

## **Automatic Formation Method of Prospecting Line Profile Map in Complex Coal Geology Based on AutoCAD**

Zhaogui Shou, Enke Hou and Zhenni Ye

Institute of Geology and the Environment, Xi'an University of Science and Technology, Xi'an, 710054,  
Shaanxi, China

### **Abstract**

With the progress of computer science and technology, automation mapping in the coal geology has become the trend of times. Based on the method of organization and management of the basic data of prospecting line, this paper discusses the main automatic formation method of the prospecting line profile map in complex coal geology, including the automatic formation method of terrain line, drill hole, fault, coal pinch out, angular unconformity and so on. Based on the VS2005 and Object ARX and through the method of using ODBC to connect the database, this paper realizes the automatic generation of prospecting line profile map by using the data of prospecting line based on the platform of AutoCAD2007, and the process and the results are analyzed in detail. The research results show that this method can realize the automatic generation of the profile map of the complex coalfield geological exploration line, and it can improve the working efficiency of the exploration line profile drawing greatly.

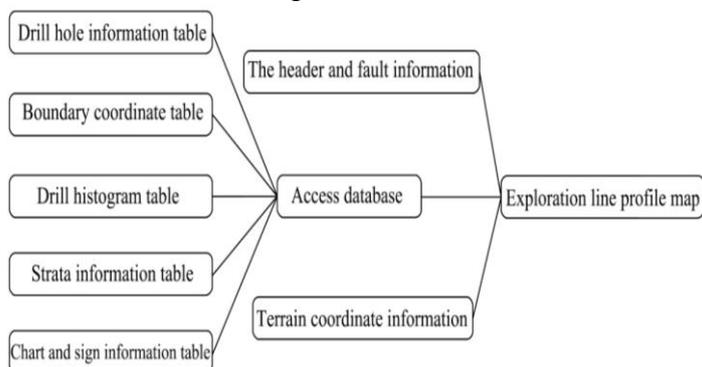
**Keywords:** prospecting line profile map; coal geology; formation method; complex geological phenomena; AutoCAD.

### **Introduction**

Using engineering data, computer automatic mapping is the development trend of modern information technology in the field of engineering [1,2,3]. In geological prospecting, we need a lot of prospecting line profile maps [4], but the traditional hand-drawn maps are inefficient and difficult to modify [5,6]. So, it is very necessary for us to use computer technology to realize automatic generation of prospecting line profile [6]. MapGIS and CAD are normal geological drawing software, and we can use MapGIS to draw some prospecting line profile maps. But the MapGIS cannot be fully automated mapping, and the management of the library file is cumbersome. CAD software is filled with joy by geologists because of its powerful drawing features and simple drawing operations [7,8]. But the research of using CAD data files to draw prospecting line profile maps is still relatively lacking. This paper focuses on the use of AutoCAD in the automagical generation about complex coal geological exploration method of line profiles.

### **Basic Data Organization and Management**

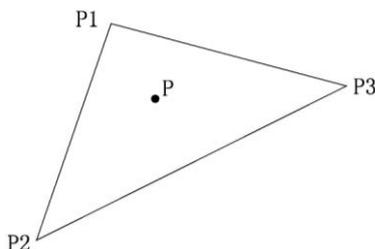
Drilling data is the foundation of prospecting line profile, and effective organization of data is the basis for stable operation of the system. Prospecting line profile includes a mass of data, such as drilling, stratigraphy, lithology and faults, so basic data organization and management is very important [1,6]. In order to reduce the workload and ensure stable operation of programs, this article puts all drilling data into Access database, and puts all surface terrain elevation coordinates into the text files, and last input some fault data and header information into the main program. There are 5 data tables in Access databases, such as the table of border coordinates, stratigraphic information, drill information and the charts; data in the DAT file is stored in accordance with the format of South CASS7.0; program interface consists of two parts: header information and fault information. Drilling information table contains each drill's name, coordinates and other information; boundary coordinates table contains some coordinate information about mining; formation information table contains the formation and watermark information; drilling column chart contains the rock's name, thickness, fill patterns and other information; sign information table contains information such as the name, unit (refer with: Fig. 1 below).



