A Microcomputer-based System for the Favorability Evaluation Using a Data-directed Numerical Method and Its Application to the Arnhem Land Uranium Area, Northern Territory, Australia*

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Abstract : We have attempted to develop a system to evaluate the favorability of the uranium exploration projects using the "Data directed Numerical Method (DdM)" (McCammon *et al.*, 1986). The system was implemented on the Macintosh personal computer and was designed so that the users can easily make the most of an iterative trial and error process. The Arnhem Land area of the Alligator Rivers Region, Northern Territory, Australia, was chosen as a prospecting area for the favorability assessment of uranium deposits. The Alligator Rivers area is one of the famous uranium provinces in the world. The genesis of the known uranium deposits of the area was studied in an extensive literature survey to find the common geological factors. All information on the distribution of lithologies and structure within the area was obtained from large scale geological maps. Five exploration parameters were selected from a statistical analysis of the relationship between the exploration parameters and the presence of the known uranium deposits and occurrences. The favorability evaluations were performed for two different types of uranium deposits, namely the Jabiluka-Type and the Nabarlek-Type.

Key Words : Exploration, Expert system, AI, Uranium, Australia

1. Introduction

The application of Artificial Intelligence (AI) as a tool for mineral exploration started only a decade ago. The systems that have been described are in most cases expert systems that can simulate the decision making processes of experts or help numerical calculation for reasonable and fast decision making.

The development of an expert system for uranium exploration by Power Reactor and Nuclear Fuel Development corporation (PNC) was commenced in 1983. Since then, KOGITO, an expert system to determine the favorability for different types of deposits of a given target area, has been developed (Ishido, 1988).

The system, KOGITO, adopted the knowledge representation method of the inference network used in PROSPECTOR (Duda *et al.*, 1978). It is written in the C language and works on the NEC-PC computer. Four types of uranium deposits were considered in

the knowledge base of this system. Ishido (1988) indicates that they have learned through development of KOGITO that the inference network could treat only simplified uranium deposit models and thus became too restrictive for the technical requirements of the professional geologist.

We have undertaken further basic studies on the possibility of supporting geologists in their evaluation of given target areas. Such studies included Data-directed Numerical Method (DdM) (McCammon, 1986) which is attractive to PNC because it can tell us favorability for exploration by using existing data. The method also helps us numerically in the analysis of a genetic model for known deposits. Thus, our next step was to construct a system which could support the favorability evaluation of a large target area by DdM.

The objective of this paper is not to describe any AI theory nor uranium exploration method by AI technology, but to review our implementation of the DdM on the Macintosh computer. We have applied this system to favorability evaluation of the uranium field in Arnhem Land, Northern Territory, Australia.

2. The Data Directed Numerical Method

2.1 Concepts

The DdM was originally designed to exclude, as much as possible, the interpretations of researchers to estimate resource endowment by directly analyzing exploration data using multivariate statistics. The

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DdM is essentially based on the Genetic Model described by Finch *et al.* (1980).

However, it is necessary to have an understanding of the genetic processes which formed the deposits prior to applying the DdM to a target area. This can be shown by considering the effects of using all available data as opposed to using data considered relevant to the genetic processes for any specified deposit.

Data used in the DdM are numerical and are processed numerically. This has the advantage that estimates of the exploration parameters are weighted according to the genetic processes that is derived using data from known deposits.

Complete exploration data, including well logs and exploration intensity, are necessary to estimate the endowment. Accuracy of the estimation of exploration intensity affects the estimation of undiscovered endowment. It is a disadvantage of the method that detailed exploration data are required before the endowment estimation is undertaken.

The DdM is similar to the general procedures followed by geologists in their estimation of favorable locations by reconnaissance exploration, such as large scale geological mapping.

2.2 Description of the Method

The details of this method can be referred to the paper by MacCammon (MacCammon,1986). We will review here this method very briefly. Fig 1 shows DdM flow.

I . Favorability Estimation Phase

With this method the area of interest is partitioned into cells and the favorability of each cell is calculated individually.

Controlling factors related to the genesis of deposits are adopted as the exploration parameters for all cells. In this paper, we refer to the factors related to the genetic model as the “exploration parameters”. The exploration parameters are considered to be key factors in guiding exploration work.

For each exploration parameter, a value of +1, 0, or −1 is assigned to each cell depending on available data, with a value of +1 being assigned positive to those cells in which the value of exploration parameter is within the specified range, a value of 0 is assigned to the cells with no data, and a value of −1 is otherwise.

