

SEG 2022 Conference: Minerals For Our Future

Structural and Kinematic Analysis of Alkaline Dikes and Mineralized Veins in the Wet Mountains, Colorado: Connecting Rare Earth Element Mineralization to Cambrian Rifting

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We investigated the structural controls on, and kinematics during, emplacement of Cambrian-Ordovician, failed-rift-related alkaline intrusive rocks and associated thorium and rare earth element (REE) mineralization exposed in Precambrian metamorphic rocks of the Wet Mountains, CO. Results were compared to other nearby Cambrian-Ordovician aulacogens to determine if they are related. Alkaline intrusive rock in the Wet Mountains comprise the McClure Mountain, Gem Park, and Democrat Creek complexes, which are sequentially cross-cut by lamprophyre, syenite, and carbonatite dikes, and mineralized quartz-barite-thorite veins. Syenite dikes contain hydrothermal alteration hypothesized to be temporally associated with the latest stage mineralized veins. REE mineralization occurs mainly within carbonatite dikes, quartz-barite-thorite veins, and hydrothermally altered red syenite dikes. Structural data show that all types of dikes/veins strike dominantly northwest and dip steeply. Outcrop observations of structural fabrics support four principal styles of emplacement: (1) fault-controlled emplacement indicated by adjacent brecciated and gouged wall rock, (2) tensile, fracture-controlled emplacement based on no associated wall rock deformation, (3) emplacement along reopened (Precambrian?) pegmatite dikes, and (4) local emplacement along Precambrian metamorphic foliation. These observations are consistent with emplacement along northwest-trending tensile fractures and high-angle faults formed in a northeast-southwest-directed extensional regime. Kinematic analysis of mineralized high angle faults and tensional fractures indicate that extension was horizontal and 045°/225°-trending. The northwest trend and extensional nature of the mineralized dikes and veins suggest that the Cambrian-Ordovician alkaline rocks of the Wet Mountains formed in a rift setting and may be a continuation of the northwest-trending, Cambrian southern Oklahoma aulacogen, the only nearby Cambrian along-strike rift system with the same orientation as the alkaline rocks in the Wet Mountains. Considering the potential relationship between the Wet Mountains and the southern Oklahoma aulacogen, future REE exploration should focus along the entire extensional system.