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Self-similar fractal analysis of gold mineralization of Dayingezhuang disseminated-veinlet deposit in Jiaodong gold province, China

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ABSTRACT

The mineralization degree in drifts in the Dayingezhuang disseminated-veinlet gold deposit in Jiaodong gold Province, China, can be categorized into non-mineralized, weakly mineralized, moderately mineralized and intensely mineralized ranks based on the number of the gold grades greater than cut-off. The grades sampled equidistantly and continuously along different drifts at −140 m, −175 m and −210 m levels of the deposit are systematically calculated via the self-similar fractal model. The grade distributions often show bifractal characteristics, including two or three non-scale ranges. It shows that with the increase of mineralized rank, the fractal dimension of the second non-scale range decreases and the corresponding threshold becomes greater. The dimension decrease comes from the increase of proportion of the wider microfracture in the ore-controlling structure system; and the threshold increase is a result from the magnitude elevation of the microfractures from the extension-shear zone to compression-shear zone. The smaller fractal dimension means the proportion of the higher gold grades increases, suggesting the thickness of the orebody is proportional to its mean gold grade.

1. Introduction

Fractal geometry is a theory describing the distribution of inhomogeneous or irregular objects, and fractal dimension is an important parameter for measuring the extent of irregularity (Mandelbrot, 1983; Turcotte, 1997). Many geological objects or events could be considered in fractal terms. A number of fracture features commonly show fractal distributions, such as fracture aperture (Laubach and Ward, 2006), fracture intensity (Ortega et al., 2006), fault displacements and lengths (Aviles et al., 1987; Okubo and Aki, 1987; Walsh et al., 1991; Jackson and Sanderson 1992; Manning 1994; Fossen and Rørnes 1996; Knott et al., 1996; Needham et al., 1996; Nicol et al., 1996; Watterson et al., 1996; Yielding et al., 1996; Pickering et al., 1997), earthquake magnitudes (Turcotte, 1997; Dimri, 2005), particle sizes of comminuted rock and fault gouge (Sammis and Biegel 1989; Korvin, 1992). The thickness distributions of veins have also frequently been described by power–law relationships (Monecke et al., 2001; Sanderson et al., 1994; Clark et al., 1995; McCaffrey and Johnston 1996; Roberts et al., 1998; Monecke et al., 2005). Mandelbrot (1983) first suggested that mineral distribution conforms to fractal distribution. More comprehensive fractal analyses of ore deposit distributions are made by Carlon (1991), Turcotte (2002), Kaye (1994), Blenkinsop (1994), Agterberg (1995) and Agterberg et al. (1996). The statistical relationship among the fractal dimensions of the spatial distribution of deposits, faults and magmatic bodies, are discussed to reveal their geological relationship by Deng et al. (2001, 2006).

Fractal models are also applied to the distribution of elements (Cheng et al., 1994; Cheng, 1995, 1999; Zhang et al., 2001; Li et al., 2003; Lima et al., 2003). Cheng et al. (1994) proposed the background geochemical values usually have normal or log-normal distributions, and the anomalous values may follow fractal distribution; he utilized a bifractal model to find the threshold value dividing the abnormal and the background levels. Yet, there are few detailed fractal analyses of grade distributions in the deposits. De Wijs (1951, 1953) pointed that the log-normal or binomial curve can fit the frequency distributions of mine samples. Yet Sanderson et al. (1994) showed that gold grades in the quartz vein deposit La Codosera, Spain, follow a power–law distribution, and Monecke et al. (2001) noted that base metal concentrations in drill core from the Hellyer massive sulphide deposit, Australia, also obey the power–law relationship. Monecke et al. (2005) showed that the frequency distributions of Zn, Pb, Cu, and Ag in the Waterloo massive sulphide deposit conform to truncated power–law relationships. Wang et al. (2007b) found that the grade distributions of the Au, Ag, Pb, Zn, Mn elements in the Damoqujia disseminated-veinlet deposit, Shandong province, China can be

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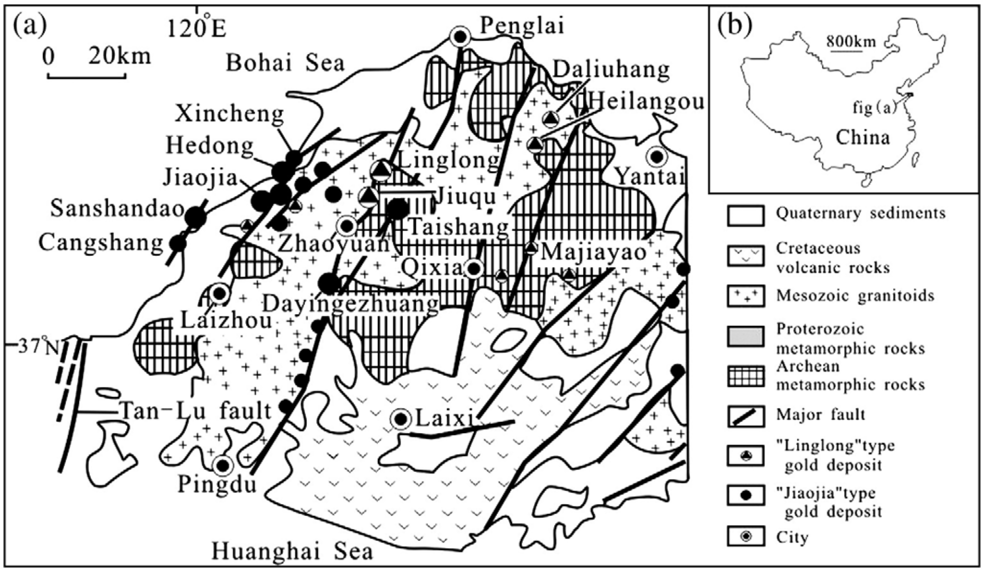