Favorability scores are determined by two steps. The first step is to calculate weight vector which characterizes the known uranium deposit. The second step is to find the favorability applying this weight

Fig. 1. Data directed Numerical Method Flow. The method transforms numerical geological data to ternary values (−1, 0, +1) by the preset ternary filter. The weight vector is calculated from ternary transformed data and the model cells in which the uranium deposits or occurrences are known. The weight vector is used to compute the favorability of unknown cells. There are three steps where the users may assign the calculation conditions which are shown by arrows.

vector to each cell.

The weight vector is a vector whose dimension is the number of exploration parameters. A deposit type is expressed in terms of a weight vector by calculating the correlation between the ternary-transformed exploration parameters of the known deposits. The weight vector is determined by the relative importance of the exploration parameters in the target area.

Favorability scores are calculated from the vector of ternary-transformed variables to each cell in the area of interest using the weight vector. A threshold value for favorability score is chosen to minimize the inconsistency between discovered

endowment and favorability score of the cells.

II. Endowment Estimation Phase

The DdM estimates the expected endowment of the target area. To compute the unknown reserves by DdM, it is necessary to define two variables, calibration constant, C , and a exploration intensity of a cell, P_j . The calibration constant, C , is determined by the division the total known reserves by the sum of the exploration intensity.

$$\begin{aligned} D &= \sum_{j=1}^n d_j \\ C &= D / \sum_{j=1}^n \delta_j \cdot P_j \end{aligned} \quad (1)$$

where n : number of model cells

D : total known endowment in the target area

d_j : individual endowment

$\delta_j = 1$: if the cell j is classified as favorable

$\delta_j = 0$: if the cell j is classified as unfavorable

P_j : exploration intensity of j -th cell

The exploration intensity, P , is a variable between 0 and 1 which is assigned to express how the exploration has been active in the given cell. If no exploration work has been done in j -th cell, P_j is zero and if no additional endowment is expected, in other word, an extensive exploration has been finished, P_j is put to be 1.

The total amount of endowment expected in a target area is the sum of discovered and undiscovered endowment.

$$\begin{aligned} TEE &= D + C \cdot \sum_{j=1}^m \delta_j \cdot (1 - P_j) \\ &= \sum_{j=1}^n d_j \cdot \left\{ 1 + \sum_{j=1}^m \delta_j \cdot (1 - P_j) / \sum_{j=1}^n \delta_j \cdot P_j \right\} \end{aligned} \quad (2)$$

where TEE : total expected endowment

m : total number of cells

In the present case study described latter, m is 9660 and n is 59.

2.3 Characteristics of the DdM and the Developed System

In this method, users can control determination processes by choosing the deposit type in question, the ternary filter value of the exploration parameters and the threshold values of favorability. In summary, the users have options in :

- 1) the selection of the exploration parameters,
- 2) the selection of the ternary filter and
- 3) the variable setting of threshold values for the determination of favorable cells.

The user can easily see how the favorability score or the expected endowment of a given target varies as the change of parameter.

The developed system was designed to make the most of the rerun-process of DdM. We judged that this could only be properly realized on a computer with a good user interface. We adopted the Macintosh personal computer for this purpose.

Goal-directed backward-chaining activation was adopted in the kernel processes to effectively support users. Task control, under which reprocess and redisplay in response to changes of parameters propagate automatically, was also adopted for support.

Fig. 2. The goal directed process activation mechanism. One of the main characteristics of the developed system is the goal directed process activation mechanism. The results are obtained sequentially which are from the top of the finished process to the goal.

Fig. 3. Propagation of reprocessing and redisplay of the results due to the change of parameters. A second characteristic of the system is the automatic propagation of processes due to changes of parameters. Any necessary processes to the directed process are carried out first but the results are not shown on the display. The required results are only shown on the display. By this method, the trial and error processes are done effectively.

Fig. 4. Working panel. The buttons in the working panel are not for tasks but for the display (change) of data, results and parameter settings. The required processes are activated automatically by clicking the button. The filled triangle, check mark and reversal arrow indicate the goal which a user specified, finished process and activation of processes, respectively.

The program was written in the C language since the essence of DdM is numerical calculation.

(1) Goal-directed chaining activation of data processes

In the task of favorability assessment, processes are carried out successively according to the flow of DdM. However the developed system only displays the results required. In other words, any necessary processes to achieve the directed process are calculated first and they are not shown on the display. This is named a "Goal-directed chaining activation of data processes".

