Way of ten times increase efficiency of geological branch and row stok safety of mankind

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Abstract. *Because of exhaustion of stocks of deposits on the Earth's surface, new deposits can be discovered mainly in depth. But confidence of deep earth prognosis of industrial deposits in the modern geology is for most of the minerals just 5-10% (90-95% error!). It threatens the world economy and development of the mankind. To solve this crucial issue, the author developed and successfully used for 40 year a new system of high-precision deep earth prognosis of deposits [3]. This system of prognosis makes the mining and geological industry more than 10-fold efficient, provides mineral and raw-stock supply security and creates the basis for efficient development of civilization.*
Key words: *deposits, deep earth prognosis, high confidence of prognosis, discovery of deposits.*

Introduction. At present probability of discovering surface deposits diminished sharply, and the problem of deep earth prognosis of deposits for constant replenishment of departed ore reserves was brought to the foreground quite a time ago. The most important task for most minerals shall be also targeted search of large and rich deposits. However, at present the confidence level of deep earth prognosis for most minerals is only 5-10%.

To cardinally increase efficiency of geological works, the author *developed a principally new system of prognosis of deposits which allows, on basis of complex researches (geological, geophysical, geochemical and thermobarogeochemical) on daylight surface (and prior beginning of mining-drilling survey works), to receive the precise quantitative data concerning the following: 1) what is probability of finding of an industry-scale object in this very place (problem of confidence level of the prognosis); 2) how to bring this confidence level to the value over 80%; 3) size of the object of prognosis; 4) reserves of the mineral in them; 5) content of the mineral; 6) quality of the mineral raw stock; 7) cover thickness of ore body [2,3].*

Development of the new system of prognosis was conducted on territories of 15 ore fields and 40 deposits of solid and liquid mineral fossils: phlogopite, muscovite, graphite, lithium, rubidium, cesium, tantalum, niobium, beryllium, tin, quartz stock, potassium and sodium-alumina feldspar stock, rhinestone, facing stone, hard endurance break-stone, underground water sources.

When developing the system of quantitative prognosis, a big *complex of research methods* was used: detailed geological, geophysical, geochemical and thermobarogeochemical survey and other methods: 20 research methods were used in total.

1) The basic research method was *detailed geological plotting according to formally unambiguous technique* developed by B.M. Ronenson [4]. In this technique, all stages of geological plotting are based on a strict (statistical) base. It is only this technique which eliminates ambiguity of plotting, which is usual for modern geology, especially for complicated metamorphic complexes, when principally different geological maps are composed by different organizations for one and the same area. As a results of works in various regions of Russia: in Aldan area of Yakutia, in Karelia, in Murmansk Region and in Urals, detailed geological maps were composed on 19 ore fields and deposits, with documentation of 20 quarries, 20 running kilometers of underground mine roadways and 30 running kilometers of drill hole cores, geological plans of 12 mining planes were composed. It was detailed geological maps by technique of B.M. Ronenson which allowed increasing the confidence level of deep earth prognosis up to 50-70% (instead of 5-10% usual in the world's geology).

2) Geochemical survey and special geochemical researches were conducted on basis of a confident geological map with obligatory accounting of mineralogical-geochemical peculiarities of rocks. For instance, there is an example of the prognosis (developed by the author) of the largest rare metal deposit on Kola peninsula (40% of world's reserves of cesium, and also industrial reserves of lithium, rubidium, tantalum, niobium and beryllium) [3], on the area which earlier was rejected at the conventional (standard) geochemical survey of 1 : 25 000 scale made without taking into account of mineralogic-petrographic peculiarities of rocks.

3) Thermobarogeochemical researches are conducted with use of new research-estimation criteria (developed by the author) on basis of the new theory of fluid ore formation developed by the author [2, 3]. These new criteria allowed 10-forl increasing of practical efficiency of thermobarogeochemical methods.

Principles of quantitative local prognosis of mineralization

1) Local prediction of mineralization is *quantitative* prediction, i.e. as a result of the prognosis amounts and reserves of ore bodies, content and quality of the mineral shall be estimated in quantitative terms; confidence of the prognosis shall be estimated too.

