Advances in Environmental Biology, 8(11) Special 2014, Pages: 224-229

AENSI Journals

Advances in Environmental Biology

ISSN-1995-0756 EISSN-1998-1066

Journal home page: http://www.aensiweb.com/aeb.html

Identification of uranium targets based on airborne radiometric data analysis by using fractal modeling, Goljeh 1:50000 sheet, NW Iran

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ARTICLE INFO

Article history:
Received 2 April 2014
Received in revised form
13 May 2014
Accepted 28 June 2014
Available online 23 July 2014

Keywords:
Concentration-Area (C-A) fractal model; Uranium; airborne geophysical data; Goljeh; Iran.

ABSTRACT

The aim of this study is separation of uranium anomalies based on geophysical airborne data by utilizing the Concentration-area (C-A) fractal model in Goljeh 1:50000 sheet, NW Iran. Threshold values for the different anomalies of uranium were computed with the statistical method which shows that uranium anomaly from 22 eppm. Furthermore, selected anomalies were further investigated by using surface radiometric data. Firstly, threshold values to define anomalies were determined and compared by means of conventional statistical methods. Several relatively large anomalies were identified with uranium (U) equal to 368.5 eppm. Log-log plot s obtained for the C-A method indicate existence of some stages of uranium enrichment, with a major event being the cause of U concentration values above 750 eppm. These higher intensity anomalies are located in the north-western part of the Gloljeh sheet. In this area , the C-A anomalies were further investigated using ground radiometric using ground radiometric data and ICP-MS analysis revealing higher than 280 ppm U concentration values in this area. Correlation between the anomalies and geological units show that the anomalies are associated with limestone and sand stone units.

To Cite This Article: Hedieh Rahimi Moghim, Afshar zia zarifi, Mohammadreza jafari, Ali Solgi., Identification of uranium targets based on airborne radiometric data analysis by using fractal modeling, Goljeh 1:50000 sheet, NW Iran. ***Adv. Environ. Biol., 8(11),*** *224-229, 2014*

INTRODUCTION

Airborne geophysical data especially gamma ray spectrometry are utilized to identify uranium targets [26]. Interpretation of this data is important for mineral exploration, specifically radioactive elements. Several methods have been conducted for interpretation of geophysical airborne data [1,27,35,4]. Statistical methods are customized for determination of uranium anomaly locations and extensions. Statistical analysis was applied to the airborne spectrometric data for separation of uranium anomalies from background [1,5]. In traditional statistical methods, threshold values are calculated in regard to mean and standard deviation or median based on a normal distribution. These methods, indicate normality or log-normality which does not consider the shape , extant and magnitude of anomalous areas [25,2]. In addition, geological and geochemical anomaly separation from background [29].

Fractal geometry is Non-Euclidean geometry established by Mandelbort [23] and has been applied in geosciences and mineral exploration, especially in geophysical and geochemical exploration since 1980s e.g. Turcotte [32], Meng and Zhao [24], Bolviken et al. [7], Schloz and Mandelbort [30], Korvin [19], Cheng et al. [8], Barton and La Pointe [6], Agterberg et al. [3], Turcotte [33], Cheng [9], Li et al. [21], Turcotte [34], Daya Sagar et al. [11], Dimiri [13] and Shen et al. [31]. Application of fractal and multifractal models has given rise to a better understanding of geophysical phenomena from micro to macro levels [31], Q. Cheng, F.P. Agterberg, [8]. In addition fractal dimensions in geological and mineralogy, lithology, stratigraphy, fluid phases, alteration zones and structural feature [28], V.P. Dimry, [13].

In this study, concentration-area (C-A) fractal method was used in order to explain the geophysical airborne data, including U (eppm) from Goljeh 1:50000 sheet, NW Iran.

Concentration-area:

Fractal method Cheng et al. [8] proposed concentration area (C-A) method which is employed to define the geophysical background and anomalies. The method has the general form as follow:

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$$A(p \le v) \propto p - a1; A(p \ge v) \propto p - a2 \quad (1)$$

Where A(p) denotes the area with concentration values greater than the contour value $p; v$ represents the threshold and a1 and a2 are characteristic exponents the breaks between straight line segments in C-A log-log plot and the corresponding values of p are known as threshold to separate geophysical values into differences, geochemical processes and mineralizing events [22]. The C-A method serves to depict the relationship between element concentration values and geological data. The most useful feature of the C-A method is its capability to compute anomaly threshols [17].