It is more convenient for users to only display the required results rather than to display all steps. The results, from the top of the finished process to the goal, are obtained as shown in Fig. 2. The control of the process flow has a recursive structure, in which the data processing for the calculation of the i -th result activates that of the $(i-1)$ -th result. The data processing is activated in a backward chaining way by this control.

(2) Propagation of reprocessing and redisplay due to changes of parameters.

In the processes of favorability assessment, the system was designed such that the ternary filter and the threshold value of favorability are assigned by users. The results are refreshed automatically without the user's command when the input parameters are

changed. By automatic propagation of reprocessing and redisplay due to changes of parameters, trial and error processes could be done more effectively.

As shown in Fig.3, the results are refreshed automatically and are redisplayed at the same time, if parameters are changed in the i -th process.

(3) User interface

The system has the top level window called a "working panel" shown in Fig. 4, which is an interface between users and task controls. The working panel is the window that has one of the most important functions in the system. Users can get results by inputting commands (clicking buttons) on the working panel. The panel also shows the state of processing and a user can understand the specified goal and the state of processing from the display.

3. Application to the Exploration Area Assessment in Arnhem Land

The Alligator Rivers Region in Australia is one of the famous uranium provinces of the world and several unconformity type uranium deposits, notably Nabarlek, Ranger, Jabiluka and Koongara, have been discovered in the region.

We choose the Arnhem Land in the Alligator Rivers Region as a target area for the favorability assessment of a uranium deposit because it may have a high potential for containing further deposits but

Fig. 5. General geology of target area (from Needham,1988).

Table 1. Geological data of the model cells.

No	Host Rock	Fault Density	Dist.Souce(km)	Neg. Area	Dist.Dolerite(km)	Exploration Intensity
1	Cahill Formation	0	5	0	5	0.0
2	Cahill Formation	0	4	0	2	0.0
3	Cahill Formation	1	4	0	5	0.0
4	Cahill Formation	0	2	0	4	0.0
5	Cahill Formation	0	1	0	3	0.0
6	Cahill Formation	0	1	0	3	0.0
7	Cahill Formation	0	1	0	1	0.0
8	Cahill Formation	2	0	0	2	0.0
9	Cahill Formation	0	1	0	1	0.0
10	Cahill Formation	1	1	0	2	0.0
11	Cahill Formation	1	2	0	2	0.0
12	Cahill Formation	0	2	0	2	0.0
13	Kakadu Group	3	1	0	2	0.0
14	Kakadu Group	5	1	0	2	0.0
15	Cahill Formation	0	2	0	6	0.0
16	Cahill Formation	0	2	0	7	0.0
17	Cahill Formation	1	2	0	6	0.0
18	Cahill Formation	1	1	0	8	0.0
19	Cahill Formation	1	1	0	6	0.0
20	Cahill Formation	2	1	0	5	0.0
21	Cahill Formation	0	1	0	7	0.0
22	Cahill Formation	0	2	0	6	0.0
23	Cahill Formation	1	1	0	7	0.0
24	Nourlangie Schist	1	6	0	10	0.0
25	Cahill Formation	4	7	0	3	1.0
26	Koolpin Formation	1	9	0	1	0.0
27	Cahill Formation	0	1	0	5	1.0
28	Cahill Formation	0	3	0	2	0.0
29	Nourlangie Schist	0	5	0	1	0.0
30	Cahill Formation	1	2	0	12	0.0
31	Cahill Formation	3	8	0	6	0.0
32	Koolpin Formation	0	12	0	4	0.0
33	Cahill Formation	0	2	0	3	1.0
34	Cahill Formation	0	1	0	4	1.0
35	Nourlangie Schist	0	8	0	2	0.0
36	Cahill Formation	2	1	0	9	1.0
37	Koolpin Formation	1	12	0	9	0.0
38	Nourlangie Schist	1	11	0	3	0.0
39	Cahill Formation	0	1	0	8	0.0
40	Koolpin Formation	0	12	0	7	0.0
41	Cahill Formation	1	2	0	8	0.0
42	Koolpin Formation	0	12	0	12	0.0
43	Cahill Formation	1	3	0	6	0.0
44	Koolpin Formation	0	12	0	12	0.0
45	Koolpin Formation	1	8	0	4	0.0
46	Myra Falls Metamorphics	0	3	0	4	0.0
47	Myra Falls Metamorphics	0	0	0	5	0.0
48	Myra Falls Metamorphics	1	0	0	2	0.0
49	Nimbuwah Complex	1	0	0	4	0.0
50	Nimbuwah Complex	1	0	0	6	0.0
51	Cahill Formation	4	0	0	1	0.0
52	Cahill Formation	2	0	0	0	0.0
53	Myra Falls Metamorphics	3	0	0	1	0.0
54	Myra Falls Metamorphics	3	0	0	1	0.0
55	Myra Falls Metamorphics	8	0	0	3	0.0
56	Myra Falls Metamorphics	1	0	0	0	1.0
57	Myra Falls Metamorphics	3	0	0	2	1.0
58	Nimbuwah Complex	1	0	0	1	0.0
59	Nimbuwah Complex	0	0	1	2	0.0

