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The Application of Nonlinear Method in Exploration Geochemistry

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1 Preface

The discontinuity, mutability, heterogeneity, diversity, randomness, uncertainty, irregular and Self-Similarity are the characteristics of Geochemical Elements' distribution. That is to say, Geochemical Elements' distributions have nonlinear characteristics, which lead to the complexity of the geochemical anomalies[1].

2 The basic principle of nonlinear method

2.1 AiNet network model to remove geochemical data noise

The uncertainties of geochemical data are always the result of the degree of measurement, the errors of analysis, and the random of sampling process. Removing the noise can make geochemical data and calculated results to be more accurately to reflect the objective facts of geological. This paper tries to use the research achievements of artificial immune in data processing to improve AiNet network model to remove geochemical data noise.

Using the original earth chemical measurement data as the antigen of immune system, the geochemical elements which reflecting the content of real information data as the antibody, based on immune algorithm to find out the memory antibody in the set to improve the accuracy of the fitting. Chart 1 is the algorithm flow chart:

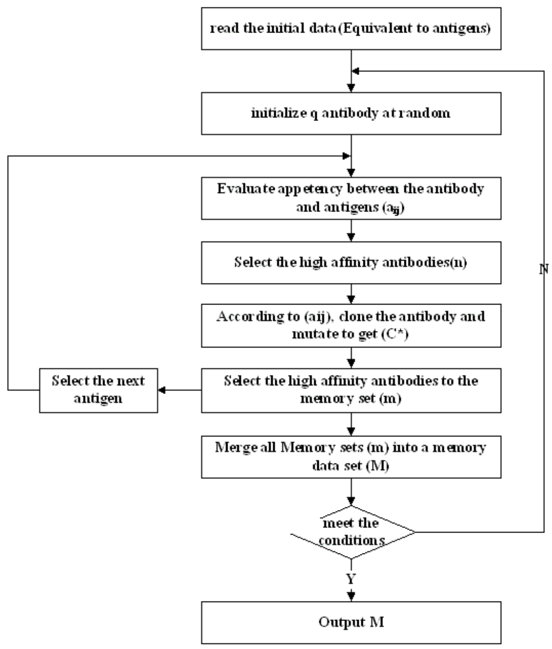

Fig.1. aiNet work model flow chart

2.2 The model construction of fractal content area method

The basic idea is based on the sample point in space and the content to build content surface, changing the content scale to determine the corresponding surface area, using the least square method to determine the different fractal model, at last through the correlation coefficient inspection and variance analysis to determine the lower anomalies.

2.3 The model construction of fractal gradient method

The concept of elements' abnormal gradient refers to that when the anomalous source's element dispersing outwards, the content between two adjacent is in change. The concept of element abnormal gradient change provides new parameter for the geochemical anomalies evaluation: gradient rate. The point whose content is maximum value, we regard this point as the inflexion point of content curve or surface. The characteristic react the boundary of geological element content Mutation.

The nonlinear of geochemical element distribution make the traditional method determining the abnormal concentration zoning have heavy limitation.

Fractal theory can dynamically reflect the accumulation

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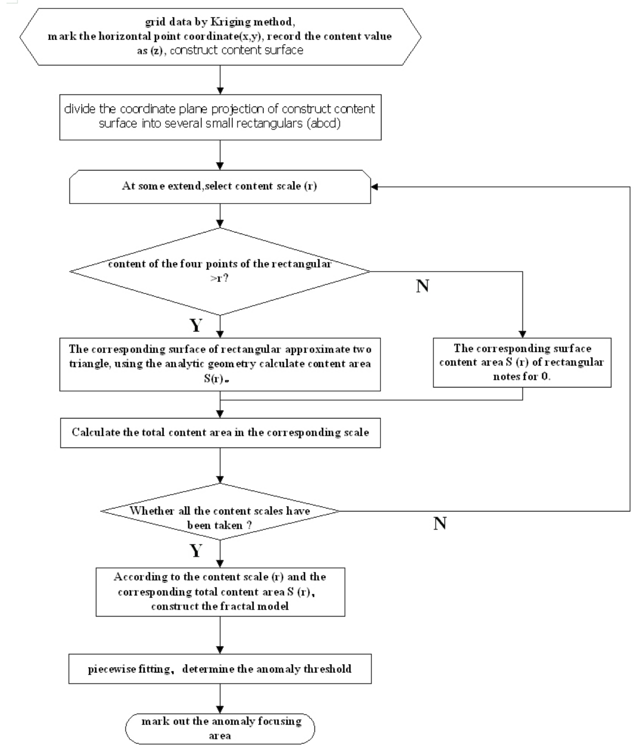

