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Stylolite stress scaling: determining depth of sedimentary basins, tectonic stresses and fault location.

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Stylolites are localized dissolution seams that can be found in a variety of rocks and in sedimentary as well as tectonic settings. Dissolution of the host-rock next to the stylolite is a function of the applied stress on the stylolite plane. Roughness on the stylolite is known to be a good indicator of the major compaction direction and thus the direction of the largest principle stresses during stylolite formation. Recent advances have shown that the stylolite roughness also shows a stress scaling relation that can be used to calculate magnitudes of stress.
The method is based on the idea that particles that dissolve slower than the surrounding matrix pin the stylolite interface, which essentially leads to roughening. Rough surfaces, however, have a high surface and elastic energy. Thus surface and elastic energies work against the roughening and tend to flatten the stylolite. This interplay between pinning and destruction of roughness leads to the complex stylolite geometries that can be seen in the field. Surface and elastic energy show a different scaling behaviour, so that the stylolite interface is dominated by surface energy at the small scale and by elastic energy at the large one. In addition these two scaling regimes produce a different roughness that can be characterized by different hurst exponents. The transition between these two scaling regimes is a function of the differential and mean stress on the interface and thus shifts with varying stress.
We measured the stylolite roughness in natural examples and numerical simulations and show that a) stylolites can be used to estimate the depth of formation in sedimentary basins, b) tectonic stylolites can be used to calculate tectonic stresses and c) that stylolites can be used to locate faults. In the last example we will illustrate how a set of stylolites sampled across a fault can be used to determine the nature of the fault and we show that they can be used to find early growth faults as well as late basin faults.