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Critical Mineralising Plumbing Systems - Analysis Using Wavelets

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Crustal plumbing systems consist of an interconnected set of fractures. Recently, fracture systems have been viewed as examples of critical systems (Perez-Reche et al., 2008). Various styles of critical systems can be distinguished. The classical form of critical behaviour occurs when some tuning parameter (such as elastic modulus or stress) reaches a critical value that initiates fracture. This is expressed as a single catastrophic event which is repeated as the system reloads. Another extreme in behaviour is self-organised criticality (SOC) where the system fails through the development of small avalanches of fractures with continuous forcing. Perez-Reche et al. (2008) discuss systems that can evolve from classical criticality to self-organised criticality or to other regimes. Each regime is characterised spatially by a range in the fractal dimension, D. Massive catastrophic behaviour (called SNAP), in two dimensions, is characterised by$1 \leq D \leq 1.5$. SOC has $D \approx 1.5$whereas distributed small avalanches (called POP) are characterised by$1.5 \leq D \leq 2$. The aim is to distinguish SNAP terrains from POP terrains which seem highly probable mineralising plumbing systems based on previous modelling (Miller and Nur, 2000) and work by Sibson (1992), Cox (1999) and Cox et al. (2001) that portrays the evolution of the plumbing system as a swarm of seismic aftershocks; this constitutes a typical POP regime. We explore whether or not the plumbing systems for hydrothermal systems have fractal dimensions in the POP-range for critical systems, and whether or not there is more diagnostic information to be obtained from the multi-fractal spectrum. The hypothesis is that fracture systems analysed using wavelets define multifractal patterns which are diagnostic of hydrothermal systems.

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