

### **Timing and Conditions of Zinc Mineralization in the Southwest Davis Zinc Field (Oklahoma): Insights From Clumped Isotopes and U–Pb Geochronology**

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The Southwest Davis Zinc Field, Oklahoma, is located approximately 300 km west of the Tri-State and northern Arkansas Mississippi Valley–type (MVT) districts. Mineralization occurs within sphalerite–dolomite bodies hosted by Upper Cambrian Royer and Lower Ordovician Butterly dolostones along the northern limb of the Arbuckle anticline. Despite limited production in the early 20th century, the timing and physicochemical conditions of ore formation remain poorly constrained. The ore system is characterized by stratabound sphalerite–dolomite–smithsonite mineralization associated with tectonic breccias and supergene alteration. Petrographic and structural observations indicate a polyphase history involving two main stages: (1) formation of tectonic breccias cemented by hydrothermal dolomite and sphalerite (stage 1), and (2) development of cataclastic bands cemented by smithsonite during later deformation and supergene processes (stage 2). Stable isotope analyses, including conventional and clumped isotope ( $\Delta 47$ ) thermometry, indicate that the primary mineralization formed at temperatures of  $\sim 100$  °C from basinal and/or modified marine fluids. Integration with published fluid inclusion data constrains ore formation pressures to  $\sim 2.5$  MPa, corresponding to burial depths of approximately 2.4 km. In situ U–Pb geochronology of hydrothermal dolomite further constrains the timing of the main mineralization event to 424–416 Ma (Silurian).

The polyphase mineralization has been a target for critical mineral commodity evaluation looking at the distribution of key elements and is interpreted to result from basinal brines migrating upward along reactivated Cambrian rift structures during Silurian for stage 1, and during Cretaceous for stage 2. Fluid flow was focused within brecciated zones, where precipitation of sphalerite and dolomite occurred around host-rock clasts.

These results provide new constraints on the timing, temperature, geochemistry, and fluid evolution of this understudied MVT system and highlight the role of structural reactivation in focusing mineralizing fluids within intracratonic settings.