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Research Article

Preliminary Findings of Fe-Skarn Mineralization in Southeast Anatolian Orogenic Belt (Pertek, Tunceli)

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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 mineralizations. 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 Anatolian orogeny formed in response to the subduction of the Paleo-Tethys and Neo-Tethys oceanic crusts [5]. The Southeastern Anatolian Orogenic Belt (SAOB) is the southernmost segment of the Anatolian orogeny that extends eastward to the Zagros Mountains of Iran [5].

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 [6-9].

With this study, an evaluation has been made for the extension of the origin studies of Fe-Skarn formations [7, 9] in the west of Tunceli Pertek region. This paper, which reflects the mineralogical and geochemical content, is intended to support forthcoming isotope, liquid inclusion and mineral chemistry studies.

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*

Turkey was formed by main tectonic units. These are the Pontides, Anatolides, Taurides and the Arabian Platform [10]. The Taurid block represents the Cambrian basement rocks and overlained by the Paleozoic to Early Tertiary succession [11].

The study area is tectonically located west of the Pertek region in the Tauride block (Figure 1). This region is positioned between Elazığ and Tunceli and a large part of it is covered by the waters of the Keban Dam Lake (Figure 2a).

The basement rocks in the vicinity of Pertek are Keban metamorphic rocks (Figure 2b). It mainly consists of marble, dolomitic marble and greenschist facies rocks [9]. This unit is also cut by dioritic intrusions (Figure 2b) belonging to the Elazığ Magmatic Complex (EMC) [12-16]. Skarn formation developed [7, 9] at the interface of these two units (Figure 3a). Macroscopic examination of this skarn zone shows quartz, magnetite crystals and limonite (Figure 3b). This skarn zone can be easily identified in the field by its colour.

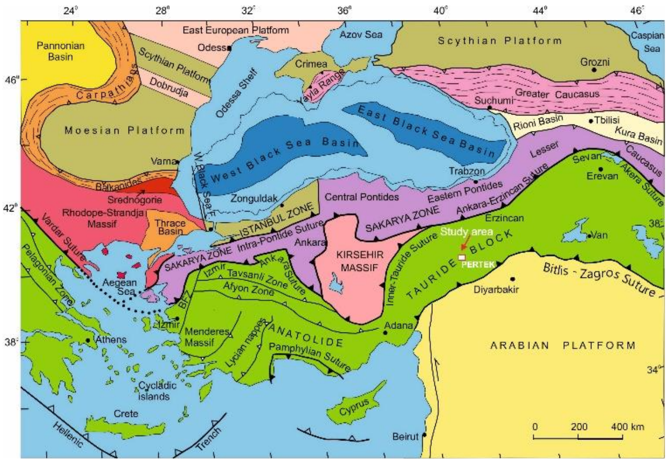


Fig. 1 Tectonic location of the study area [17].

Tertiary volcanic rocks and sedimentary rocks also overlie both units with angular unconformity (Figure 2b).

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 4 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 4c-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 5).

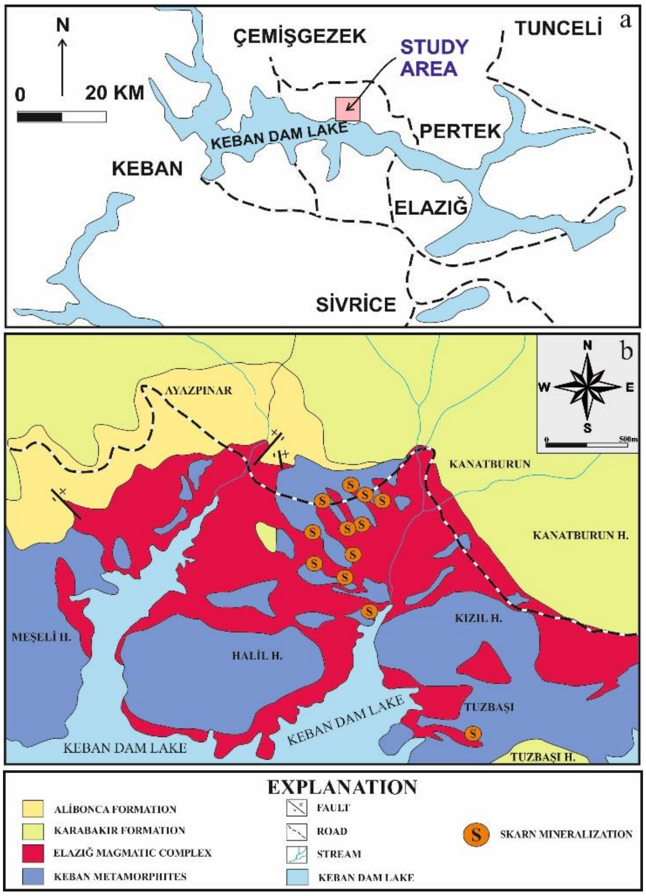


Fig. 2 (a) Location map of the study area, (b) Geology map of the study area, modified from [9].

