SEG 100 Conference: Celebrating a Century of Discovery

ST.190

Dakotan Tectonic Zone: ca. 1730 Ma Transpressional Shear Zone, Black Hills, SD: Implications for Late Tectonic History and Au Mineralization in Southern Trans-Hudson Orogen

Stephen T. Allard[2], Brian Lentz[1, 3], Robert Bergmann[1, 3], Eric Nowariak[3], Chris Nicosia[3]
1. F3 Gold, Minneapolis, MN, USA, 2. Winona State University, Winona, MN, USA, 3. Big Rock Exploration, Minneapolis, MN, USA

Paleoproterozoic rocks in the Black Hills of southwestern South Dakota record deformation associated with accretion from the south by Proterozoic terranes (Yavapai Orogeny) followed closely by suturing of the Wyoming and Superior cratons (Black Hills Orogeny; ca. 1785–1715 Ma). Orthogonal collision during the latter event is responsible for ca. 1750 Ma regional metamorphism and NW-striking F_2 folds forming the regional grain of the hills. Post-tectonic intrusion of the ca. 1715 Ma Harney Peak granite punctuates the cratonic suturing.

Rare F_3 cross folds were described by past workers as local reworking of F_2 and inconsequential; however, our results from more recent detailed mapping and microstructural analysis, focusing on penetrative fabrics along the eastern margin of the uplift, recognize the F_3 folds as pervasive and coupled with strong NNW-striking mylonitic fabrics. This roughly 10-km-wide zone varies from abundant narrow 1- to 10-m-wide shear zones anastomosing around near-vertical isoclinal F_3 hinges in the southeast near Rockerville, to a series of ≥4-km-wide shear zones separated by lower-strain zones and F_3 fold hinges in the northeast near Nemo. Outcrop and microstructural analysis document left-lateral, east-side-up transpression. Ongoing mapping west of the original discovery has recognized numerous similar shear-fold coupled high-strain zones across the hills supporting an uplift-wide transpressional zone.

Furthermore, identical fabric and kinematic indicators are recognized in Archean basement rocks near Nemo previously thought to have escaped Proterozoic deformation. The lack of D_2 structures in the Archean basement signals a change from thin-skinned to deep-seated basement-involved deformation coincident with a switch from orthogonal to transpressive collision. This major D_3 structure, now named the Dakotan Tectonic Zone (DTZ), is constrained by published ages to post D_2 (1750 +/- 10 Ma) and pre-Harney Peak intrusions at 1715 +/- 3 Ma. Evidence that stresses associated with the DTZ were transferred inboard to the Wyoming Province is seen to the southwest in the Hartville Uplift and Laramie Mountains where structures with similar timing and kinematics overprint Cheyenne Belt deformation.

Metamorphism during D_3 is scarce and limited mostly to grain-size reduction and fabric development; however, static post-D_3 hydrothermal alteration leading to downgrade metamorphic assemblages along with oxide/sulfide mineralization in quartz-rich veins is ubiquitous along D_3 structures. This alteration dissipates within meters perpendicular to D_3 structures, consistent with these structures acting as hydrothermal fluid conduits. The temporal proximity to Harney Peak intrusion and the through-crustal nature of these structures allows for either the granite or a deep crustal source for the hydrothermal fluids.

The giant Homestake Gold Deposit occurs along strike and within mapped expressions of the eastern DTZ structure, with mineralization controlled by similar fold-and-shear structures. Timing for gold mineralization in Homestake is dated at 1736 +/- 8 Ma by others, within permissive ages for alteration along the DTZ. If DTZ structures are controlling mineralization, then the accepted stratabound model for mineralization at Homestake may need to be reconsidered, and the wide-spread presence of DTZ deformation across the hills opens the possibility of similar lode gold mineralization elsewhere in the uplift.