ESTIMATION OF GEOLOGICAL COAL RESERVE BY STRUCTURE MODELING FOR VINACOMIN COAL SEAMS

Truc Kim Kieu

Vietnam Mining Science and Technology Association, 226 Le Duan Str., Hanoi, Vietnam

ARTICLE INFOR
TYPE: Research Article
Received: 21/10/2025
Revised: 23/11/2025
Accepted: 28/11/2025
Corresponding author:
Email: kieukimtruc@gmail.com

ABSTRACT

The structure of coal seams in Vietnam is quite complex with tectonic disturbances and inseam rock partings. Determining the geological structure, calculating reserves and especially the geological reserves of coal seams is a common but rather difficult task for mining engineers. The traditional method in Vietnam is linear interpolation and calculating reserves by parallel cross-sections. But now, with the support of computers, the modeling method is being widely applied, and moreover, it also helps to accurately describe the structure of the coal seam and eliminate the rockpartings located between the roofs and floors in the seams, which is very necessary for calculating coal reserves. At the same time, new criteria for coal reserves have also been introduced, such as T, T1, T2. This newly applied method of calculating coal reserves not only increases the accuracy, but also shortens the time and even increases the calculated coal volume compared to the traditional method, has many scientific and practical meanings, and can be effectively applied to geological and surveying works such as calculating geological reserves and calculating mining excavated volume.

The main content of the paper is to introduce the method of calculating reserves by combining structural modeling and thickness of coal seam. This method is applied to calculate all major coal seams in large open-pit mines of Vinacomin, but the typical case study presented in the paper is the case of Cao Son and Ha Tu mines, using data from boreholes in Vinacomin's geological exploratory reports.

In order to have good results of reserve estimation, the article also introduces the creation of relational geological databases of coal deposits for mines. The modeling results demonstrate the effectiveness of these PC applied works, including establishment of coal seam structural maps such as elevation isolines of roof, floor and thickness of coal seams, as wel as tectonic zone planes. These modeling results can be served as the basis for mine design, mine planning, mine scheduling, mine optimization and economic efficiency calculation... on computers in a continuous and intergrated way.

Keywords: *relational geological databases, coal reserve estimation, coal seam structure modeling and geometrization, Vinacomin.*

1. INTRODUCTION

Coal in Vietnam has been exploited for over 160 years (since 1840). Coal resource in Vietnam is rather abundant. Anthracite in Quang Ninh province, sub bituminous coal in Red river delta and peat coal in Mekong river delta. To the depth of 300 m, the rough figure of proved coal reserve is estimated at about 6 billions tones, including 4 billions tones of anthracite, 1.5 billions of sub bituminous and 0.5 billion of other kinds (lignite, peat and fat coal). Other coal basins are expected in continent shelf under sea water and other inland places.

The main coal regions that Vinacomin is assigned to manage are Quang Ninh and the inland area.

Anthracite coal is located in Quang Ninh province, along coastal area, and consists of 2 strips: northern part is a synclinal, called Bao Dai – Yen Tu – Vang Danh strip. Second strip is Dong

Trieu – Hon Gai – Cam Pha – Cai Bau (island). The second strip is divided by various big equatorial faults, and smaller submeridial faults, dipping at 60-89 degree. There is about 40 coal seams here, 20 of them has industrial significance. Reserve from out crop to the depth of 300 m (or below see level) is estimated at 3.8 billion tones, to – 100 m is 1.2 billion tones (with criteria of ash less then 40%, but with criteria of ash ≤ 60%, the number will increase by 20%). The coal quality is high: calorific value is from 6000 to 8000 kcal/kg; ash content is 10-27%; sulfur content is less than 1%. Some fat coal is located separately in northern part of Vietnam (called inland coal): Thai Nguyen, Lang Son, Lai Chau... Reserve is about 15 million tones [1, 8].

The estimated Reserve or Resource figures are often different, depending on the calculation categories and criteria, depth and thickness of coal seam, mining technology, ash content ... as well as different sources of information. However, because the article focuses on methodology, so the reserve information is mainly for just illustration purposes.

To meet the stable growth of output and sustainable development in Vietnam coal industry, many measures have been applied, focusing on introduction of higher efficiency technology, including searching for new source of coal and method of reserve estimation.

The main contribution of this study is applying the method of calculating reserve volume by modeling which is very popular in the world, but here in the paper it is based on the combination of modeling of elevation of coal seam roof, floor and especially the thickness to calculate the wouldbe rawly excavated coal reserves, as well as real coal reserves with eliminating rock partings layers in coal seams. Result of thickness modeling makes it posible to create virtual seam roof, that is the real confine for volume calculation. This is also a necessary need to effectively calculate the output of exploited real coal in addition to rawly excavated coal.

2. MATERIALS AND METHODS

2.1. Criteria and method of coal reserve estimation

Traditional method

Over long period of time, according to Government decision, most important indicator of coal seam quality used for reserve calculation is thickness and ash content. Thickness (m) of coal layers must be equal or more than 0.8 m (m ≥ 0.8 m), and ash content must be equal or lower than 40 % (A^k ≤ 40%).

The common method of reserve calculation based on parallel sections, limiting in separating seam blocks. First, to draw isoline plan of seam floor level, then to divide it into different blocks according to density of drill holes and seam structure. Use formula to calculate reserve of each block as follow: T = S * m * d, where T – reserve of coal in a block; S – area of each section, or inside of each level isoline; m – coal thickness between sections or isolines, average from hole data in block; d – volume unit weight of coal. The method is called "Secang" method.

Reserve grades are divided into several categories as follow: Proven reserve is called category A and B, probable - C1, estimated - C2, and forecasted (poorly estimated) – P.

The limitation is that, the whole seam area must be divided into many smaller blocks with similar structure condition and be treated manually for each block, each roof, each floor, each time, consuming a lot of time. Meanwhile, there is the use here of average thickness for area counted as mean of linear interpolation from only limit amount of data, but not real gridding thickness according to location and density of data.