Multifractal models are utilized to quantify patterns such as geophysical data.

Fractal and multifractal modeling are widely applied to eliminate the different mineralized zones [10].

Multifractal theory could be interpreted as a theoretical frame work that explains the power law relationships between areas enclosing concentration below a given threshold value and the actual concenteration itself. To olemonstrate and prove that data distribution has multifractal nature, an extensive computation is required [18,14]. This method has several constrains especially when the boundary effects on irregular geometrical data sets are involved [3,16,8,36]. Multifractal modelings in geophysical and geochemical exploration help to find exploration targets and mineralization potentials in different types of deposits [38].

The C-A method seems to be equally applicable to all cases which means that geophysical distributions mostly satisfy to properties of a multifractal function. There is some evidence that geophysical and geochemical data distributions have fractal behavior in nature, e.g. Bolviken et al. [7], Turcotte [33], Goncalves [17], Getlings [15], Li and Cheng [20] and Afzal et al. [2]. This theory improves the development of an alternative interpretation validation and useful methods to be applied to geophysical distributions analysis.

3. Geological setting of the case studies:

The Goljeh 1:50000 sheet is one of the fourth sheets of Hashtjin 1:100000 sheet which situated in north west of Zanjan province, NW Iran(Fig.1).

The area is located in Azarbayjan-Alborz zone that has high potential of economic geology. There are several metallic prospects like Zn,Pb,Cu and heavy metal like Ti deposits. Also there are many evidence for Au and Pt elements in this area.

Oldest rock types in the area are Paleozoic limestone as named Mobarak. There are sedimentary units including qrtzitic sand stone. Furthermore, carbonate units contains dolomite. There are Paleozen granite as named Hajseyran in several parts of the sheet. Moreover, there are some faults with trends of N-S and NW-SE.

4. Geophysical airborne analysis:

23000 geophysical airborne data were collected by Austrex co. in a grid with 1000×500m distance between air route surveys during 1976-1978. Line spacing between flight lines is 500m with line direction of 41 degrees and sample intervals of 1 s. Detected parameters of these data include U_{235}, Th_{232}, K_{40}.

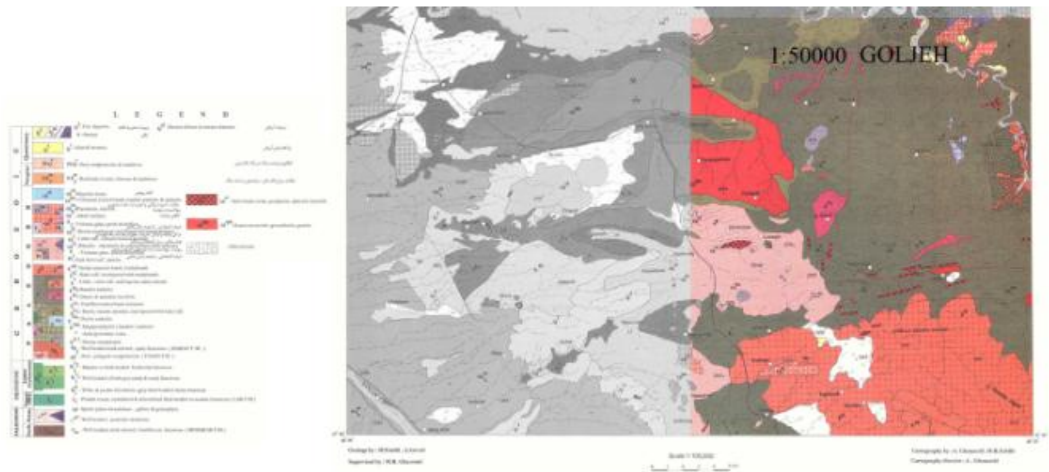

Fig. 1: Goljeh geological map

4.1 statistical analysis:

