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几种地质图件的数据存贮与处理

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本文主要叙述了在开发煤矿地质信息系统(CMGIS)中的几种主要地质图件的数据存贮与处理技术。地质图件作为一种专业图件，有它特有的属性，如岩性花纹符号的大量出现，各种构造、地物等特殊线条的出现，地质曲线与文字标注的大量出现等。实践表明，采用商品化通用软件包(Auto CAD)已满足不了用户的要求，因为它缺乏地质上所需要的特殊性线型。用它编辑后的图形数据难以二次利用，图素的地质含义不再表现在图形数据库中，况且，如果图形编辑量过大，还必须考虑是否要对原始数据进行调整或增加辅助数据，为此，用户必须在不同的软件环境下运行不同的软件和数据，造成用户学习掌握和使用上的困难。

本文介绍的是在"CMGIS"基础上新开发的一种煤矿地质计算机辅助设计系统(MG－CAD)，它可以直接生成煤矿地质勘探、矿井与设计中几种常用的图件，其中的图形编辑器除基本的作图和编辑功能外，还增加了专门的编辑功能，以适应地质特点，其图形数据库也是针对地质图件中的一些特点设计的。由于这种专业化的图形数据库的建立，图形数据与地质体之间不仅是几何上的描述，还包括了确定的地层和构造的含义；因此可以实现各相关图形之间数据的传递和对应。文中主要描述了岩性符号的"形"处理方法，特殊线条和地质曲线的处理与存贮，柱状图、剖面图、平面图的图形处理技术，如柱状图的文字标注法，剖面图的断层处理方法等。

DATA STORAGE AND PROCESSING FOR SOME GEOLOGIC MAPS

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ABSTRACT

This paper mainly introduces the processing technique used in some geologic maps for Coal Mining Geological Computer Aided Design (MGCAD) system. "Shape" processing in lithologic symbol, the storage and processing of special lines and geologic curves, and the processing of some graphs, such as column, profile and plane, etc. are detailed.

INTRODUCTION

Geologic map as a professional graph has its unique attribution . It is focused on that lithologic symbol,plenty of structure and ground object,geologic curve and character mark are used frequently.

There are mainly three types of geological map used in coal geolgoical exploration and mining planning in China,i. e. ,column,profile and plan map for reserve calculation. Considering the practical experience,the commercial software package(Auto CAD)can not satisfy the user's requirements due to lack of the special line style used in geolgoic mapping. The graphic data produced in Auto CAD is diffcult to be reused. The graphic elements concerning the geology are not included in the graphic database. Moreover,if the amount of graph editing is too large,adjusting the original data and/or additional aided data must be considered. Thus,the user has to run different software and access data in different environment. It is diffcult to learn and grasp.

To use the graphic data edited directly and keep its geologic meaning ,to reduce the edit operation and integrate the running environment,and to maximize the flexibility,we developed a Coal Mining Geological Computer Aided Design(MGCAD) system,which is based on the Coal Mining Geological Information System. The MGCAD applies the computer aided design to sedimentary and layered deposit exploration and mining. Several maps that widely used in coal mining design can be generated easily. Its graphic editor provides not only the basic mapping and editing but also special edit function relating to geology. Its graphic database is also specially designed,which is aimed at some features of geological mapping . So the graphic data have some geological attribution except the normal things.

PROCESSING AND STORAGE OF LITHOLOGIC SYMBOLS

Shape is a special graph element that can be defined by certain straight line and arcline. Auto CAD approximates the vector character or symbol that user specified with a 16-direction-vector and eightant circle. It is appropriate and convenient that use shape to describe the lithologic symbol of sedimentary rock(Fig. 1). Lithologic symbol can be treated as a combination of some basic units(named graphic elements)with certain rules. During the development of MGCAD,a geological symbol library was built . Each basic graph representing rock symbol has its unique displayable ASC Ⅱ code. Based on the different drawing methods (such as with/without horizontal line,solid filling, etc.)used in the lithologic symbols,the primary and secondary lithologies were considered to define the full lithologic symbol with three-byte-code.

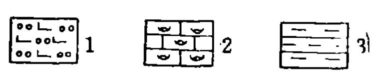


Fig. 1 Legend of lithologic symbol
1=quartz sandstone;2=bioclastic limestone;3=mudstone

