Tracking Strain and Fluid Localization in Fault Zones by Re-Os Pyrite-Chalcopyrite Geochronology

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Accommodation of strain in fault zones may affect and steer fluid transport and distribution in the crust. Our combined structural, petrographic, and Re–Os and K–Ar geochronological study documents the collective impact of (1) strain localization and (2) ingress of oxidizing fluids during cyclic viscous–frictional oscillations. These processes impact sulfide stability and Re–Os systematics within the fault zones. Mylonitic, Cu-bearing carbonate veins of Paleoproterozoic age in northern Norway were studied to constrain the time of deformation and the physical and chemical conditions during strain localization. Re and Os are chalcophile–siderophile elements that fractionate strongly into the sulfide phases. Therefore, as long as oxidizing, sulfide-corrosive fluids are absent, sulfides hosted in silicate- or carbonate-rich rocks are unlikely to lose or gain Re and Os during later tectono-metamorphism. The obtained spread in Re–Os model ages (between ~2540 Ma and ~460 Ma) reflects structural reactivation and ingress of oxidizing fluids during both brittle fracturing and ductile deformation. We suggest that fluid flow under viscous conditions is attained by cavitation creep. Strain and fluid flow may exert a significant, yet localized, control on the integrity of the Re–Os systematics in pyrite and chalcopyrite.