Probing paleoearthquakes with *in situ* U-Pb SHRIMP-RG analyses of fault-related opals

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In the past decade U-Pb and U-series dating techniques have been successfully applied to opals from arid regions, providing important temporal constraints on paleohydrology, paleoclimate, and depositional environments. In particular, the use of *in situ* SHRIMP-RG (Sensitive High Resolution Ion Microprobe – Reverse Geometry) dating techniques has been demonstrated to resolve mixed multiage problems that arise from slow-growth or multi-stage growth at the sub-millimeter scale. Building upon these advances, we apply *in situ* SHRIMP-RG dating methods to fault-related opal precipitates taken from seismically active fault zones with the aim of dating brittle deformation events. The Mojave Desert fault segments within the Eastern California Shear Zone (ECSZ) are ideal faults to investigate the long-term history because of the need for improved constraints on the timing of fault initiation and the observed discrepancy between long-term and short-term estimates for strain accumulation rates.

We analyzed fault-related opal samples from five different fault exposures within the Camp Rock and the Cave Mountain fault systems. Millimeter size fragments of fault-related opal, occurring as fault coating, filling or fault-breccia cement, were imaged using cathodoluminescence and backscattering electron microscopy in order to identify distinct phases of opal associated with specific syntectonic microstructures. Sub-samples within each phase are then targeted with multiple SHRIMP-RG analyses (<50 μm in diameter) to allow the construction of $^{238}U/^{208}Pb$-$^{206}Pb/^{208}Pb$ and/or Tera-Wasserburg U-Pb isochrons. Of the 30 distinct phases that were identified, 10 were successfully dated, providing U-Pb ages with $2\sigma \leq 10\%$ and MSWD between 0.42 and 1.8. The most important factors for successful age determinations were low amounts of common Pb, high U concentrations (between 50 and 1300 ppm) and heterogeneities within each phase. Ages range from 1.45 to 0.58 Ma and coeval ages are clustered into several periods during this time interval, suggesting periods of enhanced fault activity. Additional analyses of syntectonic opals, taken from several sites and from additional faults segments can constrain the long-term deformational history and contribute to our understanding of how strain is distributed both locally (within a specific structure) and regionally (within different fault systems) over a geological time scale.

U-series isotopes as tracers of particles fluxes and deposition rates of Heinrich layers H2 and H1 from a core raised off Hudson Strait

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A ~9 m-long core was retrieved from the lower Labrador Sea slope (2674 m water-depth), approximately 180 km off the Hudson Strait shelf edge. It yielded a high resolution record of recent detrital carbonate (DC) sedimentary pulses from the Hudson Strait outlet of the Laurentide ice sheet, assigned to "Heinrich events" H2 and H1. These fine carbonate-rich layers (calcite/dolomite ~ 2.5) originated from glacial erosion of Paleozoic rocks in Hudson Strait and Ungava Bay. The coarse sediment fraction content of the layers suggest intense iceberg calving at the ice-stream edge, while sub-glacial meltwater flushing over the Hudson Strait sill carried fine silt-sized, carbonate-rich glacial flour to the shelf edge. Such suspended sediment pulses led to the spreading of turbidites into the deep Labrador Sea. These layers are characterized by a ^{234}U deficit (vs ^{238}U) and by very low ^{230}Th excesses corrected from decay to the time of deposition $(^{230}Th_{xs})_0$. These low values indicate extremely fast deposition. Inventories of $(^{230}Th_{xs})_0$ were used to estimate durations of ~1.28 and ~1.99 ka respectively for H2 and H1, relative to estimates of ~1.15 and ~2.12 ka from calibrated ^{14}C ages on planktic foraminifers. Another DC-layer was deposited at ~8.3 cal ka BP, during the final drainage of Lake Agassiz. Above, high $(^{230}Th_{xs})_0$ activities but low $^{230}Th_{xs}$-fluxes point to some ^{230}Th-focussing with enhanced biogenic carbonate fluxes, under a stronger Western Boundary Undercurrent influence leading to the winnowing of slope sediments, thus reduced sedimentation rates at the site. $^{231}Pa/^{230}Th$ ratios are used to further document sedimentary regimes at the site.

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