Structural Evolution and 3D Modelling of the Giant Vasilkovskoye Gold Deposit, Northern Kazakhstan

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Kazzinc's Altyntau Koshetau, Kazakhstan's largest gold mine, is centred on the giant and structurally complex Vasilkovskoye Gold Deposit (VGD). The VGD is spatially associated with the Zerendinsky Intrusive Complex (ca. 442 Ma) which is hosted within proto-continental basement and volcano-sedimentary and/or accretionary sequences that record protracted deformation from 635 Ma to 252 Ma as part of the Kazakhstan Collage System and greater Altaid Orogenic Belt. Structurally, the VGD is located at the intersection of two major fault systems, viz. the NE-trending Vasilkovskoye (VFS) and NW-trending Dongulagashsky (DFS) faults, which are both associated with Au mineralization. On a deposit-scale, studies of kinematics, cross-cutting relationships and controls on Au mineralization for the FVS and DFS have been challenging; whilst on a regional-scale, the temporality and development thereof are ambiguous, largely due to a lack of outcrop, high-resolution mapping or detailed geophysical data interpretation. This study follows a fully-constrained structural analysis and 3D geomodel, based on an all-encompassing pit mapping and drillhole database, combined with local- to licence-scale geophysical data interpretation. The 3D model depicts the initial sinistral VFS, which comprises multiple, well-developed anastomosing brittle-ductile shearing, in response to strain localization along regional sub-Zerendinsky intrusive suite contacts. This was followed by the cross-cutting, dextral DFS, comprising a combination of incipient to well-developed, en-echelon tensional fractures and hybrid-tensional shears, related to progressive regional belt contraction. Cross-cutting relationships and Au-grade discontinuities suggest that high-grade Au mineralization was introduced by the DFS, whilst local re-activation and partial transposition of the locally-overlapping pre-existing VFS-associated structures resulted in discordant (re-) mobilization of Au along VFS trends. Overall, the VGD represents a complicated, but 'text-book' example of how the intersection of major faults system can locally enhance fluid-flow and Au-mineralization. This rationale accentuates exploration opportunities, including continuation of VGD at depth, as well as regionally beyond the mine tenements.