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Delineation of the porphyry-skarn mineralized zones (NW Turkey) using concentration–volume fractal model

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ABSTRACT

This study is carried out for delineation of the Tepeoba porphyry-skarn Cu–Mo ± Au mineralized zones at the Biga peninsula (NW Turkey) using the concentration–volume (C–V) fractal model. The power-law C–V relationships of Cu, Mo, and Au reveal five mineralized zones of Cu, three zones of Mo, and five zones for gold in the Tepeoba deposit. The main phase of the mineralization has average ore grades of 0.257% Cu, 0.357% Mo and 5.3083 ppm Au. Cu–Mo sulfide-rich hypogene ore zone overlain by mineralized oxidation zone are encompassed by three main alteration types, which are represented by biotite ± muscovite-K-feldspar, actinolite-albite and outer chlorite-epidote-calcite mineral associations occurring within the porphyritic microgranite and hornfels in the mine area. The delineated mineralization trend, based on the C–V fractal model, suggested that Cu and Mo enrichment zones were controlled by the same geochemical processes in the deposit due to their similar trends with the C–V log-log plot. Cu and Mo occurred mainly within the breccia zones along with stockwork veining at the contact between the hornfels and the biotite (±muscovite)-K-feldspar-altered Eybek microgranite. The main mineralization zone of Au developed in the oxidation zone due to of supergene enrichment processes.

1. Introduction

Any exploration target of a hydrothermal deposit e.g., porphyry, epithermal and skarn, depends on differentiation between hypogene- and oxidation-mineralized zones from the barren host rocks (Afzal et al., 2011). In addition, the mineralogy and geological structures as well as alteration parameters are used in detecting the alteration zones associated with the porphyry-skarn system (Sillitoe, 1997). Lowell and Guilbert (1970) proposed a model of lateral and vertical diversity in mineral assemblages within different alteration zones. Through this model, the changing-ore grades could be observed based on the mineralogical and alteration assemblages in the different porphyry-skarn deposits. Consequently, the boundaries between distinct zones in the system that are important in recognizing the distribution of ore grades of each zone can be determined. This model is constructed based on the methods of fractal analysis that used the geochemical data in the form of fractal dimensions to define the relationship of geological, mineralogical, and geochemical surroundings with spatial analytical data from a distinct

mineral deposit (Goncalves et al., 2001; Carranza et al., 2009). The method of fractal analysis also classified the geochemical population in a deposit when the mineralization is controlled by geological and geochemical environments (Goncalves et al., 2001; Carranza, 2009). Moreover, this method is used to recognize and classify mineralized and barren zones within a porphyry (-skarn) deposit (Afzal et al., 2011). Herein, the methods of geostatistical, fractal and geometrical structural statistics have been used to delineate anomalous zones during the stages of mineral exploration (Sun and Liu, 2014; Rajoli et al., 2015). Hence, the fractal is described as a scaling law based on two variables; the scale factor and the object being measured. A power-law function that refers to the fractal dimension describes this scaling relationship as well as characterizes the physical assignments of the analyzed object (Takayasu, 1990; Lauwerier, 1991; Ortega et al., 2006).

Sim et al. (1999) suggested that the fractal dimensions in geological and geochemical processes are compatible with differences in the physical characteristics of the rock units e.g., rock type, mineral compositions, alteration types, vein density and orientation, and fluid phase.

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