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Features of the Geological Structure and Genesis of the Tebinbulak Deposit (Ridge Sultan-Uvais)

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Abstract

In this article, we want to draw attention to the hysteron-magmatic origin of titanium-magnetite ores of the Tibinbulak gabbro-peridotite complex located in the northwestern part of the Sultan-Uvais ridge. Which is the only outlet of the Phanerozoic foundation between the mountain structures of the Urals and the Southern Tien Shan. The article examines the characteristic features of petrochemical and structural features of ore minerals (ilmenite, magnetite) and the main rock-forming minerals of the gabbro-peridotite complex (peridotite, pyroxenite, tebinnite, pyroxene hornblendite and plagioclase) with clarification of the structural relationships. It was found that magnetite mineralization of the Tebinbulak intrusion was superimposed on ultrabasic rocks in the final stages of crystallization of the latter. Prolonged auto-metasomatic transformations led to the enlargement of magnetite crystals in places subject to decay. In this case, aggregates of spinel - hercynite with sphene rims were formed. Simultaneously with the formation of sphene, ilmenite crystals appeared in the form of radiant needle-shaped aggregates. In this case, the primary crystals of magnetite lost their faces and became shapeless. Relatively large precipitates of titano-magnetite formed at this stage with the filling of cracks in the rock and interstices between minerals. Based on the data presented, we note that the titano-magnetite ores of the Tebinbulak deposit arose in the late magmatic (hysteron-geneous) setting of auto-metamorphic replacement of the main carriers of iron and titanium pyroxene and plagioclase with hornblende. Also, the studied geochemical composition of ores damages that the titano-magnetite ores of the Tebinbulak deposit are a complex raw material, from which not only iron but also vanadium concentrate can be extracted.

Keywords: *Karakalpak Autonomous Republic; Sultan-Uvais Ridge; Tebinbulak Area; Suite; Assessment; Prospecting;Forecast; Mineralized Zone;Ore Body; Thickness; Content;Vanadium-Containing Titanium-Magnetite Mineralization; Genesis;Autometamorphic;Iron;Titanium;Late Magmatic(Hysteron-Geneous)*

Introduction

The Sultan-Uvais ridge, located in the extreme southwestern part of Kyzyl-Kumov, is administratively part of the Karakalpak Autonomous Republic. It is characterized by an exceptionally wide occurrence of deeply metamorphosed Phanerozoic rocks.

In the Sultan-Uvais ridge, the westernmost part of the strip of basic and ultrabasic rocks of the Southern Tien Shan is exposed, stretching from the Alai ridge in the east. The study of the geological structure of the ridge began with the work of Barbot de Marni (1874) and was then continued by A.E. Voznesensky, K.A. Popov, I.A. Preobrazhensky (1912), A.I. Churakov, A.V. Peck (1936) and J.S. Visniewski (1940). In these works, titano-magnetite ores associated with basic rocks were noted. Subsequent exploration of prospecting, geological survey was conducted by G.Yu. Naferov, A.A. Kulesh, R.I.Burtman and others (1953-1956), A.P. Agafonov (1955-1956), A.A. Kulesh and others (1966-1967), D.T. Boenov, Sh.T. Toshpulatov (2011 - 2020), thematic research work was carried out by V.V. Baranov, K.M. Kromskoy, A.F. Sviridenko and others (1963-1972).

The Main Findings and Results

The Tebinbulak manifestation of titano-magnetite associated with the eponymous gabbro-pyroxenite massif was discovered in 1937. Ya.S. Wisniewski.

Titano-magnetite mineralization is established in the North-Western part of the Sultanuvays ridge within the Ashenyntau Mountain as part of the Tebinbulak intrusion (Fig-2) composed of a gabbro-pyroxenite complex, which is well comparable with the dunite-pyroxenite-gabbro intrusions of the Ural platinum-bearing belt (2-7).