One of the most important methods to separate background from different anomalies is the method based on classical statistics. This method is depended on data distribution [12]. Different anomalies can be separated in normal distribution, but geophysical and geochemical data do not have normal distribution in most of the cases, e.g. Abd Ei Nabi, [1]; Ranjbar et al., [27] Li et al., [21]; Rafiee, [25] and Afzal et al., [2]. Uranium histograms

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were drawn for Goljeh 1:50000 sheet, as presented in fig.2. uranium distribution in this sheet is not normal. Based on statistical method, uranium threshold in goljeh 1:50000 sheet is equal to median and there are two societies, namely background and anomaly. Threshold value for uranium based on radiometric data is eppm and different anomalies were separated in this sheet (table 1). Uranium distribution map in this sheet was generated by Surfer 8 software in terms of inverse distance squared (IDS), and uranium was classified to different population based on classical statistic method, as illustrated in (Fig.3).

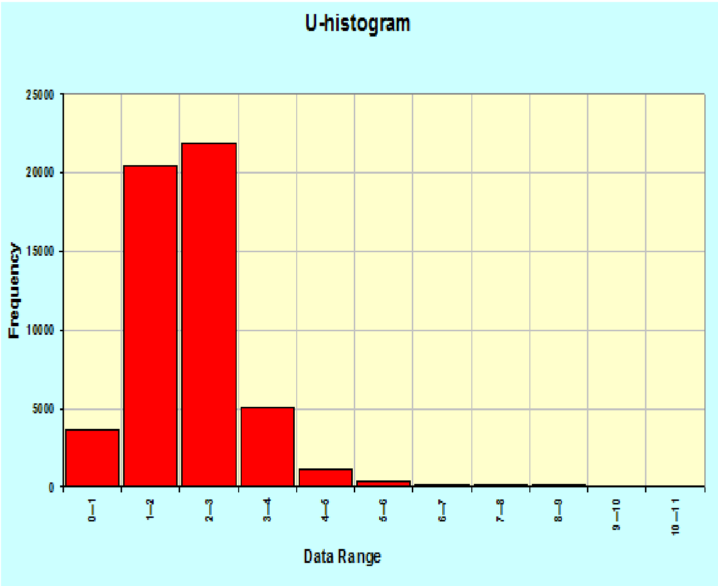

Fig. 2: Histograms of uranium in Goljeh sheet

The studied areas were gridded to 250×250m cells for evaluation of uranium distribution in this sheet .Uranium anomaly in Goljeh sheet is situated some parts of northern and specifically in NW parts of this sheet. High intensity anomalies, more than 750 eppm are located in parts of northern and NW area (Fig.3).

Table 1: Statistical parameters of radiometric geophysical raw data in Goljeh sheet.

	X	Y	Z
Minimum:	254250	4096375	22
Median:	267250	4111875	239
Maximum:	280375	4127875	787
Midrange:	267312.5	4112125	368.5
Range:	26125	31500	837
Interquartile Range:	13125	15500	90
Median Abs. Deviation:	6625	7750	45
Mean:	267314.4443165	4111821.1348763	250.37399965456
Trim Mean (10%):	267314.86822185	4111820.524234	245.11401582191
Standard Deviation:	7586.2762935004	8954.5349381521	93.125002944159
Variance:	57551588.001326	80183695.958586	8672.2661733496
Coef. of Variation:			0.37194358468788
Coef. of Skewness:			1.1373485009408

4.2 C-A method:

C-A log-log plot of uranium was constructed in Goljeh 1:500000 sheet .Geological population was divided based on linear segments and breakpoints in these log-log plots uranium distribution in Goljeh area indicates a multifractal model based on its log-log plot. On the other hand some phases for uranium mineralization are present in this area 1.7, 2.5 and 2.89 Which are low threshold, moderate intensity anomaly threshold and high intensity anomaly threshold values, respectively as illustrated in table 2.

Uranium distribution maps in these areas were generated by Surfer 8, as revealed in Fig.4.Uranium high intensity anomalies, higher than 2.89 eppm, are situated in NW of Goljeh sheet and moderate intensity anomalies, between 2.5 and 2.89 eppm are located in south and east of this area.

