

Construction and Application of 3D geological model of mianhuaba center in Wulong District of Chongqing Based on DepthInsight

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Abstract. 3D geological modeling plays an increasingly important role in the fields of mineral resources, energy, ecological geological environment and urban construction. With the continuous development of geological work and the increasing demand, many excellent 3D geological modeling software have emerged. In this paper, the 3D geological model of mianhuaba center in Wulong District of Chongqing City is completed based on DepthInsight platform by using the 1:10000 measured topographic and geological map and integrating the geological profile, geophysical interpretation profile and borehole data. This model can be used to realize arbitrary direction and angle section cutting in the modeling area, and output the model geological profile with lithologic pattern to support the business work in the fields of engineering construction and resource exploration.

Keywords: 3D geological modeling; Geological map; Geophysical profile; DepthInsight.

1. Introduction

With the development of computer technology, 3D modeling technology has experienced the initial wire frame model, surface model and then entity modeling system. Now parametric and variable 3D modeling technology has been widely used in all walks of life, and has brought considerable social benefits and economic profits. The rise of 3D geological modeling technology stems from the needs of mineral resources development and scientific and technological research, and gradually expands to the fields of resource environment and urban management.

The commonly used 3D geological modeling software in the world mainly include Surpac, EarthVision, GOCAD, etc; the domestic modeling software mainly include DepthInsight, DIMINE, 3Dmine and mapgis series[1-3]. Among them, the mapgis series of Wuhan Zhongdi Digital Technology Co., Ltd. is the most widely used in China, and DepthInsight software has certain advantages in graphic smoothness. Based on the demand of data security, this paper selects Depthinsight software to construct the 3D geological model of mianhuaba central area, and the results can support the development and application urban planning and engineering construction in Wulong.

2. Geological overview

The tectonic location of the modeling area belongs to the northwest of the Yangtze fold belt, and the regional structure is located in the east wing of Wulong syncline (Fig.1). The modeling area belongs to monoclinic strata outcropping area, and the strata tends to the northwest with dip angle of 20°~30°.

In the modeling area, the strata of the third and fourth members of Triassic Jialingjiang Formation and the first and third members of Badong Formation are exposed, and the upper and lower strata are in integrated contact relationship (Fig.2). Among them, Jialingjiang Formation is a set of sedimentary rocks of evaporation and limited platform, and the third member is mainly medium-thick layered limestone, while the fourth member is mainly medium thick-thick layered dolomite and calcareous

dolomite, intercalated with several layers of salt soluble breccia; Badong Formation is a set of clastic and carbonate sediments with alternating changes of lacustrine facies and littoral-shallow marine facies [5-6]. The first member is mainly characterized by argillaceous dolomite mixed with mudstone, and the second member is mainly purplish red mudstone and argillaceous siltstone mixed with grayish green medium-thick layered fine-grained arkose, and the third member is mainly thin-medium thick layered argillaceous limestone mixed with mudstone.