2) Development of research-estimation criteria is performed *on a reference area or a group of areas of one industrial-genetic type* where quantitative relations between criteria to be researches are established, on one hand, and between industrial parameters, from the other.

3) Local prediction of mineralization is performed *on the complex of research-estimation criteria*, the leading among which is the geological criterion. Geophysical, mineralogic-geochemical, thermobarogeochemical and other criteria are applied as supplementary ones (depending on certain conditions).

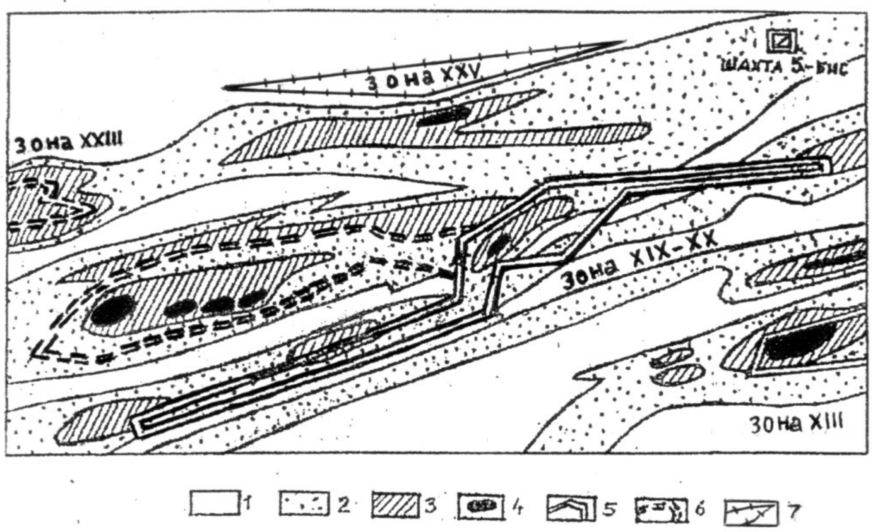
Criteria of quantitative estimation of ore bodies

1) Confidence of prognosis. To define the level of confidence, the concept of "search probability" [3] was introduced. The value of 80% was selected as the optimal level of "search probability". To achieve this level, to the basic (geological) search criterion contributing to 50-70% of "search probability", the geochemical criterion was added on deposits of rare metal pegmatites, the geophysical criterion was added on deposits of graphite, and the thermobarogeochemical search criterion on deposits of muscovite and phlogopite.

2) Size of ore bodies can be defined by the size of researched search-estimation criteria. As it can be seen in fig. 1, contours of decreptometric anomalies on the mining plane 1130 meters of the Southern deposit at Aldan exactly coincide with those of industrial phlogopite-bearing bodies XIII, XIX-XX and XXIII. At the same time, in the northern part of the plane 1130 meters, we detected one more decreptometric anomaly wherewith neither known с которой не связана известная phlogopite-bearing zone is connected. Inferred resources of phlogopite in this area were estimated as 5000 tons. According to our prognosis, under this anomaly at the depth of 60 meters, a new phlogopite-bearing zone was detected which received number XXV (see fig. 1). According to the data of underground mine roadways, resources of phlogopite in this zone were estimated as 5400 tons, which with a large precision (97%) confirmed definition of the inferred resources.