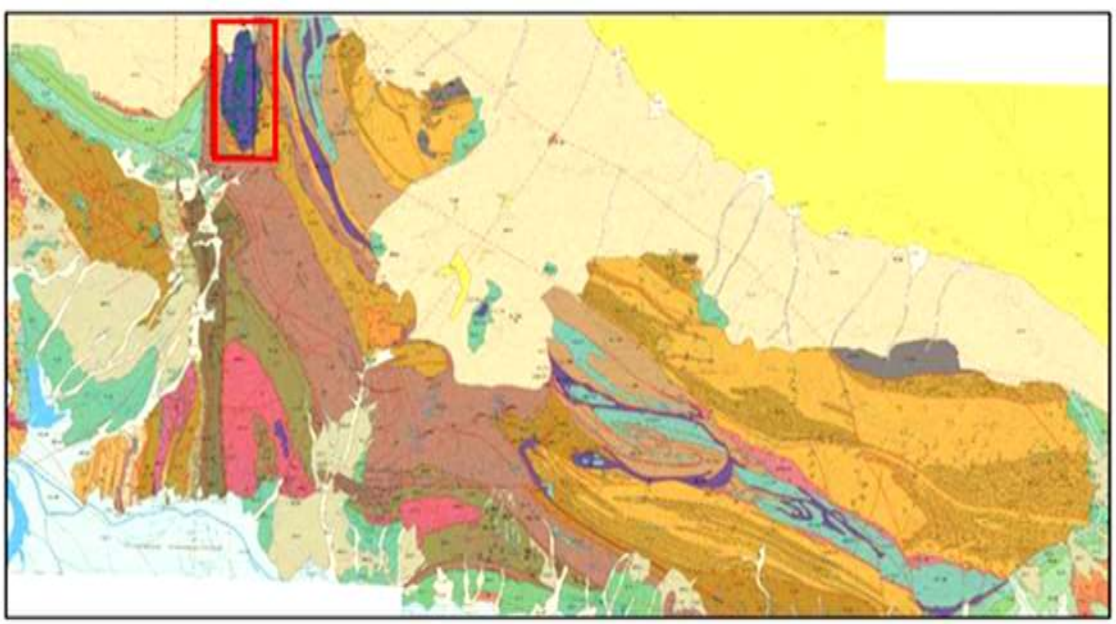

Figure 1. The Position of the Massif in The Sultan-Uvais Ridge the Area of the Array is Highlighted in Red).

The Tebinbulak intrusion is located in the core of the synclinal fold among siliceous shales of the greenstone stage of metamorphism, interbedded with sandstones and siltstones. They surround the intrusion in a semicircle from the west, south, and east; in the north, the intrusive goes under the aeolian sands of the Kyzyl-Kum.

The size of the intrusion is 4.5 x 1.6 km and has an ellipse-like shape, elongated in the meridional direction (Fig. 1). In the near-contact parts of the intrusion, the products of contact metamorphism are developed, represented by plagioclase, micaceous hornfels and marbleized, skarnated limestones. In these parts, garnet, rutile, tourmaline and apatite appear among the sericite-quartz schists. In the southern and eastern parts of the massif, the basic rocks are broken through by the later gabbro-syenites of the Jamansai complex.

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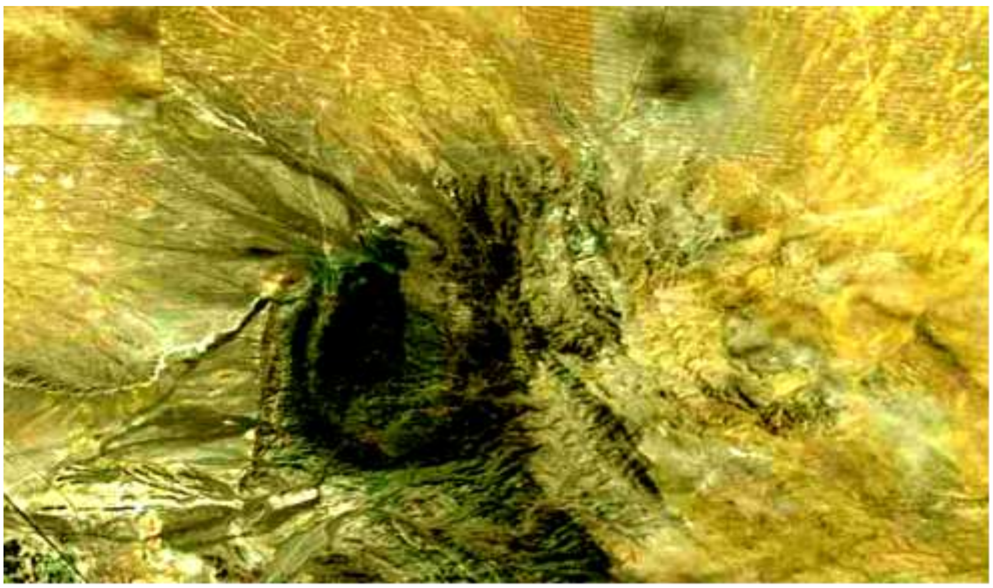

