Geophysical criteria for the separation of productive micaceous veins of the Mariinsky emerald-beryllium deposit (the Middle Urals)

Mikhail Petrovich POPOV1, 2*, Oleg Petrovich PELESHKO1, 3*, Evgeniya Anatol’evna BAZHENOVA4**, Viktor Sergeevich IVANCHENKO4***, Vladimir Vasili’evich BAKHTEREV4****

1Ural State Mining University, Ekaterinburg, Russia
2Zavaritsky Institute of Geology and Geochemistry of the Ural Branch of RAS, Ekaterinburg, Russia
3AO Mariinsky rudnik, Asbest, Malysheva, Russia
4 Institute of Geophysics of the Ural Branch of RAS, Ekaterinburg, Russia

Relevance of the work is the development of new methods for rapid extraction (determination) of ore bodies in the underground mine of the field directly. Measurements were carried out both on specially prepared samples in the form of cubes of the same size, and under conditions of natural occurrence.

Purpose of the work is to study the magnetic susceptibility and electrical resistivity of the main host rocks and the ore complex (emerald-bearing glimmerites and quartz-plagioclase veins with beryl) in the most famous Ural emerald-beryllium deposit, the Mariinsky deposit.

Methodology of research. In order to study the magnetic properties of typical rocks and ore bodies of the Mariinsky deposit, the PIMV-M field magnetic susceptibility meter with a measurement range of 1 · 10⁻⁵...1 SI units was used in the underground mine directly. The relative measurement error does not exceed ± 10% in the range of 10⁻⁴...1 SI units. The measurement was carried out by applying the flat surface of the measuring transducer to the bottomhole wall in a lithologically homogeneous section with subsequent measurement and recording of the obtained value in the field document. To study the electrical resistivity, standard samples in the form of cubes of 24 × 24 × 24 mm were used; their composition was investigated with the help of binocular enhancer MB8-10. The measurements were carried out along three axes since almost all samples have anisotropy.

The teraohmmeter E6-13A was used for working.

Results. The data on the magnetic susceptibility and electrical resistance of the main host rocks and the ore complex (emerald-bearing glimmerites and quartz-plagioclase veins with beryl) from the Mariinsky deposit are presented. All data are adjusted with the petrographic characteristics of rocks.

Conclusions. Possibility in principle is shown for creating a new express-method for isolating quick micaceous veins in wells and mine faces with the simultaneous measurement of magnetic susceptibility and electrical resistance of rocks during mining operations in an underground mine.

Keywords: The Urals, magnetic susceptibility, electrical resistance, glimmerites, quartz-plagioclase veins, emerald-beryllium deposits, Ural emerald mines.

Introduction

Currently, the Government of Russia entrusts executives of the Malyshevsky (Mariinsky) emerald-beryllium deposit with the task to restore beryllium mining in Russia. During mining operations, a very important factor affecting the cost and quantity of the extracted commercial element is the possibility of isolating and sorting out quick micaceous veins carried out directly in the mine face while blasthole drilling. Earlier during the active mode of operation of the Malyshevsky mine group (1950–1990), the enterprise used the photoneutron method for such tasks [1]. The application of this method is associated with certain managerial difficulties (the use of strong radiation sources, the creation of isotopes storages, and the organization of a special control service). Therefore, at the early stage of geological exploration, geophysical methods are promising, operational, and low-cost methods of searching for quick micaceous veins and serpentinite contacts [2–4].

According to early literature data [2], the magnetic susceptibility of highly basic rocks of the Emerald-bearing line of the Urals ranges from 25 ... 63 · 10⁻⁵ to 2520 ... 5040 · 10⁻⁵ SI units, and in some cases up to 12 600 · 10⁻⁵ SI units. The increased magnetic properties of ultrabasic rocks are associated with accessory magnetite. Moreover, a considerable heterogeneity of ultrabasic rocks was established according to the magnitude of magnetic susceptibility (Table 1), which is mainly due to their serpentinitization, carbonatization, and development of talc. Table 1 shows the magnetic susceptibility values obtained by the authors of the work [2] for rocks typical of the deposit. Unfortunately, the authors did not indicate in their work the way the measurements were made (using samples or under conditions of natural occurrence). However, according to their data, rocks of the basic and acidic composition are mainly non-magnetic; amphibolites, gabbros, granitic rock, and glimmerites are distinguished by reduced magnetic susceptibility.