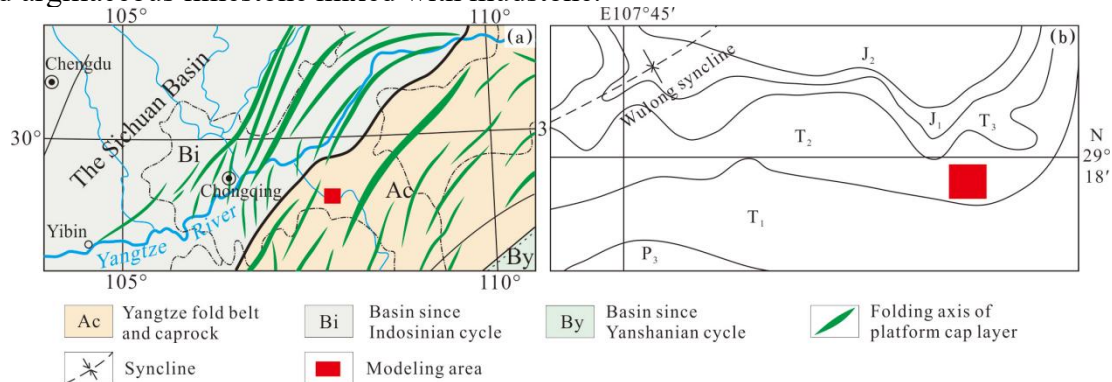


Fig. 1 Tectonic location of the modeling area

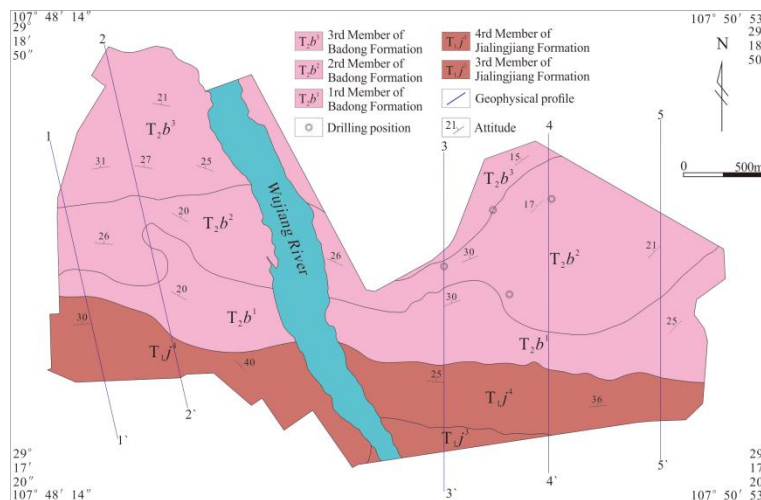


Fig. 2 Geological map of modeling area

3. Modeling ideas

The construction of 3D model is based on Depthinsight software. On the basis of comprehensive sorting, analysis and research of geological data in the study area, a conceptual geological framework is formed. After that, load the data required for modeling into the modeling software, and use the interpretation function to interpret the existing plane geological map and section map. Based on the constraints and references of interpreted data and DEM data, several new grid sections are drawn in the target area and the model is constructed. The model is corrected according to the borehole stratification information and geophysical data to achieve the purpose of optimization, and then the mesh model is formed by meshing to complete the storage of 3D model data.

4. Data import and spatial registration

The construction of 3D model should first normalize the elements required for modeling such as contour line, geological boundary, occurrence, formation lithology and profile of the geological map of the modeling area based on the format requirements of the modeling platform, so as to meet the format requirements of the platform for the elements required for modeling. When the data preparation is completed, the maximum and minimum values of X and Y and the upper and lower elevation values

of the boundary of the modeling area are determined based on the scope, altitude difference and modeling depth of the modeling area to form the boundary of the 3D modeling area. Generally, the boundary of the modeling area shall be larger than the actual boundary of the model. After determining the boundary of the model, the contour line is extracted based on the plane geological map to establish the surface elevation model (Fig.3). The method is to convert the contour line of the topographic map into a discrete point file with spatial coordinate format (processed into .PRN text files in X, Y and Z formats) through ArcGIS or MapGIS. The geological boundary still adopts the conversion method of contour lines, and the difference is that the geological boundary needs to be assigned elevation by software projection and then output to the discrete point file. The occurrence, lithology, stratum code, stratum thickness and other information are stored in the database for call. The plane geological map uses MapGIS mapping function to export .jpg format and convert it to .bmp format for reference and interpretation of strata in modeling software. Geological mapping hand-drawn section, route section and so on are mostly stored in the form of pictures, and after vectorization, projection and correction, they can assist in modeling or correcting the formation depth. A standardized file organization structure table (Table1) is established according to the classification of prepared data to facilitate model establishment and data search. After the data is processed as required, it is imported into the modeling software to match the DEM surface with the plane geological map and other relevant data, and prepare the map cutting section.

Table 1. organization structure of modeling data file

Primary directory	Secondary directory	Tertiary directory	Level IV directory	Five level directory
			Mapgis source data	Vector
			DEM	Vector/Scatter
			Stratigraphic boundary	Vector / Scatter
		Surface data	Stratigraphic occurrence	Vector
Modeling sheet name	Modeling source data		Plane geological map	BMP/TIFF
			Remote sensing image	BMP/IMG/TIFF
		Profile data	Measured stratigraphic / structural profile	BMP/TIFF Scatter
		Other data	Figure cut section	Scatter

