

Revisiting South Pass's Golden Years: A High-Resolution Aeromagnetic Perspective on the Structural Geology of the South Pass Mining District, Wyoming

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The historic South Pass Mining District in central Wyoming lies within a Neoarchean granite-greenstone terrane of the Wyoming Province. Gold mineralization occurs in quartz-sulfide veins localized within transpressional shear zones developed in Archean metasedimentary rocks. These veins commonly occur along contacts with mafic intrusions, where competency contrasts localized deformation and fluid flow. The district preserves a complex deformation history, and the continuity and connectivity of major structural boundaries remain poorly constrained beneath Phanerozoic cover. Here, we analyze airborne magnetic data acquired by the Wyoming State Geological Survey and the USGS as part of the Earth Mapping Resources Initiative (Earth MRI) to identify lithologic contrasts and structures influencing gold mineralization. The survey, flown at ~100 m terrain clearance with 200 m flight-line spacing, provides the first high-resolution aeromagnetic dataset covering the South Pass greenstone belt. Phanerozoic sedimentary rocks produce little aeromagnetic expression, whereas the Archean basement generates magnetic highs associated with banded iron-formations and mafic metavolcanic rocks. These magnetic units contrast sharply with surrounding sedimentary and metasedimentary rocks. Resulting linear magnetic gradients coincide with district-scale structural boundaries, particularly the Oregon Trail Fault system, which defines a key component of the district's structural framework and is associated with gold-hosting shear zones. Proterozoic mafic dikes produce linear magnetic anomalies and occupy northeast- to east-northeast-trending Neoarchean fault zones. Collectively, linear magnetic trends parallel regional faults, shear zones, and mafic intrusions, and their alignment suggests structural linkage among faults, indicating Neoarchean fault zones are more laterally continuous than surface mapping implies. Aeromagnetic data also reveal the lateral extent of the greenstone belt beneath Phanerozoic cover to the east, delineating the Neoarchean framework beyond mapped exposures. These results refine the structural architecture of the South Pass Mining District and provide geophysical constraints on the distribution of shear zones hosting gold mineralization, supporting exploration in concealed terranes.