Fig.2. Flowchart of content-area method of fractal theory

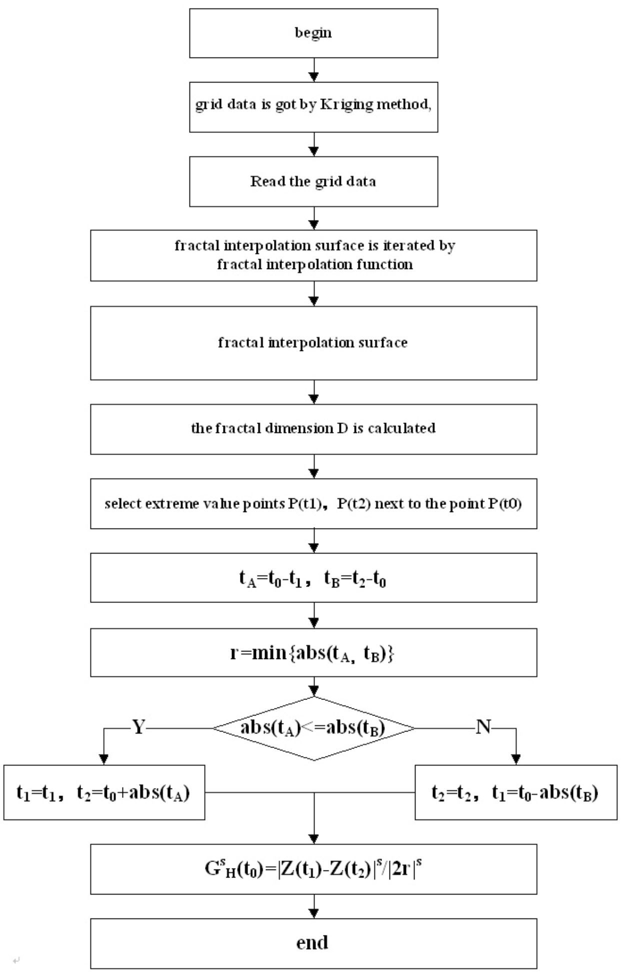

Fig.3. Flowchart of Fractal content gradient method

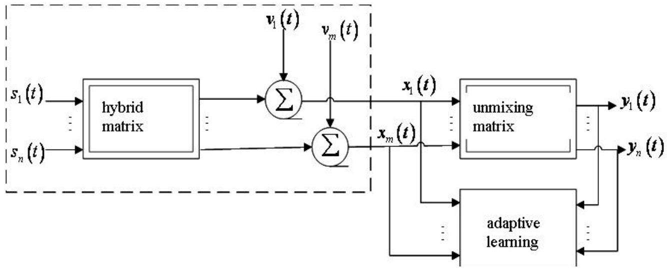

Fig.4. Basic diagram of ICA

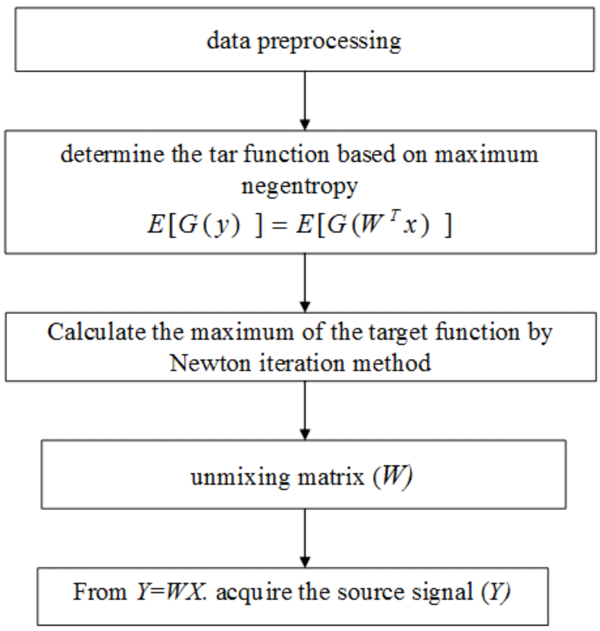

Fig .5. Algorithm flow chart of FastICA

and migration rule of elements.Base on the first derivative in Hausdorff Measure, fractal gradient theory put forwards the formula of calculating the value .

