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### Geospatial integration of different types of geological data using Micromine Origin & Beyond

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#### **SUMMARY**

The article discusses the integration of different geological data used in complex geological studies. Data usually have different sources, file formats, coordinate systems, and can be one-, two-, or three-dimensional. An overview of modern tools and features for integrating different types of geospatial data is provided for Micromine Origin & Beyond, which helps to improve workflows and reduce data errors.



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## Introduction

Comprehensive geological researches, including the modelling of geological objects and processes, utilize various types of data, including geophysical, geochemical, mineralogical, petrological (lithological), stratigraphic, topographic, hydrogeological, environmental, remote sensing and others. These data can be historical or current, quantitative or qualitative, and obtained through drilling, surveying, measurements, laboratory testing, or other operations. To effectively integrate and collaboratively process various geological data, it is necessary to combine data from different time periods, from diverse sources, and utilize various file formats, dimensionality, coordinate systems, and other parameters.

## Data formats

They typically originate from diverse sources, are presented in different formats, and use various coordinate systems, which may pose challenges for their accurate integration and joint utilization. Modern software offers tools for effective data integration, exemplified by Micromine Origin & Beyond. Micromine supports about 70 data formats that are common to most GIS, in addition to its own formats (Table 1).

**Table 1** Data formats supported by Micromine.

Data type	File Sources	File Formats
Tabular data	Microsoft Excel® or text files	XLSX, CSV, TXT
<i>Vector (GIS/GPS) Data</i>	CAD, GNSS, ESRI, Mapinfo, Google Earth, GPS eXchange, TrackMaker, Micromine	DXF, DWG, SHP, TAB, MIF, KML, KML, GPX, GPS, GTM, GTZ, STR, DAT
Geophysical data	2D and 3D SEG-Y, LAS file	SGY, SEGY, LAS
Data Base	Microsoft Access®, SQL Server® or Oracle®, Micromine	PODB, DHDH, MMDBF
Raster	ESRI, ERDAS, Autodesk, Joint Photographic Experts Group, Virtual Raster, JPEG File Interchange Format, Adobe, ArcMap, Windows	sID, J2K, JP2, JPC, JPX, VRT, JPG, JPEG, TIF, TIFF, BIL, BIP, BSQ, GIF, BMP, EMF, WMF
Grid File	ESRI, Arc/info, ERMapper, Surfer, Grid eXchange File, SRTM, GeoTIF, Carlson, ASCII, USGS SDTS	ASC, ADF, BIL, FLT, ERS, GRD, GXF, HGT, TIF, GRD, XYZ, DDF, DEM
Block Model	SURPAC, DATAMINE, VULCAN, An Open Mining Format, Micromine	MDL, STR, OBS, FBM, DM, BMF, OMF, DAT
Wireframes	AutoCAD, VULCAN, DATAMINE, 3D Studio Max, GOCAD TSURF, Micromine	DWG, DXF, DXB, 00T, DM, 3DS, TS, TRIDB

Advanced software products allow to combine data presented in different file formats in one software environment using import and export functions. For example, geophysical data (LAS, SGY), drillhole databases (DHDH), topographic data (DWG, GRID, TIF, DTM), geochemical data (DAT, XLSX) can be jointly analysed, interpreted and used for complex modelling in one workspace.



## Coordinate systems

Geospatial data can use global coordinate systems that cover the entire World, regional coordinate systems that are used for specific regions, and local coordinate systems that are created for local areas. The most common modern global coordinate system used for geological data is UTM (WGS 84) - Universal Transverse Mercator (World Geodetic System 1984). In Ukraine, historical geological data are mostly represented in CS-42 (Gauss-Kruger), and topographic and geodetic and cartographic data are represented in UCS-2000 (formerly CS-63) - the State Geodetic Coordinate System of Ukraine. Micromine Origin & Beyond uses the EPSG (*EPGS Geodetic Parameter Dataset*) (European Petroleum Survey Group) registry, which includes more than 5000 standard coordinate systems.