**Fig. 1 Flow chart based data organization and management**

**Automatic Generation Method of Prospecting Line Profile Map**

**The Drawing of the Terrain Line.** Form line is an important part of prospecting line profile map. The drawing of the terrain line will read data from the DAT file first. Secondly, users will choose suitable line and set some sampling intervals from CAD, in order to ensure the line location and sampling of distance. Then this program will look for some data from the DAT file to generate the best triangle to calculate the elevation value. Last it will draw the terrain line through the sampling points. The smaller the setting of the sampling interval, the more the sampling points are, and the more accurate the terrain line is, obtained by the interpolation of the program. According to the coordinates of each sampling point, the program automatically look for the nearest three points from the sampling points to form the best triangle, and it will use the triangle interpolation model (refer with: Eq. 1, Eq. 2, Eq. 3 and Eq. 4 below) to automatically calculate the elevation of each sampling point [10]. The specific calculation method of using the triangle to calculate the elevation value is as follows:



**Fig. 2 The schematic diagram of triangle interpolation**

Set the three vertices of the triangle,  $P_1$ ,  $P_2$ , and  $P_3$  respectively, as shown in Fig. 2. Then for any

point in the triangle plane, there exists:

$$P = P_1 + C_1 \times (P_2 - P_1) + C_2 \times (P_3 - P_1) \quad (1)$$

Using the Eq. 1 above to expand the plane of x and y, the parameters and values can be solved by two or more points. The physical meaning of the system is the coordinate of the radial coordinate system:

$$x_1 = Px = P_1x + C_1 \times (P_2x - P_1x) + C_2 \times (P_3x - P_1x) \quad (2)$$

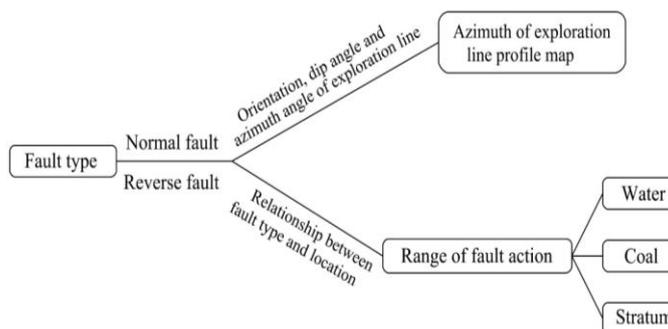
$$y_1 = Py = P_1y + C_1 \times (P_2y - P_1y) + C_2 \times (P_3y - P_1y) \quad (3)$$

And the value ( $C_1$  and  $C_2$ ) is brought into the Eq. 1 above to get the elevation value of the point:

$$z_1 = Pz = P_1z + C_1 \times (P_2z - P_1z) + C_2 \times (P_3z - P_1z) \quad (4)$$

**The Drawing of the Drill.** The drilling column is the main part in the prospecting line profile map, and drawing a suitable drill automatically according to the horizontal and vertical scale is particularly important. A good drilling column includes 3 parts, such as the pattern, hole marking and the type of drill. The program will read some basic drill 'data from ACCESS database by the ODBC basic information of each drill, and then it uses the function of drawing points, drawing lines and drawing surface features to complete the drill column in CAD. By reading the borehole coordinates in the database, the program automatically determines the plane position of the borehole and prints the elevation value at the top. According to the thickness of each layer, the program will draw the corresponding hole and lithologic filling pattern from top to bottom. Finally, the program will mark the corresponding elevation value at the bottom of the hole. In the reading process, if the seam is encountered, the height of the roof and floor of the coal seam and the thickness of the coal seam will be marked on one side of the drill hole. The lithologic filling pattern of the borehole is called directly from the base of the CAD, and the users can conveniently select the pattern of the code number from the pattern database to fill the holes in each layer. This not only simplifies the procedure of the procedure, but also enhances the stability of the program running, and realizes the interactive work from the database to the CAD work area.

