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Nonlinear Processes in Geophysics
Discussions

Interactive comment on "Application of fractal models to delineate mineralized zones in the Pulang porphyry copper deposit, Yunnan, Southwest China" *by* Xiaochen Wang et al.

Xiaochen Wang et al.

qlxia@cug.edu.cn

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1. We have checked this paper and the typing/spacing issues have been revised. 2. We have checked this paper and revised the grammatical issues. A new revision of this manuscript has been uploaded. 3. We have added many newer references to improve the paper. And a new revision of this manuscript has been uploaded. 4. We have checked this paper and found that the paper is prolonged by repeating obvious things for example the amounts of the thresholds. We have deleted these obvious things. And a new revision of this manuscript has been uploaded. 5. Given the Referee comments, we have tried to add the N-S fractal model to improve the structure of the paper and

revolutionize the style of the paper. Furthermore, the results of N-S fractal model were compared with the C-V and S-V models.

5.1 Number-size (N-S) fractal model

Number-size (N-S) method proposed by Mandelbrot (1983) can be utilized to describe the distribution of geochemical populations (Sadeghi et al., 2012). In this method, geochemical data do not undergo any pre-processing (Mao et al., 2004). This model shows a relationship between desirable attributes (e.g. Cu concentration in this study) and their cumulative number of samples (Sadeghi et al., 2012). A power-law frequency model has been proposed to explain the N-S relationship according to the frequency distribution of elemental concentrations and cumulative number of samples with those attributes (e.g., Li et al., 1994; Sadeghi et al., 2012; Sanderson et al., 1994; Shi and Wang, 1998; Turcotte, 1996; Zuo et al., 2009a).

The N-S model proposed by Mandelbrot (1983) has been expressed as follows: $N(\geq p)=Fp\text{-}D$

where p denotes element concentration, $N(\geq p)$ denotes cumulative number of samples with concentration values greater than or equal to p, F is a constant and D is the scaling exponent or fractal dimension of the distribution of element concentrations. According to Mandelbrot (1983), log-log plots of $N(\geq p)$ versus p show straight line segments with different slopes -D corresponding to different concentration intervals.

5.2 Number-size (N-S) fractal modeling

The N-S model was applied to the Cu data (Fig. 8). The selection of breakpoints as threshold values appears to be an objective decision because geochemical populations are defined by different line segments in the N-S log-log plot. The straight fitted lines were obtained based on least-square regression (Agterberg et al., 1996; Spalla et al., 2010). In other words, the intensity of element enrichment is depicted by each slope of the line segment in the N-S log-log plots (Afzal et al., 2010; Bai et al., 2010). Based

on the classification of the 3D model of Cu data and the thresholds obtained from N-S fractal model (Table 2), highly mineralized zones are situated in the southern and central parts of Pulang deposit that coincide with the potassium-silicate alterations. However, small highly mineralized zones are located in the central parts of the Pulang deposit (Fig.9). Moderately mineralized zones are disposed in a northwest-southeast trend correlated with phyllic zones. Weakly mineralized zones and barren host rocks are situated in the marginal parts of the area.

A comparison between highly mineralized zones based on the fractal models and potassic alteration zones resulted from the 3D geological model shows that there is a similarity among these fractal models. Overall accuracies for the C-V, N-S and S-V models are 0.50, 0.51 and 0.52, respectively (Table 6), which indicate that the S-V model gives better results to identify highly mineralized zones in the deposit. Because the fact that the number of overlapped voxels (A) in the S-V model is higher than those in N-S and C-V model. The correlation (from OA results) between highly mineralized zones obtained from S-V modeling and the potassic alteration zones is better than the N-S and C-V model because of a strong proportional relationship between extension and positions of voxels in the S-V model and potassic alteration zones in the 3D geological model.

