FLUID MIGRATION IN AND ACROSS FAULT ZONES WITH FOOTWALL SHALES AND HANGING WALL CARBONATES (SAWTOOTH RANGE, NW MONTANA)

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Abstract

The study of fluid migration and fluid-rock interactions during rock deformation has recently become a priority for several disciplines of geology such as seismogenesis, fault mechanics, and formation of ore and petroleum deposits. Faults can either conduct or trap fluids, depending on many parameters including lithology, deformation history, temperature/pressure conditions, fluid pressure, and fluid chemistry. This research investigates the fluid-rock interactions and fluid migration in carbonate-shale-hosted thrust faults in the Sawtooth Range of the foreland fold-thrust belt of the Rocky Mountains. This research is focused on the study of the migration of the fluid during the thrusting event and identifying of the most important parameters that controlled interactions between fluid and rock in and across limestone-shale-hosted thrust faults.

I am focusing the investigation on thrust faults in the Sawtooth Range, in north-west Montana. The north-south trending foreland fold-thrust belt is considered to be one of the best exposed examples of a fold-thrust belt in North America. The incisions of the Sun River canyon and other east-west trending valleys provide good cross-sectional exposures of the belt. West-dipping thrusts transported the Mississippian carbonates of the hanging walls over Lower Cretaceous shales and sandstones of the footwall.

I am using a multidisciplinary approach that integrates fieldwork and laboratory analyses. The fieldwork involves detailed geologic and structural mapping, collecting structural data, and collecting samples of host rocks, fault rocks, veins, and slickenfibers. Laboratory work involves analyzing samples and thin-sections by petrographic techniques to document the mineralogy,

microstructures, cementation events, and analyzing carbonate for their stable isotope values (carbon and oxygen).

The principal strike directions for the structures at Sun River canyon are oriented NNW-SSE and ENE-WSW. The faults oriented NNW -SSE are related to the thrusting phases and they have reverse kinematic. The faults oriented ENE-WSW have mostly strike-slip kinematic and they are related to differences in amount of displacement in different zones of the thrust. The stable isotope analysis results are consistent with the hypothesis of a pervasive fluid flow in the hanging wall rocks, limited to a narrow zone adjacent to the thrust. Fluid also flowed from the footwall to the hanging wall through secondary fracture networks developed during deformation. The isotopes data are consistent with a fluid surface derived.