Table 2. Chi-square test results for 11 exploration parameter candidates (modified from Yamada *et al.*, 1991).

	Degree of Freedom	5% Limit Value	Test Value	Test Value/ 5% Limit Value	Exploration Parameter
Distance from Source	12	21.03	166.3	7.91	○
Fault Density	11	19.68	55.3	2.81	○
Lineament Density	7	14.07	6.3	0.45	
Joint Density	1	33.92	14.6	0.43	
NS Direction Fault	1	3.84	25.8	6.72	
NW Direction Fault	1	3.84	27.1	7.06	
NE Direction Fault	1	3.84	22.9	5.97	
EW Direction Fault	1	3.84	6.8	1.77	
Dolerite	1	3.84	2.6	0.67	
Distance from Dolerite	12	21.03	31.6	1.50	○
Mag. Contour Density	16	12.48	12.5	0.47	

Table 3. Ternary filters of calculated examples.

	Case 1 (Jabiluka Type)	Case 2 (Nabarlek Type)
Host Rock	Chahil Formation NourLangie Schist	Chahill Formation Myra Falls Metamorphics
Fault Density	1 and more	1 and more
Dist. Source	1-4 Km	Disregarded
Neg. Area	Kombolgie S.S. Source Rocks	Kombolgie S.S. Source Rocks
Dist. Dolerite	0-6 Km	0-4 Km

has not been intensively explored.

Geological maps of scale 1:100,000 were used as the database for the favorability assessment of uranium deposits in the area. An insight into the genetic mechanisms of ore deposition and of the selection of exploration parameters was obtained through a comprehensive survey of published literature. The general geology of the area is shown in Fig. 5.

3.1 Characteristics of the Uranium Deposits in the Alligator Rivers Region

The well-known deposits in this region are Jabiluka, Ranger, Koongara and Nabarlek. Each deposit has a different geological setting and mineralization style, but the former three deposits have relatively similar characteristics as follows :

- (1) The deposits are located near an Archaean granitic complex (Nanambu Complex).
- (2) The deposits are hosted by the Early Proterozoic Cahill Formation.
- (3) The deposits are controlled largely by structures, such as faults and collapse dolines within carbonate rocks (Ewers *et al.*, 1984; Gustafson and Curtis, 1983).
- (4) Graphitic lithologies and carbonate rocks are com

mon in the deposits and they are closely related to genetic processes of uranium mineralization (Ewers *et al.*, 1984 ; Gustafson and Curtis, 1983).

In contrast with these deposits, characteristics of the Nabarlek deposit are as follows:

- (1) The deposit is located near an Archaean to Early Proterozoic granitic complex (Nimbuwah Complex).
- (2) The deposit is hosted by Myra Falls Metamorphics, which are metamorphosed equivalents of the Cahill Formation, Kakadu Group and Nourlangie schist of Early Proterozoic age (Needham, 1988)
- (3) The deposit is located just above a sill of Oenpelli Dolerite.
- (4) The deposit is strictly controlled by a NW trending fault, but no collapse doline has been observed.
- (5) Graphitic lithologies or carbonate rocks are not observed in the vicinity of the deposit.

3.2 Exploration Parameters for Favorability Evaluation by DdM

The target area was confined within 132°30' E to 134°0' E and 11°30' S to 13°0' S, and covers an area of 7 geological maps of 1:100,000 scale. The area was divided into 9660 cells. In total, there are 59 known uranium occurrences, including the major uranium

Fig. 6. Calculated example case 1. This example is for Jabiluka Type deposits. The distance from the source rocks should be less than 4 km whereas the distance from dolerite is allowed to be up to 6 km.

