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Titanomagnetite Mineralization in Albania

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Abstract: ***The most important accumulations of titanomagnetite mineralization known in Albania occur at the northern part of the western ophiolitic belt of Mirdita zone. The mineralization lies within thesideronite gabbros as layered or irregular ore bodies, consisting of disseminated and banded Fe-Ti-V oxide minerals. The sideronite gabbros (ferrogabbros) belong to the uppermost part of the mafic cumulate section where they predominate. Sukaxhi, Thanez, Ungrej and Fregen are the main titanomagnetite ore deposits, related to the outcrops of these rocks, explored so far in Albania. Ilmenite, magnetite and titanomagnetite are the main ore forming minerals. They compose 15 % - 25 % of the ore and consist of ilmenite and magnetite disseminations of size 0.1 ÷ 0.2 mm. The average ore composition is Fe_2O_3 17.9 %, TiO_2 6.43 % and V_2O_5 0.2 %. There is a positive linear correlation between titanomagnetite, ilmenite and magnetite values. Ilmenite / (magnetite + titanomagnetite) ratio is 3-5 and the TiO_2 values vary between 4.40 ÷ 7.10 %. The sulphide minerals compose 0.5 ÷ 2 % of the ore and consist mainly of pyrite, marcasite and chalcopyrite and less pyhrrotite and scarce pentlandite. Plagioclase, pyroxenes and chlorites are the main gangue minerals. The ore reserves explored so far are calculated to be 147 million tons. The explored ore deposits present appropriate technical-mining conditions for open pit exploitation. Actually, the titanomagnetite mineralization represents an important potential mineral resource for Albania.***

Keywords: Titanomagnetite, sideronite gabbros, Mirdita ophiolite, Albania

1. Introduction

Ophiolites represent the most important features of the geotectonic Mirdita zone that determines their geological evolution and metallogenesis. The two ophiolitic belts developed within Albanides are characterized by specific petrologic and geochemical features which are associated to well distinct metallogenic evolutions. While the eastern ophiolites are characterized by their high chromite-bearing potential and for the Cu-Zn mineralization, this already confirmed by a considerable number of ore deposits discovered and exploited for these mineralizations, the western ophiolites, although with lower bearing potential for these mineralizations, are of interest for their potential for other mineralizations, among which the titanomagnetite is the most important one. This mineralization represents a typical metallogenic feature for the gabbros of the western ophiolite belt. This mineralization is of interest not only in the metallogenic scientific aspect, but also because the mineralization of titanomagnetite known and discovered in them represents a huge potential mineral resource for Albania. Their detailed geological-mining-technological-metallurgical assessment would be a contribution on making them more attractive to local and foreign investors interested in investing in the mining industry in Albania. A very attractive feature of titanomagnetite ore deposits in Albania is their technical-mining conditions that enable the exploitation of large ore reserves in open pit with low exploitation cost. The study area is located between Shkodra and Lezha, in the north of Albania (Figure 1).

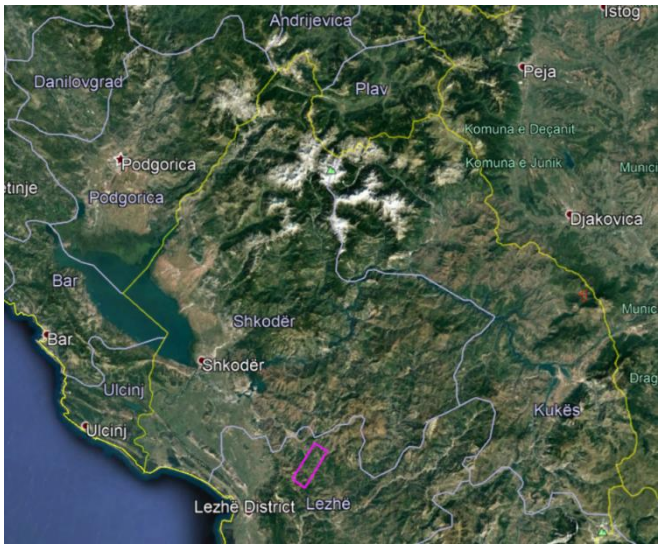

Figure 1: Geographic location of study area

Geology of Mirdita

The geology of the Mirdita zone is mainly represented by the ophiolites that extend in two belts: the eastern and the western ones with their mantle and crustal rock lithologies.

