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New Eyes on Old Rocks: A New Structural Model Reinvents a World-class Gold District – Black Hills, South Dakota, USA

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The Black Hills region of South Dakota is home to one of the world's richest gold mines, the Homestake Mine. Over 137 years, Homestake produced over 40 million ounces of gold from deformed Proterozoic rocks. Homestake is historically interpreted as a Banded Iron Formation (BIF) hosted, synformal, stratabound deposit with remobilized gold mineralization locally controlled by F3 fold and shear structures. This host-rock driven model guided exploration elsewhere in the Black Hills for decades, resulting in minor successes.

The geology and structure of the greater Black Hills region has been primarily characterized by lithostratigraphy and local, brittle fault structures. However, recent publications suggest a model dominated by transpressional, brittle-ductile shearing along the Dakotan Tectonic Zone (DTZ), a long-lived, deep-seated, through-going regional NW-striking shear zone, strongest along the eastern margin of the Black Hills, but now recognized across the entire uplift.

Critically, the eastern high-strain zone of the DTZ lies along strike with the Homestake gold mine and numerous DTZ shear structures (F3a and F3b), which have been found elsewhere in the hills to be coincident with gold mineralization. Furthermore, previous workers suggest the highest ore grades within Homestake are near these shear structures. This recognition of deep-rooted shearing (DTZ) casts new light on Homestake mineralization controls and suggests that a metamorphic shear zone, lode gold model may be fitting for the Black Hills.

Extensive field work over the last decade tests this new model and encourages exploration for overlooked gold deposits. This work includes over 6,000 surface samples combined with detailed 1:8,000-scale geological mapping, petrography, SEM-EDX, and mineralogical analysis. These data provide compelling evidence correlating DTZ structures across the Black Hills to high-grade gold at surface; they are now being considered the controlling driver of gold mineralization in the region. This suggests the Black Hills region is more similar to other world-class shear-hosted orogenic gold regions and reopens Black Hills to exploration for additional large gold deposits.