2.4 FastICA seek geochemical element combination

Multi-stage mineralization, multi-source ore-forming material, multiplicity ore-controlling factors lead to the diversity of deposit types. In the association and combination of elements, the quality and quantity of each element's distribution is not balance. That is to say that geochemical elements' combination in space is variant. Such diversity sometimes performs for differences of geological history stages, sometimes performs for the space combination relations differences. Therefore, the element combination relative to each single element has "blind" feature.

Chart 5 is the basic diagram of ICA. Multi-channel observation signal X integrated with multiple sources S by mixing matrix A. Now, the task is: with the condition that both A and S is unknown, we have to get a matrix W to make X through it and obtain a value which is the optimal

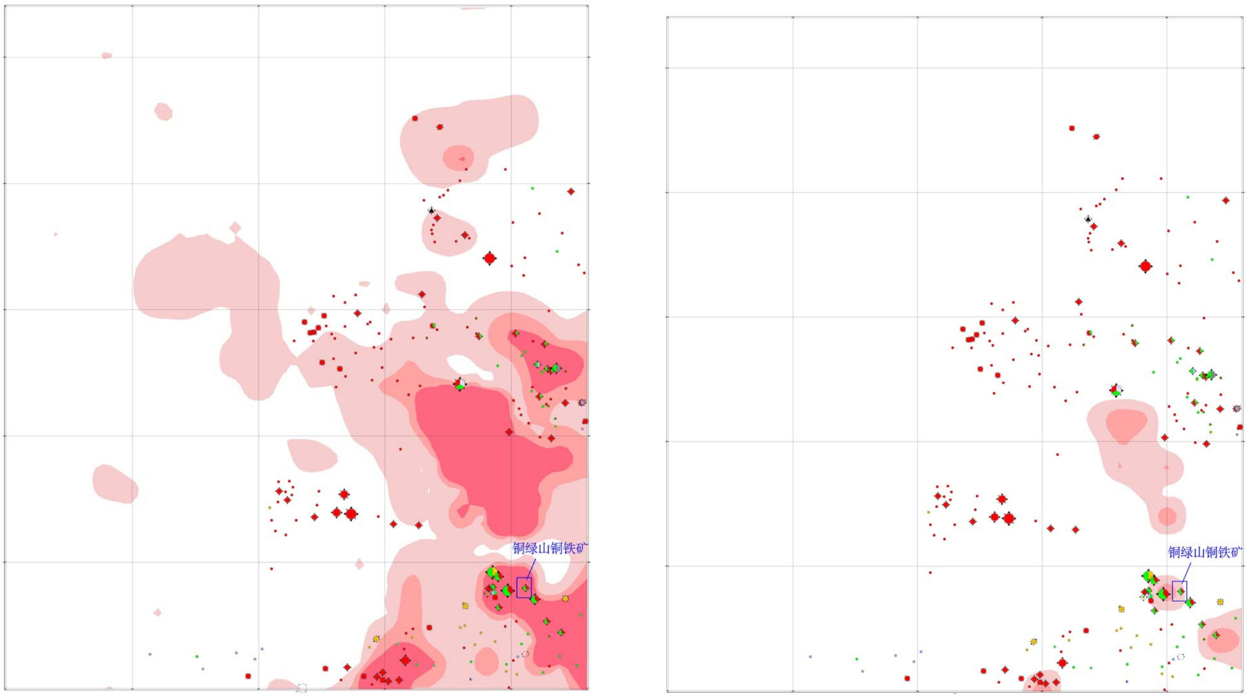

Fig. 6. Contrast diagram between fractal method and traditional method

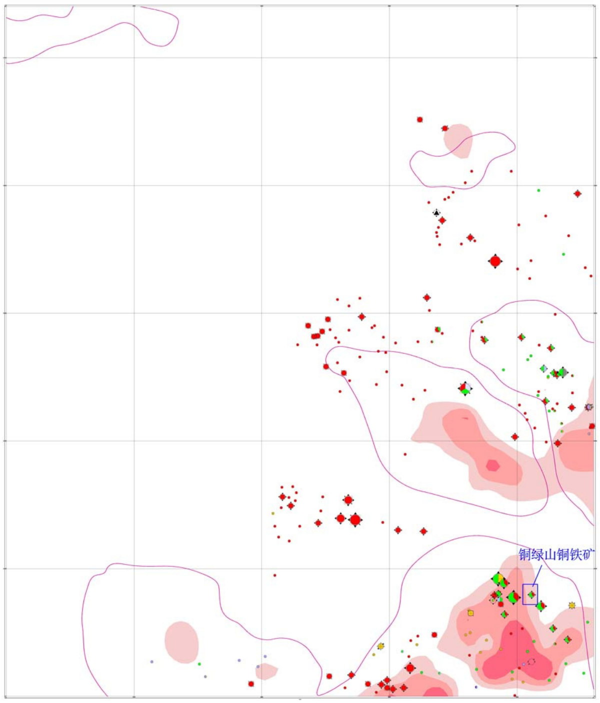

Fig 9. FastICA integrated anomaly map

approximation of S.

3 Application

Model based on the above algorithm, this article uses the 1:200000 Hubei Tong lv Shan stream sediment survey validation samples, 39 kinds of elements were analyzed.

3.1 Artificial immune algorithm for data preprocessing

Comparison of cu and au data before and after processing:

3.2 The Lower limit and the concentrated centre of abnormal area

Use the traditional method and the fractal content area method to do a comparative analysis of anomaly thresholds. The value of anomaly thresholds by traditional method is that the mean plus 2 times of standard deviations.

Use the traditional method and fractal gradient method to delineate the abnormal concentration zoning. Traditional methods use the mean to plus the 2 times of standard deviations on the outskirts, 2 times of anomaly thresholds' value in mesozone, 4 times of anomaly thresholds' value in intrazone.

3.3 Delineating the element associations of anomalies

Using fractal content area method and fractal content gradient method to process the comprehensive variables what were gotten by FastICA algorithm. Figure 9 :