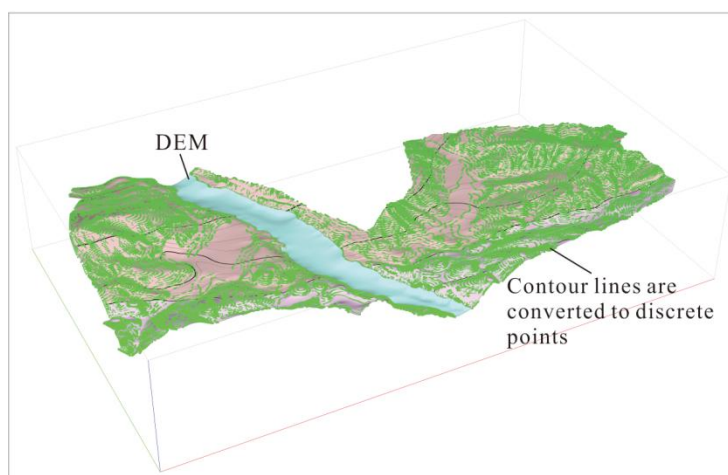


Fig. 3 DEM surface constructed by contour line extraction

5. Figure-cut section and structural interpretation

The drawing cutting section is an important process of modeling. The blank 3D section about 500-1000m apart from the boundary and vertical structural direction outside the modeling range (Fig.4). Using the geological factors such as the imported DEM and geological boundary, combined with the measured stratigraphic occurrence, stratigraphic profile and other profile data in the study area, the structural interpretation is carried out in the structural interpretation module, and the interpretation data can be directly extracted into the structural modeling module.

The sequence of structural interpretation is structural morphology interpretation to stratigraphic interpretation. Stratigraphic interpretation is to establish the stratigraphic thickness and lithologic characteristics of the modeling area according to the measured stratigraphic profile, and interpret the stratigraphic line according to the stratigraphic thickness on the cutting profile. In the area under engineering control, the geophysical profile and geological drilling are needed to correct the profile to improve the modeling accuracy (Fig.5).

