Features of the condition of underground mines are presented and basic principles for developing ore mining technology are formulated. It is noted that the main direction for improving mining operations in nonferrous metal deposits is development of mining systems with stowing by solidifying mixtures with waste utilization from mining and metallurgical industries based on the complexes of self-propelled machinery. In order to extract low-valuable ores under conditions of great depths new variants of breast chamber mining systems, and sublevel caving systems with leaving rock intercalations in the bowels are considered. For ferrous metallurgy mines of the region the expediency is demonstrated for radical reconstruction of technology with development of mining system by sublevel caving with end ore drawing and comprehensive use of self-propelled equipment.

In the extensive territory of Siberia and the Far East there is a significant number of ore deposits of world class many of which (more than thirty) are mined by the underground method. Within the overall balance of mineral resources mining in Russia the basic quantity of diamonds, platinum, gold, silver, tin, copper, nickel, zinc, lead, etc., is produced in these regions.

Radical reforms within the country with a change-over to a market economy, crisis phenomena in production, and the financial system have had a particularly negative effect on the mining-extractive enterprises of this rich region. A sharp reduction in investments, the geographical remoteness with an unbuilt infrastructure, and the complications of natural-climatic conditions have above of all affected the activity of these capital intensive production.

1. CONDITION OF UNDERGROUND MINES

Analysis of the current condition of underground mines makes it possible to note the following:

1. Within the last ten years hardly any mines have been constructed in Russia, no new ore reserves have been accumulated, and previously opened reserves and those prepared for extraction have been used. The annual productivity of the majority of existing enterprises has decreased by 40–50%. In order to maintain the competitiveness of their production mines are induced to work the most valuable ores of deposits with respect to quality. This promotes an intensive increase in the depth of mining operations. The majority of large enterprises of Siberia, the Far East, and the Urals carry out ore mining at depths greater than 500 m. In mines of Norilsk region the depth of mining has reached 1.5 km, in Gornaya Shoriya it has reached 900 m, and in the Far East it has reached 1000 m. Rock pressure control is the main problem in the field of ore mining technology for these enterprises. Rock bursts with an energy up to $10^8-10^9$ J have been recorded in the Oktyabrsbky, Tashtagol, Nikolayevsky, and Yuzhny deposits being mined [1]. There is an increase in the volumes of rock caving in workings, loss of pillar stability, and the difficulties in providing mine safety are increasing.

2. There are no plants in Russia manufacturing mining equipment for underground work. There are plants for producing self-propelled technique, i.e. in Kazakhstan and the Ukraine, and drilling technique in the Ukraine. The equipment produced by these states is markedly inferior to foreign analogs with respect to reliability and technical productivity, although the prices of these machines are comparable with those of well-known foreign engineering firms. There is an urgent requirement for developing our own engineering industry for mining-ore production. In almost all of the underground mines of ferrous metallurgy and mining-chemical raw material mining is performed with transportable mining equipment. In order to maintain competitiveness in the twenty first century these enterprises will need to carry out radical reconstruction. World practice of underground mining of ore deposits has
convincingly proved that a modern industrial mine with high-intensity, resource-saving, safe, and in the future automated, mining technology may be built on the basis of self-propelled technique for the main and subsidiary purposes. Accumulated experience in nonferrous metallurgy mines has shown that self-propelled technique may be used most effectively with multiple face operation within a limited class of mining systems that however embrace different ore deposit conditions: with an open mined-out space (chamber-pillar mining); with ore and surrounding rock caving (sublevel and limited-level caving with end ore drawing); with stowing (continuous chamber and slice mining); combined (with stowing and caving).

3. The raw material mined in Russia in many ferrous and nonferrous metallurgy mines lags behind in quality (metal content) similar deposits of many countries of the world. In the past domestic mining-ore enterprises were mainly orientated towards the quantitative principle of evaluating the results of work and as a rule they used gross methods of mining and processing. Control of mined raw material quality, and separation of the types and sorts of complex ores, was carried out nominally. The ecological consequences of storing the dumps of barren rocks and tailing dumps at the surface of dressing plants were not taken into consideration. Meanwhile, enormous amounts of production waste were accumulated at mineral resources and raw material processing enterprises, part of which is dangerous and requires burying, and the other part contains useful components subject to secondary processing.

4. An increase in the quality of mined raw material, completeness for extraction of it from the bowels, and ecological purity and mine safety, particularly at great depths, is achieved in reality by different versions of ore mining technology with stowing of the mined-out space using solidifying mixtures. However, due to the increase in the cost of binding materials and electric energy this process became exorbitantly expensive and even with a moderate gross value for mineral resources it is not economically justified. In mines of Norilsk region within the total cost of ore mining the proportion for stowing exceeds 30%, and in the Nikolayevsky mine it exceeds up to 40%. Therefore a number of underground mines were induced to turn away from this advanced technology and to look for cheaper methods of ore mining.

5. The lack of a state policy for the mineral-raw material complex, the tax policy existing in the country, and inflationary processes prevent investments in the mining industry. Paying the whole range of taxes, mining enterprises are subject to the additional taxation in the form of payment for the bowels and compensation for geological survey work. Foreign partners having bought the stocks of a number of extractive enterprises are represented within the country mainly by firms trading in raw material. Their interests are limited to the maximum profits being obtained in a short period. This policy causes rapid depletion of the bowels reserves.

6. In the pre-reconstruction period the tasks of mining science and extractive branches were providing for the demands of society for mineral raw material at the expense of the country’s resources. Now the dominant problem is the conservation and enrichment of the natural conditions for human activity, and provision of a stable gradual development of society, combining ideas for rational use and renewal of natural resources.

In this connection the idea advanced in the 1960s by Academician Melnikov [2] and subsequently developed by Academician Agoshkov [3] and later by Academician Trubetskoi [4] for complex development of bowels from a contemporary standpoint is supplemented by new subject-matter. Degradation of the environment, particularly in mineral resources regions, the ecological problems of humanity, exacerbating shortage of mineral, material-technical, and finance resources, force us to consider the bowels in the future as "a natural integral multifunctional resource for the life-sustenance of society that is in the process of constant reform" [5]. The role and importance of mining science in this interpretation gives rise to appropriate orientation of the scientific and methodical activity of mining institutes and correspondingly mining enterprises [6].

2. TECHNOLOGY DEVELOPMENT PRINCIPLES

Considering the problems accumulated in mines, including ecological, entry into market economy conditions, and the contemporary role of mining science formulated above, mining institutes under the scientific leadership of Corresponding Member of the Russian Academy of Sciences D. R. Kaplunov are working out a new concept for developing resource-saving geotechnology for underground mining of mineral raw material. In our view the following should be taken into account within the concept:

— adaptation of geotechnology to the rock mass and the external environment with allowance for the requirement for utilizing production waste, ecological safety, conservation of the natural environment, and renewal of natural resources;