Modeling method

Over the past ten years, there is new concept of criteria for coal reserve estimation. Thickness of coal layer can be not only 0.8 m, but also 0.3 m, and ash content can be not only ≤ 40%, but also may be 50 % or even 55 %. So there are several results of reserve according to different criteria. Reserve with criteria m ≥ 0.8 m, A^k < 40 % is called reserve T; with m ≥ 0.3 m, A^k < 40%, is called T1; with m ≥ 0.3 m, A^k < 55%, is called T2, and so on.

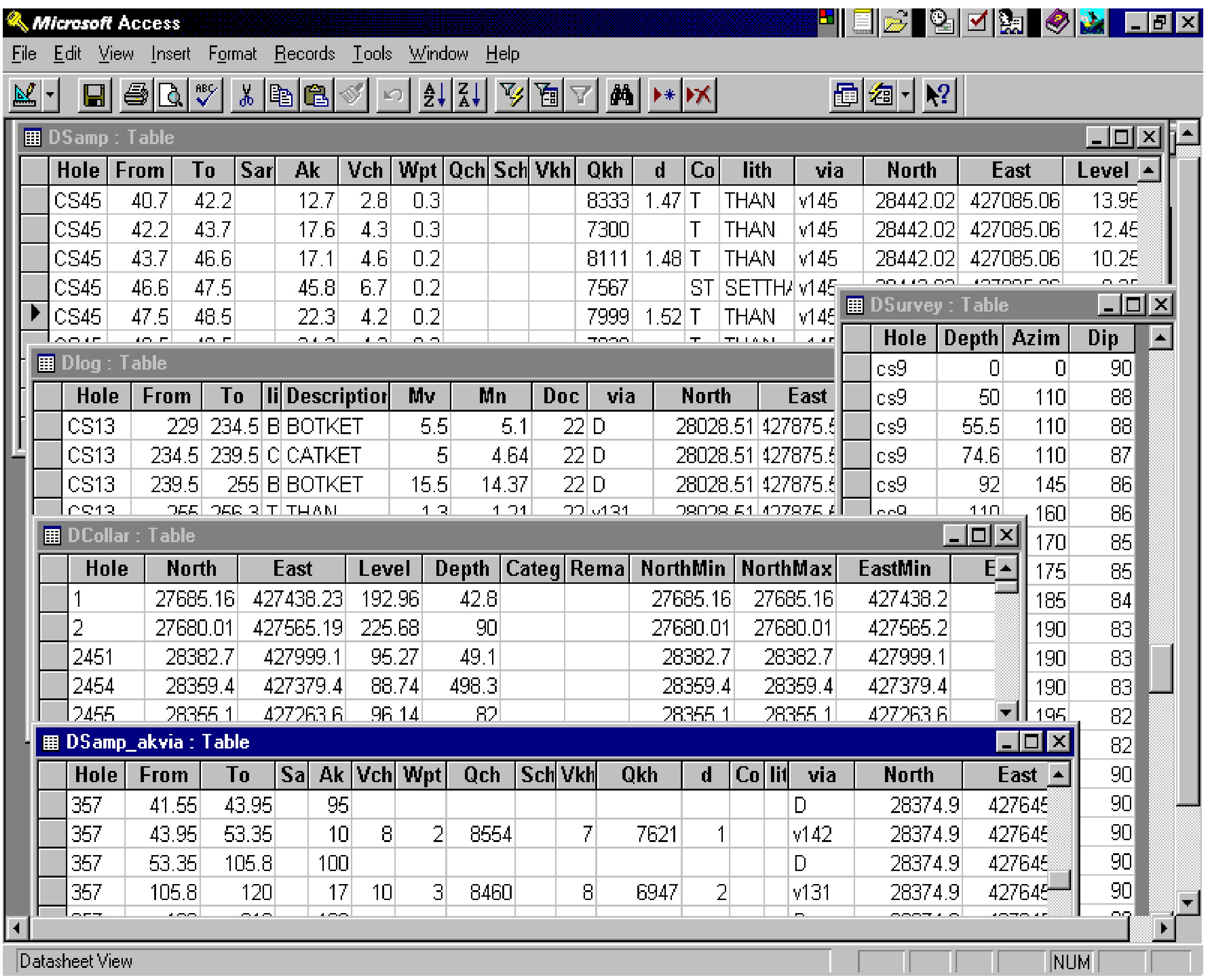
With application of computer, methods of estimation now can be both by parallel sections, or by modeling. Modeling method has a lot of advantages to traditional one, especially it can give quick result to different kinds of reserve according to different criteria. Modeling is another approach, which is processed by computer.

The purpose of computer application is to simplify and increase the speed of storing, processing and modeling information. Modeling is the biggest effort, the most difficult and important step because of the large number of calculations and diverse, abundant utilities, which manual methods cannot do.

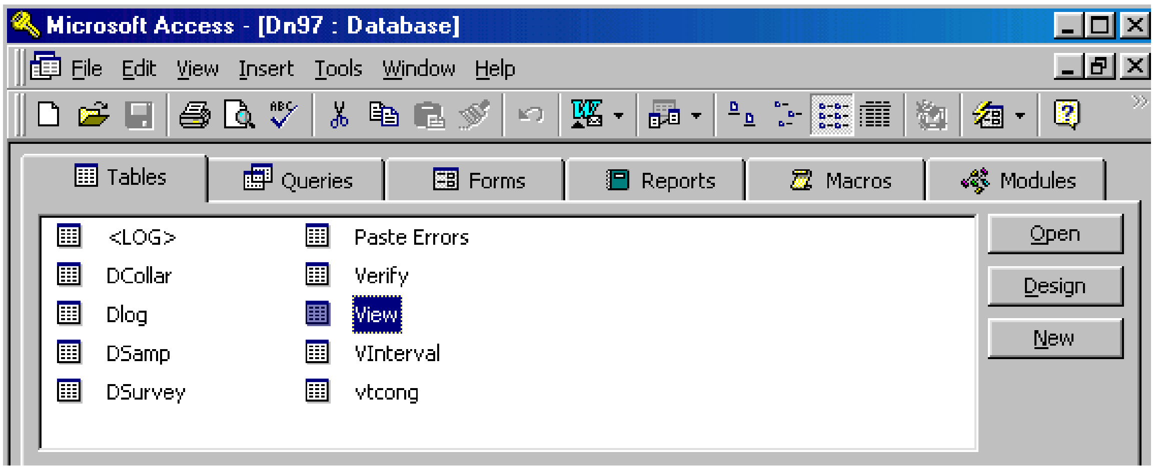
The only one manual step is to input and update data, then computer can create very important product that is relational geological database, which includes every data of all exploration drilling works. All the other following steps such as creating a structural map (isometric of seam roof, floor and thickness...), calculating reserves, reporting results are all done automatically by the computer, without having to go through the steps of building cross-sections and calculating intermediate areas…

