SEG 100 Conference: Celebrating a Century of Discovery

ST.185
Characterization of the Footprint of Hydrothermal Ore-Forming Processes in the Cooke's Peak Pb-Zn-Ag-F District, New Mexico

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The Cooke's Range in Grant and Luna Counties, New Mexico, is host to multiple mining districts and mineral occurrences (i.e., Hadley Pb-Zn-Cu-Ag sulfide district, Cooke's Peak Pb-Zn-Ag-F carbonate replacement district, Fluorite Ridge fluorite vein district, and the Northern Cooke's Peak fluorite vein occurrences). These deposits combined have produced over 8 million pounds of Pb, 6 million pounds of Zn, 70,000 oz. of Ag, and 100,000 tons of fluorite since their discovery in 1876. Fluorite Ridge and the Northern Cook's occurrences have a higher proportion of fluorine to metal content and were primarily mined for fluorite, while the Hadley and Cooke's districts are more enriched in Pb-Zn-Cu-Ag and were mainly mined for these metals. The proximity of these deposits, the spatial association with Eocene magmatism and large-scale faults, as well as the similarities in mineral paragenesis and fluorite morphology suggest that these subdistricts may have originated from the same hydrothermal system. Nonetheless, they have previously been attributed to different geologic events ranging from the intrusion of the Cooke's Peak granodiorite at 38.8 Ma ± 1.1 to the Rio Grande Rift extension at 25-10 Ma. The Central and Hadley districts have been attributed to the development of a hydrothermal system related to intrusion of the Cooke's Peak granodiorite, while the Fluorite Ridge district and Northern Cooke's Peak occurrences have recently been attributed to Rio Grande Rift-type deposits involving fluids sourced from basinal brines with a minor magmatic component. This study will use a combination of field work, fluid inclusion petrography and microthermometry, and fluorite trace element geochemistry to characterize the footprint of hydrothermal processes in each district.

Field observations of sulfide and fluorite veins crosscutting relationships and their association to faulting and dikes will be used to determine the timing of ore formation relative to magmatism and normal faulting in the Cooke's Range. Representative samples of Pb-Zn-Ag-F-mineralized zones from each subdistrict provide the basis for studying the mineral paragenesis of the different vein types. The focus of this study is on the different fluorite generations in these veins and their REE chemistry as well as their fluid inclusion assemblages. LA-ICP-MS will be used to analyze REE elements and other trace elements in fluorite. In the Central Cook's Peak district, three distinct fluorite generations can be distinguished (Fig. 1a), of which the first generation coincided with sulfide mineralization and two-phase fluid inclusions (10-15 vol % vapor to 90 vol % liquid; Fig. 1b); the latter two fluorite generations show fewer inclusions with much smaller vapor proportions of ~3-5 vol %. (Fig. 1c). These observations indicate cooling of hydrothermal fluids resulting in variations of mineral paragenesis along the fluid pathway and likely trace element compositions within fluorite, providing new insights into ore-forming processes. The combination of microscopic analysis with multidistrict-scale observations is a novel approach for this range, as these analytical methods were unavailable when research in the region was first conducted.

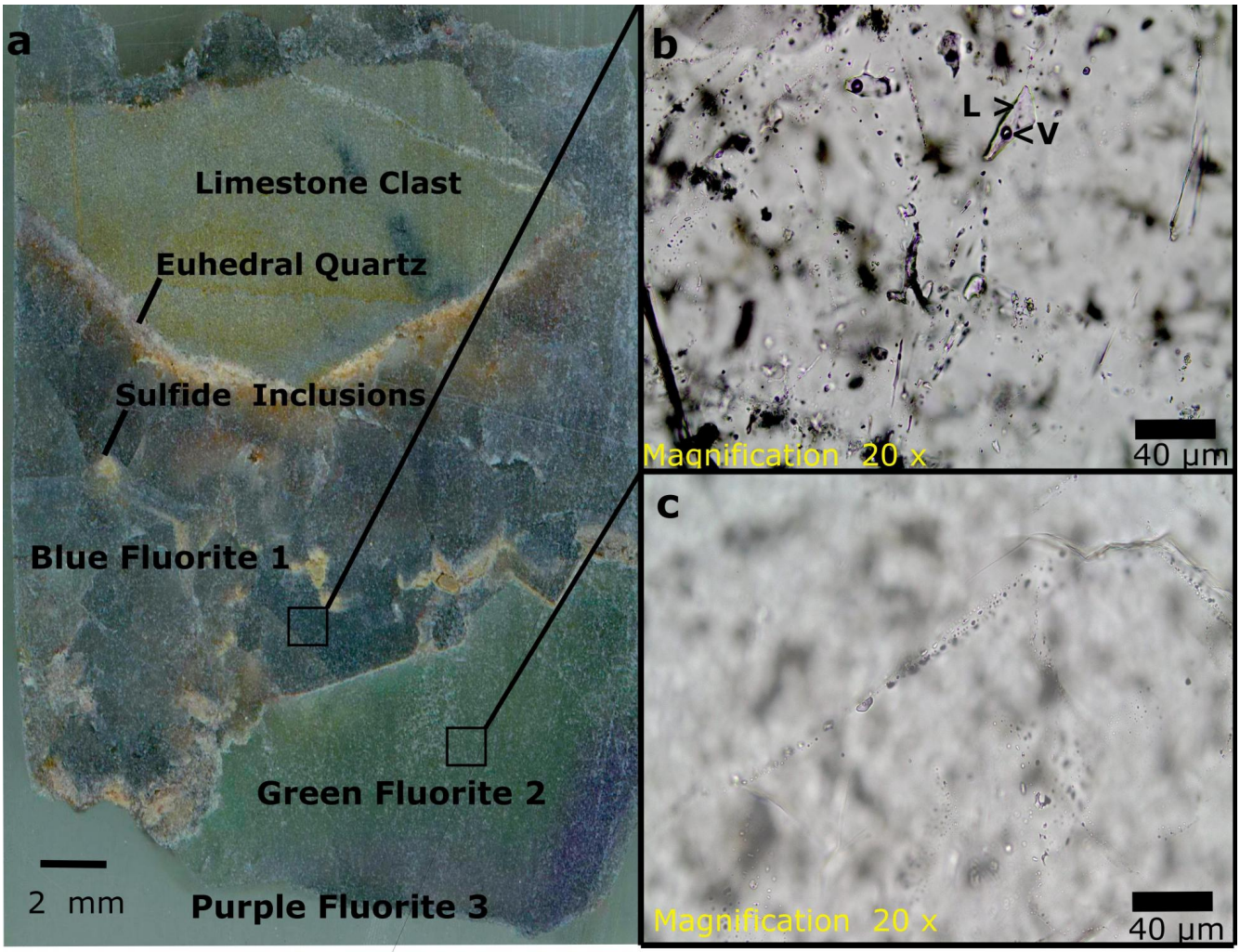

Figure 1: a) Slabbed section showing three fluorite generations b) pseudosecondary 2-phase fluid inclusions (FI) in fluorite 1 and c) secondary 2-phase FI in fluorite 2.