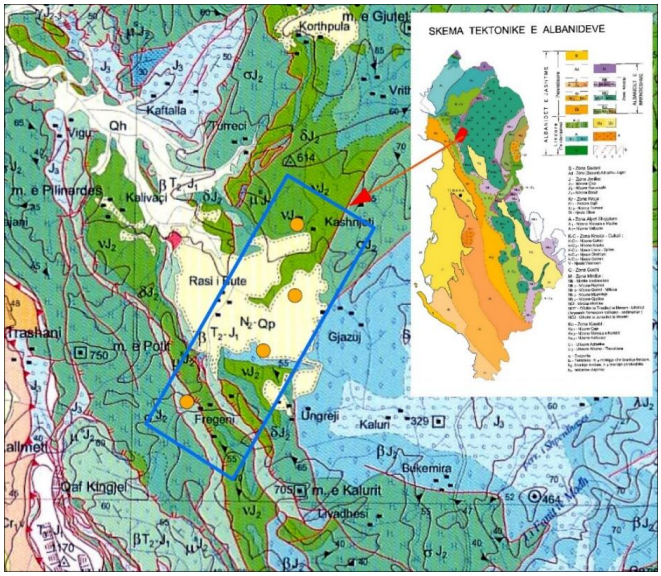

Figure 2: Geological map of the study area

The western ophiolites section from the bottom to the top, consists of the ultramafic rocks, the gabbros and the jurassic volcanicand volcanic-sedimentary rocks, Figure 2, (Grup Autoresh, 2002). In the metallogenic aspect, the titanomagnetite mineralization represents one of the typical metallogenic features of Mirdita ophiolites. This mineralization is considered to be of great interest both, in the metallogenic context of the ophiolites of the Albanides and in the regional metallogenic context of the entire Alpine ophiolitic chain, (Shallo, 1989).

Titanomagnetite Mineralization

The most important concentrations of titanomagnetite mineralization occur in the northern part of the western ophiolitic belt, at Kashnjetiarea. Titanomagnetite mineralization is concentrated in small, irregular elongated massifs consisting of ferrogabbros. These massifs represent the upper part of the mafic cumulates dominated by ferrogabbros. The titanomagnetite mineralization consists of disseminations and veins within the gabbroic rocks. The main titanomagnetite ore deposits explored so far are Sukaxhi, Thanez, Fregen, Ungrej, etc. Sukaxhi ore deposits represent the main geological and industrial titanomagnetite resources explored in Albania.

The mineralogical composition of mineralization is quite uniform: ilmenitite, magnetite, titanomagnetite (Magnetite with thin exsolusions of ilmenite, **Error! Reference source not found.**). Minorsulfide minerals are always present, (Çaku, et al., 1972), (Çaku, et al., 1976), (Tershana, 1982).

Considering the exsolution morphology the mineralization seems to be formed over 440° and the dissolution is evolve in two main stages (Craig 1990 and Taylor 2009).

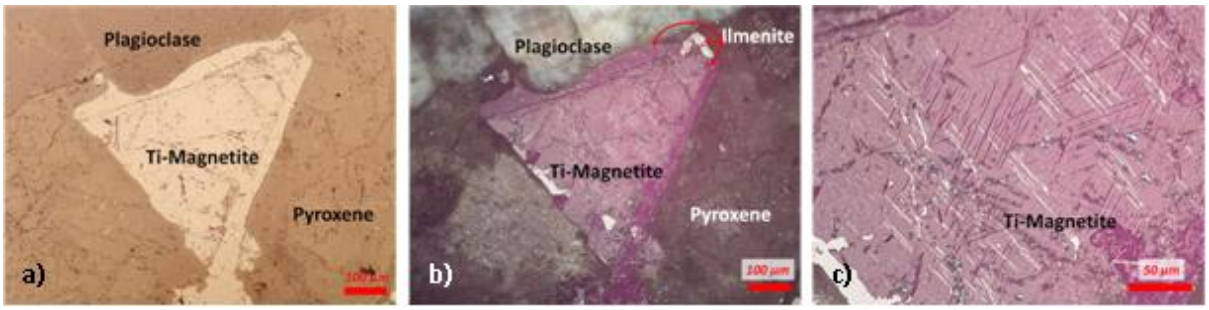

Figure 3: Microscopic image of Ti-Magnetite mineralization. a) Ti-Magnetite surrounded by plagioclase and pyroxene (reflected PPL). b) The same area as "a" the core of TI-Magnetite grain is composed by magnetite with ilmenite exsolutions, where at the lateral parts large ilmenite formation are visible (reflected XPL). c) Detail of image "b", Ilmenite lamellae within magnetite present three preferred orientation corresponding to cleavage plains of magnetite (reflected XPL).