Relational Geological Database is a collection of records and files that are logically related to each other, to store the original geological exploration information. The data is stored starting from the original exploration document with the main information tables such as the borehole coordinate table (DCollar), the borehole travel log table - according to the drilling depth (DLog, DSample) including the names of the rock types, the values of the test samples and the borehole curvature table with the inclination, drilling azimuth (DSurvey) ... The experimental values can be ash content, heat content, sulfur content, compressive strength, shear strength, coal seam thickness, coal quality, heat content, density and so on ... (Fig. 1.a, 1.b, Tables 1, 2, 3).

Figure 1 illustrates example of relational geological database with the basic data tables of Cao Son coal pit mine (Cao Son.mdb), firstly created on the very popular and convenient software of Microsoft Access with data of coordinates, travel log, curvatures, test samples… from more than 300 drill holes and exploration works, then imported into or read by any of intergrated mining softwares, such as MicroLynx, Techbase, or Surpac… [9, 10]. So, all main exploration data of tens of kilograms of previous paper documents can be stored in a file of Microsoft Access Database with volume of only about tens of megabites. Next, all geological structures, planes and blocks can be modeled, including topographical relief and cross section (Fig. 2).

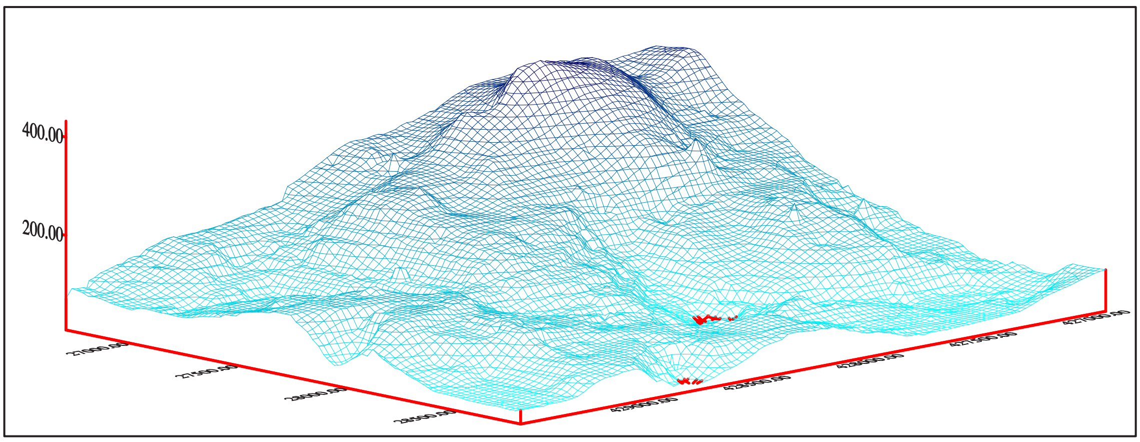


(a) – Data of main tables of Microsoft Access Database file Cao Son.mdb

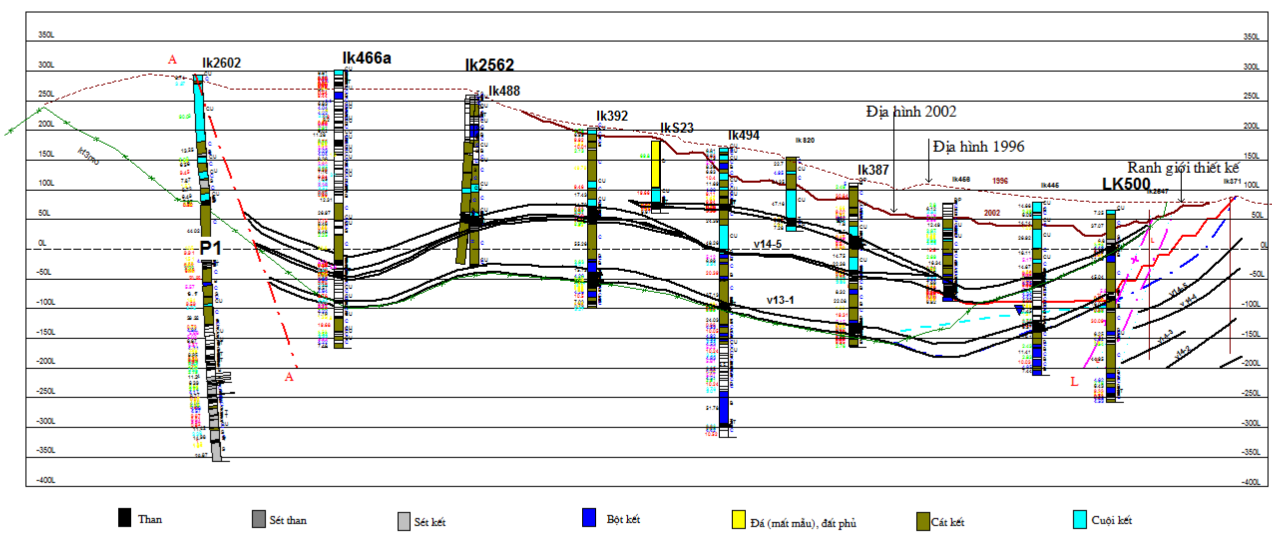


(b) - Main tables of Microsoft Access Database file.

Figure 1. Tables of relational geological database of Cao Son coal pit mine [6].