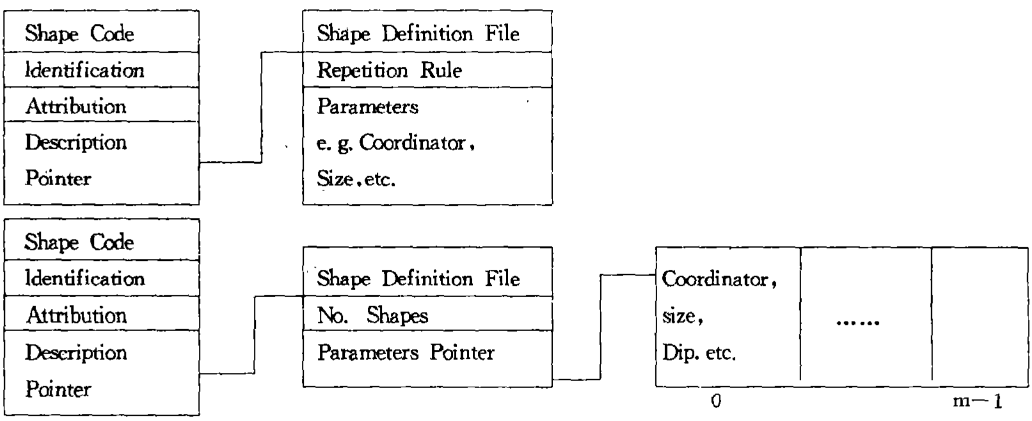
The storage of shape in graphic database is similar to the vector character. What they are stored are shape code, description filename and its relevant parameters. The vector description of actual pattern was not recorded. Once you want to output them, only reading out from the description file is required.

To speedup the accessing , all description files were pre-processed, indexed, binary-coded. The procedure for a shape processing is as follows.

1. Read index according to th shape code.
2. Read description according to the index.
3. Make graph based on the description.
4. Output the graph.

Without regard to the regular repetition of lithologic symbols, it has to repeat the procedure 1 through 4 every time. Meanwhile, it will occupy the large resource space due to same size space being assigned for the each unique shape.

To utilize this regular repetition fully, two graphic elements, shape and mshape were introduced. The only difference between these two graphic elements is that the size and angle of rotation for the former are constant . The positioned point is a function of the coordinate. It is defined as follows.



Now we know that either processing speed or storage resources of the two-graph-element above is much better than that of one-graph-element.

PROCESSING AND STORAGE OF SPECIAL LINE STYLE

Special line style includes railway, ground objects boundary and structure line, etc. in the plane map, which must be represented using 2-D lines. Its basic features are: continuous line with special equidistant marks (Fig. 2). These special marks also can be represented by shape. The arranging rules are equivalent line segment, same angle of rotation and tangent. So a special line style can be broken down to several basic graph elements. They were stored with mshape just like lithologic symbols. The curves were fitted and stored with cubic spline function, or with polygonal line directly.

The definition can be based on the name of the line style, code, comment, line width, the length of short line, separation, etc. The code described the segmentation. Thus, we can know the shape codes, determine if there are equidistant line and other things. They are four-byte codes in MGCAD system. The last two bytes are shape codes. They will be set to zero, if there is no the defined shape (for example, railway)

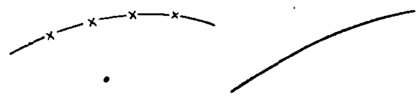


Fig. 2 Special line style

DESCRIPTION AND STORAGE OF GEOLOGICAL CURVES

The cubic spline curve can be used to describe the geological curves that pass through a series geological points. Besides the data describe the whole idea of the object, the coordinate value of each point and its derivative are recorded. Most these geological curves are the objects with thickness and their tips. As shown below, for a limestone segment, there are several points with different thickness. Also, it has different shape at both the start point and the end (Fig. 3).

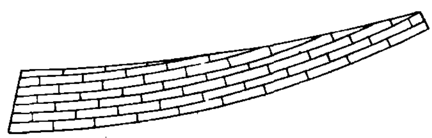


Fig. 3 One segment of limes.one

This limestone segment can be described as follows:

General
Geoline
Parameter
Pointer

X_1, Y_1 …… X_n, Y_n
Px_1, Py_1 …… Px_n, Py_n
dx_1, dy_1 …… dx_n, dy_n

Where, P'xi and P'yi are the derivative with respect to x and y at (xi, yi), dxi and dyi are the incremen between Pi and Pi' at x-direction and y-direction, respectively. Its lithologic symbol, stratigraphy and geological structure can be accessed from the index pointer of layer description.

It is very important that define a graphic layer in graph database processing. The graphic layer is similar to the formation except that there is no concept of geological times. In the whole attribution structure of all graphic elements, a field is used to determine whether it is a geological body or not. Once it is , the graphic layer has the concept of geological formation. Its geological times can be accessed from the registered table. Now, a curve with formation and structure meaning has been described completely.

GRAPHIC PROCESSING

Columns

Lithologic symbol and annotation are the main features. The former has been discussed above . A method that determines where the lithologic symbol and annotation are placed will be introduced in this section. As shown in Fig. 4, the thickness was expanded to fit the lithologic symbol, description and annotation. The buffer line was used as a boundary for different description column.

The minimum width drawn is based on the actual situation of different layer. The layer with the width less than the minimum width drawn can borrow the width required from the adjacent thicker layer according to certain rules. To draw the annotation, the minimum width required for different layer should be determined first, named min-th_{ij} (the two subscripts represent the stratum unit No. and layer No. , respectively). Then, the minimum average width required is the largest one in all min-th_{ij} as follows:

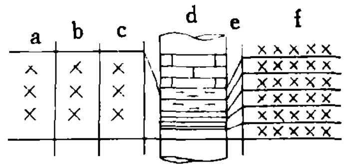


Fig. 4 Schematic of column
a=system; b=series; c=formation; d=lithologic symbol; e=buffer line; f=description an annotation

$$\text{min-th}_i = \text{MAX}(\text{min-th}_{ij}), \text{ where } i = 0, \cdots\cdots, n$$

The stratum width can be borrowed again. The method introduced above is named as Minimum thickness Method, which has advantage of programming easily and the excellent results.

