Rapid migration of micro and nano-fluids hosted in carbonate minerals.

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The transport of fluids is fundamental of importance for several geological processes. Calcite, ubiquitous in geological environments may contain supercritical CO_2 trapped under the form of fluid inclusions that may move through grain boundaries affecting the rock physical properties. However, despite the macroscopic evidence of this process it was not until now possible to characterize this process at the nano-scale because these observations were difficult. In this study, we report nanometer-scale observations on calcite crystal surfaces and demonstrate that stress with absence of visible deformation produces fluid leakage from CO_2 fluid inclusions.
Atomic Force Microscopy scanning experiments on freshly cleaved calcite crystals containing visible fluid inclusions from the micro to the nanometer scale revealed the spontaneous formation of nanometer-scale hillocks on flat crystal terraces in only a few minutes, without evidence of surface dissolution. The fact the hillocks formed on flat surface in a short time was unexpected and suggests deposition of material from the inner to the surface crystal through small-scale fluid migration.
We estimated the rate of this fluid mobility is by several orders of magnitude higher than the diffusion rate through vacancies estimated in calcite crystals. Quantifying fluid transport at the standard external conditions in the case of calcite, we show that mobility of these fluids through micro-pore and nano-pore spaces is in reality much higher than previously assumed using current models.