Mining production negative impacts on the environment in Baikal natural territory

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Abstract. Mining production impact factors on the state of the natural environment are diverse and complex. However, environmental and social consequences are even more complex. They represent a great danger, since they can cause irreversible processes. Therefore, taking into account the factors and consequences of the impact of this large resource-exploiting area of material production is extremely important for predicting the effects of technogenesis associated with the development of the subsoil, for taking measures to prevent the growing influence on the state of natural complexes both in the areas of natural-technical geosystems and at the level of the entire region.

The environmental impacts of mining are varied. Among them, a significant place is occupied by the change of the relief under the influence of mining - geotechnomorphogenesis, in the terminology of L.L. Rozanov [1]. Especially noticeable changes in the topography are caused by open-pit mining. Intensification of gold mining, especially of the alluvial kind, intensified the impact on nature in the 1830s, which was reduced to the movement of large masses of alluvial and terraced sediments, destruction of the soil layer and changes in the temperature regime of permafrost.

On the territory of the Republic of Buryatia, gold mining is mainly carried out using the open hydraulic method. The actual volume of gold extracted from the depths is small. The most important consequences of the hydraulic method of extraction of this metal are as follows: violation of the integrity of soil and vegetation cover, intensification of erosion processes, changes in the structure and productivity of floodplain complexes, the emergence of new landforms, an increase in soil albedo, a change in their filtration properties, geocryological regime, reduction of groundwater levels, pollution surface water suspension, clogging and deformation of river beds [2].

Modern prospecting cooperatives use almost the same technology that has been used since the mid-60s. They are equipped with modern bulldozers, dump trucks, hydraulic monitors, pumping stations and other machines. A large artel processes millions of cubic meters of rock mass per year. So, Buryatzoloto company processed about 3 million m$^3$ of rock mass.

One of the significant negative factors affecting the mining of alluvial deposits was the contamination of mercury enrichment tailings, which was used to extract gold from the concentrate by amalgamation (Irokinda mine).

In general, the level of the negative impact of open gold mining on the environment remains significant due to the involvement in the development of deposits containing large amounts of muddy-clay inclusions in sands and overburden; depreciation of industrial and production assets; lack of
opportunities to introduce new energy- and resource-saving technologies into the mining industry; the lack of interest of subsoil users in the acquisition, operation and maintenance of equipment for the cleaning of discharges and emissions of pollutants into the environment, since the economic costs of the above are significantly higher than the amount of fines required by law for environmental damage [3].

The long period of activity of the Dzhidinsky Mining and Processing Plant led to focal (the region of the plant’s activities) destruction of the floodplain-valley geosystems of the region, accumulation of large volumes of toxic tailings of enrichment, pollution of soil, surface and groundwater. The environmental situation in the area of activity of the plant can be characterized as a crisis.

The Bilyutinsky mine of chemically pure limestone is characterized by the largest mechanical disturbances of the natural environment. As of January 1, 1717, the volume of extracted and enclosing rocks for it amounted to 24.6 million m³, the volume of special dumps and tailing dumps - 1.2 million m³, the area of disturbed lands - about 180 hectares.

Mining of other minerals (fluorspar, coal, granulated quartz) was relatively small in terms of mining and processing of raw materials. But a long time of work of many of them led to the accumulation of waste (overburden and waste rock, tailings), to the development of underground space, to pollution of the adjacent territory.

To assess the significance of subsoil resources in determining the strategy of environmental management regimes, mining enterprises have been identified (with the exception of some facilities for the extraction of natural building materials). At the same time, the objects that mine the mineral by the open (quarries, dredge and hydraulic polygons) and underground (mines, adits) method are identified. With the open method, first of all, the surface layers of the lithosphere are disturbed, both due to the formation of workings, and the occupation of vast areas of land for overburden and containing minerals, there is also dust and dust and gas pollution of the atmosphere, violation of the mode and quality of surface and groundwater. In large areas around the quarries formed depression funnels, etc. Underground work is accompanied by deformation of the earth's surface, violation of the regime of groundwater, dust and gas pollution of the atmosphere and chemical pollution of surface and groundwater, etc. [4].

As a generalizing indicator characterizing the scale of mechanical disturbances of the natural environment, data on the volumes of rock mass production for the entire period of exploitation of deposits with the underground method of their development and the number of disturbed lands were used with the open method.