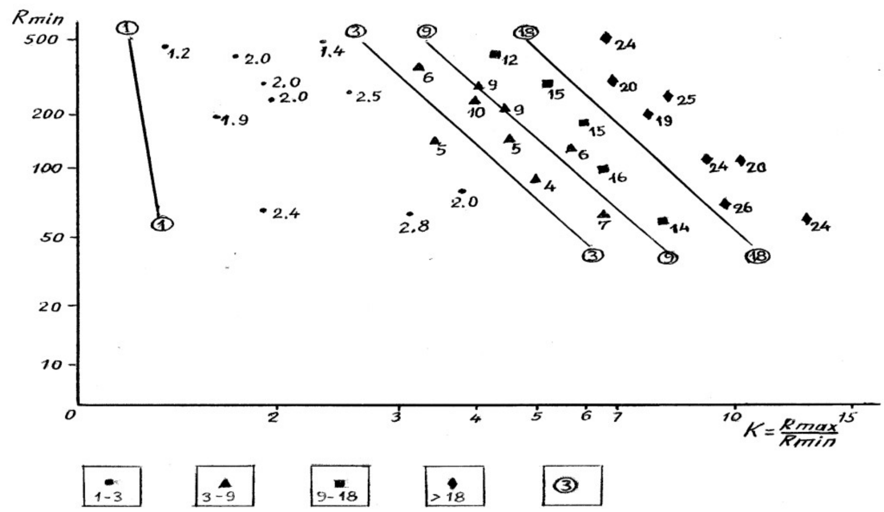
It should be noted that the phlogopite-bearing zone XIX-XX shown in fig. 1, with phlogopite resources 40 000 tons (the largest phlogopite-bearing zone in the world, as on the date of its discovery) was also discovered by the prognosis of the author, on basis of the same search-estimation criteria.

Fig.1. Scheme of decreptometric anomalies and location of phlogopite-bearing bodies on the plane 1130 m of the Southern deposit (Aldan) [3].
1 – 3 – zones with values of "decreptometric search factor" Kd: 1 – 0-7%, 2 – 7-20%, 3 – 20-35%; 5 – 6 – phlogopite-bearing zones: 5 – on the plane 1130 m, 6 – projection onto plane 1130 m from plane 1089 m; 7 – projection onto plane 1130 m of the phlogopite-bearing zone XXV detected by the author's prognosis, from depth 1070 m.



3. Mineral values. On the reference nomographic chart (fig. 2) built with use of the method of "electro anisotropy" developed by the author (RF patent, 1992) we can see that by means of "electro anisotropy factor" (Ka) defined by the data of electric survey researches on daylight surface, one can determine graphite values, including those in depth, with accuracy 89%.

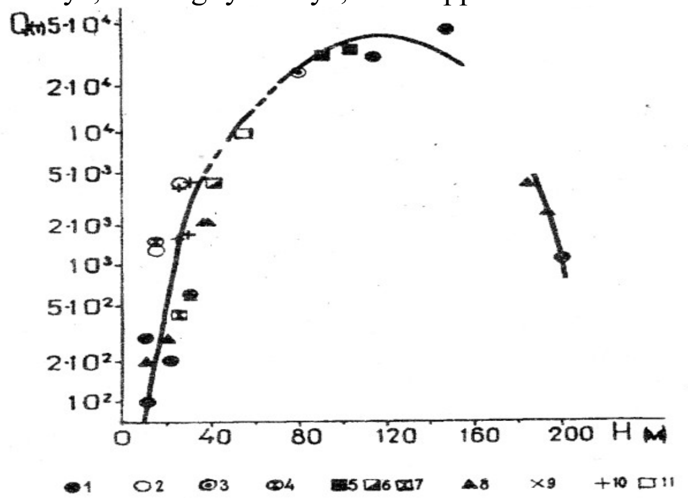
Fig. 2. The reference nomographic chart of interrelations between graphite values of interrelations between graphite values in the ore, minimum apparent resistance (Rmin) and "electro anisotropy factor" (Ka = Rmax/Rmin) at Chebere deposit (Aldan, Yakutia). Graphite values (contents) in ore: 1-3 – lean ore, 3-9 - medium-grade ore, 9-18 – rich ore, over 18% - very rich ore.



Reserves of minerals. Fig. 3 shows a plot "reserves of industrial-grade phlogopite (Qт) vs. amplitudes of ore control disharmonic folds (Hм) at Aldan deposits. Here we can see that small-size folds (amplitude up 40 m) and large-size folds (amplitude over 180 m) are controlling small bodies with reserves of phlogopite up to 5000 tons. The largest and richest bodies with reserves of phlogopite over 20000 tons are controlled with medium-size (optimal) folds with amplitude 80-150 m.