Additionally, according to literature data [2], the dependence of the specific electrical resistance of ultrabasics on the metamorphism intensity is noted:
- slightly serpentined peridotites – 1210 ... 3900 Ohm · m, at an average 1900 Ohm · m;
- serpentinites – 300–960 Ohm · m, at an average 750 Ohm · m;
- serpentinite-talc-carbonate rocks – 16 ... 21 Ohm · m, at an average 18 Ohm · m;
- talc-carbonate rocks – 2 ... 26 Ohm · m, at an average 10 Ohm · m.
Micaeous veins are distinguished among the host rocks by high electrical resistance, which is caused by their composition – these are shales, consisting mainly of phlogopite with mica scales oriented along shaliness. According to the data of parametric measurements of samples, the average electrical resistivity is 70 000 Ohm · m, which is significantly higher than the electrical resistance of the host rocks [2]. However, the measurement technique is also not specified in the work.

The brief geological structure of the Mariinsky emerald-beryllium deposit

The Ural emerald mines are the world-famous ore region, where the largest deposits of beryllium ores and gems are located in Russia: emerald, alexandrite, and phenakite. Gem-stones mining began in 1831 and do not stop until today. Within the Emerald Mines, the only source of beryl is micaeous veins, which are found in the contact of serpentinites in talc-chlorite rocks.

The Mariinskoe (Malyshievskoye) deposit is included in a group of fields that goes under the general name of the Emerald Mines of the Urals. The ore field is attributed to the deposit which is located in the eastern exocontact zone of the large Adauisky granite massif of the late orogenic type. Granites burst a complex of metamorphic and intrusive rocks, which includes: amphibolites and amphibolite schists, carbon-bearing siliceous schists, serpentinites ultrabasites, serpentinites and dolerines derived from them, diorites, quartz diorites and diorite porphyry (Fig. 1).

The contact of the granite massif with a complex of metamorphic and intrusive rocks has the east dip with 65 ... 80 ° angle and is complicated by bends with flat areas and broad warps. The Mariinskoe deposit is confined to one of such downwarps. The ore field is located in the eastern flank of the anticlinal bend. The main ore-controlling and ore-distributing structures at the deposit are spatially connected fault zones and dikes of diorite porphyrites [6]. Fault zones are fixed by highly foliated and broken dolerines (usually with additions of chlorite, actinolite, and phlogopite); there are lenticular bodies of serpentinites, as well as dikes of diorite porphyrites and separate sheet-like bodies of carbonaceous siliceous schists. Most ore bodies are concentrated in the fault zones oriented mainly in the near-north-south and lateral directions. In the fault zones and adjacent areas, all rocks are subject to tectonical boudinage and profound metasomatic changes — phlogopitization, fluoritization, and development of talc (serpentinites). In addition, the most intensive formation of beryllium mineralization is observed in fault zones. In the vertical sections, schistosity zones often unite and diverge again; wedging out and bulges are often noted. It was also noted that sometimes separate feathering fractures depart from the main fault zones; large ore shoots are formed in the areas of intersection with faults. Fault zones can be tracked along the strike up to 1200 m, their thickness varies from 5 to 70 m. Dykes of diorite porphyry play an important role in the formation of the structure of the ore field of the deposit. Along the strike and the fall of the ore zone, five largest dykes are observed in accordance with it, the length of which reaches 1150 m with a thickness of 5 to 10 m. Dyke-like bodies are spatially closely associated with the identified large fault zones, and the development of ore-bearing structures occurs precisely here, that is, in the areas of occurrence of dykes that create a profound mechanical heterogeneity of the surrounding formation. The ore zone of the deposit has a southern declination at an angle of 50 °. On the strike, it is tracked for 1 100 m (horizon –30 m), and it has been explored to a depth of 360 ... 500 m [6]. The vein assemblage is represented by emerald-bearing micaeous and beryl-bearing quartz-plagioclase veins (Figure 1).

