV. DISCUSSION

Kuşçu [14] reports that the skarns in the SAOB region are mostly Fe-skarn. The same author stated that the skarn zones are developed in limestone-granodiorite and/or diorite porphyry contacts, and the regions characterized by andradite are calcic skarns. He also stated that both endo and exoskarns are present in these regions, and massive magnetite ore bodies are observed in exoskarns. Altunbey [6] presented preliminary data on Fe-skarn formation in the Tunceli region. Supporting these data with isotope, mineral chemistry, and fluid inclusion studies is important. This study represents the preparation stage of the studies just mentioned.



Ref. Code	Mineral Name	Chemical Formula
98-004-5956	Andradite	Ca3Fe2 O12 Si3
98-005-4830	Quartz low	O2 Si1
98-008-0473	Magnetite	Fe3 O4
98-004-6518	Hematite	Fe2 O3
00-003-0251	Goethite	Fe +3 O (OH)

Fig. 3 XRD analysis of the sample.

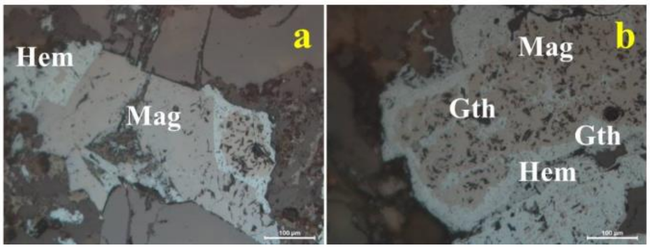


Fig. 4 Ore microscopy views of ore samples collected from the skarn mineralization. Abbreviations: (Mag) magnetite, (hem) hematite, (Gth) Geothite

V. CONCLUSION

In light of the findings of this study, it is concluded that the study should be expanded. Comparing the data obtained for Fe-skarn formation in previous years with the recent geodynamic evolution models and revealing the origin of ore-forming fluids will provide important implications for the metallogenesis of the region.

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Table 1 Major-oxide concentrations of the skarn samples.

SAMPLE	SiO_2	Na_2O	MgO	Al_2O_3	P_2O_5	K_2O	CaO	TiO_2	MnO	Fe_2O_3	SO_3	LOI
P 1	29,44	<0,01	0,29	0,97	0,09	0,02	34,78	<0,01	0,29	11,95	0,02	22,12
P 2	32,38	<0,01	0,19	0,65	<0,01	<0,01	32,89	<0,01	0,27	31,48	0,01	2,11
P 3	67,44	<0,01	0,22	0,19	0,02	0,02	15,25	<0,01	0,19	6,24	0,03	10,34
P 4	25,50	<0,01	0,25	0,68	0,03	0,01	39,51	<0,01	0,34	7,17	0,02	26,48
P 5	35,18	<0,01	0,51	0,59	0,02	0,01	29,72	<0,01	0,32	23,44	0,05	10,13
P 6	44,69	2,23	6,28	17,96	0,12	0,48	12,67	0,80	0,22	12,77	0,05	1,56
P 7	32,09	<0,01	0,13	0,26	<0,01	<0,01	0,27	<0,01	0,10	60,50	0,17	6,17

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