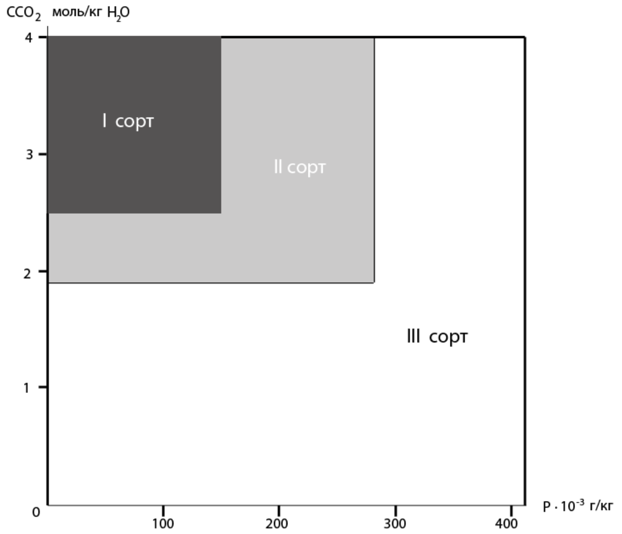
With use of the shown plot, by the author's recommendations, 6 phlogopite-bearing zones were discovered with total reserves 68000 tons, including the world largest (as on the date of discovery) zone XIX-XX of the Southern deposit with reserves of phlogopite 40 000 tons (see fig. 1).

Fig. 3. Relation of reserves of phlogopite-bearing zones (Qт) vs. amplitudes of ore control disharmonic folds (Hм) at Aldan deposits: 1 – the Southern, 2 – Fedorovskoye, 3 – Ozernoye, 4 – Burdykhlayskoye, 5 – Bezymyannoye, 6 – Beliberdinskoye, 7 – the Northern, 8 – Tabornoye, 9 – Legliyerskoye, 10 – Upper Emeldzhakskoye, 11 – Poiskovoye.



5. Quality of minerals. Quality of minerals is of special importance for non-metallic minerals, and for crystal raw stocks it is often the most essential qualitative and economic characteristics. For ad-hoc estimation of industrial significance of researched areas, the author (with the help of his assistants) developed express methods of definition of various qualitative characteristics of different non-metallic minerals: diopside, quartz and field-spar stock materials, graphite, phlogopite, facing stone, underground water sources. In fig. 4 we can see that for quartz materials there is the definite dependence between their quality grade, total gas saturation and CO_2 concentration in gas-liquid inclusions.

Fig. 4. Dependence between quality grade of quartz stock materials, gas saturation (P) and CO_2 concentration ($C^{CO}{}_2$) (inventor's certificate, 1993, authors: F.M. Royzenman et al.).



Validation of deposits anticipating. As a result of checking of 76 prognoses made by means of the specified quantitative system, 70 industry-grade bodies of 18 various solid and liquid mineral fossils were discovered, estimated and surveyed: potassium and sodium-alumina feldspar stock materials, phlogopite, muscovite, graphite, quartz stock materials, lithium, rubidium, cesium, tantalum, niobium, beryllium, tin, facing stone, hard endurance break-stone, underground water sources. Among the mentioned objects, four are of world significance (the world's richest deposit of the most high-quality graphite and others). The total value of mineral raw stocks in depth is USD 17 billion. The value of excavated raw stock: USD 3 billion. *Efficiency of industrial estimation of deposits with use of the new prediction system increased (as compared to the conventional technique) by 11-18 times. Amounts of search drilling were decreased by max. 10 times.*

Conclusions

1. The system of high-precision quantitative prognosis allows estimation, in quantitative terms, of probability of finding an industry-grade object and achieving confidence of prognosis up to 80-90%.

2. This system also allows, on basis of complex researches on the daylight surface and prior search-survey drilling, identifying in depth all industrial parameters of ore bodies: their sizes and reserves of minerals, their content and quality, and the depth of the ore body setting.

3. The new technique allows intentional prediction of large and rich deposits (including those in depth).

4. The conducted approbation of the new system allowed discovering, estimating and surveying 70 industry-grade bodies of 18 various solid and liquid mineral fossils, including 4 deposits of the world level.

5. The quantitative prognosis system allows increasing efficiency of mineral and stock material surveys by more than 10 times.

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