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New U-Pb Sphene Ages Confirm Synchronous Gold Mineralization and Dakotan Tectonic Zone Deformation at Homestake Mine and the Black Hills Region, South Dakota, USA

Stephen T. Allard², Eric Nowariak¹, Kevin R. Chamberlain⁴, Robert Bergmann^{3, 1}, Brian Lentz^{3, 1}

1. Big Rock Exploration, Minneapolis, MN, USA, 2. Winona State University, Winona, MN, USA, 3. F3 Gold, Minneapolis, MN, USA, 4. University of Wyoming, Laramie, WY, USA

The Paleoproterozoic tectonic and deformational history of the Black Hills, South Dakota, has historically been interpreted to be dominated by 1780-1750 Ma deformation (D_1 and D_2) related to the accretion of Paleoproterozoic volcano-sedimentary terranes and subsequent suturing of the Archean Wyoming and Superior provinces. Recent publications, however, document the Dakotan Tectonic Zone (DTZ), a system of pervasive north-northwest-striking transpressional shear zones expressed along the eastern margin of the Black Hills that overprint regional D_2 structures and fabrics and attributed to the final suturing of the Wyoming and Superior Provinces. Reconnaissance mapping and sampling reveal that DTZ shear zones intersect the Homestake Gold Mine and several gold deposits and occurrences that lie in the eastern and southwestern Black Hills.

This study presents new IDTIMS U/Pb metamorphic sphene dates of 1710.2 \pm 3.8 and 1712 \pm 12 Ma from DTZ deformation zones. The dated samples include isoclinally refolded quartz-garnet-amphibole-sphene-pyrrhotite calc-silicates interlayered with pelitic schists within the Paleoproterozoic Mayo Formation and mylonitic actinolite-microcline-pyroxene-biotite-sphene-carbonate calc-silicate from the Paleoproterozoic Crow Formation, respectively. In both samples, microtextural and mineralogical analysis shows the dated sphene crystals overgrew metamorphic fabrics and is associated with metasomatism, suggesting static growth syn- or postdeformation with the dates representing minimum ages for deformation.

With these new dates, the bracket for DTZ deformation and final suturing of the Wyoming and Superior Provinces can be constrained to ca. 1750-1710 Ma. DTZ deformation ages described here are coeval with published ca. 1730 Ma ages for gold mineralization at the Homestake Gold Mine, supporting a temporal and spatial relationship between DTZ deformation and shear-hosted gold mineralization in the Black Hills. Regionally, this ca. 1720 Ma tectonic event is also observed to the west in the southeastern Wyoming Province where structural analysis and geochronology have described a NW-SE compressional-transpressional deformational event along the eastern margin that postdates the accretion of island arcs along the Cheyenne Belt and suggests the Wyoming and Superior Provinces had separate secular Paleoproterozoic histories before DTZ deformation during final suturing at ca. 1720 Ma.