Micaeous ore bodies are the only carriers of beryllium raw materials. They contain an overwhelming (more than 95%) amount of beryl, which is also characterized by the highest (13.4 g/t) content of this component. Micaeous assemblage found in talc schists is characterized by the highest (16.1 g/t) content of emerald raw materials. They are quite diverse. This diversity is due to different chemical and mineral composition of protoliths, the duration and polygeneration of metasomatic processes.

Methods of studying the magnetic susceptibility of rocks and objects of study

The study of magnetic susceptibility to differentiate the magnetic properties of natural minerals has been repeatedly used by researchers [8–10]. In order to study the magnetic properties of typical rocks and ore bodies of the Mariinsky deposit, the PIMV-M field magnetic susceptibility meter with a measurement range of 1 · 10⁻⁵...1 SI units was used in the underground mine directly. Relative measurement error does not exceed ±10% in the range (10⁻⁵ ... 1) SI units, in the range (10⁻⁴ ... 10⁻³) SI units is not rated. Measurement was carried out at barings in mine workings (laying crossdrifts, dass, ore drifts) at horizons +15, –30, –120 m. The measurement was carried out by applying the flat surface of the measuring transducer to the bottomhole wall in a lithologically homogeneous section with subsequent measurement and recording of the obtained value in the field document. At

| Rock                  | Number of determinations | Measurements range | Average |
|-----------------------|--------------------------|--------------------|---------|
| Amphibolites          | 3646                     | 0...302            | 25      |
| Gabbro                | 800                      | 0...126            | 35      |
| Diorites              | 3370                     | 0...2520           | 21...370|
| Granitic rock         | 2375                     | 0...630            | 10      |
| Serpentinites         | 1226                     | 6...10000          | 1612    |
| Dolerines             | 555                      | 6...3126           | 831     |
| Chlorite rocks        | 135                      | 6...1612           | 227     |
| Apoultrabasite glimmerites | 324                  | 9...40             | 18...21 |
| Apodiorite glimmerites | 120                     | 12...50            | 23...30 |

### Table 1. Characteristics of magnetic susceptibility of rocks of the Ural emerald mines [2].

| Rock                  | Number of determinations | Measurements range | Average |
|-----------------------|--------------------------|--------------------|---------|
| Amphibolites          | 3646                     | 0...302            | 25      |
| Gabbro                | 800                      | 0...126            | 35      |
| Diorites              | 3370                     | 0...2520           | 21...370|
| Granitic rock         | 2375                     | 0...630            | 10      |
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| Apodiorite glimmerites | 120                     | 12...50            | 23...30 |
the same time, the faces under study were uneven (rough), and the gap between the device and the surface under study was from 0.3 to 0.7 mm, 0.5 mm on average. Since the PIVM-M device measures the apparent magnetic susceptibility $k'$, the transition to the true magnetic susceptibility value $k$ is realized by the formula $k = k' / (1 - 0.5k)$. Since all obtained values of apparent magnetic susceptibility are less than 0.1 ($k' \leq 0.1$ SI units), then it was considered to be $k = k' \[11\]$. Due to irregularities of the face walls, i.e. an "outshot-lobe" difference, as a result of which the gap between the measured surface and the flat surface of a transducer is 0.5 mm on average, the unevenness-correction factor of 1.41 was introduced to calculate the magnetic susceptibility. Table 2 shows the measurement data of magnetic susceptibility in the underground mine.

Methods of studying the electrical resistivity of rocks and objects of study

The electrical resistivity of rocks is carried out both using samples in a laboratory and in natural occurrence. This kind of work has already been done in laboratory setting but with other species of rocks \[12, 13\]. We used standard samples in the form of cubes of size $24 \times 24 \times 24$ mm, the composition of which was examined using the binocular enhancer MBS-10 for studying the electrical resistance. The measurements were carried out along three axes since almost all samples have anisotropy. Table 3 shows the average measurement data for different axes. The teraohmmeter E6-13A was used for working. The measurements were carried out according to the method described in \[14\]. In addition, Table 3 shows the average data of magnetic susceptibility measured along three axes using the same samples in laboratory setting (PIMV-M device).

