Effect of Fluid Salinity on Subcritical Crack Propagation in Calcite

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The slow propagation of cracks, also called subcritical crack growth, is a mechanism of fracturing responsible for a ductile deformation of rocks under crustal conditions. In the present study, the double-torsion technique was used to measure the effect of fluid chemistry on the slow propagation of cracks in calcite single crystals at room temperature. Time-lapse images and measurements of force and load-point displacement allowed accurate characterization of crack velocities in a range of 10^{-8} to 10^{-4} m/s. Velocity curves as a function of energy-release rates were obtained for different fluid compositions, varying NH_4Cl and NaCl concentrations. Our results show the presence of a threshold in fluid composition, separating two regimes: weakening conditions where the crack propagation is favored, and strengthening conditions where crack propagation slows down. We suggest that electrostatic surface forces that modify the repulsion forces between the two surfaces of the crack may be responsible for this behavior.

Halogens in the early Solar System inferred from meteoritic phosphates

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Although F, Cl, Br, and I are relatively abundant elements in the Solar System, their distribution, abundances and the related fractionation processes in early formed meteoritic material is poorly constrained. Owing to different condensation temperatures, the halogens each have different volatility, which makes them suitable for constraining early Solar System processes such as degassing and fluid-rock interactions. The halogen budget of individual meteorite samples appears dominantly controlled by apatite, which preferentially incorporates halogens. However, merrillite, if present, also contributes to the bulk halogen budget. Although these phases are accessory rock components, they are widely distributed among meteorite classes. Fluorine, Cl, Br, and I concentrations together with the stable Cl isotope composition of individual apatite and merrillite grains were determined in ordinary (OC) and Rumuruti chondrites (RC), primitive achondrites (PA), eucrites (EUC), and silicate-bearing IAB iron meteorites. Petrography and chemistry of phosphate grains were determined using SEM and EPMA. Halogen concentrations and stable δ^{37}Cl values were determined using a Cameca IMS 1280. δ^{37}Cl values of most meteorite groups are in the range of -0.05±1.20 ‰ (2σ), consistent with results from [1], but with an evolutionary trend from chondritic to more evolved differentiated rocks. The EUC apatite is in the range of -4.49±0.33 ‰ to +11.93±0.33 ‰, similar only to the Moon. For the latter dry fractionation processes were discussed [2]. Thus, the EUC parent body was either as dry as the Moon, or other mechanisms such as metasomatism [3] may fractionate the Cl isotopes. The same evolutionary trend is seen for halogen concentrations, which are dominated by Cl- and Br-rich apatite in OC, and IAB irons, and F- and I-enriched EUC apatite, with PA being intermediate. Compared to apatite, merrillite halogen concentrations are an order of magnitude lower, with limited Cl variation, except for EUC, consistent with a parent body halogen fractionation process.

[1] Sharp *et al*. (2007) *Nature* **446**, 1062-1065. [2] Sharp *et al*. (2011) *Science* **329**, 1050-1053. [3] Barrat *et al*. (2011) *Geochem. Cosmochem. Acta* **75**, 3839-3852.

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