Comparison between phyllic alteration zones resulted from the 3D geological model and moderately and weakly mineralized zones from fractal modeling shows that overall accuracies of the C-V, N-S and S-V fractal models with respect to phyllic alteration zones of the geological model are 0.59, 0.56 and 0.54, respectively. Overall accuracy values of moderately and weakly mineralized zones obtained from C-V modeling is higher than the mineralized zones obtained from N-S and S-V modeling (Table 7). On the other hand, moderately mineralized zone defined by C-V modeling has overlap with the phyllic zones in the 3D geological model. However, the results of the C-V model are more accurate than those of the N-S and S-V model with respect to the phyllic zones in the 3D geological model.

And a new revision of this manuscript has been uploaded.

Please also note the supplement to this comment:
https://www.nonlin-processes-geophys-discuss.net/npg-2019-8/npg-2019-8-AC2-supplement.pdf

Interactive comment on Nonlin. Processes Geophys. Discuss., https://doi.org/10.5194/npg-2019-8, 2019.

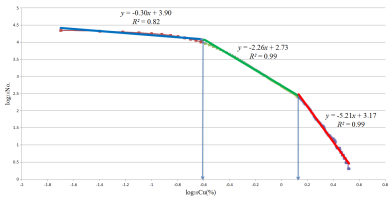

Fig. 1. N–S log–log plot for Cu concentrations in the Pulang deposit.

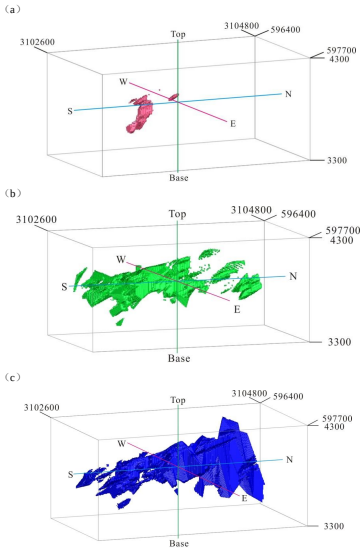

Fig. 2. Zones in Pulang deposit based on thresholds defined from N–S fractal model of Cu data: (a) highly mineralized zones; (b) moderately mineralized zones; (c) weakly mineralized zones and barren host rock

Mineralized zones	Thresholds(Cu%)	Range(Cu%)
Barren host rock and weakly mineralized		<0.28
Moderatelymineralized	0.28	0.28-1.45
Highly mineralized	1.45	>1.45

Fig. 3. Thresholds concentrations obtained by using N-S model based on Cu% in Pulang deposit.

Table 6

		Potassic alteration of geological model	
		Inside zones	Outside zones
C–V fractal model of highly mineralized zones	Inside zones	A 2850	B 1360
	Outside zones	C 77927	D 76913
		T1E 0.96	T2E 0.02
		OA 0.50	
N–S fractal model of highly mineralized zones	Inside zones	A 3092	B 1570
	Outside zones	C 75025	D 75473
		T1E 0.96	T2E 0.02
		OA 0.51	
S–V fractal model of supergene enrichment zones	Inside zones	A 4431	B 2318
	Outside zones	C 72985	D 75726
		T1E 0.94	T2E 0.03
		OA 0.52	

Fig. 4. Overall accuracy (OA), Type I and Type II errors with respect to potassic alteration zone resulted from geological model and threshold values of Cu obtained through C–V , N–S and S–V fractal modeling.

Table 7

		Phyllic alteration of geological model	
		Inside zones	Outside zones
C–V fractal model of moderately and weakly mineralized zones	Inside zones	A 36518	B 48027
	Outside zones	C 25461	D 69155
		T1E 0.41	T2E 0.40
		OA 0.59	
N–S fractal model of moderately mineralized zones	Inside zones	A 40080	B 44943
	Outside zones	C 26899	D 54239
		T1E 0.40	T2E 0.45
		OA 0.56	
S–V fractal model of the hypogene zones	Inside zones	A 35555	B 46943
	Outside zones	C 23955	D 48223
		T1E 0.40	T2E 0.49
		OA 0.54	

Fig. 5. Overall accuracy (OA), Type I and Type II errors with respect to phyllic alteration zone resulted from geological model and threshold values of Cu obtained through C–V, N–S and S–V fractal modeling.