Discussion of results

The average values of magnetic susceptibility of various rocks and ore complexes of the Mariinsky emerald-beryllium deposit are close (with the exception of serpentinites). The unevenness in magnetization intensity of rocks indicates the connection of their magnetic properties with accessory minerals that are found in them. In serpentinites, magnetite Fe$_3$O$_4$ (magnetic susceptibility is $4 \ldots 25$ SI units) is most common, and chromite is found. In diorite porphyrites – pyrrhotite Fe$_7$O$_8$ (magnetic susceptibility...
Table 2. Average data for magnetic susceptibility of the main rocks of the Mariinsky field obtained directly from measurements in an underground mine.

| Names of rocks             | Number of measurements | The average $\chi$, SI units · 10^{-4} | The average, taking into account the coefficient 1.41, SI units |
|----------------------------|------------------------|----------------------------------------|-------------------------------------------------------------|
| Serpentinites              | 25                     | 7.2                                    | 10.2                                                        |
| Talc schists and rocks     | 39                     | 3.4                                    | 4.8                                                         |
| Diorite porphyrite and quartz diorite | 62               | 5.2                                    | 7.3                                                         |
| Tremolite-actinolite schists | 13                 | 3.1                                    | 4.4                                                         |
| Chlorite schists           | 7                      | 2.7                                    | 3.8                                                         |
| Quartz-plagioclase veins   | 10                     | –                                      | –                                                           |
| Micaceous assemblage       | 43                     | 1.5                                    | 2.1                                                         |
| Carbon-bearing-siliceous shales | 10               | 5                                      | 7.1                                                         |

Table 3. Characteristics of the main host rocks and ore complex of the Mariinsky deposit.

| Sample number | Rock                  | Texture   | Mineral composition                                      | Peculiar properties                                   | Magnetic susceptibility, SI units | Electrical resistivity, MOhm |
|---------------|-----------------------|-----------|----------------------------------------------------------|--------------------------------------------------------|----------------------------------|-------------------------------|
| 1A            | Quartz-plagioclase     | Massive   | Quartz – 80 %, plagioclase – 20 %, sulfides (less than 1 %) | Sulphide mineralization in gray quartz                | 0                               | 900 000                       |
| 1B            |                       |           |                                                          |                                                        | 900 000                          |                               |
| 2A            | Glimmerite            | Schistic  | Bastonite                                                | Occasional ore inclusions                             | 2.4 · 10^{-4}                   | 200 000                       |
| 2B            |                       |           |                                                          |                                                        | 320 000                          |                               |
| 3A            | Glimmerite            | Massive   | Light-colored micas sulfides (less than 1 %)             | Small sulphides are distributed unevenly              | 4.3 · 10^{-4}                   | 100                           |
| 3B            |                       |           |                                                          |                                                        | 95                              |                               |
| 4A            | Glimmerite            | Stratified| Brown-colored mica – 90%, feldspar – 10 %                | Feldspar grains in glimmerite                         | 2.9 · 10^{-4}                   | 340                           |
| 4B            |                       |           |                                                          |                                                        | 180                             |                               |
| 5A            | Serpentinite          | Massive, eutaxic | Serpentine – 90 %, talc – 10 %                         | Ore mineral is not visible                            | 1.7 · 10^{-4}                   | 25 000                        |
| 5B            |                       |           |                                                          |                                                        | 25 000                          |                               |
| 6A            | Plagioclase gabro      | Massive, spotted | Amphibole – 80 %, feldspar – 20 %              | Ore and sulphide mineralization is not detected       | 1.7 · 10^{-4}                   | 27 000                        |
| 6B            |                       |           |                                                          |                                                        | 28 000                          |                               |
| 7A            | Quartz-muscovite rock | Massive, eutaxic | Quartz – 20%, light-colored mica – 0%, brown-colored mica – 50% | Rare small, sulphide mineralization                    | 5.0 · 10^{-5}                   | 900 000                       |
| 7B            |                       |           |                                                          |                                                        | 450 000                         |                               |
| 8A            | Talc-serpentinite      | Knotty    | Serpentine – 68 %, talc – 30 %, ore mineral – 2 %       | Pulverous ore inclusion                               | 1.8 · 10^{-4}                   | 400                           |
| 8B            |                       |           |                                                          |                                                        | 450                             |                               |
| 9A            | Talc                  | Massive, schistous | Talc – 95 %, ore mineral (4-5 %)                 | Ore mineral is distributed evenly along stratification | 6.2 · 10^{-4}                   | 300 000                       |
| 9B            |                       |           |                                                          |                                                        | 170 000                         |                               |
| 10A           | Phlogopite-plagioclase | Knotty    | Plagioclase – 60 %, brown-colored mica (40 %)            | Mica evaluates along cracks in plagioclase vein       | 5.0 · 10^{-5}                   | 70 000                        |
| 10B           |                       |           |                                                          |                                                        | 80 000                          |                               |
| 11A           | Silicious-carbon-bearing rock with mica | Massive | Mica – 80 %, Carbon-bearing substance – 14 %, ore mineral – 1 % | Single grains of ore mineral                          | 3.2 · 10^{-4}                   | 0.36                          |
| 11B           |                       |           |                                                          |                                                        | 0.24                            | 700                           |
| 12A           | Talc-actinolite        | Massive   | Actinolite – 70 %, talc – 15 %, phlogopite – 13 %, ore mineral (about 1-2 %) | Single grains of ore mineral are distributed unevenly | 1.4 · 10^{-4}                   | 90 000                        |
| 12B           |                       |           |                                                          |                                                        | 17 000                          |                               |
| 13A           | Glimmerite            | Schistous | Brown-colored mica – 100 %, ore mineral is not identified |                                                        | 2.0 · 10^{-4}                   | 50 000                        |
| 13B           |                       |           |                                                          |                                                        | 30 000                          |                               |
is $10^{-1}$ ... $10^{-3}$ SI units), ilmenite (magnetic susceptibility is 4...25 SI units) and titanite (less commonly magnetite). There are magnetite, ilmenite, and titanite in talc, chlorite and tremolite-actinolite schists, which affect the overall magnetic susceptibility of rocks. Mica complexes mainly consist of phlogopite (magnetic susceptibility is $20 \cdot 10^{-3}$ SI units), but chromite, ilmenite, and titanite are rarely found in them. The content of accessory minerals in micas does not exceed two decimal places and three decimal places [15]. Sometimes fine-grained magnetite is found in apodiorite glimmerites, which increases the overall magnetic susceptibility of the samples.

