THE DEPOSIT NUMERIC MATHEMATICAL MODEL USED IN RESOURCE CALCULATION AND MINING DESIGN

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GENERALITIES

Up to now, the most widely used deposit model in mining design is the graphical-analytical model which consists of two modules:

1. The first module, also called the written part, consist of: the description of seams, veins, bodies, etc.; the description of deposit properties (deposit tectonics, hydrology, gasodynamics, the petrographic and mineralogic properties of seams, bodies, veins, etc. and the physical, mechanical and chemical characteristics of the deposit); description of deposit environment; description of the tectonics of the area; the results of the processing of information obtained in geological research under the form of synoptic tables.
2. The second module, also called the graphical part, consists of: the basic plans of each seam, vein, body, etc.; directional and transversal cross-sections through seams, veins, bodies and through the whole deposit; structural maps of each seam, vein, body and of the whole deposit; the geological map of the area.

From experience and scientific references it is known that during information processing, the following error types are transmitted: technical, analogy errors and method errors. For decreasing the value of these errors, especially of the method ones, old algorithms should be perfected and new ones should be developed for processing, interpreting and achieving the graphical layout by means of automatic data processing.

In this respect, we propose a new deposit model based on mathematic modelling which requires the use of automatic data processing. For the numeric model of the proposed deposit, in the first phase of processing the information obtained from geological research, an accurate classification should be made. The most adequate classification for the present purpose is given by the criterion "Information classification according to the description mode of a complex system". This criterion groups information according to:

- the nature of status variables (category variables, continuous variables and discrete variables);
- their variation in time (static variables, dynamic variables and quasi-static variables);
- the connection with the decident (reaction and stimuli variables);
- result indicators.

THE DEPOSIT NUMERIC MODEL BASED ON THE INFLUENCE OF KNOUWLEDGE POINTS

The proposed mathematical model consists of three modules:

- module 1, used in tracing the outlines of horizontal sections, based on knowledge points;
- module 2, used in tracing the outlines of vertical sections, using information obtained from the first module;
- module 3, comprises a mathematical model which solves the following problems: the rotation of the coordinate system, achievement of cross-sections through the deposit body, resource calculation, etc..

Obs. The objective of the first module can be changed when the information regarding vertical sections exists in greater volume and is of a better quality than that referring to the outline of the hoizontal secion. In this case, it follows that the objective of module 2 will also change.

1. The tracing of section outlines on grounds of the algorithm of influence points.

Let be a set of points N_i, $i=1,n$; between these points there are variable distances and they have a constant coordinate. This property is accompanied by others, such as: the same content of useful components, the same specific weight and other qualitative or physical-mechanical characteristics. It is required that through these knowledge points an isoline (an outline) should be traced.

The solving of the problem involves two cases:

Case I, when the set of points describes an open outline. In this case point thickening cannot be achieved for the first and the last segment, since points M_1, and M_i are influenced by a single point M_2, respectively M_{i-1}. As shown in case I, in order to be possible to achieve point thickening within a given interval both influence points adjacent to the analyzed interval are necessary.

Case II, when the set of points describes a close outline. The proposed algorithm consists of the following stages:

- the establishing of the uniting order for the research point by a curve;
- the writing of the equations for the lines passing through two successive points;
- the determining of the value of the angles formed by the segments having a common research point, (according to the values of these angles, the following situations exists:

1. outline portions in which only angles smaller than 180° are to be found;

2. outline portions in which only angles bigger than 180° are to be found;

3. outline portions in which an angle is bigger and the other is smaller than 180°;

4. outline portions in which an angle is smaller and the other is bigger than 180°);

- the construction of the tangentoid triangle;
- the writing of equations for the sides of the tangentoid triangle;
- the determining of the gravity center of the tangentoid triangle when its vertexes are known, thus resulting a points within the interval given by the two known points M_i, M_{i+1}.

The forming of tangentoid triangles differs according to the situations of the outline portions as it followes:

Situation 1. The tangentoid triangle results from the segment which unites the two research points and the bisectors of the angles formed by the segment $[M_i, M_{i+1}]$ and the half-lines resulted from the prolongation of the segments which go into and come from the two points M_i, M_{i+1}.

Situation 2. The tangentoid triangle is formed in the same way as in the situation 1, but it is inverse positioned with respect to the segment (in situation 1, if the triangle is on the left of the segment, in situation 2 it will be on the right of the segment).

Situation 3. By the intersection of the bisectors of the angles formed in the two points of segment $[M_i, M_{i+1}]$ a quadrilateral will result. By tracing the second diagnonal in the formed quadrilateral, four triangles will result: two above segment $[M_i, M_{i+1}]$, and two below it. The gravity centers will be determined for those triangles situated on a convex and on a concave outline with respect to segment $[M_i, M_{i+1}]$.

Obs. In this case there will result two points through which the outline curve traced between the two research point will pass.

Situation 4. Is identical to situation 3, except that the first determined point will be situated on a concave curve and the second one on a convex curve with respect to segment $[M_i, M_{i+1}]$.

