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Scaling behavior of natural and simulated stylolites

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In this contribution we investigate the scaling of natural and simulated Stylolites, an abundant deformation pattern in sedimentary rocks, by means of fractal concepts. Our approach is twofold, we first characterize the roughness of natural stylolites to verify that stylolites demonstrate a self affine scaling invariance. Secondly, we investigate the dynamic roughening of simulated stylolites using a 2D lattice spring model (Koehn et al., 2007).

Our findings demonstrate that (i) natural and simulated stylolites exhibit two scaling regimes with different Hurst-exponents, separated by a crossover-length (L) that is dependent on the surrounding stress field; (ii) surface roughness of simulated stylolites grows exponentially and tends to saturate after a critical time; (iii) characteristic scaling parameters of simulated stylolites (e.g. roughness and growth exponents) are independent of the kind of heterogeneities introduced in the system.

The results of our investigation have several important implications. The fact that a crossover-length exists that is dependent on stress allows using natural stylolites as stress/depth gauges. The complex surface growth evolution exhibited by our model implies that stylolite amplitude heights, previously used to estimate the amount of volume loss, only capture a small part of the compaction history and thus underestimate the real amount of volume loss. Our results also suggest that scaling parameters of our simulated stylolites that are very consistent over a wide range of heterogeneities introduced in the model are independent of the quenched noise in the system.

Koehn et al., 2007 *Earth and Planetary Science Letters* 257(3-4), p. 582-595.