Figure 1. Satellite Image of the Tebinbulak Deposit of Titanium-Magnetite Ores

Two-mica hornfels, garnet-pyroxene-wollastonite and rhodonite skarns are developed here in the contact halo.

According to (4), the intrusive is dominated by ultrabasic rocks (wehrlites, shrisheimites) olivine pyroxenites, pyroxenites, hornblende pyroxenites, and pyroxene hornblendites with ore varieties named by J.S. Visniewski - tebinites. For the rocks of the Tebinbulak intrusion, there are radiological age data: 306-378 million years (potassium-argon) method.

The Early Carboniferous age of the complex is based on radiological data and is also determined by the breakthrough of the Middle-Late Devonian rocks of the Karakuduk sequence and the Sultanuizdag complex.

The rocks of the Tebinbulak complex are represented by hornblende gabbro with areas of pyroxene gabbro. They are considered as differentiates of gabbroid magma intruded into the forming synclinal folded structure.

Peridotites, pyroxenites, tebinites, and hornblendites gradually merge into each other and it is difficult to establish the areas of their distribution in the field. Gabbroids are developed in the central and southwestern parts and along the eastern contact of the intrusion. The predominant type of rocks is the cossurite gabbro. The structural varieties of gabbro and hornblendites include gabbro-pegmatites, which have irregular areas and elongated stripes.

Based on the results of gravimetric work, a significant over 0.8 km depth of distribution of the ultramafic intrusive rocks was determined, its potential productivity was determined.

Ground magnetic survey 1: 10000 revealed 18 large anomalies with an intensity of more than 1000 gammas, the nature of which is explained by the dissemination of titanomagnetite concentrated in the meridional direction with the following parameters: length from 350 to 2650 m, with a width of 40 to 425 m (I.M. Zhigarlovsky et al. 1972, Kremnev et al. 2004, A. V. Golovko et al. 2018)).

Lithochemical testing revealed scattering halos: copper (0.1-0.5%), chromium (0.02-0.5%), nickel (0.01-0.2%), single arsenic halos (up to 0, 3%), gold (up to 0.1 g / t) and platinoids (up to 0.12-0.2 g / t).

According to technological laboratory tests from finely disseminated and schlieren-banded titanomagnetite ores, it was established that the ores of the Tebinbulak deposit are a complex raw material, from which an iron-vanadium concentrate can be isolated, which in its qualities was not inferior to the concentrates produced at the Kachkanarsky GOK. The iron content was 63.5%, $V2O5$ - 0.65%? $TiO2$ - 4.64%. At the same time, it was noted that samples were taken from the upper parts of the field, which had undergone the process of martitization (hypergenesis).

The issues of the genesis of ores associated with such rocks were not covered by previous researchers in all possible aspects. In this article, we would like to draw attention to the hysteromagmatic origin of the noted ores.

The study of the material composition of titanomagnetites of the Tebinbulak intrusion ores with the elucidation of the structural relationships of ore minerals with nonmetallic minerals has established that magnetite mineralization here is superimposed on ultrabasic rocks in the final stages of crystallization of the latter. The primary rocks, represented by pyroxenites, were subsequently altered by the replacement of titanium-bearing augite with hornblende. Simultaneously with the crystallization of hornblende, intense leaching of pyroxene with decomposition into titanomagnetite and plagioclase occurred. Moreover, plagioclase was initially in equilibrium with hornblende and quantitatively prevailed over it. This basic plagioclase in individual relicts containing more than 90% of the anorthite component was subsequently decomposed with the formation of epidote in paragenesis with more acidic andesine. Relatively large precipitates of titanomagnetite formed at this stage with the filling of cracks in the rock and interstices between minerals. In terms of the form of precipitation, the titanomagnetite crystals were initially xenomorphic and small. During the metasomatic transformation of pyroxenites into hornblende rocks - hornblendites, the primary crystals of magnetite recrystallized with the formation of large well-faceted crystals (Fig. 2).