(a) – Created terrain model of Cao Son Southwest area, with mountainous features.



(b) – Created geological cross section of Cao Son pit mine along exploration line XIII.

Figure 2. Created images from relational geological database of Cao Son coal pit mine [6]

Other way to input data can be done by using Microsoft Excel tables firstly, the tables then to be joined and imported, creating database. The input data are shown on Tables 1, 2, 3 for case of Ha Tu pit mine [1].

Table 1. Dlog of Ha Tu database

№	Hole	From, m	To, m	color	Lithcode	Dip,°	North, m	East, m	Level, m
1	C149	0.0	4.1	156	Datphu	0.0	22152.26	411880.14	78.60
2	C149	4.1	10.8	155	Cuoiket	30.0	22152.26	411880.14	73.20
3	C149	10.8	13.8	154	Catket	30.0	22152.26	411880.14	68.35
4	C149	13.8	22.2	153	Botket	30.0	22152.26	411880.14	62.65
5	C149	22.2	24.6	151	Than	30.0	22152.26	411880.14	57.25
6	C149	24.6	25.9	152	Setket	30.0	22152.26	411880.14	55.40
7	C149	25.9	36.6	151	Than	30.0	22152.26	411880.14	49.40
8	C149	36.6	38.2	152	Setket	30.0	22152.26	411880.14	43.25
9	C149	38.2	62.5	153	Botket	21.0	22152.26	411880.14	30.30
10	C122B	0.0	16.6	154	Catket	50.0	22056.48	411095.97	50.93
11	C122B	16.6	17.8	152	Setket	50.0	22056.48	411095.97	42.03
12	C122B	17.8	20.6	153	Botket	50.0	22056.48	411095.97	40.03
13	C122B	20.6	43.2	155	Cuoiket	50.0	22056.48	411095.97	27.33
14	C122B	43.2	45.0	153	Botket	50.0	22056.48	411095.97	15.13
15	C122B	45.0	97.0	155	Cuoiket	50.0	22056.48	411095.97	-11.77
…	…	…	…	…	…	…	…	…	…
1592	C136	0.0	40.2	156	Datphu	0.0	21568.05	411593.37	58.52
1593	C136	40.2	46.4	153	Botket	36.0	21568.05	411593.37	35.32
1594	C136	46.4	48.2	151	Than	36.0	21568.05	411593.37	31.32
1595	C136	48.2	49.0	153	Botket	36.0	21568.05	411593.37	30.02
1596	C136	49.0	50.6	151	Than	36.0	21568.05	411593.37	28.82
1597	C136	50.6	59.0	153	Botket	36.0	21568.05	411593.37	23.82
1598	C136	59.0	62.2	155	Cuoiket	36.0	21568.05	411593.37	18.02
1599	C136	62.2	104.5	154	Catket	36.0	21568.05	411593.37	-4.73
1600	C136	104.5	108.4	153	Botket	36.0	21568.05	411593.37	-27.83
1601	C274	0.0	14.3	156	Datphu	0	2.22E+04	4.11E+05	38

Table 2. DSurvey of Ha Tu database

№	Hole	North, m	East, m	Level, m	Depth, m
1	A1	22127.18	411293.66	110.26	210.40
2	A2	22015.92	411443.40	80.62	253.00
3	A3	22020.42	411634.84	99.17	242.10
4	A4	22024.90	411872.81	80.21	100.00
5	A5	21800.89	411113.67	65.39	210.00
6	A6	21778.74	411580.86	100.90	229.20
7	A7	21649.80	411363.48	94.49	250.40
8	B3	22134.22	411806.51	68.91	141.00

Table 3. DCollar of Ha Tu database

№	Hole	Depth, m	Azim,°	Dip,°
1	10	0	0	90
2	10	175	0	90
3	A1	0	0	90
4	A1	20	290	90
5	A1	40	270	88
6	A1	60	270	88
7	A1	80	270	87
8	A1	120	270	87

9	B4	22229.87	411697.88	21.58	130.00
10	B5	22136.07	411697.79	15.33	116.00
11	C10	22291.98	411297.52	174.87	116.84
12	C101	22721.34	411591.19	112.03	49.93
13	C102	22606.04	411661.45	110.19	76.20
14	C103	22542.50	411662.37	109.20	75.00
---	…	…	…	…	…
242	VT9	22311.45	410948.63	164.76	87.10
243	BB1	23275.85	411555.58	264.76	58.10
244	BB2	23344.06	411671.83	274.79	60.30
245	BB3	23416.69	411723.37	275.59	98.50
246	BB4	23417.40	411661.26	276.80	81.00
247	BB5	23499.66	411831.52	266.74	116.05
248	20	21778.79	411696.56	49.24	131.60

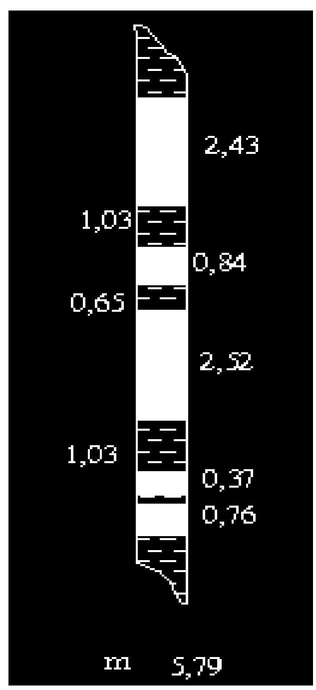
9	A1	140	265	86
10	A1	150	270	86
11	A1	160	265	86
12	A1	180	260	85
13	A1	200	265	84
14	A1	210	265	84
15	A2	0	0	90
16	A2	253	0	90
17	A3	0	0	90
18	A3	242	0	90
19	A4	0	0	90
…	…	…	…	…
568	VT9	0	0	90
569	VT9	87	0	90

At the same time, the modeling results and databse is also the basis for developing other applications such as mine design, mine planning, mine optimization, economic efficiency... on computers in a continuous and intergrated way. Modeling works have been applied and developed widely and strongly in the world, and have started effectively since 1997 in our country's coal industry and needs to be continued to develop in accordance with the common standards of international integration.