It can be seen from figure 9 that FastICA processing

Table 1 Comparison between before and after aiNet data preprocessing

Element	Minimum value		Maximum value		Mean value		Standard deviation		The traditional method for abnormal lower limit	
	Before	After	Before	After	Before	After	Before	After	Before	After
Cu	11.90	11.90	2468.00	963.17	61.41	58.35	150.29	111.44	362.00	281.22
Au	0.20	0.20	150.00	48.23	2.27	2.06	7.66	4.19	17.59	10.43

results can reflect the position of the mines, and has a good set with the past geochemical exploration anomaly (red line).

4 Conclusions

From the theoretical analysis and real application, we can get the following conclusions:

According to the elements affinity, correlation, the corresponding relationship between samples and variable spaces，FastICA algorithm monitors the separation results by measuring non-Gaussianity or mutual independence of results during thus Process, Trying to separate quantitative element combination which has the largest energy, that is to say, in a certain area geochemical space form and mechanism are two way to measure anomaly.

According to processing technology, independence decomposition will inevitably involve probability density function or higher order statistics, and the process usually introduce nonlinear. And geochemical data is general nonlinear, so the application of the technology to the geochemical data processing is reasonable and feasible. From this point of view, FastICA technology is superior to linear processing technology commonly used only in the second order statistics.

FastICA algorithm can more scientific remove the relationship between the element combinations. It will get more persuasive element combination than traditional methods. From the contrast figures, we can see abnormal combination reflected more distribution of ore-induced anomalies, and provided new strong support for geochemical secondary halos generation and distribution.

Abnormal integral distributions of elements reflect the actual conditions of the area. Exploration showed that abnormities are consistent with ore body, mineralized bodies which had been found.

Key words：BBS;ICA; matallogenetic elements combination

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