| Sample number | Rock | Texture | Mineral composition | Peculiar properties | Magnetic susceptibility, SI units | Electrical resistivity, MOhm |
|---------------|------|---------|---------------------|---------------------|----------------------------------|-------------------------------|
| 14A           | 14B  | Massive | Plagioclase – 40 %, amphibole – 45 %, mica – 5 % | Single inclusions of ore mineral are noted. | $3.2 \cdot 10^{-3}$ | 2000 1750 |
| 15A           | 15B  | Schistous | Mica – 80 %, quartz – 15 %, | Ore mineral is not identified | $4.0 \cdot 10^{-4}$ | 300 000 400 000 |
| 16A           | 16B  | Massive, spotted | Serpentine – 96 %, ore mineral – 4 % | Ore mineral (veinlets) is unevenly distributed | $2.8 \cdot 10^{-4}$ | 310 360 2400 3500 |
| 17A           | 17B  | Massive | Serpentine – 90 %, ore mineral – 10 % | Ore mineral is distributed unevenly | $2.5 \cdot 10^{-3}$ | 25 000 18 000 |
| 18A           | 18B  | Massive, knotty | Amphibole – 35 %, plagioclase – 45 %, mica – 15 %, quartz – 5 % | Ore mineral is not identified | $1.5 \cdot 10^{-4}$ | 1600 2400 |
| 19A           | 19B  | Massive | Quartz – 100 %, | Ore mineral is not identified | 0 | 50 000 400 000 |
| 20A           | 20B  | Schistous | Talc – 75 %, chlorite – 20 %, ore mineral (less than 5 %) | Ore mineral (silt) is evenly distributed | $2.0 \cdot 10^{-4}$ | 9000 320 000 |
| 21A           | 21B  | Schistous | Mica – 75 %, fluorite– 25 % | Ore mineral is not identified | $1.7 \cdot 10^{-4}$ | 150 000 100 000 |
| 22A           | 22B  | Massive | Serpentine – 95 %, talc – 4 %, ore mineral – 1 % | Ore mineral (single grains) is distributed unevenly | $6.5 \cdot 10^{-4}$ | 320 000 20 000 |
| 23A           | 23B  | Massive | Talc – 45 %, Serpentine – 40 %, ore mineral – 5 % | Ore mineral (single grains) is distributed extremely unevenly | $1.5 \cdot 10^{-4}$ | 600 000 80 000 |
| 24A           | 24B  | Schistous | Talc – 65 %, mica – 34 %, ore mineral – 1 % | Ore mineral in the form of small grains | $2.2 \cdot 10^{-4}$ | 170 000 100 000 |
| 25A           | 25B  | Schistous | Amphibole 5-7%, feldspar – 65 %, mica – 25-30 % | Ore mineral is not identified | $1.3 \cdot 10^{-4}$ | 300 000 200 000 |
| 26A           | 26B  | Massive | Serpentine – 80 %, talc – 15 %, ore mineral (about 5 %) | Ore mineral (bunches) is distributed very unevenly | $4.0 \cdot 10^{-4}$ | 90 000 150 000 |
| 27A           | 27B  | Schist | Actinolite – 60 %, talc – 35 %, ore mineral (about 5 %) | Ore mineral (single grains) is distributed unevenly | $1.7 \cdot 10^{-4}$ | 110 115 |
| 28A           | 28B  | Schistic | Amphibole – 44 %, chlorite – 25 %, talc – 30 %, ore mineral – 1 % | Ore separation in the form of fine grains | $2.3 \cdot 10^{-4}$ | 32 40 2300 2200 |
| 29A           | 29B  | Knotty | Serpentine – 80 %, talc – 15 %, ore mineral (5 %) | Ore mineral (fine impregnation) is distributed along cracks and occasionally | $1.7 \cdot 10^{-4}$ | 4500 4700 |
| 30A           | 30B  | Knotty, eutaxic | Serpentine – 30 %, talc 65 %, ore mineral (5 %) | Ore mineral (single grains) is distributed extremely unevenly | $3.5 \cdot 10^{-4}$ | 55 000 320 000 |
susceptibility of these rocks. The magnitude of the magnetic susceptibility of quartz-plagioclase veins is below the measurement limit of the PIVM-M device ($k < 10^{-5}$ SI units) due to the absence of the main “magnetic minerals” (magnetite, pyrrhotite, ilmenite). The location of ore-bearing zones along the boundaries of the contacts of serpentinites with glimmerites makes it possible to identify zones of these contacts by magnetic susceptibility. Serpentinites have a greater magnetic susceptibility ($10^{-4} ... 10^{-3}$ SI units) than other rocks.