To characterize the scale of the chemical impact of mining enterprises on the environment, the latter are characterized by the environmental hazard of the extracted raw materials and the reagents used in their enrichment: high production (ore gold, tungsten, molybdenum, fluorite), medium and low environmental hazard (table 1) are highlighted.

| Name of the enterprise, field | Mineral production extracted | Method of operation | Volume of rock mass, million tons, mining allotment, hectare | Environmental hazard of mining production |
|--------------------------------|-------------------------------|---------------------|-------------------------------------------------------------|------------------------------------------|
| Holtoson Mine                  | tungsten                      | underground         | less than 100 million tons more than 1000 ha                 | High                                     |
| Inkursky quarry                | tungsten                      | open                | more than 1000 ha                                            | High                                     |
| Holbol’dzhisinsky cut          | brown coal                    | open                | 100-1000 ha                                                  | Medium                                   |
| Sangino section                | coal                          | open                | less than 100 million tons less than 100 ha                  | Average                                  |
| Mine Gusinoozerskaya           | brown coal                    | open                | more than 1000 ha                                            | Average                                  |
| Tugnus Section                 | coal                          | open                | less than 100 hectares                                        | Low                                      |
| Gryaznukhinsky cut             | fusible clay                  | open                |                                                             |                                          |
Along with the problems of mountain wastes, the issues of reclamation of disturbed land mining are among the serious environmental problems. This is due to the fact that millions of hectares of land are directly affected by mining developments, as a result of which the existing biogeocenotic bonds are disturbed, the relief of the earth’s surface and lithological basis are changed, the soil and vegetation cover is completely destroyed. Therefore, the problem of land reclamation is becoming increasingly urgent, i.e. restoration of productivity and aesthetic value of disturbed landscapes. Nowadays, land reclamation is becoming an integral part of the protection and reproduction of natural resources in general, protection and reproduction of the land fund, in particular [5].
These measures are also necessary in the Republic of Buryatia, since the main share in the area of land use among the industries falls on the mining sector. According to Rostekhnadzor, the area of land allocated for the development of mineral deposits is 4.5% of the total land fund of the republic.

The area of land disturbed by mining increases every year, while the percentage of their reclamation is reduced. In 2015, about 300 hectares were disturbed, 130 hectares of which were recultivated, and in 2017 only 123 hectares were recultivated. According to Rostekhnadzor, as of 01/01/17, the area of disturbed land was 5306 hectares, only 1,100 hectares of which were restored.

Gusinozerskaya mine working for more than 50 years has been liquidated, but it has left waste heaps on an area of 5.3 hectares, rock heaps - 8.7 hectares, with volumes of 940 thousand m$^3$ and 330 t m$^3$, respectively, and disturbed lands of 84.2 ha. To date, reclamation work has not been fully funded and is not actually carried out.

The greatest concern is caused by the state of the land in the gold mining industry, which is the most developed branch of the mining industry of the Republic of Buryatia. Reclamation of lands disturbed by mining operations carried out by Iskra, Rassvet, Voskhod, Zarya, Sever, Eleninsky, Bagdarinskaya GRE, Tsiipikansky Priisk, GGTP Tsiipikanskaya Party and others, located on the Vitim Plateau, is less than 10% of the total area of disturbed land. In recent years, this work is practically not carried out. This is due to the lack of funds for the mining and technical reclamation of disturbed lands and the technical conditions associated with the recycling of gale-effel dumps for the extraction of gold in the waste deposits. On this occasion, the administration of the Bauntovsky District issued a decree permitting the temporary non-restoration of disturbed lands.

In addition, the district administration satisfies the requests of subsoil users in postponing the dates of mining and technical recultivation to the fullest extent, and allows it to be carried out only after the alluvial gold has been fully developed, which contradicts the requirements of the schedule for the mining project; and the management requirements of Rostechnadzor are not perceived by subsoil users as an indication of rigorous implementation.

If the mining allotment is provided to an enterprise, as a rule, for the development of the entire mineral deposit, it is proposed to provide land allotment (in order to restore a single order) in parts of the developed deposit (as mining engineering reclamation of disturbed lands takes place in terms and sequence) works established by the project and agreed by the management.

Work on land reclamation of lands disturbed by the development of placer gold deposits in the Zakamensky district on an area of 86 hectares, as well as in the Khorinsky and North Baikal regions, which ceased land restoration work, was postponed for an indefinite time period. The subsoil user “Baikalgeo”, conducted the development of the alluvial deposit of Lower and Upper Kindikan districts under the contract with the Irkutsk firm “Agrodorspetsstroy”, ceased mining operations and did not fulfill the requirements, as a result of which about 100 hectares of disturbed land remain unrepaid.

This is part of the practice and is subject to mandatory execution (where it is possible in the development of deposits according to the transport scheme, the placement of overburden rocks) the requirement of the district to place the overburden in the spent quarry space. As a result of fulfilling this requirement, it suffices to give an example. The labour artel "Karalon" achieved a reduction in the requested land for the development of subsoil land to 3 and 1.6 hectares, instead of 46 and 38 hectares.