2.2. Thickness modeling for coal reserve estimation

Common method of modeling and volume calculation is surface griding and finding volume between two surfaces like floor and roof of seam. But when applied for structurally - complicated coal seam, there must be great attention to seam structure and thickness.

Most coal in Vietnam is anthracite, and is located in mountainous areas in north – east of Quang Ninh province, along coastal area, and consists of 2 strips: northern part is a synclinal, called Bao Dai – Yen Tu – Vang Danh strip, and second strip is Dong Trieu – Hon Gai – Cam Pha – Cai Bau (island). The strips are divided by various big equatorial faults, and smaller submeridial faults, dipping at 60-89 degree. Seams are also folding with fold axes of all direction, but most is northwest – southeast. There are about 40 coal seams here, 20 of them have industrial significance. This is why structure of coal seam is rather complicated, requiring careful attention in modeling, by dividing seams into different blocks and especially modeling of different thickness.



(Number in right side is thickness of coal layers, m; in leftt side is thickness of rock partings, m).

Figure 3. Coal seam structure: hole K322, Khe Cham mine, seam №10 [4].

Looking at Figure 3, the very common seam structure along drill hole log. There are different layers in the log, including coal and rock partings. Thickness of coal layers is written in the right side of the log, and thickness of rock layers is written in the left side of log.

Total thickness of the seam here is 9.63 m, including all layers of both coal and rock. Total thickness (m1) of only coal in the seam here is 6.92 m if including all coal layers from 0.3 m thick for reserve T1 (m ≥ 0.3 m). Total thickness (m) is 5.79 m if including coal layer from 0.8 m thick for coal reserve T (m ≥ 0.8 m). By those assessment, we will have different points of floor and roof level of coal seam for different coal reserve criteria when building the model of coal seam, including real roof and floor. If the real solid model from real roof and floor of coal seam is used for reserve calculation, the rock partings are meanwhile included in coal reserve. But only coal parts must be counted. The way to get out from situation is thickness modeling in below concept.

We will have isoline maps of coal seam (taking example of coal seam 16, mine Ha Tu) as in Figures 4 - 6.

Main steps of briefl workflow is as folows: Modeling the structures of coal seam, such as roof, floor level and thikness, using data from the database, then calculating the volume and reserve of coal seam with various all kinds of coal thicknesses between real and virtual roof and floor of coal seam.

Using softwares such as Sufer, MapInfo and MicroLynx [2, 3, 9,10] to model the structures of coal seam. There are many modeling methods, but Kriging modeling method can be chosen when there is enough data with selecting optimal parameters for coal seam conditions in Quang Ninh area (grid size, influence radius, development direction...). The Kriging interpolation method is a method of meshing and interpolating values taking into account the radius of influence in the direction of development, using the variogram function γH, that is the variation of the deviation between the two values v_i and v_j, increasing with distance H, and stopping at a certain value. The interpolated value of the point to be found depends on the function of distance and direction.

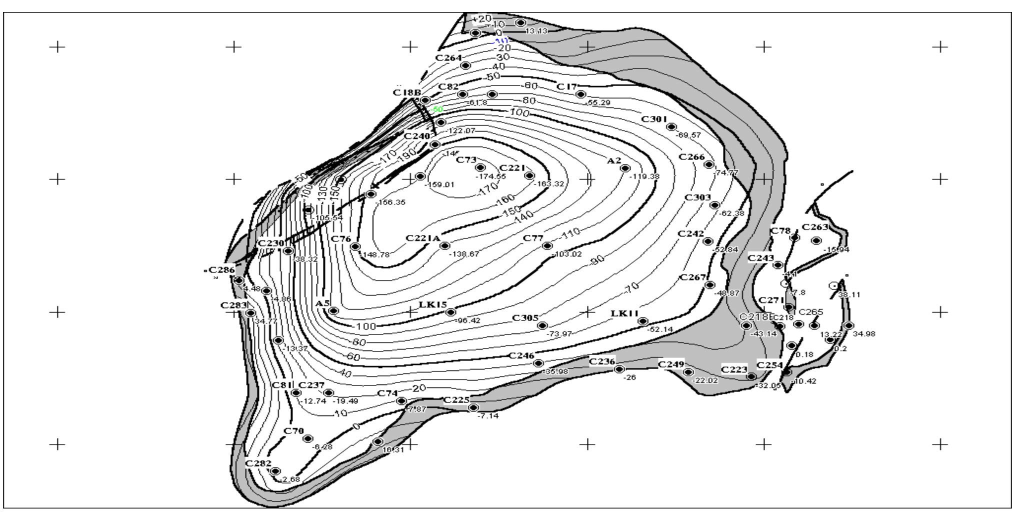
$$\gamma H = (1/2Nh)\ \Sigma(v_i - v_j)^2$$

The details of the theory are illustrated in many geostatistical documents and student books [9, 10].

For coal seams in the Quang Ninh area, the radius of influence should not be taken to exceed 200 m, depending on geological structures, faults and folds.