Fig. 1. Generalized geological map of the western part of Jiaodong gold province, China (revised from Fan et al., 2003).

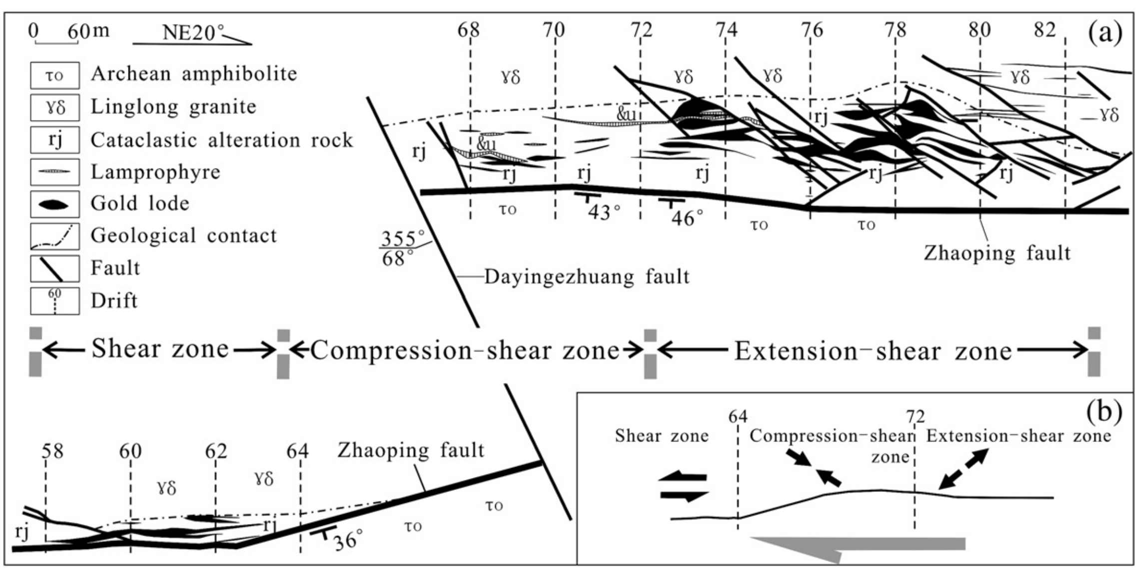

Fig. 2. Geological map of − 175 m level in the Dayingezhuang ore deposit (General geologic survey report of Dayingezhuang gold ore district in Zhaoyuan county, Shandong province, 1987, the sixth geologic team of Shandong provincial bureau of resource exploration). (a) geological map, (b) sketch showing stress condition change (The displacement of the Dayingezhuang fault is recovered).

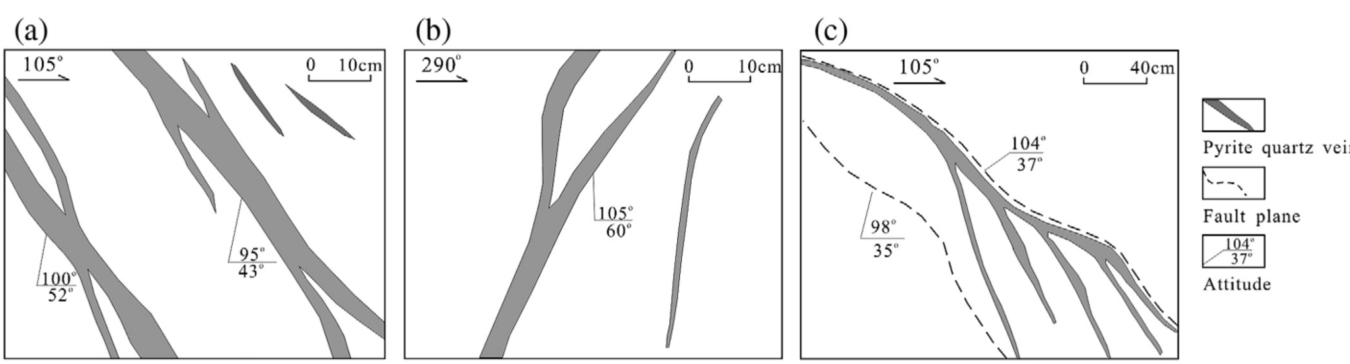

Fig. 3. Sketches of the pyrite-quartz veins in drift 73 at − 175m level in Dayingezhuang ore deposit.