The titanomagnetite deposits of the Kashnjeti area are classified as simple mineralogical ore deposits. Mineralization is low grade type: iron content ranges from 16 % to 22 %, titanium from 2 % to 6 % and vanadium from 0.10 % to 0.40 %. Ilmenite and magnetite compose 15-25 % of the total mineralization mass. The grain dimensions of these minerals are of (0.1 ÷ 0.2) mm. The average chemical composition of the titanomagnetite ore is: 18 % Fe_2O_3, 6 % TiO_2 and 0.2 % V_2O_5, TiO_2 content is 4.4-7.1 %. Chemical analyses indicate that vanadium is isomorphically bound mainly to magnetite and less to ilmenite. Vanadium content is 0.3 % to 1 %, in the magnetite is 100 times higher than in ilmenite. Mineralization also contains other elements such as Ni, Co, Cu, As, Cr and P in very low values. The thickness of ilmenite exsolutions within magnetite varies from some hundredths to thousandths of millimeter. A linear correlation between titanomagnetite, ilmenite and less with magnetite values is observed:

$$Ratio = \frac{Ilmenite}{Magnetic + Titanomagnetic} = 3 \div 5$$

Pyrite, chalcopyrite and less pyhrrotite are the main sulfide minerals that represent 0.5 ÷ 2 % of the total mineralization, (Çaku, et al., 1972), (Çaku, et al., 1976), (Tershana, 1982).

2. Main Ore Deposits

2.1 Sukaxhi Ore Deposit

The geological setting consists mainly of lherzolites, troctolites, plagioclasicperidotites and gabbros. The petrographic environment in which the titanomagnetite mineralization is found is represented by melanogabbros-ferrogabbros with cumulative and sideronite texture. The orebodies morphologies are mainly thick gabbroic strips and less lenses and veinlets of low grade to medium

titanomagnetite disseminations with uniform distribution and less dense within the host rock.

