

The Importance of Geospatial Data in Identifying Underground Structures

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Annotation

This work comprehensively analyzes the types of satellite geodata and their application in mining exploration. The role of satellite images in the detection of oil, gas and other minerals using geotechnologies, in particular, remote sensing and GIS systems, 3D modeling, multispectral and hyperspectral analysis, and the possibilities of detecting geophysical anomalies are studied. The work covers the integration of geodata with GIS, mechanisms for working with databases of geographic information systems, analysis capabilities of attributes, spatial layers, networks and relief models. In addition, the structure, functional capabilities of the ArcGIS geodatabase and its advantages in digital simulation of real-world objects are shown. The results of the research are of practical importance in the introduction of advanced, safe and cost-effective technologies in the search for minerals.

Keywords: Geodata, satellite, remote sensing, GIS, ArcGIS, minerals, mining exploration, 3D modeling, multispectral imaging, geoinformatics, database, metadata, spatial analysis, geological structure.



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Introduction

The rapid development of modern geotechnologies is expanding the possibilities of searching for and effectively using natural resources. In particular, geodata obtained via satellite has become an important source of information in identifying oil, gas, and other mineral deposits. Remote sensing technologies and space monitoring allow for precise monitoring of the state of surface and underground structures, modeling, and analysis of promising areas, which helps reduce the cost of prospecting, save time, and increase accuracy.

Within the framework of this topic, the characteristics of satellite geodata, methods of their analysis and their role in organizing mining exploration are studied in depth. In particular, it can be observed that the accuracy and reliability of geological exploration are increasing through the use of GIS technologies, 3D modeling, radar and multispectral images. The results of the research will serve to develop scientific and practical solutions based on modern approaches in the oil and gas industry and the field of mineral exploration. In the current era, with the increasing need for natural resources, the issues of mineral exploration and their effective use are gaining global

importance. Traditional mining exploration methods are characterized by a high level of environmental hazard and require a lot of time and money. In such conditions, the development of satellite technologies is leading mining exploration to a modern, safe and economically viable direction.

Geodata obtained from satellites allows for the analysis of large areas in a short time, without contact. These technologies allow the identification of geological structures, landforms, soil and vegetation cover, as well as potential resources in subsurface layers. Therefore, this topic is one of the areas that has not lost its relevance today, but has even increased, due to its widespread use in the oil and gas sector, mining, geology and ecology.

Geodata - is a set of spatial, spectral and digital data about the Earth's surface and its subsurface structures. They are mainly obtained using satellite, aerial photography, geophysical surveys, GIS and remote sensing technologies. Stratigraphic and geological layer identification - multispectral and hyperspectral images are used to determine the spectral differences of various geological layers, which is important for mapping subsurface structures.

Mineral resource prediction - using geodata, specific textures, structural fractures and geophysical anomalies are identified. This allows you to identify oil, gas, ore and other deposits.

3D modeling - based on geodata, subsurface layers are modeled in three dimensions. These models are an important tool for organizing the processes of exploration, mining and monitoring of deposits safely and economically.

Integration with GIS - when geodata is used together with GIS systems, it becomes possible to conduct a comprehensive, spatial analysis of subsurface resources.

A geoinformation system is a software and technological system that allows you to collect, store, manage, analyze, model and visually represent geospatial data on natural and social phenomena using special tools. It is managed by specialists and analysts and is an important tool for optimizing decision-making processes.

Although many definitions have been given to the concept of GIS, they all confirm that the main tasks of this system are to process spatial data and use them in making analytical decisions. Spatial and geographic data are understood as coordinates of the earth's surface, boundaries of land plots, information about their location, as well as other geodata.

Currently, GIS technologies are used in:

- ✓ Visual analysis and decision-making;
- ✓ Modeling of surface and underground structures;
- ✓ Ecology, healthcare, economics, urban planning, and other fields.

GIS allows for rapid analysis of problems in various fields, identification of solutions, and strategic decision-making based on digital maps. This system provides more information than traditional tables or numerical data, as it uses layers, colors, three-dimensional visualization, and vector images.

- ✓ Map — a projected, simplified image of the earth's surface.
- ✓ Nomenclature — a system of dividing maps into sheets and designating them.
- ✓ Digital map — the main element of the GAT information base, created in digital format, organized on the basis of coordinates.
- ✓ Computer map — an automated cartographic image produced by graphic devices.

- ✓ Geoinformation analysis — analysis of connections and relationships between objects through spatial analysis and geomodeling.
- ✓ Geoinformatics — a scientific and technological direction related to the design, construction, implementation and development of GAT.