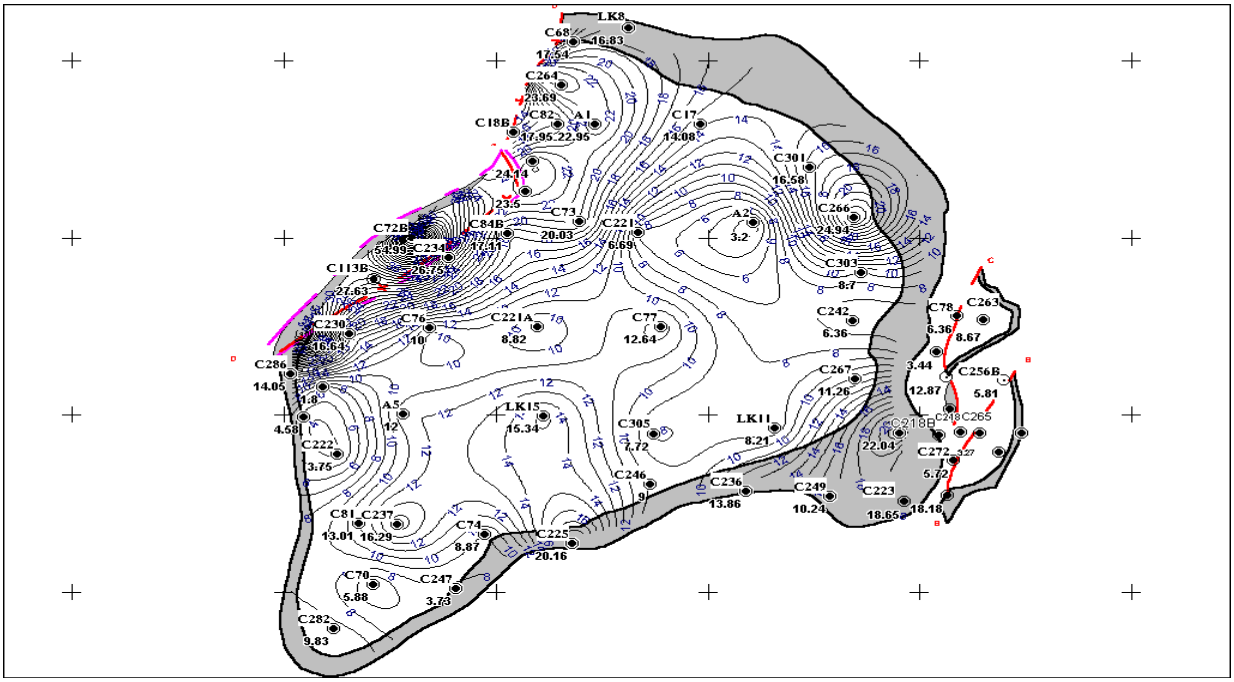
The results of calculating reserves by modeling between coal seam roofs and floors only achieve the necessary accuracy when all the above factors are selected appropriately and reasonably, resulted in logical and smooth curves of isolines (Fig. 4 - 6).

Overlaying the models makes it possible to build a virtually roofs surface with the real actual thickness of the coal seams and from there to calculate the reserves according to different criteria T, T1, T2 as prescribed.



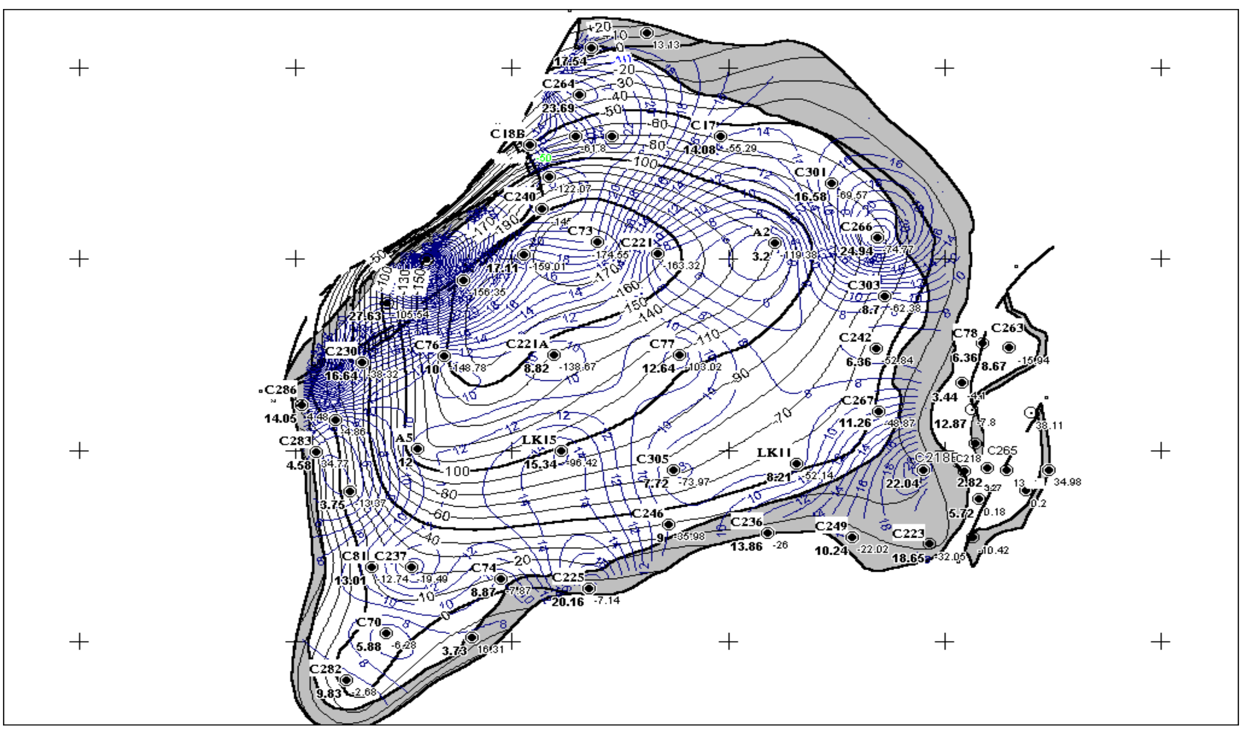
- Symbol and name of bore hole; - Elevation of coal seam floor, m;

Figure 4. Isoline map of floor level of coal seam (seam V16, mine Ha Tu)



- Symbol and name of bore hole; - Thickness of coal seam, m

Figure 5. Isoline map of coal thickness (seam V16, mine Ha Tu) [4]



- Symbol and name of bore hole; - Elevation of coal seam floor, m;

- Thickness of coal seam , m.

Figure 6. Overlay of isoline maps of coal seam floor level and thickness (seam V16, Ha Tu mine)

3. RESULTS AND DISCUSSION

Comparison of results between methods of coal reserve estimation: Reserve is estimated by both traditional "secang" and modeling methods for different categories (A, B, C1, C2) and different criteria (T1, T2) of coal. Figure 7 presents the reserves calculated by various categories and methods from data of Ha Tu mine above mentioned. Figure 8 shows additional results of reserve from Cao Son mine.