Fig. 7. Calculated example case 2. This example is for Nabarlek Type deposits. Myra Falls Metamorphics are added as host rocks. The distance from the source rocks is not considered to be important whereas the distance from dolerite should be less than 4 km.

deposits in the area. Thus 59 cells, each containing an uranium occurrence, were selected as the model cells for calculation of weight vectors. The geological data of those 59 cells are shown in the Table 1.

The DdM was applied to evaluate the favorability to the unexplored area but not to estimate the endowment, because the known deposits are very limited and no reliable data on the resources are known for this region in the published paper.

A statistical analysis, chi square test, was performed to determine the exploration parameters for DdM. Total 11 candidates for the exploration parameters were checked by chi square test if the meaningful correlation exist among the existence of the occurrences. The results are shown in the Table 2. It is found that faults in all directions control the existence of the deposits. Therefore the fault density (number of fault in one cell) was chosen to be as an exploration parameters. In conclusion, the chi square test reveals the correlation with "Distance from source", "Fault Density" and "Distance from Dolerite" which are marked by circle in Table 2.

Finally, the following 5 exploration parameters were considered to be important to control forming deposits of the given area.

(1) Host Rock

Most uranium deposits in the Alligator Rivers Region are hosted in either Cahill Formation or Myra Falls Metamorphics of Early Proterozoic age and these units were selected as the candidates for the host rock unit. Myra Fall Metamorphics are the metamorphosed equivalent of Cahill Formation, Kakadu Group and Nourlangie Schist. Therefore, Kakadu Group and Nourlangie Schist were also chosen as candidates.

These units were subdivided by constituent rock types, such as graphitic lithology and carbonate rock. The subdivided units were ranked in order of favorability for uranium deposition.

(2) Distance from Uranium Sources

The Archaean granitic gneiss is considered to be the ultimate source of uranium (Ewers *et al.*, 1984). Zones interpreted as consisting of the Proterozoic granites and granitic gneiss in the eastern part of the area, are also considered to be the alternate source of uranium. The distance from the uranium sources was adopted as a parameter, because it has been found that most uranium deposits exist within certain distance from the source rock.

(3) Faults

The deposits in the region are commonly controlled by structural features. Therefore we analyzed the relationship between the model cells and faults, lineaments and joints.

The location of uranium deposits shows a statistically meaningful correlation to the number of faults in the cell. The number of lineaments or joints, however, has no correlation with model cells. Faults may have played an important role in providing pathways for uranium bearing fluids (Ewers *et al.*, 1984; Gustafson and Curtis, 1983).

(4) Distance from Dolerite

It is known that the Nabarlek deposit is located close to a sill of Oenpelli Dolerite. As a result of chi square test, a weak but positive correlation was recognized between a model cell and distance from dolerite. Therefore we adopted the distance from dolerite as a parameter also. The uranium mineralization post-dated the dolerite intrusion (Page *et al.*, 1980; Hills and Richards, 1976), and hence hydrothermal circulation induced by the dolerite intrusion did not localize the uranium mineralization. The dolerite may have been directly related to the formation of breccia and fracture zones, which served as a space for the uranium deposition.

(5) Negative Area

The areas of Archaean granitic complex have little possibility to host economically feasible size of uranium deposit although many small uranium occurrences are present. In addition, the area, which is covered with thick Middle Proterozoic sandstone (Kombolgie Formation), is also not considered favorable since thick sandstone cover makes exploration difficult and expensive. Thus, Archaean granitic rocks and thick Middle Proterozoic sandstone were considered to be a negative indication.

3.3 Examples of the Favorability Evaluation Using the System

As mentioned earlier, there exist two types of uranium deposits in the region. These are the Jabiluka Type (*e.g.* Jabiluka, Ranger, Koongarra deposit) and the Nabarlek Type (Nabarlek deposit). The former type is considered to have a close relationship with lithological features whilst the latter type is related to structural features.

By taking the above geological controls into account, two forms of ternary filter were examined. Table 3 shows the parameters of ternary filter for the two types of uranium deposit in the region. The Jabiluka Type deposits are expected where "Distance from Source" is less than 4 km whereas distance from source is disregarded for Nabarlek Type deposits. The Nabarlek Type deposits are expected in close relationship to "Distance from Dolerite". Only the Cahill Formation is expected as a "Host Rock" for the Jabiluka Type deposits and Myra Falls metamor

phics or more favorable lithologies are expected as “Host Rock” for the Nabarlek Type deposits.

