



Singularity analysis: theory and further developments

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Since the concept of singularity and local singularity analysis method (LSA) were originally proposed by the author for characterizing the nonlinear property of hydrothermal mineralization processes, the local singularity analysis technique has been successfully applied for identification of geochemical and geophysical anomalies related to various types of mineral deposits. It has also been shown that the singularity is the generic property of singular geo-processes which result in anomalous amounts of energy release or material accumulation within a narrow spatial–temporal interval. In the current paper we introduce several new developments about singularity analysis. First is a new concept of “fractal density” which describes the singularity of complex phenomena of fractal nature. While the ordinary density possesses a unit of ratio of mass and volume (e.g. g/cm^3 , kg/m^3) or ratio of energy over volume or time (e.g. J/cm^3 , w/L^3 , w/s), the fractal density has a unit of ratio of mass over fractal set or energy over fractal set (e.g. g/cm^α , kg/m^α , J/m^α , w/L^α , where α can be a non-integer). For the matter with fractal density (a non-integer α), the ordinary density of the phenomena (mass or energy) no longer exists and depicts singularity. We demonstrate that most of extreme geo-processes occurred in the earth crust originated from cascade earth dynamics (mantle convection, plate tectonics, orogeny and weathering etc) may cause fractal density of mass accumulation or energy release. The examples to be used to demonstrate the concepts of fractal density and singularity are earthquakes, floods, volcanos, hurricanes, heat flow over oceanic ridge, hydrothermal mineralization in orogenic belt, and anomalies in regolith over mine caused by ore and toxic elements vertical migration. Other developments of singularity theory and methodologies including singular Kriging and singularity weights of evidence model for information integration will also be introduced.