The works carried out by the authors in the mine of the Mariinsky emerald-beryllium deposit followed by laboratory studies showed that the main carrier rocks of beryllium mineralization (glimmerites and quartz-plagioclase veins) differ in magnetic susceptibility from other rocks of this deposit. Thus, the magnetic susceptibility of phlogopite schists ranges from $0.2$ to $2.3 \times 10^{-4}$ SI units. The magnetic susceptibility of plagioclase-quartz veins is equal to zero. The host rocks (serpentinites), in turn, have a magnetic susceptibility $30 \times 10^{-4}$ SI units. The obtained values of apparent resistivity also show the difference between unproductive vein complexes and those containing the ore component (beryl). In addition, there is a dependence of the electrical resistance values of hyperbasites on the degree of metamorphism:

- peridotites slightly serpentinized – $1600 ... 2400$ MOhm, sam. No 18;
- serpentinites – $3500... 25,000$ MOhm, sam. No 5, 16, 22;
- serpentinite-talc-carbonate rocks – $400 ... 450$ MOhm, sam. No 8;
- mica veins – $30,000 ... 320,000$ MOhm, sam. No 13, 2.

According to the results of the work, it was found that mica veins are found only in hyperbasites of low-resistivity. It is obvious that the decrease in electrical resistance is due to a complex of metamorphic processes. Mica veins are distinguished among host rocks by high electrical resistance, which is caused by their composition – these are schists consisting mainly of phlogopite with mica scales along schistosity. According to the data of parametric measurements of samples in early studies [2], the average specific electrical resistance of mica veins is $70,000$ Ohm $\cdot$ m, which is significantly higher than the electrical resistance of host rocks. A similar situation is observed in our research.