Prolonged autometasomatic transformations led to the enlargement of magnetite crystals, which in some places underwent decay. In this case, aggregates of spinel - hercynite with sphene rims were formed. Simultaneously with the formation of sphene, ilmenite crystals appeared in the form of radiant needle-shaped aggregates. In this case, the primary crystals of magnetite lost their faces and became shapeless (Fig. 3).

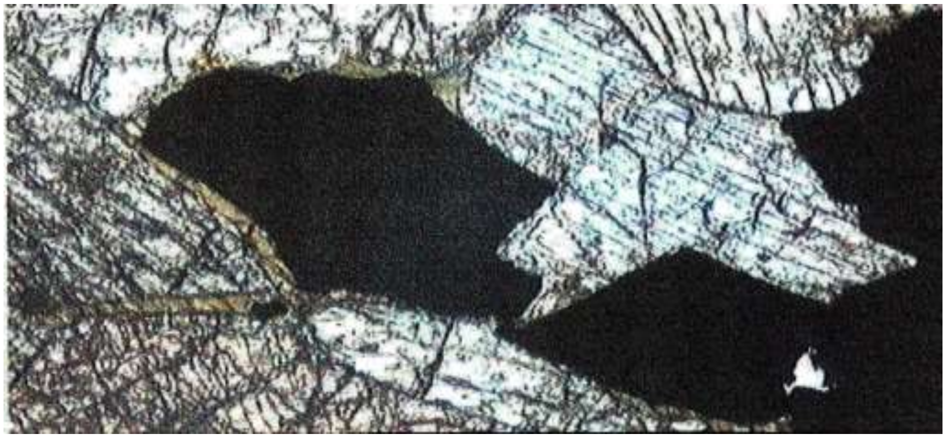

Figure 2. Recrystallization and Formation of Large, Idiomorphic Crystals of Magnetite in Hornblendite
Section EO63. Nicoli +. Magnification 60^x.

Hornblendite is a macroscopically black micro-grained rock consisting almost entirely of hornblende. The structure is granoblastic. Contains 5-8% augite (C:Ng = 42, 2V = + 62 - +63^o).

Hornblende is densely colored with weak pleochroism. The color is green, sometimes brownish-green, and forms prismatic grains with well-developed cleavage along the prism. Due to the taxite structure of the structure, sections II 00I are mainly observed in the thin section. Transverse ⊥ 00I sections are rarely observed and systems of cleavage cracks are visible in them, intersecting at an angle of 56 °, accounting for 80% of the rock volume. The grain size does not exceed 0.5mm. Augite occurs in the interstitium of hornblende crystals in xenomorphic forms. Usually they are isometric, decomposed and replaced by hornblende. The size does not exceed 0.03mm; it is 5-8% of the volume of the rock.

Magnetite occurs in small (0.01-0.05 mm) shapeless, often rounded and occasionally elongated crystals. In some places it is slightly covered with leucoxene. Magnetite crystals are distributed throughout the rock, relatively uniformly confined to the interstices of hornblende grains, forming a sideronite structure.

Figure 3. Acquisition of Xenomorphic Forms by Magnetite Grains During the Isolation of Sphene and Ilmenite Needles in the Rock.
Section EO67. Nicoli +. Magnification 60^x

The rock is relatively fresh, contains rare allocations of honey-brown micro-grained sphene. Often, sphene grains are isolated, confined to cracks in the rock, in the form of microveins. The content of inclusions of magnetite is in the range of 10-12%. Crystals of low refractive, often xenomorphic apatite are found in the rock as a secondary mineral in a small amount of no more than 0.1% (Fig. 4).