The proposals and requirements of Rostechnadzor used by the subsidiary enterprises and measures using advanced and progressive mining technical reclamation schemes, rational disposal of production waste and overburden, computational justifications for areas rejected from land use and other measures made it possible to reduce the areas of land requested (under a license for subsoil use) for the development of Hara-Khuzhirskoye brown coal deposit - on 131 hectares, alluvial gold deposits by Aunik and Ivanovo Spit districts, respectively, 167 and 1184 ha, Samokut and Side districts - 72 hectares.

Such work is carried out both at the stages of consideration of projects on the development of mineral deposits, on mining and technical recultivation of land and plans for the development of mining operations, and in the process of developing the subsoil. When developing the subsoil in the watershed...
zone of Lake Baikal, mining and technical reclamation projects of disturbed lands are usually drawn up separately from field development projects.

Most of the deposits for the development of common minerals with a depth of up to 5m fell out of sight, and therefore the state of mine reclamation of lands disturbed by development, mainly near-ground deposits, is not monitored during the construction and repair of roads of the Republic of Buryatia.

The situation is better on coal mines, for example, in Tugnui. The fertile layer of earth, rich in humus, taken at the opening of the deposit, is stored separately from the overburden rocks, accumulated and stored for use in carrying out recultivation and restoring the fertility of disturbed lands. The fertile layer of land (with a potential yield of up to 40 kg / ha) is partially exported to the fields and used for its intended purpose. In total, over the entire period of development of the Olon-Shibirskoye field, which is operated by the Tugnuy open-pit mine; 520 thousand m$^3$ of fertile soil have been accumulated.

An example of a careful attitude to land resources is the work of JSC “Timluycement”, which annually transfers to use for planting potatoes 1-2 hectares of restored fertile land disturbed by developments in clay mining.

Inventory materials of disturbed lands and current records show that strict control over the work on land reclamation and thorough examination of the specialists of enterprises on the rules and technical standards of the reclamation works, as well as annual supervision of the reception and transfer of the restored lands are necessary. For violation of certain items, the practice of depriving a license of a subsoil user should be introduced, and in extreme cases - suspension of mining operations.

In this regard, there is a need to make changes to the procedure for the provision of mining allotments for the development of mineral deposits in the instruction, also to amend the instruction on the procedure for monitoring the geological environment. These changes make it possible to organize a service for monitoring the geological environment on a legislative basis in the Baikal region in full and sufficient form for the formation of GIS.

To resolve the issue of land reclamation, it is necessary to apply the experience of both foreign countries and domestic one. For example, we can apply the experience of Germany, where the restoration and reuse of land left by the mining industry is a challenge, especially in the Ruhr area. Coal mining in this area has been going on for over a hundred years. Vast areas were disturbed by deep coal mines, coal preparation plants and waste dumps. The land restoration project consists in the fact that for these purposes it is necessary to attract capital from outside, i.e. commercial and non-profit organizations. This project finances 80% of the federal state of North Rhine-Westphalia and the European Community, estimated at between 30-35 million US dollars. They are distributed as follows: 5% for management, 11% for planning, 1% for public relations, 47% for rehabilitation, 36% for redevelopment [6].

Solving this problem requires a whole combination of the following complex problems:

- environmental, for example, cleaning of underlying soil and sanitation of the territory;
- financial, for example, raising public and private funding for the redevelopment of the territory;
- structural, for example, attracting industrial enterprises with high development potential.

Krupskaya L.T. [7] proposes a system of practical measures for the recultivation of land disturbed by mining, including schemes for mining and remediation. The system has as a scientific basis a conceptual position on the possibility of accelerated formation of a soil profile through humus reclamation, the use of highly productive communities of plants, animals and microorganisms, biotechnology, and selective dumping. The recommended system of measures is considered as an integral part of a single technological process.

Restoration of the suitability of industrial disturbed lands is a problem where a universal solution cannot be offered and where there are no ready-made strategic concepts at hand. This is a problem that requires an interdisciplinary approach and innovative ideas [8].
Extraction from the subsoil and the use of minerals with specified indicators can no longer be recognized as the ultimate and sole purpose of their development. Just as it is customary to reclaim the earth’s surface within the mining allotment as the mining enterprise’s activities are completed, i.e. to give it a form acceptable for subsequent safe economic or other use, as well as the subsoil plot as a whole, developed for any particular purpose, as it is achieved, should also be “reclaimed”, adapted in the most efficient and safe way in every way further application. In other words, it should be recreated (preserved) for society as an object valuable in economic, ecological, scientific, balneological, cultural, recreational respect, according to the conditions of geomechanical safety of the population or for other reasons, based on its natural bowels of the new georesource prerequisites. Only in this way can the crisis tendency be overcome in the technogenic evolution of the subsoil.

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