If we jointly construct graphs (Fig. 2) of magnetic susceptibility and electrical resistance for various types of rocks found in the Mariinsky deposit, then it can be noted that the separation of mica veins only according to magnetic susceptibility is impossible due to a large number of nonmagnetic rocks. The separation of productive mica veins only according to the electrical resistiv-
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Conclusions

The method proposed by the authors is based on difference in magnitude of the magnetic susceptibility and electrical resistance in the ore and ore-free sites. For each of the parameters studied, it is impossible to indicate unequivocally the degree of mineralization; however, their complex use and interpretation allow us to identify signs by which ore zones can be distinguished in the field.

The use of this express method at the site (in mine workings) will allow for prompt determination of the location of serpentine bodies and t alc schists, in contact of which micaceous complexes productive for beryllium mineralization are often found.

This method (with a large set of statistical data) will allow us to confidently distinguish productive apohyperbasite gimmersites from unproductive apodiorite and other micaceous complexes at the Mariinsky deposit.

Acknowledgements

This work was supported partly by the Ural Branch of the Russian Academy of Sciences Program called “Development of petrophysical methods for studying rocks and ores in order to study the geological structure of deposits and improve their prospecting and exploration methods” (Project 18-5-5-52) and the state program called “Reconstruction of the formation conditions complexes of the Ural-Mongolian fold belt and associated mineralization (“State number AAAA-A18-118052590033-3)."

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The article was received on November 13, 2018
Геофизические критерии выделения продуктивных слюдитовых жил Мариинского изумрудно-бериллиевого месторождения (Средний Урал)

Михаил Петрович Попов1, 2, Олег Петрович Пелешко3, Евгения Анатольевна Баженова4, 5, Виктор Сергеевич Иванченко6, 7, Владимир Васильевич Бахтерев8

1Уральский государственный горный университет, Россия, Екатеринбург
2Институт геологии и геохимии им. А. Н. Заварицкого УрО РАН, Россия, Екатеринбург
3АО «Мариинский рудник», Россия, Свердловская область, г. Асбест, пос. Малышева
4Институт геофизики им. Ю. П. Булашевича УрО РАН, Россия, Екатеринбург

Актуальностью работы является разработка новых методов оперативного выделения (обнаружения) рудных тел непосредственно в подземном руднике месторождения. Измерения были проведены как на специально подготовленных образцах в форме кубиков одного размера, так и в условиях естественного залегания.

Цель работы — изучение магнитной восприимчивости и электросопротивления основных вмещающих пород и рудного комплекса (изумрудоносных слюдитов и кварц-плагиоклазовых жил с бериллом) на самом известном уральском изумрудно-бериллиевом месторождении — Мариинском.

Методология исследования: для исследований магнитных свойств типовых пород и рудных тел Мариинского месторождения непосредственно в подземном руднике использовался измеритель магнитной восприимчивости полевой ПИМВ-М с диапазоном измерения 1·10⁻⁵…1 ед. СИ. Относительная погрешность измерения не превосходит ±10% в диапазоне 10⁻⁵…1 ед. СИ. Измерение проводилось путем плотного прикладывания плоской поверхности первичного преобразователя прибора к стенке забоя в литологически однородный участок с последующим измерением и записью полученного значения в полевой журнал документации горных выработок.

Выводы. Показана принципиальная возможность создания новой экспресс-методики выделения продуктивных слюдитовых жил в скважинах и забоях по нововременному измерению магнитной восприимчивости и электросопротивления пород непосредственно в процессе добычных работ в подземном руднике.

Ключевые слова: Урал, магнитная восприимчивость, электросопротивление, слюдиты, кварц-плагиоклазовые жилы, изумрудно- бериллиевые месторождения, Уральские изумрудные копи.

Работа выполнена частично при поддержке Программы УрО РАН «Разработка петрофизических методов исследований горных пород и руд с целью изучения геологического строения месторождений и совершенствования методов их поиска и разведки» (Проект 18-5-5-52) и государственной программы «Реконструкция условий формирования габбро-ультрабазитовых комплексов Урало-Монгольского складчатого пояса и связанного с ними оруденения» (Гос. номер AAAА-A18-118052590033-3).

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