**The Drawing of the Fault.** In geological mapping work, the exploration line often intersects with the fault, and the fault will lead to the formation of the relevant strata, such as coal seams and water level line. In profile, the fault type (this paper contains only normal faults and reverse faults), azimuth angle and fault location, the inclination angle of exploration line is the main factor affecting the fault position and the scope of the exploration line. Among them, the azimuth of the exploration line and the dip angle of the fault mainly determine the azimuth of the fault in the profile map, and the type and the location of the fault mainly determine the scope of the fault. The relationship between them can be illustrated in Fig. 3 below. Combined with the exploration line azimuth, this program will input the fault types, location, and inclination angle into the main program. To determine the fault plane position in cross-section, this program will analyse the fault type and some angle. And then it will determine the plane position of the layer, coal layer and water level because of the influence of faults. Finally, it will mark the type, fault angle and drop tendency of the fault respectively on both sides.



**Fig. 3 Relationship between fault and correlation factor**

**The Drawing of the Wedging Out of Coal Seam.** The wedging out of coal seam is the phenomenon that the coal seam becomes thin and disappears in the space distribution. In this paper, based on the data of the basic coal bed of each borehole of the exploration line, the paper draws the coal seam between the two ways of pushing and pushing. In the process of drawing out the coal seam, the distance between the point and the direction of the pointed out is fully considered. According to the geological conditions of coal mine, this paper mainly uses the form of wedge to push outward and the distance of the extrapolation is generally 1/2 or 1/3 according to the net degree, and the direction of extrapolation is generally consistent with the direction of the two-hole coal seams [11].

The extrapolation principle is shown in Table 1 below.

**Table 1 Principle table of the coal seam extrapolation**

Condition	The distance of the wedge	The direction of the wedge
The difference of the thickness of the two holes is small.	1/2	Two drill holes in the direction of the coal seam.
The difference of the thickness of the two holes is larger.	1/3	

**The Drawing of the Line of the Angular Unconformity.** The line of the angular unconformity is the line of contact between upper and lower two sets of occurrence of inconsistent strata, which is generally expressed by wavy lines. But at present, the CAD drawing software is short of ready wave line. To solve this problem, by using CAD spline curve, this paper combines vertical and horizontal scale and the distance between the drill holes to draw out the beautiful and reasonable line of angular unconformity.

**The Automatic Generation Process and Result Analysis of Exploration Line Profile Map**

**The Automatic generation of exploration line profile map.** The realization of the exploration line profile map is based on the AutoCAD 2007 and VS2005 as the development platform and Office Access Microsoft 2003 database as the database management system. Access based exploration line through the ODBC database, the program is automatically generated by the method of ObjectARX of the MFC library to complete the map. The steps are as follows:

Step 1: Basic data management. This program uses Access database to manage the based data of the profile of exploration line, and uses DAT text file to manage the elevation data, and the header and fault information is input through the main program.

Step 2: Load ARX files and determine the location of the exploration line. Open CAD first, by entering the appropriate command to complete the loading application and select the exploration line, combined with the initial drilling coordinates, the program will automatically read the starting point of the exploration line coordinates.

Step 3: Connect to the database, read DAT data and automatically generate maps. Extracting data from

the database, the program will complete the drawing of the exploration, such as: line scale, drilling, coal seam and strata, small coal pillar and illustrations sign. By extracting the corresponding data from the DAT file, this program will draw the terrain line. At last, it will draw fault through the fault information which is input by the main program. The program interface is shown in Fig. 4 below.