Micromine has special tools for creating custom coordinate systems. Advanced custom coordinate systems use the PROJ library (*PROJ contributors 2024*) to define individual parameters for non-standard, local, or historical coordinate systems, allowing the system to be tailored to the specific requirements or location of a project. Multiple coordinate grids can be displayed in one working window (Figure 1).

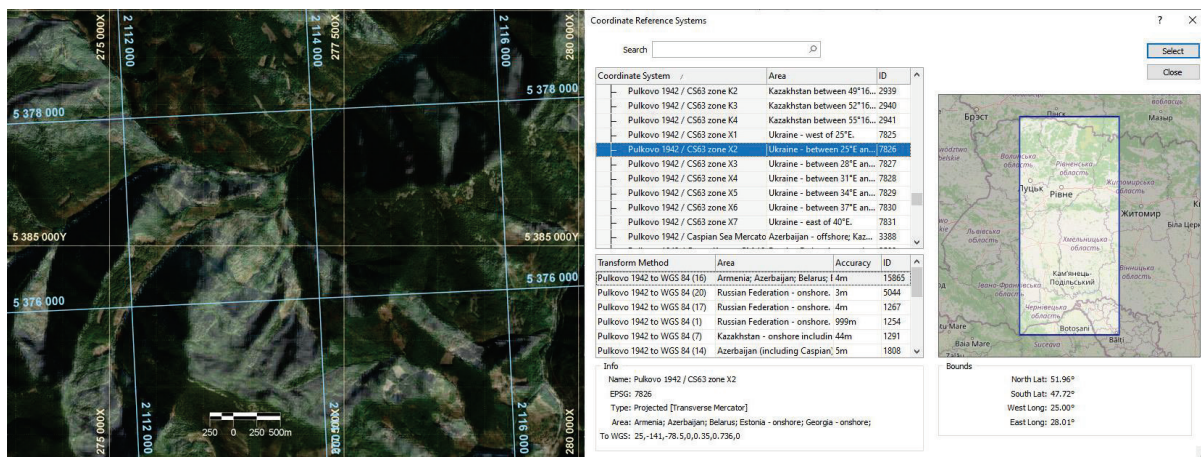


Figure 1 An example of two coordinate systems combining.

Special functions of Micromine Origin & Beyond provide coordinate conversation for:

- Single points by entering from the keyboard.
- Files and wireframes using predefined parameters or rectangular grids.
- Vector or other data during Import or Export.
- Georeferenced of raster images.

## 1D, 2D and 3D data

Geological data with one, two, or three coordinates can be used for analysis and interpretation, respectively, one-, two- or three-dimensional data. For example, drill hole data has only one coordinate (depth or Z), section or map data has two coordinates (X-Y, X-Z), and wireframe or block model data has three coordinates (X-Y-Z).

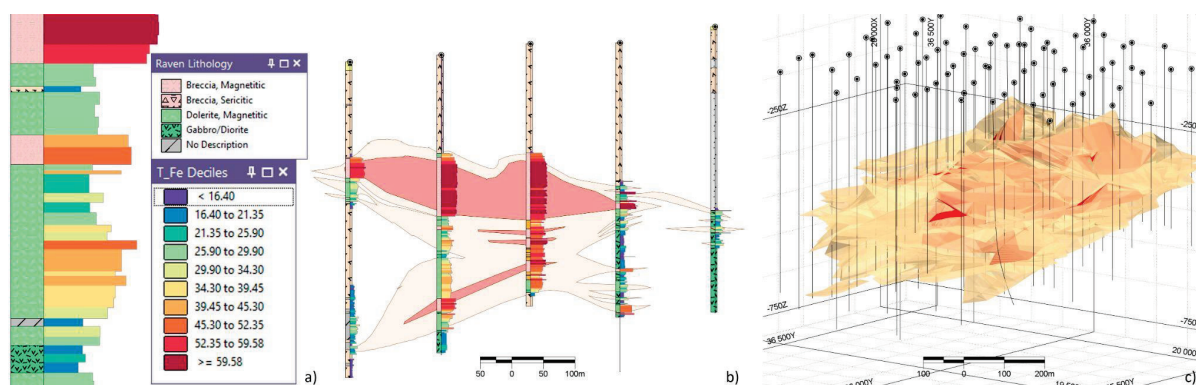
**One-dimensional data.** In geometry, an example of one-dimensional data is a line segment with only a length. In one-dimensional analysis, data are represented as one-dimensional functions, where each point on the abscissa represents the value of a particular variable at one point in space. Examples of one-dimensional geological data include drill hole data such as lithology, grades or geophysical logs. One-dimensional data can be graphically represented as graphs, columns, charts, etc.