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Table 2: thresholds of uranium (eppm) in Goljeh sheet based on C-A fractal method

	Goljeh	Threshold
	1.7	Low intensity threshold
	2.5	Moderate intensity threshold
	2.89	High intensity threshold

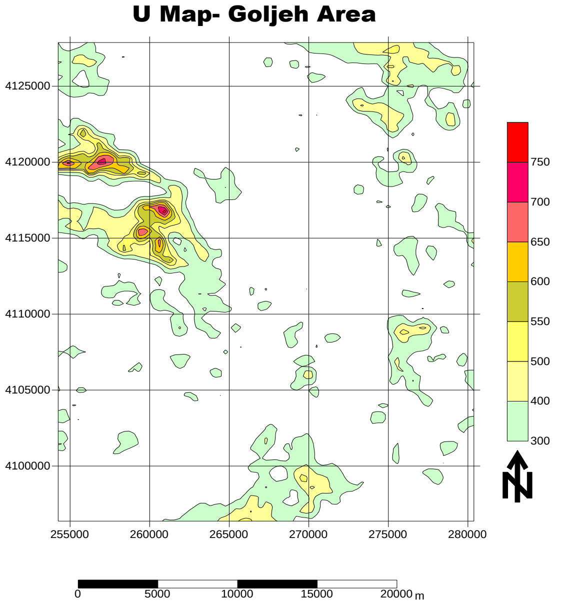

Fig. 3: Uranium anomalies based on statistical methods in Goljeh sheet.

5. Control with geological particulars, ground radiometric surveying:

Several high and moderate intensive anomaly results from C-A model were examined and controlled by ground radiometric surveying. Surface radiometric data surveyed from Goljeh some points (table4). Radiometric data collected from C-A moderate anomalies in Goljeh sheet show uranium concentration between 368 and 510 eppm. Spectrometric data from high intensive anomalies in NW of Goljeh area illustrate that there is U higher than 750 eppm (table4). The results reveal there is positive correlation between anomalies derived via C-A method and surface radio metrical surveying in table 3.

Two lithogeochemical samples were collected from uranium anomalies consisting G1 from granite, G2 from sandstone and analyzed by ICP-MS method. G1 was collected from high intensive uranium anomaly (>750 eppm) and its uranium equal to 280 ppm. G2 associated with moderate intensity anomaly (368.5 eppm) has 150 ppm uranium concentration. The uranium concentrations of the samples have proper correlation with geophysical airborne anomalies resulted by C-A method.

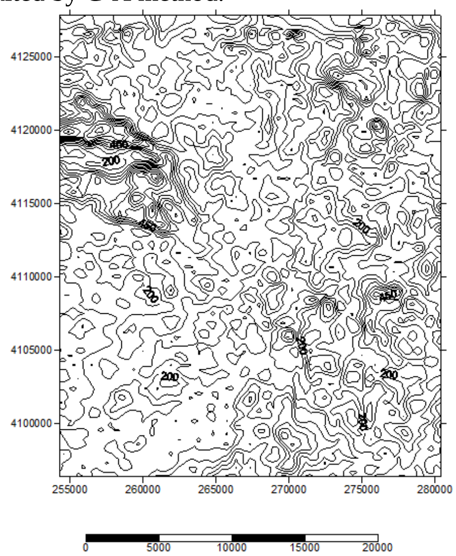

Fig. 4: Uranium anomalies based on C-A method in Goljeh sheet.

Conclusion:

Results obtained by study on Goljeh 1:50000 sheet indicate the potential use of the C-A model for radiometric airborne anomaly separation as an appropriate tool for geophysical exploration. Log-log plot for uranium in the area shows a anomaly for uranium enrichment in the sheet. Uranium anomalies resulted from C-A model and statistical method outline that main uranium anomalies are located in NW of parts of area. Resulted uranium anomalies in the area based on classical statistic are similar to anomalies from C-A model because uranium distribution is normal in this area. According to correlation between geological particulars and uranium anomalies achieved by C-A model, granite (Hajseyran) were associated with the high anomalies of uranium in Goljeh sheet. Results of analyzed samples by ICP-MS method show that uranium concentrations have a positive correlation with anomalies derived via C-A model.

It may be easy to study geophysical airborne anomalies with the C-A log-log curves can be a sufficient way for geophysists to conduct such research in order to find targets with enriched radioactive elements. The developments in multifractal theory and its utilization are highly recommended for stochastic simulation of geophysical distribution.

