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Structural Localization and Origin of Compartmentalized Fluid Flow, Comstock Lode, Virginia City, Nevada

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Abstract

Bonanza-grade orebodies in epithermal-style mineral deposits characteristically occur as discrete zones within spatially more extensive fault and/or fracture systems. Empirically, the segregation of such systems into compartments of higher and lower permeability appears to be a key process necessary for high-grade ore formation and, most commonly, it is such concentrations of metals that make an epithermal vein district world class. In the world-class silver- and gold-producing Comstock mining district, Nevada, several lines of evidence lead to the conclusion that the Comstock lode is localized in an extensional stepover between right-lateral fault zones. This evidence includes fault geometries, kinematic indicators of slip, the hydraulic connectivity of faults as demonstrated by veins and dikes along faults, and the opening of a normal-fault–bounded, asymmetric basin between two parallel and overlapping northwest-striking, lateral- to lateral-oblique–slip fault zones.

During basin opening, thick, generally subeconomic, banded quartz-adularia veins were deposited in the normal fault zone, the Comstock fault, and along one of the bounding lateral fault zones, the Silver City fault. As deformation continued, the intrusion of dikes and small plugs into the hanging wall of the Comstock fault zone may have impeded the ability of the stepover to accommodate displacement on the bounding strike-slip faults through extension within the stepover. A transient period of transpressional deformation of the Comstock fault zone ensued, and the early-stage veins were deformed through boudinaging and hydraulic fragmentation, fault-motion inversion, and high- and low-angle axial rotations of segments of the fault planes and some fault-bounded wedges. This deformation led to the formation of spatially restricted compartments of high vertical permeability and hydraulic connectivity and low lateral hydraulic connectivity. Bonanza orebodies were formed in the compartmentalized zones of high permeability and hydraulic connectivity.

As heat flow and related hydrothermal activity waned along the Comstock fault zone, extension was reactivated in the stepover along the Occidental zone of normal faults east of the Comstock fault zone. Volcanic and related intrusive activity in this part of the stepover led to a new episode of hydrothermal activity and formation of the Occidental lodes.

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