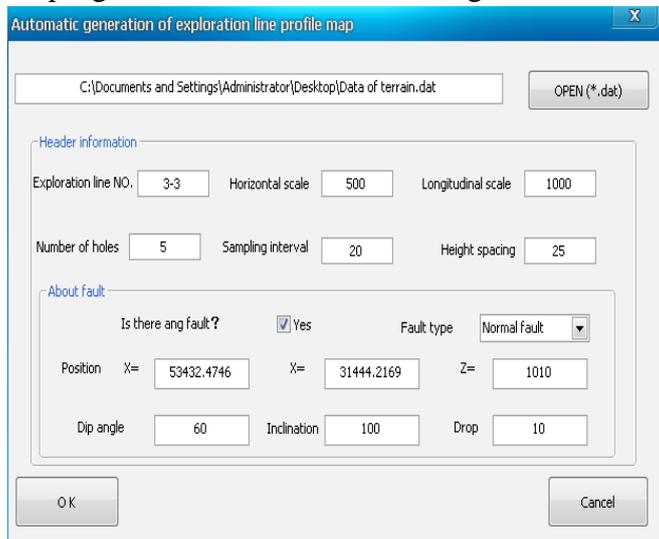


Fig. 4 The main interface of the program

Step 4: Map output. CAD has a powerful graphics file output function and it can do it well itself. In this paper, based on the above method, the automatic drawing of exploration line profile is achieved successfully by using the base data of the corresponding exploration line profile. The operation effect of the exploration line profile is shown in Fig. 5 below.

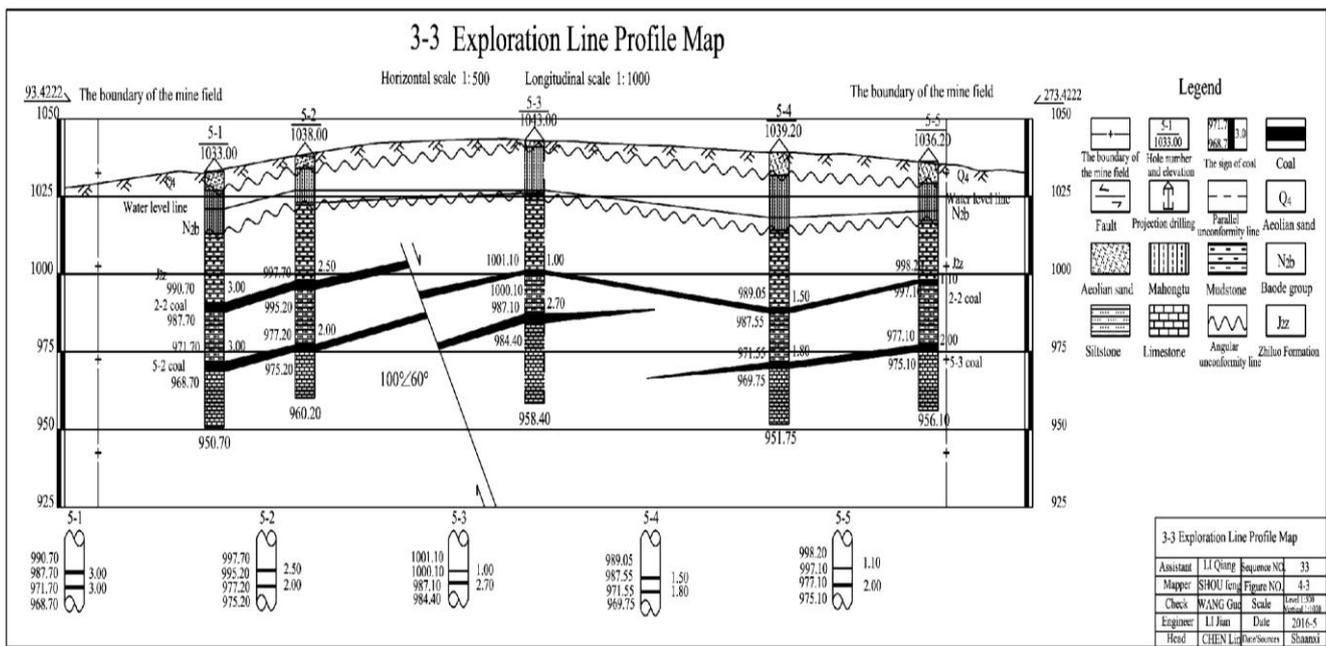


Fig. 5 Effect of exploration line profile

**Results Analysis.** Based on the results of the exploration line profile map, the advantages of this method and platform are as follows:

1. Selecting VS2005 and CAD2007 as the two-development platform, the program has a lot of advantages, such as: short development cycle, beautiful interface, simple operation and fast speed and so on. Relative to the storage point file, DWG file not only has the characteristics of saving fast, and has the advantage of simple transfer.