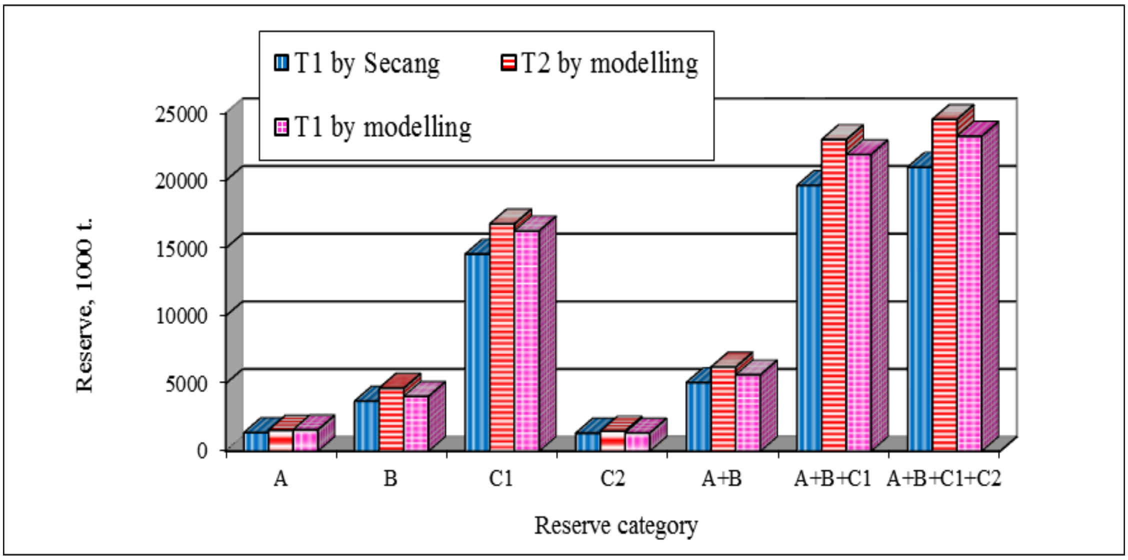


Figure 7. Results of coal reserve estimation of Ha Tu mine

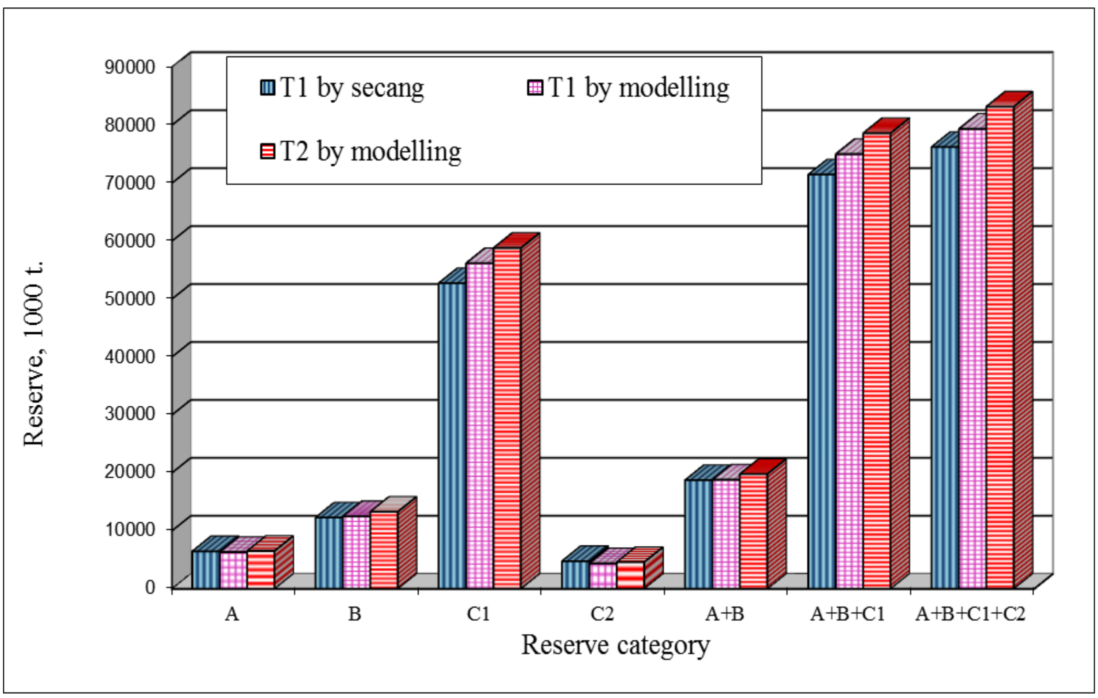


Figure 8. Results of coal reserve estimation of Cao Son mine [1]

The results of coal reserve estimation by traditional method "secang" and modeling method show a little difference between them. From the Figures 7 and 8, the proved reserves (category A and B) are nearly equal between that of the two methods (difference is 0 - 2 %), while difference of probable reserve (category C1 and C2) is about 7 %. Totally, general difference for all categories is about 5 % between the two methods. Further more, result from modeling gives more volume. It also means that good seam structure and good drill grid make good result. Other difference of reserve result is laying in difference of concept of estimation method: Modeling method uses real gridding thickness according to location and density of data. But traditional "secang" method uses average thickness that is counted as mean from only amount of data.

4. CONCLUSION

➢ The results of modeling method gives better accuracy and even more reserve. Meanwhile, thickness modeling method allows to estimate coal reserves of various criteria and categories in short time.

➢ The thickness modeling method has been applied widely since 1997 in Vietnam coal industry and bring a lot of advantages to engineers in reserve estimation, implemented for all large open-pit coal mines such as Cao Son, Deo Nai, Coc Sau, Ha Tu, Nui Beo, Na Duong and some underground mines.