The results of the two cases are shown on Fig. 6 and Fig. 7, respectively. In both figures, ternary filter, weight vector, favorability score and favorability class are shown for each case. Weight vector shows the relative importance of each exploration parameter with the value between -1 and 1 . The positive value denotes the exploration parameter has positive importance whereas negative value denotes negative importance. In both cases, the exploration parameters, whose value is small or negative, do not play an important role in the evaluation of a cell. Favorability score is shown in color depending the score. The score has the range between -1 and 1 . The higher score in hotter color is more favorable, in other words, there is more chance to find the uranium deposit of the same type found in the model cells.

Fig. 6 (Jabiluka Type) shows that of a weight vector which distributes a high score on the “Host Rock” and the “Distance from Source”. Favorable areas are located in the western part of the area within narrow bands associated with the Cahill Formation surrounding the Nanambu Complex.

Alternatively, Fig. 7 (Nabarlek Type) shows a weight vector with host rock as the most important and also a relatively high value on structural controls, such as the “Fault Density” and the “Distance from Dolerite”. Favorable areas are widely distributed in the central part of the area. Consequently, the Jabiluka Type and Nabarlek Type deposits are expected in the western and central parts, respectively.

4. Conclusions

This paper has summarized our own system for favorability evaluation of uranium exploration by the Data directed Numerical Method. Although this method can be used to estimate the uranium endowment of the area, we have only evaluate the favorability of the area. The application of the system to the Arnhem Land Uranium area indicates that undiscovered economically significant deposits can be expected in the western to central parts of the area and that the system should be further developed for practical applications.

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要 旨

Data-directed Numerical Method を用いたウラン探査有望地評価システムの開発とオーストラリアのウラン鉱床地帯アーネムランド地域への適用

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資源探査全般への人工知能の応用はまだ始まったばかりであるが動力炉・核燃料開発事業団でもウラン資源探査エキスパートシステムの開発に取り組んでいる。たとえば、米国 Stanford Research Institute International によって開発された PROSPECTOR の推論システムに事業団のこれまでのウラン探査に関する知見を知識ベースとして付加し、評価者が対象とする未探査地にウラン鉱床の胚胎の可能性が高いか判断させるプロスペクターを完成させた。ウラン鉱床にはいくつかのタイプが知られているが、プロスペクターでは砂岩型や不整合関連型など現在探査の主流となっている4つのタイプについて可能である。また、このシステムの推論ネットワークは人事考課など他の分野にも応用できるため、コギト (KOGITO) として汎用化した。

最近では、鉱床生成過程に関する知識（地化学的知識とそれに基づいた探査指針）と数値解析法をリンクさせた、より客観的な有望度査定の手法の開発にも取り組んでいる。本論文ではこの研究の一環として米国地質調査所の研究者によって提案された Data-directed Numerical Method (DdM 法) の手法をパーソナル・コンピュータ上にシステム化して、オーストラリアのウラン鉱床地帯に適用したので紹介する。

DdM 法は鉱床胚胎に関係が深い地質学的特徴（特徴変数, Exploration Parameter）について既知鉱徴地と似た地域を得点形式で抽出し、未発見の資源量を見積もる手法である (Fig.1)。完成されたシステムは鉱床成因や鉱床の規制要因に関する知識や地質データを使い、評価者が容易に未探査地評価が可能となるよう設計されている (Figs.2, 3, 4)。地質データはオーストラリア地質鉱山局発行の10万分の1の地質図と磁気図から読みとった。特徴変数はジャビルカ、レンジャーやナバレークなど、この地域に胚胎する重要なウラン鉱床に関する文献調査及び既知鉱徴地の地質データとからカイ二乗検定 (Table 2) によって選んだ。その結果、地域に分布する地層、ウランの源岩分布域からの距離、断層数、ドレライト貫入岩からの距離や被覆岩の存在などが鉱徴の有無を評価する上で重要であることがわかり特徴変数とした。DdM 法の適用では既知ウラン鉱徴地の地質データを用いて、特徴変数の相対的重み付け（重みベクトル, Weight Vector）を計算し、この重みベクトルと評価される地域の地質データから有望得点 (Favorability Score) を計算した。今回の評価の対象になったのは東経132度30分から134度、南緯11度30分から13度でこれを120×120のセルに分割した。このうち既知鉱徴地は59セル (Table 1) に存在する。本報告では本地域で代表的なジャビルカ鉱床タイプ (Table 3) とナバレーク鉱床タイプ (Table 3) に関して、それぞれの有望地の評価 (Figs.6, 7) を行なった。なお、今回の適用では有望地の抽出を行い、未発見資源量の見積は既知鉱量が少ないため評価していない。

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