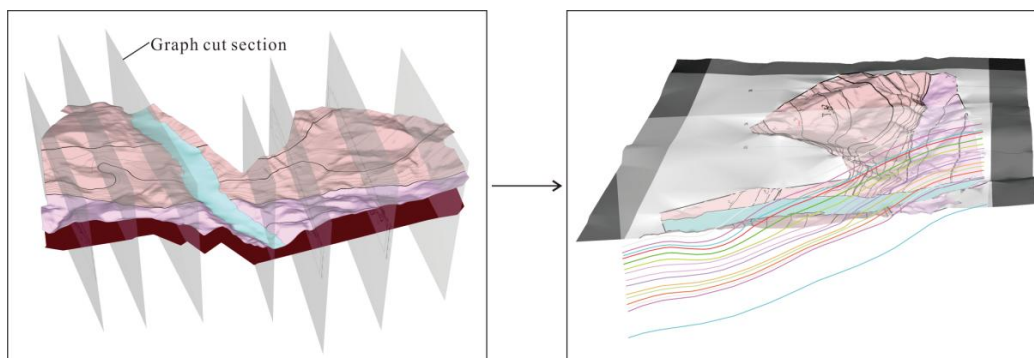


Fig. 4 Cutting section of geological map

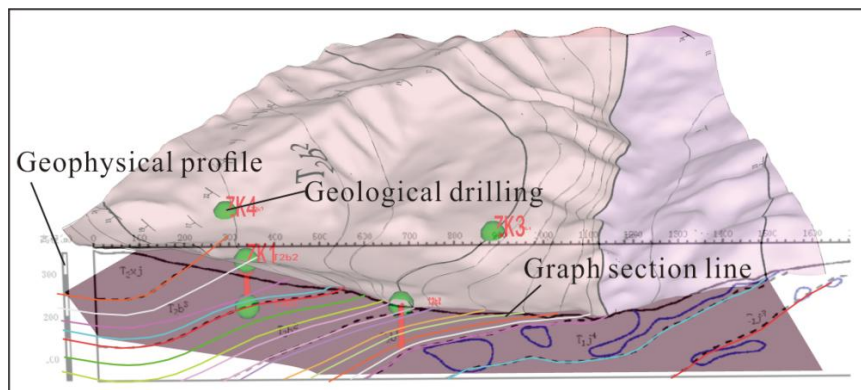


Fig. 5 Profile correction

6. Construction of 3D geological model

Firstly, according to the stratigraphic parameters (occurrence, type, etc.) in the plane geological map and the stratigraphic data explained in the geological section, the three-dimensional stratigraphic model of the study area is constructed from bottom to top, and the bottom strata and surface DEM surface are taken as the top and bottom surfaces of the model. In terms of contact relationship, the study area is composed of sedimentary rock strata, and the upper and lower strata are integrated contact. Therefore, it only needs top-down sequential construction. Based on the determination of the top and bottom surfaces, the geological body model is constructed, and the geological body color is determined according to the plane geological map (Fig.6). After the model construction is completed, it is necessary to carry out quality inspection on the model, and examine whether the structural form is reasonable through raw data comparison, structural profile inspection, geophysical profile inspection and other methods, so as to edit the unreasonable place, and update the model.

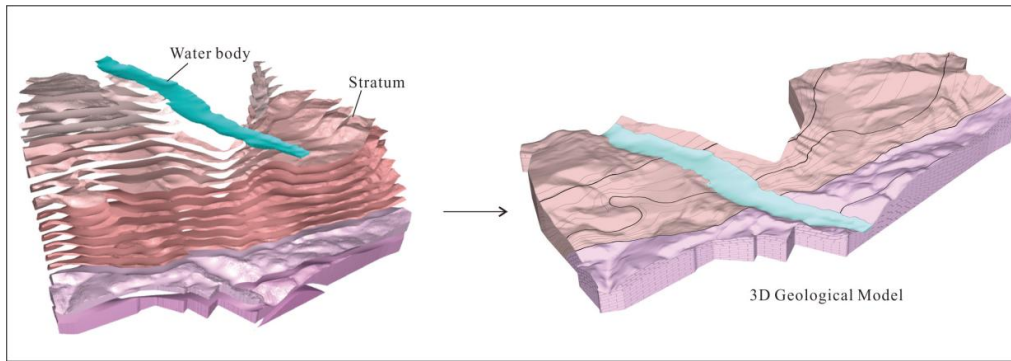


Fig. 6 Model construction

7. Mesh subdivision

The attribute model is constructed on the basis of grid subdivision. After grid subdivision, the attribute data can be stored according to the geological body grid, such as lithology, lithofacies, geostress, water content, temperature, saturation, permeability and so on, and then the attribute model is established.

Different types of meshes have different types of application scenarios. Common meshes include truncated rectangular mesh, PEBI mesh and step mesh. The structure of the study area is relatively simple, so the truncated rectangular grid and step grid are used to build the attribute model (Fig.7 and Fig.8). After the grid model is built, attribute extraction and data analysis are started, and then attribute interpolation calculation is entered. After interpolation, the attribute modeling is completed.