**Two-dimensional data.** A geometric example of a two-dimensional object is a flat figure (polygon, circle, etc.) with a length and a width. In two-dimensional analysis, two-dimensional functions are used, where each point represents a value of a variable and has two coordinates on the abscissa and ordinate axes. Examples of two-dimensional geological data include topographic, geological, structural, geochemical, geophysical and other maps or cross-sections (profiles).

**Three-dimensional data.** A three-dimensional geometric object is any three-dimensional figure, such as a cube, ellipsoid, prism, etc., that has length, width, and height and occupies a given volume in space. Three-dimensional analysis uses variable values for points with three coordinates. Three-dimensional geological objects are usually called models (wireframe, block or factor models, etc.) representing ore or geological bodies, etc.

In general, the modelling workflow involves a step-by-step progression from one-dimensional to two-dimensional and then to three-dimensional data. At first, data from drill holes or other workings are used to create a two-dimensional interpretation as maps or sections, which are then combined into three-dimensional models (Bariatska et al., 2018, Safronova N., & Bariatska N. 2024). Initially, data from drill holes or other workings are used to make a two-dimensional interpretation in the form of maps or sections, which are then combined into three-dimensional models (Figure 2).



**Figure 2** An example of 1D a) (drill hole), 2D b) (section) and 3D data c) (ore body model).

The use of one- and two-dimensional data to create three-dimensional models is a common practice. For example, three-dimensional modelling based on drill holes, outcrops, sections, and geologic maps has demonstrated its effectiveness for coal deposits, sedimentary (Jiskani et al., 2018, Kaufmann & Martin, 2008, Zhu et al., 2012 and others). Also, the combination of 2D and 3D data is successfully used to adjust geological sections and 3D modelling based on geological and geophysical data (Wu et al., 2020, Wang et al, 2012 and others).

Different software is used to work with multidimensional data. For example, Golden Software Grapher, Micromine Geobank can be used to display one-dimensional data, Q-GIS, ArcGIS, MapInfo can be used for two-dimensional data, and Micromine Origin & Beyond, Geovia Surpac, Datamine, Petrel can be used for three-dimensional data. In general, software for three-dimensional data allows the processing of two-dimensional and one-dimensional data, but never backwards.

## Results and Conclusions

A comprehensive geological research usually uses geological, geophysical, geochemical, topographic, hydrogeological and other data. Problems can be caused by different data origins, file formats, coordinate systems, and different dimensions. To model complex geological processes and systems, the data should be integrated in a unified workspace to be processed, analysed, and interpreted collaboratively.



Modern software, including Micromine Origin & Beyond, allows to work with various file formats using the import and export functions, convert coordinate systems, and move from one-dimensional and two-dimensional to three-dimensional data in the modelling process. With special tools and functions, different types of data, such as core photos, geophysical surveys, geological logging, laboratory tests, geospatial satellite data, and more, are used together in a single workspace and can form the basis of complex models. Processing different geological data in one software environment reduces additional operations, ensures high quality and minimizes errors.

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