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Power Spectrum Density-Area Model (S-A) for Quantifying Generalized Scale Invariance of 2D Map Patterns: Case studies for Mineral Exploration and Environmental Assessments

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Maps created from geological quantities (density of mineral deposits, earthquakes, and faults), geophysical fields (magnetic field, gravity field and radiometric anomaly), geochemical concentration data (soil, till, and water) and remote sensing images are often used for characterizing underlying geo-processes by means of pattern recognition. Generalized scale invariant properties observed in these types of patterns may be caused by generalized self-similar geo-processes. Quantification and characterization of such generalized scale invariant properties from 2D maps are useful not only for characterizing the patterns but also for understanding relevant geo-processes.

There are some models which are capable of characterizing generalized self-similarity of spatial patterns. One of them is so-called generalized scale invariance technique (GSI) implemented in the Fourier domain. It quantifies the scaling property of patterns as well as the potential scaling transformation which may be responsible for anisotropy scaling. The technique introduced in the current paper is closely related to GSI but it can be used to estimate the generalized scaling property without calculating scaling transformation and therefore can simplify the calculation process. It is based on a new power-law relationship between the values of contours drew on the basis of power spectrum density and the “area” enclosed by the contours on the frequency

plane. This model can be used not only for characterizing generalized scale invariant property of map patterns but also for decomposing spatial patterns into components which is useful in many of applications of maps. Examples chosen for demonstrating the method include patterns generated from toxic element concentration values in soils, tills and water samples from Abitibi mineral district of Canada. Patterns are decomposed into components reflecting the influences of rock types and location of mines, respectively.