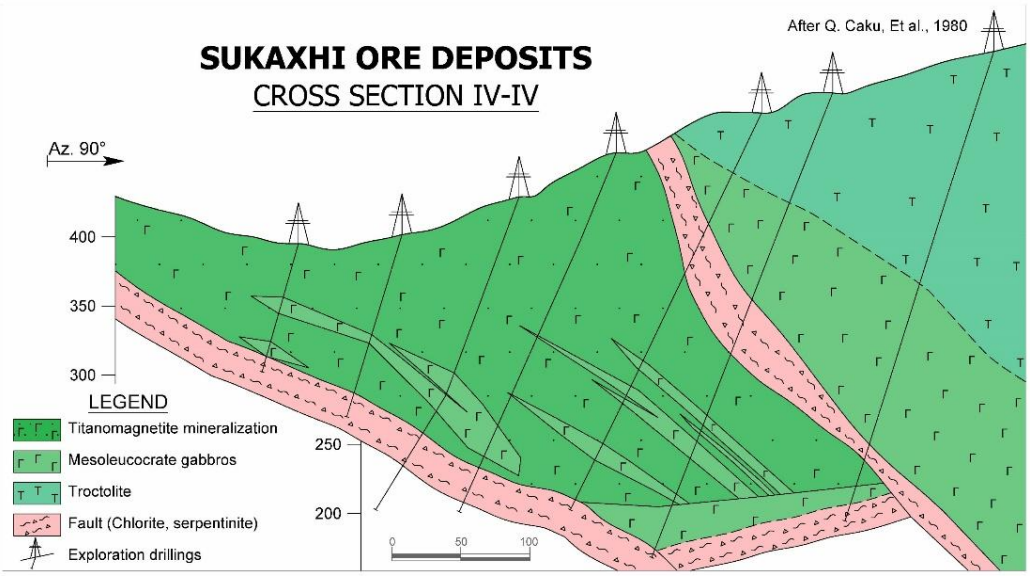

Figure 4: Sukaxhi ore deposits, Cross Section IV-IV

The mainoreminerals are magnetite, ilmenite and titanomagnetite. The minor ore minerals include pyrite, chalcopyrite, pyhrrotite, pentlandite, hematite, leucoxene andiron hydroxides. The gangue minerals are plagioclase, pyrexene, actynolite, tremolite, chlorite, epidote, calcite, serpentine, chrysotile-asbestos, talc, ceolite. The average chemical composition of mineralization is: FeO 18.15 %; TiO_2 6.44 % and V_2O_5 0.20 %, (Çaku, et al., 1972), (Çaku, et al., 1976), (Tershana, 1982).

2.2 Thanez Ore Deposit

The geological setting consists mainly of small to medium grained melanogabbros-ferrogabbros with sideronite texture. The morphology of the orebodies are thin gabbroic bands 1 m-2 m thick. Mineralization consists of disseminations and less of schlierens. The main ore minerals are magnetite, ilmenite and titanomagnetite. The minor minerals are pyhrrotite, chalcopyrite, hematite, leucoxene and iron hydroxides. The average chemical composition of mineralization is: FeO 17.90 %; TiO_2 6.55% and V_2O_5 0.20 %, (Çaku, et al., 1972), (Çaku, et al., 1976), (Tershana, 1982).

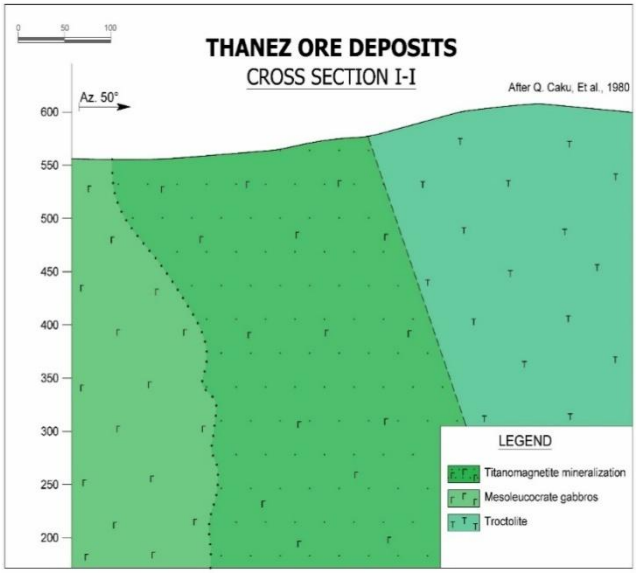

Figure 5: Thanez ore deposits, Cross Section I-I

2.3 Ungrej Ore Deposit

Petrographic environment is represented by mesocratic-melanocratic gabbros to ferrogabbros and gabrodiabases, with sideronite texture. Mineralized zones are bands of gabbros and gabrodiabases with dissemination ores. Surrounding rocks are represented by gabbros and microgabbros without mineralization. The main ore minerals are magnetite, ilmenite and titanomagnetite. The minor minerals are pyrite, chalcopyrite, pyhrrotite, leucoxene and iron hydroxides. The gangue minerals are plagioclase, pyrexene, actinolyte, tremolite, chlorite, serpentine, epidote, calcite, kaolin. Average chemical composition of mineralization is: FeO 17.41%; TiO_2 6.14 % and V_2O_5 0.20 %, (Çaku, et al., 1972), (Çaku, et al., 1976), (Tershana, 1982).