➢ The relational geological database for each mine is created only once and can be continuously updated over time, storing original exploration drilling data from all boreholes, mining works in all periods, from all geological exploration and mining document reports, serving as a single, unique database throughout all the mine's life. This database provides data for modeling geological structures, creating maps of elevation isovalue lines of roof, floor and thickness of coal seams, estimating volume and reserve, constructing geological cross-sections, and at the same time serving as the basis for mine design, mine planning, mine scheduling, mine optimization and economic efficiency calculation …

➢ However, due to the lack of experts and organizational reshuffle, the mentioned method has slowed down somewhat at present. Therefore, it is necessary to continue to maintain and develop this modeling method, not only for coal of Vinacomin, but also for other of seam types minerals throughout the country ❒

REFERENCES

[1] Doan Van Kien, Nguyen Chi Quang, Kieu Kim Truc and others (2001). *Building geological databases for coal basins of Vietnam National Coal Corporation (TVN)*. TVN Project Report. ITE. Hanoi (in Vietnamese);

[2] Doug Keckler (2015). *Surfer for Windows*. Golden Software Inc. Colorado. USA. 1995-2015.;

[3] Ed. McElroy (2016). *MapInfo User's Guide. MapInfo Corporation*. Troy, New York.1994-2016;

[4] Geological report of Khe Cham II Coal Mine (2006). Vinacomin. Quangninh (In Vietnamese);

[5] Kiều Kim Trúc, Nguyễn Chí Quang, Nguyễn Đăng Sin, Nguyến Trọng Khiêm and others (1997). *Report on totalizing, reviewing of geological documents and recalculating of Ha Tu coal mine reserves. Company for Development of Informatics, Technology and Environment (ITE).* Vinacoal. Hanoi (In Vietnamese);

[6] Kiều Kim Trúc (2005). Computer applications for geological and mining modeling. *Mining Industry Journal, Nº. 6-2005 (In Vietnamese);*

[7] Kiều Kim Trúc (2007). Estimation of geological coal reserve by thickness modeling for Vietnam coal seams. *Proceedings of 13th International Congress of International Sociaty for Mine Surveying ISM13*. Budapest, Hungary;

[8] Phung Manh Dac, Kieu Kim Truc (2005). Enhancement of safety technology to ensure rapid development of Vietnam coal production. *Proceedings of Annual Meeting of International Committee for Coal Research - ICCR. Cologne, Germany;*

[9] Smith M. L. *Geologic and Mine Modeling using Techbase and Lynx*. AA. Balkema (1999). Rotterdam. Netherland;

[10] Using MicroLynx Release for Windows (2007). *Lynx Geosystem Inc. Vancouver, British Columbia. Canada;*

TÍNH TOÁN TRỮ LƯỢNG THAN ĐỊA CHẤT BẰNG PHƯƠNG PHÁP MÔ HÌNH HÓA CẤU TRÚC CHO CÁC VỈA THAN VINACOMIN

Kiều Kim Trúc

Hội Khoa học và Công nghệ Mỏ Việt Nam, 226 đường Lê Duẩn, Hà Nội, Việt Nam

THÔNG TIN BÀI BÁO
CHUYÊN MỤC: Công trình khoa học
Ngày nhận bài: 21/10/2025
Ngày nhận bài sửa: 23/11/2025
Ngày chấp nhận đăng: 28/11/2025
Tác giả liên hệ:
Email: kieukimtruc@gmail.com

TÓM TẮT

Cấu trúc vỉa than ở Việt Nam khá phức tạp với các biến động phá hủy kiến tạo và các lớp đá xen kẹp trong vỉa. Việc xác định cấu trúc địa chất, tính toán trữ lượng và đặc biệt là trữ lượng địa chất vỉa than là công việc phổ biến nhưng khó khăn đối với các kỹ sư mỏ. Phương pháp truyền thống ở Việt Nam là nội suy tuyến tính và tính toán trữ lượng bằng các mặt cắt song song. Nhưng hiện nay, với sự hỗ trợ của máy tính điện tử, phương pháp mô hình hóa đang được áp dụng rộng rãi, và hơn nữa, còn giúp mô tả chính xác cấu tạo vỉa than và loại trừ các phần đá xen kẹp nằm giữa vách và trụ trong vỉa, một việc rất cần thiết đối với việc tính trữ lượng than. Đồng thời, các tiêu chí mới về trữ lượng than cũng đã được đưa ra. Phương pháp tính toán trữ lượng than mới được áp dụng này vừa làm tăng độ chính xác, vừa rút ngắn thời gian và thậm chí tăng khối lượng than tính được so với phương pháp truyền thống, có nhiều ý nghĩa khoa học và thực tiễn, có thể áp dụng hiệu quả đối với công tác địa chất – trắc địa như tính trữ lượng địa chất và tính khối lượng khai thác mỏ. Nội dung chính của bài báo là giới thiêu phương pháp tính toán trữ lượng bằng kết hợp mô hình hóa cấu trúc và chiều dày vỉa than. Phương pháp này được áp dụng tính toán cho tất cả các vỉa than mỏ lộ thiên lớn của Vinacomin, nhưng ví dụ nghiên cứu điển hình được trình bày trong bài báo là trường hợp của mỏ Cao Sơn và Hà Tu, với việc sử dụng dữ liệu các lỗ khoan thăm dò trong các báo cáo địa chất của Vinacomin.

Để có kết quả ước tính trữ lượng tốt, bài báo cũng giới thiệu việc xây dựng cơ sở dữ liệu địa chất quan hệ khoáng sàng than cho các mỏ. Kết quả mô hình hóa đã chứng minh tính hiệu quả của các công tác ứng dụng máy tính này, bao gồm cả việc thành lập bản đồ cấu trúc vỉa than như đường đẳng cao vách, trụ và đẳng chiều dày vỉa than, cũng như các mặt phẳng đới kiến tạo. Kết quả mô hình hóa có thể làm cơ sở cho việc thiết kế mỏ, quy hoạch mỏ, lập lịch khai thác, tối ưu hóa mỏ và tính toán hiệu quả kinh tế... trên máy tính một cách liên hoàn và tích hợp.

Từ khóa: *cơ sở dữ liệu địa chất quan hệ, tính toán trữ lượng than, mô hình hóa và hình học hóa cấu trúc vỉa than, Vinacomin.*