Figure 4. Isolation of Rounded (White) Xenomorphic Crystals of Paragenic Apatite with Magnetite Cut EO-66-1, Nicoli +. Magnification 60^x

In some places, micro-grained pyroxene hornblendite acquires a granoblastic slightly porphyritic structure. It consists of hornblende and augite in a ratio of 2: 1, sometimes 3: 1. Magnetite makes up about 20% of the rock volume. The micro-grain size of the rock is clearly expressed - the grain size does not exceed 0.1-0.2 mm. Against the background of these mineral aggregates, sometimes larger - up to 0.5-0.7 mm hornblende crystals are found, usually rounded. Hornblende replaces augite crystals with the formation of wide rims around them. Often augite crystals remain in the form of poikilitic inclusions among hornblende crystals. In transmitted light, small rounded augite grains are colorless; in crossed nicols they give high interference red-blue colors. In intensively altered areas, the amount of ore mineral increases (Fig. 5).

Gradually, the rock turns into fine-grained plagioclase hornblendite. In this case, the structure remains granoblastic. Composition: hornblende - 60, plagioclase - 25, augite - 5, magnetite - 10. This rock of basic composition is transitional to hornblende gabbro with a medium-grained hypidiomorphic structure. Hornblende crystals in it are up to 2 mm in size, more often 1.0-1.5 mm with prismatic and pinacoidal cuts are relatively isometric, often develops replacing pyroxene (augite), the dimensions of which remain small. In most cases, the shapes of pyroxene grains are not preserved; they acquire a xenomorphic - rounded shape surrounded by hornblende crystals.

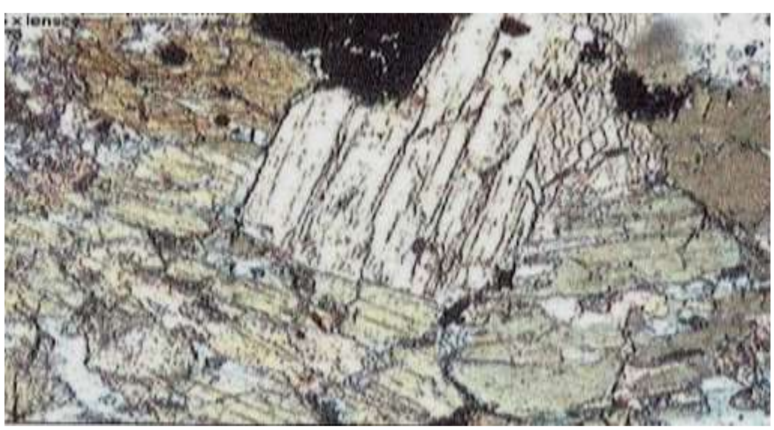

Figure 5. Isolation of Magnetite Grains at The Junctions of Dark-Colored Minerals and Its Recrystallization with the Capture of Microinclusions of Augite (On the Upper Middle Part).
Section EO66. Nicoli ||. Magnification 60^x

Plagioclase (an-0-40) develops in the interstitium between hornblende crystals, representing an intercumulus phase, showing deoxidation of the magma composition due to crystallization differentiation. Does not form clear faceted crystals, often gives a granophyre-like structure in a mixture with cosurite and quartz.

Magnetite, which is the main ore mineral, crystallizes in the form of well-faceted crystals, which are much larger than in fine-grained xenomorphic varieties (Figures 2 and 5), and a well-developed form of octahedral magnetite crystal (black) replacing prismatic grains of brownish-green hornblende is also clearly visible. White shapeless segregations in the upper right corner of figure (5) represent an accumulation of fine-grained aggregates consisting of granophyre intergrowths of plagioclase - quartz.

Conclusions

Based on the above data, it can be noted:

- titano-magnetite ores of the Tebinbulak deposit are a complex raw material from which iron-vanadium concentrate can be isolated;

- the ores of the deposit are similar to the titano-magnetite ores of the Kachkanar intrusion in the South Urals:

- we note that the titano-magnetite ores of the Tebinbulak deposit arose in the late magmatic (hysteron-geneous) setting of auto-metamorphic replacement of the main carriers of iron and titanium pyroxene and plagioclase by hornblende.

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