The ore mineralogy studies determined that the common ore mineral is magnetite (Figure 6). It was noted that magnetite turned into hematite (Figure 6a), and then hematite turned into goethite (Figure 6b). Ore crystals are generally disseminated and irregular in shape. Magnetites, which occasionally present semi-self-shaped forms, are generally oxidized.

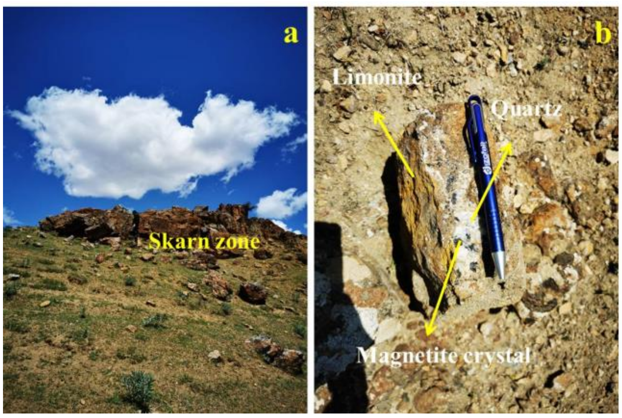


Fig. 3 General view of Pertek Fe-Skarn Zone.

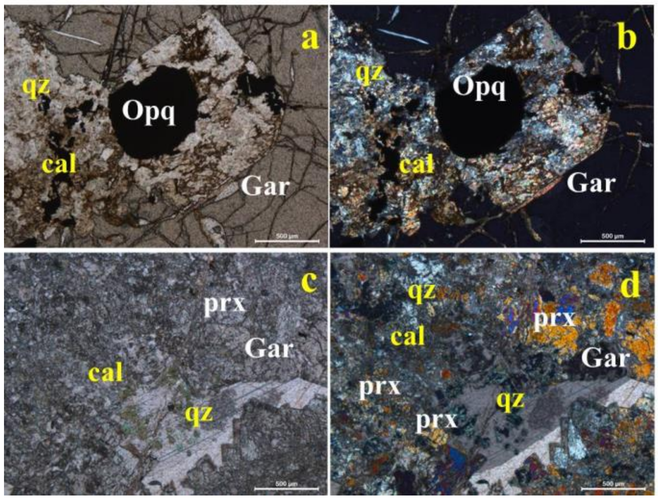
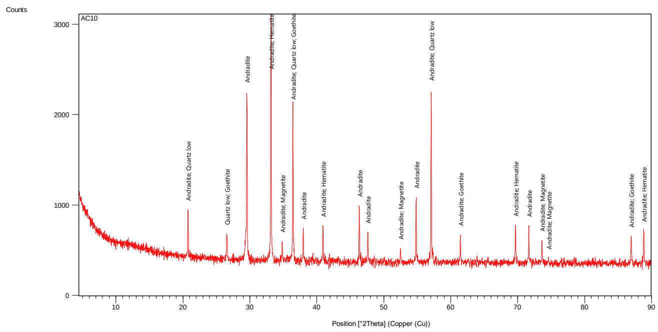


Fig. 4 Polarizing microscope images of skarns. Abbreviations: (Gar) Garnet, (prx) pyroxene, (cal) calcite, (qz) quartz, (Opq) opaque mineral.



Ref. Code	Mineral Name	Chemical Formula
98-004-5956	Andradite	$Ca_3\,Fe_2\,O_{12}\,Si_3$
98-005-4830	Quartz low	O_2 Si
98-008-0473	Magnetite	$Fe_3\,O_4$
98-004-6518	Hematite	$Fe_2\,O_3$
00-003-0251	Goethite	Fe^{+3} O (O H)

Fig. 5 XRD analysis of the sample.

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 [18] 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.

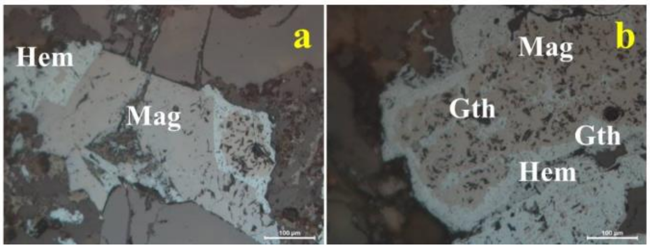


Fig. 6 Ore microscopy views of ore samples collected from the skarn mineralization. Abbreviations: (Mag) magnetite, (hem) hematite, (Gth) Geothite

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

In previous studies [7, 9], important skarn formations were mentioned in this region and iron skarn and ilmenitic skarn were distinguished [9]. Many parameters were evaluated together and an origin interpretation was made. In this study, a preliminary study was carried out to reveal the origins and characteristics of the formation of the targeted F-skarn zones. The data obtained are in agreement with the data of previous authors. This study will be supported by further technological analysis and new implications will emerge.

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.

For this reason, samples collected from the field are prepared for detailed analysis. In addition to the mineralogical and geochemical analysis of the samples taken especially along the skarn zone, they will be supported by detailed studies and evaluated together.

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