Impact of calcite precipitation on flow alteration in porous media

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One of the major challenges associated with sequestration of carbon dioxide, given the complexity and range of coupled thermal, hydrological, mechanical, and chemical processes involved, is the understanding of geochemical reactivity in the case of long-term sequestration. Mineral trapping involves precipitation of minerals like calcite, which can cause a significant reduction in permeability of reservoirs by altering the shape, size and connectivity of the pores, the roughness of their surface, or by plugging the pore throats.

The effects of calcite precipitation in porous media are evaluated through an experimental and modeling study. Two experiments using cylindrical core packed with glass beads and calcite (Iceland spar) or aragonite (Bahamas ooids) were injected with a supersaturated mixture of $CaCl_2$ and $NaHCO_3$ to induce calcite growth. Bulk rates of precipitation based on the change in aqueous chemistry over the length of the columns are compared with spatially resolved determinations of carbonate precipitation using X-ray synchrotron micro-tomography with a resolution of 4.46 μm. The new crystals are shown to be very different according to the initial mineral surface on which they grow. Results are compared in terms of growth rate, crystal shape, surface area and pore roughness. The impact of crystal distribution on roughness increase and on pore scale flow and permeability is evaluated through numerical modeling. The results are compared with results for several model porous media for which different crystal growth rates were implemented. The effect of differing calcite growth rate laws and surface roughness are compared for cases in which the total porosity change is comparable.

Ten years of ground deformations monitored by the ground-based SAR system on Stromboli volcano and its use in forecasting intense volcanic activity

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A Ground Based Interferometric Syntetic Aperture Radar (GBInSAR) system has been installed on Stromboli Volcano since 2003, when on the 30 December 2002, after a major eruptcionan a subsequently large landslide occurred on the NW flank (Sciara del Fuoco, SdF) of the volcano. This GBInSAR is a remote sensing tecnique based on microwaves interferometry that permits the production of 2D displacement maps, called interferograms, with millimetre precision. The apparatus installed on Stromboli, exploits a metric spatial resolution and acquisition frequency of about 11 min. Only the component of the displacement vector to parallel to the line of sight can be assessed.

The investigation conducted by analysis of the GBInSAR data, has permit to divided the crater area and the SdF area in five differents sectors, to better analyze and undestand the behaviour of the volcano flank dynamics.

The GBInSAR installed at Stromboli volcano has been used as a remarkable early-advice tool for mass and gravitative movements on the Sciara del Fuoco. GBInSAR monitoring highlights different deformation patterns, related to the imminent new vent openings. The analysis of the displacement rates in the summit crater area has been used as early warning signal before the occurrence of major explosions and lava emission. Changing in displacement rate registered by the GBInSAR system in the upper part of the volcano, corresponding to the external flank of the summit craters and at the base of the summit area, has been used to forecast the change in the pressure conditions in the shallow plumbing system and the lateral propagation of the conduit-dike system of Stromboli volcano.

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