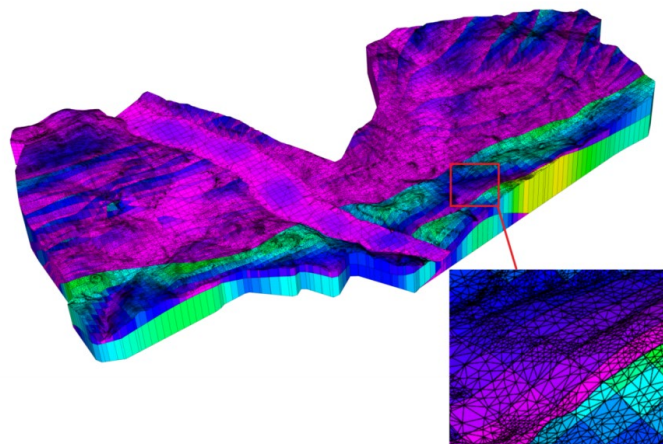


Fig. 7 Model truncated rectangular grid

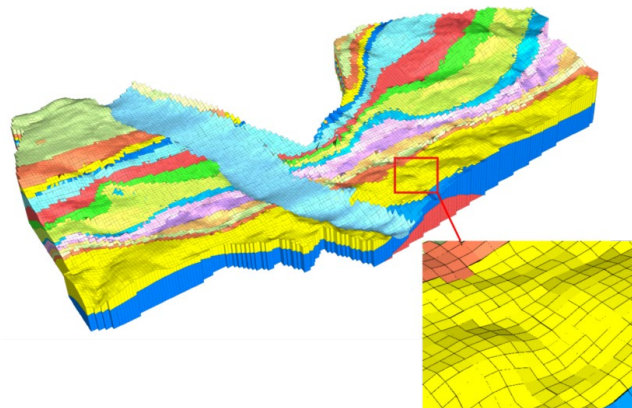


Fig. 8 Model step grid

8. Model achievement and Application

The bedrock model is matched with remote sensing geological map or surface model through DEM surface, and a complete 3D geological model is formed. The model can be cut from any direction, and then the profile required by the task can be processed (Fig.9). In the field of mineral resources, the calculation of mineral resources reserves and the visualization analysis of simulated digital drilling can be completed based on the model; in terms of geological disaster prevention, the quantitative evaluation of landslide stability can be assisted based on the parameters of landslide.

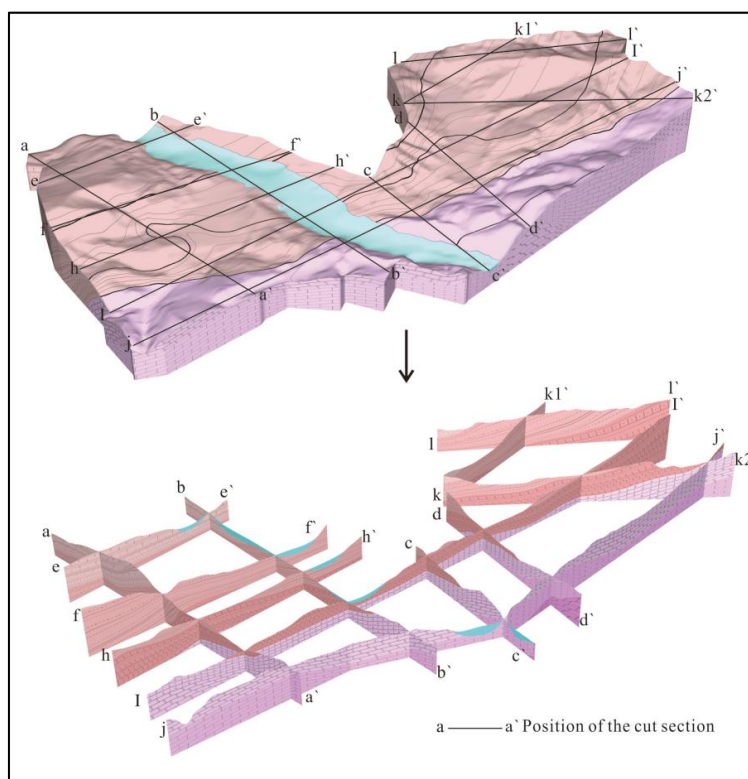


Fig. 9 3D model diagram cut section

9. Epilogue

3D geological modeling technology is to form a 3D geological model from a large number of geological information frames, which realizes the digitization, three-dimensional, visualization, popularity and practicality of the expression of geological results, and makes the geological maps vivid, intuitive and easy to be understood and applied by non professionals.

At the same time, 3D geological modeling technology and its practical application still face many difficulties. It is mainly reflected in: (1)the 3D geological model in human-computer interaction mode often distorts the geological structure of the modeling area due to human factors, resulting in the inconsistency between the final result model and the actual geological situation; (2)The workload of 3D modeling based on borehole, section and plane geological map is heavy, especially the 3D digitization process, which poses a great challenge to the software and hardware facilities; (3)Modeling is a highly professional work. In the process of deepening geological work, professional 3D geological modeling personnel are required to participate in real-time updating of the model; (4)The accuracy of the model is not enough to serve the social and economic construction, especially the geological work is in the refinement stage.

Therefore, it is still necessary to explore the 3D geological modeling technology and its application in practical production, so as to make the fine 3D geological model applied to production. The following requirements are needed to be achieved: (1)it has high accuracy and can be consistent with the geological data of drilling, geophysical prospecting and other aspects; (2)The Real-time updating

of models requires simplicity in order to allow staff from different industries and tasks to work together to improve model accuracy; (3) Making the modeling method universal, easy to operate and popularize.

Acknowledgments

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