Profiles

Using scattered data points (like borehole and mining data) to create a profile, it is very difficult to adjust the pattern of geoline due to faults existing. They can not be connected directly according to the geologic strata. Faults treatment must be considered.

Geolines in Fig. 5 represent an inferred structure acceptable. The formation was continuous (represented with dash lines) before it was faulted. Assumed the formation is rigidity. The faulted formation is shown in Fig. 5 with continuous lines. Now the formation can be restored by means of shifting one side of the fault (Fig. 5—B). Getting the formation-fault intersected points and all the other control points, which usually are actual points, shifting to their actual position, a satisfied graph processing technique is developed. It is called Faulted Again or Moving Rigidly.

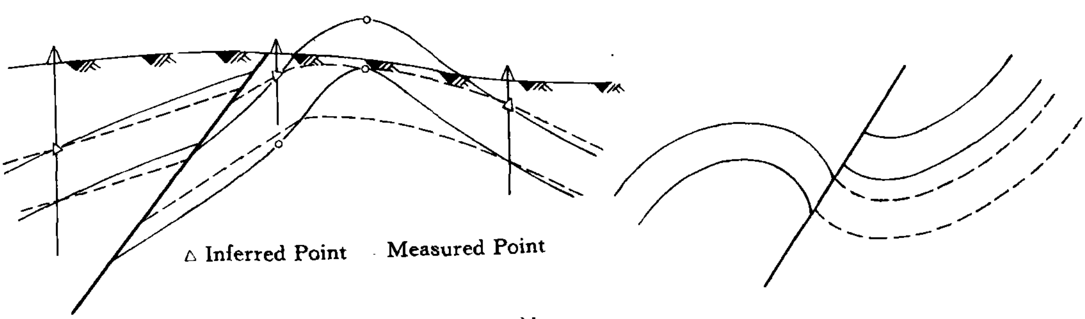


Fig. 5 Fault treatment and adjustment of stratigraphic form

However, shifting entirely is impossible for actual situation due to variable dip and throw of the fault. Single layer shifting separately technique was developed based on the same principle. To harmonize the different layers, assistant control point and computer-user interactive editing were used.

Plane for Resources Calculation

In China, contour on the plane for resource calculation must go through the points known. It still can be described with cubic spline. To get a unique description, coordinates from the plane and the cross-section must be the same for a control point (Fig. 6). Point P on th plane must have the same coordinates with Point S on the cross-section because they are the same point indeed. This is so called correlation. Many control points can make it possible to contour without actual borehole data, even without gridding. This technique is used frequentenly in MGCAD system due to its convenience, linear processing velocity and the least storage space.

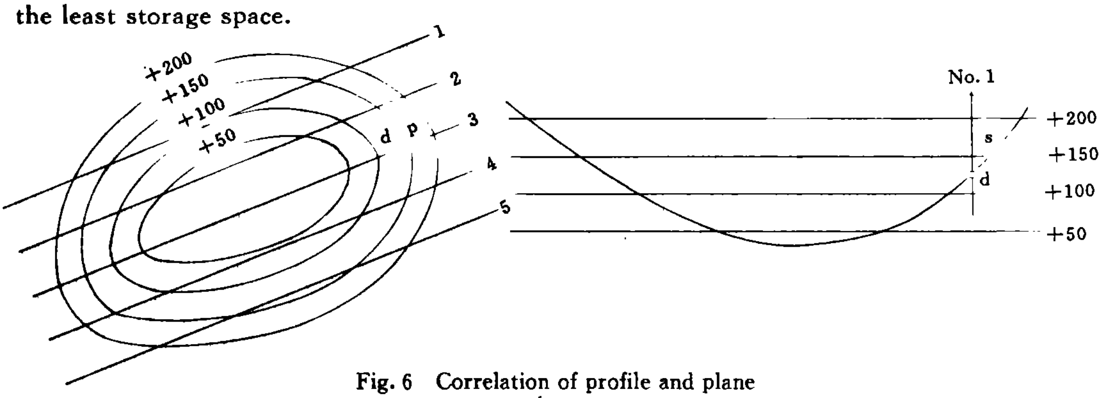


Fig. 6 Correlation of profile and plane

CONCLUSION

Several geological mapping were provided with certain basic instructions. They are at the same system level with line, circle and geoline. The only diffrence is that they can generate several basic graphic elements with an instruction, which includes a lot of data processing. So some common geological maps can be generated with one or several instructions. The professional graphic database makes the graphic data describe not only its geometry but also its geological meaning. Thus, it is possible to transport a correlate the data sets. The graph data edited by user can be used directly as raw data. The data structure built was based on the geological meaning and the geometry.

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