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Mixtures of multiplicative cascade models in geochemistry

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Multifractal modeling of geochemical map data can help to explain the nature of frequency distributions of element concentration values for small rock samples and their spatial covariance structure. Useful frequency distribution models are the lognormal and Pareto distributions which plot as straight lines on logarithmic probability and log-log paper, respectively. The model of de Wijs is a simple multiplicative cascade resulting in discrete logbinomial distribution that closely approximates the lognormal. In this model, smaller blocks resulting from dividing larger blocks into parts have concentration values with constant ratios that are scale-independent. The approach can be improved by adopting random variables for these ratios. The Turcotte model, which is a variant of the model of de Wijs, results in a Pareto distribution.

Often a single straight line on logarithmic probability or log-log paper does not provide a good fit to observed data and two or more distributions should be fitted. For example, geochemical background and anomalies (extremely high values) have separate frequency distributions. Separate straight line segments fitted then do not necessarily result in unbiased estimates of the parameters of the mixed frequency distributions. Mixing distributions with known parameters helps to assess the extent of this bias. Mixtures of distributions can be simulated either by adding the results of separate cascade models, or by using a single cascade model with ratio parameters that depend on magnitude of concentration value.