Table 3: The coordinates of sampling points in Goljeh area.

Sample name	C-A anomaly intensity	U (eppm)
89-HA-GO-01	Moderate	310
89-HA-GO-02	Low	22
89-HA-GO-03	High	715
89-HA-GO-04	High	787
89-HA-GO-05	Low	174
89-HA-GO-06	Moderate	310
89-HA-GO-07	High	575

ACKNOWLEDGMENT

The paper was supported by Islamic Azad University, Science and research branch. The authors wish to acknowledge the research deputy of Azad University, Science and research branch for supporting of this study. The authors would like to thank the editors and reviewers of this paper for their comments and valuable remarks.

REFERENCES

[1] Ab El Nabi, S.H., 1995. Statistical evaluation of airborne gamma ray spectrometric data from Magal Gebriel area, south eastern Desert, Egypt, J. Appl. Gheophys., 34: 47-54.

[2] Afzal, P., A. Khakzad, P. Moarefvand, N. Rashidnejad Omran, B. Esfandiar and Y. Fadakar Alghalandis 2010. Geochemical anomaly separation by multifractal modeling in Kahang (Gor Gor)porphyry system, Central Iran, J. Geochem. Explor., 104: 34-46.

[3] Agterberg, F.P., Q. Cheng, A. Brown and D. Good, 1996. Multifractal modeling of fractures in the Lac du Bonnet batholite , Manitoba, Comput. Geosci., 22: 497-507.

[4] Airo, M.L. and S. Mertanen, 2008. Magnetic signatures related to orogenic gold mineralization, Central Lapland Greenstone belt, Finland, J., Appl. Geophys., 64: 14-24.

[5] Asfahani, J., R. A-Hent and M. Assis, 2009. Uranium statistical and geological evaluation of airborne spectrometric data in the Al-Awabed region and its surroundings (Area-3), Northern Palmyrides, Syria, Appl. Radiat. Isotopes, 67: 654-663.

[6] Barton, C.C. and P.R. La Pointe, 1992. Fractals in the earth sciences, Plenum Press, New York, 265.

[7] Bolviken, B., P.R. Stokke, J. Feder and T. Jossang, 1992. The fractal nature of geochemical landscapes, J. Geochem. Explor., 43: 91-109.

[8] Cheng, Q., F.P. Agterberg, S.B. Ballantyne, 1994. The separation of geochemical anomalies from back ground by fractal methods, J., Geochem. Explor., 51: 109-130.

[9] Cheng, Q., 1999. Spatial and scaling modeling for geochemical anomaly separation, J. Geochem. Explor., 65: 175-194.

[10] Cheng, Q., 2007. Multifractal imaging filtering and decomposition methods in space, Fourier frequency, and eigen domains, Nonlin. Processes Geophys., 14: 293-303, doi:10.5194/npg-14-293-2007.

[11] Daya Sagar, B.S., G. Rangarajan and D. Veneziano, 2004. Fractalsin Geophysics, Chaos, Soliton. Fract., 19: 237-239.

[12] Davis, J.C., 2002. Statistics and data analysis in Geology, 3rd Edn., John Wiley & Sons Inc., New York.

[13] Dimri, V.P., 2005. Fractal behavior of the earth System, Springer, 208.

[14] Evrtz, C.J.G. and B.B. Mandelbort, 1992. Multifractal measures (appendix B), in: Chaos and Fractal, edited by: Peitgen, H.-O., Jurgens, H., and Saupe, D., Springer, New York.

