WORLD FINANCE REVIEW

March 2012

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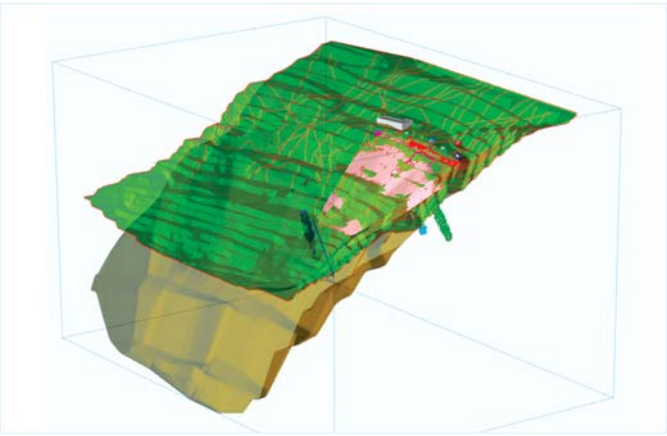
NEW STRUCTURAL ENGINEERING SURVEY METHOD FOR DESIGN AND OPERATION OF DEEP OPEN PIT MINES

Open Joint Stock Company «Murmansk Geological Prospecting Expedition» (MGPE) together with scientific research institutes (Mining and Geological institutes KSC RAS, Institute of Geomechanics and Mine Survey - VNIMI) has developed a new method of pre-mining geotechnical and geomechanical survey for design and operation of deep open pit mines.

The importance of such a research is determined by a particular position of major and world-class deposits. As is well known, these deposits provide approximately 2/3 of the world's mineral commodities, but the majority of them face the problem of reserves depletion. Quite often there are more reserves below the mine's design depth, so a new project for an underground mine or a deep open pit has to be developed to excavate ore from deeper levels. Further excavation by the deep open pit method is usually economically preferable and allows carrying out reconstruction without interruptions to mining operations. However, it requires the execution of a whole complex of detailed engineering and geomechanical investigations.



3D tectonic modelling

This article briefly describes scientific, methodical and technological aspects of the new method of pre-mining geotechnical and geomechanical survey on the basis of the results of the successful test at the open pit Zhelesny (Iron) of JSC Kovdorsky GOK (North-East of the Fennoscandian Shield).

The stability of slopes of deep open pits depends on several risk factors related to the properties of the rock massif: faults structure, high stress and hydro-geological conditions. Unfortunately, these characteristics are often studied last, as at all stages of a geological survey and prospecting the priority focus is on the ore properties, its forms and the volume of the deposit. This results in insufficient detail of data on engineering-geological, structural and geomechanical conditions of a deposit and the country rock. As a result, the financial and technical risks at the design and operational stages increase significantly. To reduce or mitigate these risks, it is necessary to carry out a complex of anticipatory engineering-geological and geomechanical studies.

To determine the main parameters of a deep open pit, a range of structural engineering and geomechanical studies has to be carried out, including:

- Fault tectonics with dangerous angles of dip for slopes stability of an open pit;
- Zones of invasion, weathering, disintegration and other trouble factors;
- Estimation of deformation mode including the tensor of principal strains and its absolute values;
- Technical and geomechanical parameters, such as the angle of internal friction, cohesive resistance, coefficient of structural attenuation;
- Hydrogeological characteristics: watered grounds and rocks, position of the underground waters level and filtration properties.

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The complex of engineering-geological works includes four main stages: 1) the preparatory stage, 2) field works, 3) in-office studies and 4) analysis of the collected data and preparation of reports.

At the preparatory stage, all data on geology, tectonics, hydrogeology, seismic activity, aerial and space views of region and object are collected and analysed.

Field works include surveys and investigations "in situ":

- Geological mapping and documentation of fault tectonics, jointing (cracks) structure and its kinematics, geological documentation and mapping of slopes and structural elements with spatial data binding; collecting representative data on geological, geotechnical and hydrogeological characteristics of the rock mass (country rock);
- Ground geophysics including acoustic measurements and crosshole seismic surveys with tomography modelling of fault structure and zones of weakness;
- Drilling, sampling and documentation of engineering-geological holes with aligned core, filtrational tests and well surveys;
- Mapping of slope deformations and instability of open pit construction, seismographic observations and monitoring of the rock massif deformations and stability of flange;
- Special researches "in situ" for determinations of mode of deformation and tensor of principal strains;
- Technical and geotechnical tests of samples from tectonic and geological contacts.

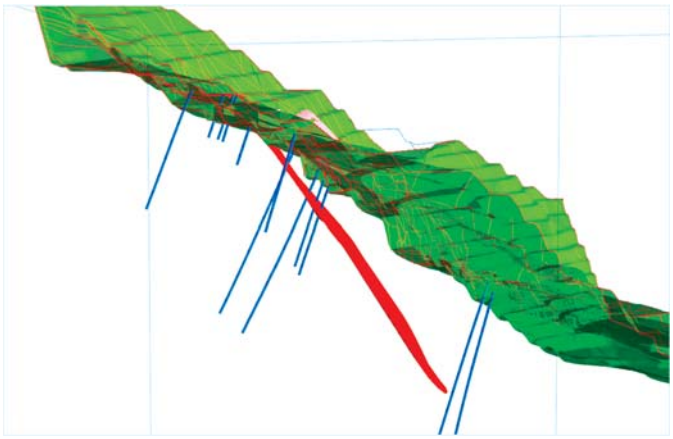
In-office studies include:

- Documentation of the aligned (orientated) drill core;
- Test results and data classification;
- Stereography of structural data and statistical treatment of technical and spatial data;
- Graphic works.

The objectives at the summary stage are the following:

- Complex analysis of spatial and technical data;
- Tracing and correlation of fault tectonics, crack structure and its kinematics
- 3D modelling and geometrisation of dangerous structures;
- 3D computational modelling of stress and strain;
- Hydrodynamic modelling for optimisation of system of drainage;
- Validation of results, reliability prediction and reporting.

The potential risks that became evident at the design stage or during operation of deep open pits with maximum angles of slopes and flanges are mitigated by high quality, accuracy and comprehensiveness of the data on geological, geotechnical and hydrogeological properties of the rock mass. Thus, the results of the complex survey enable mining companies to redesign deep open pits taking into account all possible geohazards.



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