Preliminary spatial modeling of ore grades over a deposit by a combination of geostatistics and physical law

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This study is aimed to develop a method for highly precise spatial modeling of metal contents in a metal deposit. For this, a combination of geostatistics and a physical law is examined. Matsumine and Fukazawa mines, typical large kuroko deposits in the Hokuroku district, Akita Pref., northern Japan, are selected for a case study of the combination. Kuroko is a Japanese term for massive, compact black-ore mainly composed of sphalerite, galena, and pyrite. Kuroko deposits were originated from felsic to intermediate submarine volcanic activity (e.g. Yamada and Yoshida, 2013). The metal contents of Cu, Zn, and Pb (chief metals of kuroko) in the drilling cores were used for the spatial analyses.
After semivariogram analysis to clarify the spatial correlation structure of the metal data, kriging and sequential Gaussian simulation were used to produce a 3D spatial model of ore grade. Assuming that the transport of ore solutions and the deposition of metals are approximated by an advective-diffusion spread phenomenon, theoretical solution of an advective-diffusion equation was applied to the ore grade data by solving unknown parameters such as advective velocity and diffusion coefficient. Then, ore grades over the study area were assigned from the physical model. Finally, geostatistical and physical models were combined by a kriging technique so that the calculated ore grades by these models were coincident with the sample grade data. The combined model shows roughly main paths of ore solutions, which may contributes to interpret the deposit formation process. Our next step is a multi-scale spatial modeling by extracting and characterizing distributions of sulfide minerals in kuroko ore samples.
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References
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