



## **UkrNIMI developments in the field of geoinformation technologies in applied geophysics**

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Ukrainian State Research and Design Institute of Mining Geology, Rock Mechanics and Mine Surveying (UkrNIMI) is the leading research institute in Ukraine in the field of applied geophysics for mining industry. At present the Institute's activities concern many lines of geophysical research. Among these is prediction of mining-geologic conditions in open and underground mining exploitation of coal beds, prediction of hazardous physical-geologic processes, revealing and mapping of potentially hazardous zones (old mine workings, pits, tectonic faults). Since 1995 UkrNIMI Institute has been developing geoinformation systems (GIS) for coal-mining industry as a tool for integration and subsequent analysis of geological and geophysical information.

The GIS GeoMark has been developed in the UkrNIMI Institute in 2001. The system has passed the basic tests successfully and is being employed in the Institute and also in the Company "Ukruglegeologia" and in a number of mine enterprises of Ukraine. It serves:

1. To generate electronic map-based mine-oriented information systems that allow analyzing and using information, which was obtained during geophysical experiments.
2. To solve a wide range of computational problems in the field of land and mine geophysics, geomechanics, mine-surveying *et al.* based on the mine-oriented information systems.

3. To produce electronic map-based mine-oriented information systems that allow analyzing and using information, which was obtained during geophysical experiments.
4. To generate 3D models of mines, locations of mine workings, coal and rock seams behavior (taking into account zones of tectonic faults), distribution of geophysical, geochemical and geological properties of rock mass and other geological and industrial objects.
5. To obtain, on the basis of electronic maps, high quality printed matter. The UkrNIMI Institute generates electronic maps and plans for mine enterprises since 1997. It has a great experience in this business in Ukraine.

The GeoMark system is based on the databases of boreholes and mine workings, databases of results geological, geophysical, and geochemical explorations.

The system consists of two special modules: geomechanical and geophysical ones. They are designed for the analysis of data, obtained on the basis of *in situ* geological, geophysical, mine seismoacoustical, geochemical and other types of observations and for solution of engineering problems: calculation of safety pillars, zones of increased rock pressure and others; description of coal and rock seams behavior; analysis of zones of tectonic dislocations and solution of a wide range of other problems. UkrNIMI is the leading institution in the former USSR countries in the field of mine seismic acoustics and mathematical modeling of seismoacoustical wave propagation process in coal seams. The final object of research is detection and description of coal seam dislocations. Geophysical module uses some versions of finite-difference approach to calculate wave propagation processes and to predict their technological parameters.

Mathematical modeling is used before realization of the real geophysical experiments in order to select the best procedures for them and also at the stage of analysis and interpretation of results.

The next target of geophysical module is to calculate distributions for various parameters within the layers of the Earth on the base of *in-situ* observations. The information for each set of stations along profiles of observations can be loaded into the program and analyzed by the module. In the first step you can chose a mathematical method and calculate variations of parameter in depth along the line of station locations. They are different versions of sliding average method, Deloné triangulation, and other approaches. At the next step you can calculate sections by horizontal or arbitrary located planes. The sections can be stored for subsequent use (for example, as a raster image). You can transform the image according to a map scale, orientation and so on and add

the image as an object for a map of the region under exploration. It will be useful for a wide scope of scientific or industrial tasks.

Additional GIS component parts are as follows: module for computational problems, module for 3D and 2D modeling, module for obtaining graphical products, manager of industrial objects and target classifiers, manager of object properties and parameters, module for communication with external databases.

Module for computational problems is designed to solve particular calculation problems by various industrial services. It represents an environment that allows selecting for execution sets of natural and man-made objects of mine fields, to visualize 2-D and 3-D outlines of their mutual locations and to make necessary computations with them. The environment is supplied with primary sets of means to solve a number of problems.

Module for obtaining graphical products allows solving problems in relation to printing maps, mine plans, layouts etc. From our point of view, it has one important difference from the standard approach in this domain. Most GIS generate maps and layouts, and any other “pictures” using target classification of their objects. Therefore, generating one and the same map in the other system of notifications means essentially generating a new map. GIS GeoMark rests upon a global classification; therefore substitution of one system of notifications to the other comes to the attachment of the appropriate target classifier to execution.

Manager of industrial objects and target classifiers allows involving into operation maps obtained with other GIS. It makes possible to import objects into maps of different formats and target classifiers, to combine maps of different initial layouts into a single whole, to generate new target classifiers of GeoMark format and attach to execution available classifiers of other formats, and many others.

Manager of object properties and parameters allows using global classification for properties and parameters being developed in the field. It will make possible in the future to solve problems of interaction with other GIS as regards the use of computational problems.

Module for communication with external databases is designed to import objects and their parameters from databases generated by other software.

Furthermore, works are under way in the UkrNIMI Institute dealing with development, within the limits of GIS GeoMark, of a number of software modules allowing solving dedicated problems in various fields. Interface is being improved and also measures are being carried out to integrate the system into technological processes realized by UkrNIMI in cooperation with a number of coal-production associations.