Combined structural, elemental, and isotopic characterisation of calcite fracture-fill mineralisation

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Calcite fault and fracture-fill mineralisation can provide both a temporal record of fluid-flow through open fractures, as well as timing and structural constraints on the fracture opening-history. Calcite mineralisation typically exhibits complex structural and growth histories due to competing physical and chemical processes. Here we demsonstrate the combination of various imaging and geochemical datasets, and highlight their utility for better understanding the excellent temporal record of fluids and fractures that calcite can provide.

Correlative optical (transmitted and reflected light), cold-stage cathodoluminescence, and SEM-based (back-scattered electron and charge-contrast) imaging reveals chemical zonation and microstructure, as well as providing crucial contect for further isotopic analyses. Compositional techniques comprise laser ablation ICP-MS trace element mapping and U-Pb geochronology, and carbon and oxygen isotope analyses via micro-milling and/or ion-microprobe. Additional datasets that can be integrated include Sr isotopes, clumped isotopes and fluid inclusions. Collectively the data provide constraints on fluid source and fluid-rock interaction processes tied to absolute chronology. Combination and visualisation of different imagery and compositional data are achieved through GIS-based software.

Case studies that highlight the combination of these techniques will be presented from basalt-hosted fault zones in the Faroe Islands, and shale-hosted fracture-zones in northern England. Both of which reveal complex fluid histories at varying length-scales during evolving fracture development.