2. The algorithm for the tracing of vertical section outlines.

For the tracing of the curves which describe the outlines in vertical plan for different surfaces resulting from the intersection of a vertical plan V_i with the useful minerals body in question, the procedure is the following:

- the direction of the perpendicular on the parallel vertical plans which intersect the body is established;
- axis X will be rotated with the angle between axis X and the direction of the perpendicular until axis X will be superposed on the perpendicular direction;
- coordinates X and Y of the points through which the horizontal outlines describing the body pass are recalculated in the new axes system X'OY'Z' with the relations:

$$x'=x*\cos a-y*\sin a$$
$$y'=x*\sin a+y*\cos a \qquad (1)$$
$$z'=z$$

- the distances between the vertical parallel plans and the values of coordinate X' through which these plans pass are established;
- then, each vertical plan V_i is intersected with the horizontal outlines H_j , thus obtaining the points through which the outlines of the vertical surfaces

resulted from the intersection of the body with the vertical plans V_j.

The equation of a vertical plan is:

$$By'+Cz+D=0 \quad (2)$$

In order to find the points through which the outline of a vertical surface V_i passes, the procedure is as follows: each horizontal outline is intersected with the vertical plan (2) thus resulting the points with the coordinates $M_{ijh}(X_{ijh}, Y_{ijh}, Z_{ijh})$ in which coordinates X_{ijh} and Z_{ijh} are known and valueY_{ijh} is calculated with the relation:

$$Y_{i,j,h} = (Y_{l+1,j,h} - Y_{l,j,h})\frac{X_{i,j,h} - X_{l,j,h}}{X_{l+1,j,h} - X_{l,j,h}} + Y_{l,j,h} \quad (3)$$

where: -l=1,o, represents the number of points known from the iteration file on which the tracing of outline "j" was based;

-i=1,n, represents the number of vertical plans;

-j=1,m, represents the number of horizontal plans (equal to the number of horizontal outlines);

-h=1,p, represents the number of points resulted from the intersection of the vertical plan V_i with the horizontal outline which belongs to the horizontal plan H_j; h has different values for the intersection of plan V_i with each outline H_j. The number of "h" points is given by the number of intervals [X_i , X_{i+1}], which contain point X_i found in the set M_1 of the iteration on which the tracing of outline "j" is based.

-$X_{i,j,h} \equiv X_j$, where X_i is the abscissa of the vertical plan V_i, constant for all its intersections with all the horizontal plan H_j;

-$Z_{i,j,h} \equiv Z_j$, where Z_j represents the elevantion of the horizontal plan H_j which contains outline "j"; it is constant for all the points resulted from the intersection of a vertical plan V_i with all the plans H_j;

-$Y_{i,j,h}$ is variable for each plan intersection $V_i 1 H_j$.

PRACTICAL EXAMPLE

For the testing of the proposed model we have selected from the nature an object of an irregular form, (e.g. a potato), which was sectioned into horizontal slices 15 mm thick. Then each slice outline was copied on squared paper and a coordinate system was attached to each outline, which allowed the establishing of a set of knowledge points.

Each set was processed by means of the programmed algorithm and the following results presented in tables and graphical by transposed were obtained, fg.1.

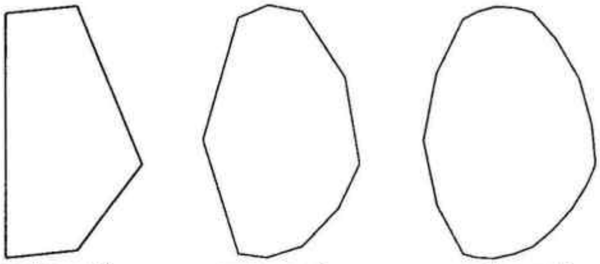
Resorting to command AREA from the AUTOCAD programming environment we obtain the following values of the section areas S_1-S_8 (for the set of initial data and for each iteration taken separately) presented below:

S_1=1023.75, S_{111}=1047.6293 cmp;

S_2=932.5, S_{222}=968.3505 cmp;

S_3=1286.25, S_{333}=1327.5551 cmp;

S_4=1965, S_{444}=2001.8765 cmp;



section no. 8 | section no. 8 -iteration no. 1 | section no. 8 -iteration no. 2

Fig.1

S_5=1991.25, S_{555}= 2078.7555 cmp;

S_6=163.25, S_{666}=1674.0703 cmp;

S_7=1602.5, S_{777}=1638.5951 cmp;

S_8=123.25, S_{888}= 168.5159 cmp.

Knowing the section areas by SIMPSON'S relation the volume of the sectioned body is calculated, and the following results are obtained: V_1 =165.251 cmc, for the initial data; V_{111}=170.821 cmc, for the second iteration.

The volume obtained by immersing the body into liquid is 165.7 cmc. The difference between the two ways of determining the volume is 5.121 cmc. This difference is caused by the way of monitoring the initial points, the non-parallelism between sections, the difference between slice thicknesses and the width of the pencil trace.

CONCLUSION

- The model is used for any deposit form;
- It is used for the calculation of deposit resources (volume, weight and content);
- It is used in design due to the facility of obtaining sections through the deposits area;
- It eliminates at "0" the errors of graphical data trascription;
- The use of the model imposes a uniform geological research;
- The algorithm is transposed in a package of programs.

BIBLIOGRAPHY

1. Murgu Martian - Evaluare geologică şi industrială a zăcămintelor minerale. Ed. Tehnică, Bucuresti - 1986;

2. Coordonator Aron Popa - Manualul inginerului de mine, vol.2. Editura Tehnică, Bucuresti -1985.