Geophysical Research Abstracts
Vol. 14, EGU2012-1877, 2012
EGU General Assembly 2012

Sylolites in carbonate rock: barriers to fluid flow?

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Stylolites, products of intergranular pressure-solution, form laterally-extensive, clay-enriched, planar features in porous sedimentary rocks. While mechanical strain localisation has been shown to dramatically decrease permeability in sedimentary rock (Baud et al., 2012), little attention has focused on the impact of chemical strain localisation. Potentially, stylolites could significantly influence regional fluid flow, an important consideration in, for example, geotechnical engineering and petroleum geoscience. To this end, we have performed a systematic study of the influence of stylolites (both parallel and perpendicular to the imposed flow direction) on the water and gas permeability of three oolitic limestones with porosities ranging from 6 to 16 %. Our experimental data show that the presence of stylolites increased the permeability of our limestone samples by about a factor of two (when compared to the adjacent stylolite-free material). However, the magnitude of the permeability increase was found to be independent of stylolite orientation and number. Porosity measurements demonstrated that core samples containing stylolites were consistently more porous than the adjacent stylolite-free material. We therefore suggest that it is the increase in porosity (or "stylolitic porosity", as a result of the presence of a stylolite) that is responsible for the observed modest increase in permeability. This conclusion is supported by x-ray computed tomographic images of the samples that show that sample density is unperturbed by the presence of a stylolite. We can further conclude that the impact of mechanical strain localisation (e.g., compaction bands, see Baud et al., 2012) has a much greater impact on fluid flow than chemical strain localisation (e.g., stylolites, this study).