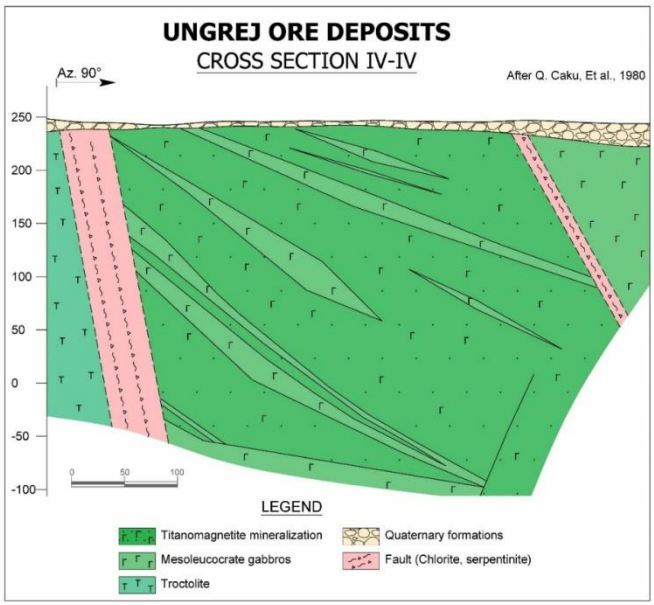

Figure 6: Ungrej ore deposits, Cross Section IV-IV

2.4 Fregen Ore Deposit

The petrographic environmentconsists of **mesocratic** to **melanocraticgabbros** and **gabrodiabases** with sideronite texture. Mineralized zones are bands of gabbros and gabrodiabases with dissemination ores. Surrounding rocks are represented by gabbros and microgabbros without mineralization. The main ore minerals are magnetite, ilmenite and titanomagnetite. The minor minerals arepyrite, chalcopyrite, pyhrrotite, leucoxene and iron hydroxides. The gangue minerals include plagioclase, pyrexene, actinolyte, tremolite, chlorite, serpentine, epidote, calcite, ceolite and kaolin. Average chemical composition of mineralization is: FeO 17.60%; TiO_2 6.04% and V_2O_5 0.20%, (Çaku, et al., 1972), (Çaku, et al., 1976), (Tershana, 1982).

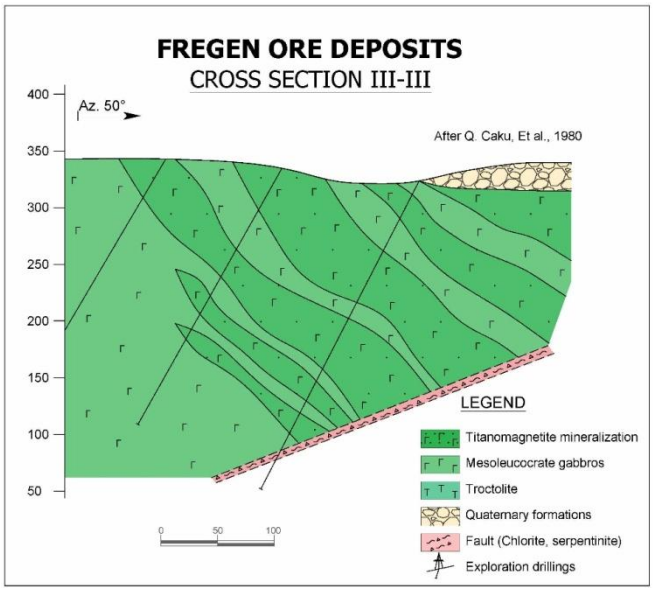

Figure 7: Fregen ore deposits, Cross Section III-III

3. Conclusions

The mineralization of titanomagnetite related to the gabbros of the Kashnjeti area represents one of the typical metallogenical features of the western ophiolitic belt of Mirdita.

The main titanomagnetite ore deposits are located in Kashnjeti area. The area extends ~ 10 km long and ~ 2 km wide. The most important ore deposits are Sukaxhi, Ungrej, Fregeni and Thanez. Titanomagnetite mineralization is always associated with melanocratic gabbros. The mineralized zones occur like lenses of several tens of meters to 1 km long, several meters to 200 m wide that extend for 100 m-400 m towards their plunge. Mineralization of titanomagnetite consists of ilmenite-magnetite-titanomagnetite. It occurs in relatively large disseminated mineralized zones. Titanomagnetite mineralization is low grade type with average 18 % Fe_2O_3, 6 % TiO_2 and 0.2 % V_2O_5. The proven ore resources explored to date are 140 million tons. The prospect for new ore resources is open in whole of the Kashnjeti area. Good exposure to the surface of all titanomagnetite deposits in the gabbros of the Kashnjeti area offers favorable technical and mining conditions for their exploitation in open pit. Mineralization of titanomagnetite represents a potential mineral resource for Albania, (Çaku, et al., 1972), (Çaku, et al., 1976), (Tershana, 1982).

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