[15] Gettings, M.E., 2005. Multifractal magnetic susceptibility distribution models of hydrothermally altered rocks in the needle Creek Igneous Center of the Absaroka Mountains, Wyoming, Nonlin. Processes Geophys., 12: 587-601, doi:10.5194/npg-12-587-2005.
[16] Goncalves, M.A., 2001. Characterization of geochemical distributions using multifractal models, Math. Geol., 33: 44-61.
[17] Goncalves, M.A., A. Mateus and V. Oliveira, 2001. Geochemical anomaly separation by multifractal modeling, J. Geochem. Explor., 72: 91-114.
[18] Halsey, T.C., M.H. Jensen, L.P. Kadanoff, I. Procaccia and B.I. Shraiman, 1986. Fractal measurements and their singularities: The characterization of strange sets. Phys. Rev. A, 33: 1141-1151.
[19] Korvin, G., 1992. Fractal Models in the earth science, Elsevier, Amsterdam, pp: 396.
[20] Li, Q. and Q. Cheng, 2006. Visual Anomaly: A GIS-based multifractal method for geochemical and geophysical anomaly separation in Walsh domain, Comut. Geosci., 32: 663-672.
[21] Li, C., T. Ma and J. Shi, 2003. Application of a fractal method relating concentration and distances for separation of geochemical anomalies from background, J. Geochem. Explor., 77: 167-175.
[22] Lima, A., B. De Vivo, D. Cicchella, M. Cortini and S. Albanese, 2003. Multifractal IDW interpolation and fractal filtering method in environmental studies: an application on regional stream sediments of (Italy), Campania region, Appl. Geochem., 18: 1853-1865.
[23] Mandelbrot, B.B., 1983. The fractal Geometry of Nature, W. H. Freeman, San Fransisco, 486.
[24] Meng, X. and P. Zhao, 1991. Fractal method for statistical analysis of geological data, Chinese., 2: 207-2011.
[25] Rafiee, A., 2005. Separating geochemical anomalies in stream sediment media by applying combination of fractal concentration-area model and multivariate analysis (Case study: Jeal-e-Barez 1:100000 sheet, Iran), 20th World Mining Congress Proceeding, Iran, 461-470.
[26] Raghuuwanshi, S.S., 1992. Airborne gamma-ray spectrometry in uranium exploration, Adv. Space Res., 12: 77-81.
[27] Ranjbar, H., H. Hassanzadeh, M. Torabi and O. Ilaghi, 2001. Integration and analysis of airborne geophysical data of the Darrehzar area, Kerman Province, Iran, using principal component analysis, J. Appl. Geophys., 48: 33-41.
[28] Rashidnejad Omran, N., A. Afzal, H. Harati, P. Moarefvand, H. Asad Haronii, L. Daneshvar Saeein, 2011. Application of power-law frequency fractal model in determination of vertical geochemical distribution of Cu in Kahang porphyry deposit, Central Iran, J. Mining and Metallurgy, 47: 1-8.
[29] Reimann, C., P. Filzmoser and R.G. Garrett, 2005. Background and threshold: Critical comparison of methods of determination, Sci. Total Environ., 346: 1-16.
[30] Scholz, C. and B.B. Mandelbrot, 1992. Special issue on fractals in geology and geophysics, Pure Appl. Geophys., 131: 96-171.
[31] Shen, W., C. Fang and D. Zhang, 2009. Fractal and Chaos Research of Geomagnetic Polarity Reversal, Earth Sci. Front., 16: 201-206.
[32] Turcotte, D.L., 1989. Fractals in geology and geophysics, Pure Appl. Gephys., 131: 171-196.
[33] Turcotte, D.L., 1997. Fractals and Chaos in Geology and Geophysics, Cambridge University press, Cambridge, 398.
[34] Turcotte, D.L., 2004. The relationship of fractals in geophysics to " the new science", Chaos , Soliton. Fract., 19: 255-258.
[35] Tourliere, B., J. Perrin, P. Le Berre and J.F. Pasquet, 2003. Use of airborne gamma-ray spectrometry for kaolin exploration, J. Appl. Geophys., 53: 91-102.
[36] Xie, S., Q. Cheng, S. Zhang and K. Huang, 2010. Assessing microstructures of pyrrhotites in Bsalts by multifractal analysis, Nonlin. Processes Geophys., 17: 319-327, doi: 10.5194/npg-17-319-2010.
[37] Ziazarifi, A., p. Afzal and A. Darvishzadeh, 2010. Separating geophysical anomalies in airborne radiometric data by applying fractal concentration- area model, Tark 1:50000 Sheet NW Iran, Proceeding of International Mining Congress and Expo 2010 (Abstract volume), p: 20.
[38] Yao, L. and Q. Cheng, 2011. Multi-scale interactions of geological processes during mineralization: cascade dynamics model and multifractal simulation, Nonlin. Processes Geophys., 18: 161-170, doi:10.5194/npg-18-161-2011.