2. By using Access database and DAT files to manage basic data, the program can control the type of data, and table management also allows users to make data more clearly in the right position.

3. The algorithm of using the method of Eq. 1, Eq. 2, Eq. 3 and Eq. 4 to calculate the values of the surface elevation line is clear, and it can quickly and accurately interpolate the exploration line elevation of the pitch point value. Besides, the logic relationship between the elevation of borehole and terrain line can be checked automatically, providing convenience for users to check the map.

4. This program can draw small coal pillar, sign and legend automatically, which greatly reduces the workload of drawing and improves the drawing efficiency.

## Conclusion

Referring to the complex problem about the manual section of drawing exploration line profile maps, based on CAD development, this paper can automatically draw the prospecting line profile maps in complex coalfield geological conditions. It has the characteristics of short development period, stable operation and simple operation, which saves manpower, financial resources and material resources, and can greatly improve the working efficiency of drawing the exploration line profile.

## References

- [1] X. X. Zhang, "Research on automatic mapping methods of borehole histogram and section based on MapGIS," Xi'an University of Science and Technology, 2011.
- [2] J. H. Chen, Z. Y. Zhou and G. Chen, "Automatic formation method of prospecting line profile map based on drill hole database," Central South University Journal (NATURAL SCIENCE EDITION), vol. 3, pp. 486-490, 2005.
- [3] L. W. Chen, "The application of MapGIS in geological mapping," Journal of Xi'an Institute of science and technology, vol. 1, pp. 36-38, 2002.
- [4] X. R. Zhu, "The automatic generation of the design profile of the exploration line," Geospatial Information, vol. 3, pp. 150-152, 2012.
- [5] Erarslan K, "Practical approach for 3D modeling of orebodies and the design of development for underground of mines," Mineral Resources Engineering, vol. 9, no. 3, pp. 45-48, 2000.
- [6] X. X. Luo and X. X. Zhang, "A method of Borehole Histogram automatic mapping based on MAPGIS," Computer Engineering and Science, vol. 1, pp. 98-102, 2012.
- [7] Archibald N. J and Power W. L, "Geology and orebody delineation using 3D computer modeling," Computers & Geosciences, vol. 15, no. 8, pp. 58-62, 1997.
- [8] Gibbs B. L, "Computer software for mine design, an overview," Journal of Mines, Metals & Fuels, vol. 96, no. 7, pp. 317-322, 1996.
- [9] Schofield D and Denby B, "Computer graphics and virtual reality in the mining industry," Mining Magazine, vol. 171, no. 5, pp. 58-63, 1998.
- [10] G. A. Tang, F. Y. Li and X. J. Liu, "Digital elevation model course (Second Edition)," Beijing: Science Press, 2010.
- [11] Ministry of coal industry of the people's Republic of China, "Several provisions on the reasonable exploitation of coal resources to improve the recovery rate (for Trial Implementation)," Beijing, 1982.

- [12] G. Z. Zheng, W. G. Dong and L. Zhang, "An automatic drawing method of borehole histogram based on MapGIS secondary development," *Geological Science and Technology Information*, vol. 3, pp. 196-201, 2014.
- [13] Iglesias A, "Computer Graphics Techniques for Realistic Modeling, Rendering and Animation of Water. Part I: 1980–88," *Computational Science–ICCS 2002*, 2002, pp. 191-200.
- [14] F. J. Ferri, J. M. Inesta and A. Amin, "Segmentation of text and Graphics/ Images Using the Ray-Level Histogram Fourier Transforms," *Computer Science*, vol. 8, pp. 757, 2000.
- [15] Lous Y. L, "Report on the First Euro-graphics Workshop on Visualization in Scientific Computing," *Computer Graphics Forum*, vol. 9, no. 5, pp. 371-372, 2007.