Geodata is information about geographic locations stored in a format that can be used in a geographic information system (GIS). Geographic data sets can be of the following types:

- ✓ Satellite imagery;
- ✓ Collected and interpreted data such as land use polygons, parcel boundaries, or infrastructure;

A geodatabase is a collection of geographic data of various types, stored on a file system share or in an enterprise relational database. When a specific type of feature data or values is organized into datasets (i.e., feature classes, raster datasets, and tables), the user has the ability to add new layers to them or extend their geodatabase with new capabilities.

The user can also add geodatatypes such as topology, networks, or types to model the GAT data, ensure data integrity, and work with a set of important spatial relationships between feature classes. Examples of extended GAT datatypes include:

- ✓ Networks used to connect individual features to transportation, water, and other communications.
- ✓ Relief and digital elevation models used to model terrain and other 3D surfaces.

A dataset is a collection of facts about an object. A dataset is a collection of data stored in an electronic medium. A geodatabase contains basic spatial data. A geodatabase is a collection of geographic data. Database management systems, used for large workgroups and corporate databases, are relational systems—they operate according to the rules of relational algebra. A database is not just a collection of data, but also a data model.

A key activity in data modeling is deciding which abstraction to use. For example, a spatial database might represent a linear transportation system with a centerline, but the actual technical tool is an area with a single long axis. In a geodatabase, an object is represented by a class.

ArcGIS geodatabase combines object-oriented software that handles much of the data management workload. A geodatabase is not a passive data repository, but an active part of the ArcGIS platform.

A geodatabase is a standard environment (Login) for storing and managing data in the ArcGIS software product, which can be installed on desktop computers, servers (including the Internet), or mobile devices. ArcGIS introduces a new approach to storing and presenting geographic data - an object-oriented data model called a geodatabase. Using this model, users can create objects with new properties, thereby simulating real-world objects.

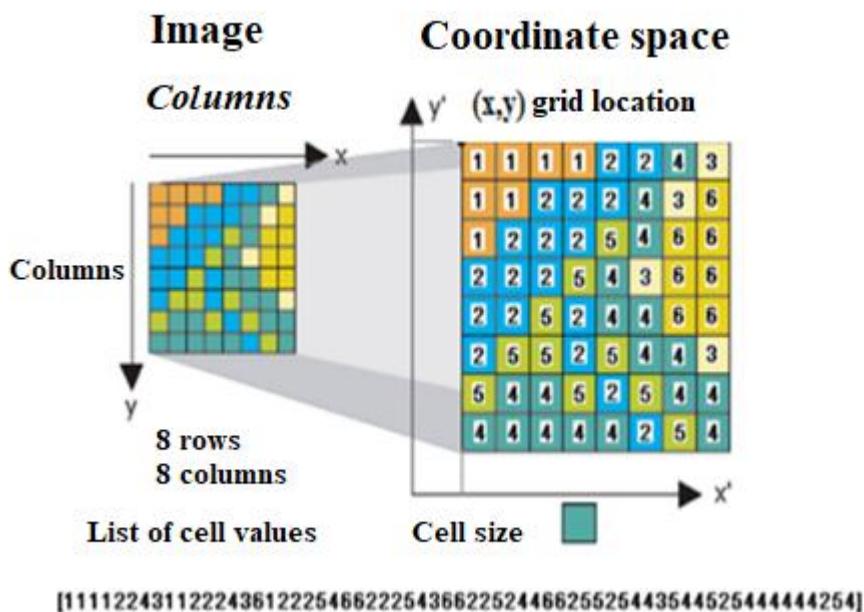


Fig 1. List of cell values (left) and representation of cell size in coordinate space (right).

The geodatabase data model bridges the physical and logical data models. The data objects in a geodatabase are essentially the same objects defined in the logical data model, such as buildings, parcels, and roads. Geodatabases have a comprehensive information model for representing and managing geographic data. This comprehensive information model is implemented by a set of simple data tables that include feature classes, raster sets, and attributes. In addition, advanced GAT data features add GAT behavior, spatial integrity management rules, and tools for working with multiple spatial relationships between underlying features, rasters, and attributes.

Summary

A geodatabase is a data structure and the basic format of ArcGIS. This thesis provides detailed information on the following: the main and functional features of a geodatabase, its origins, advantages, and its interoperability with many database management system platforms, and its ability to come in different sizes and serve different users.

They range from small, single-user file databases to large workgroup, departmental, or enterprise geodatabases that can be accessed by multiple users.

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