Characterization of the footprint of hydrothermal ore forming processes through trace metal signatures in fluorite 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 that have produced over 45 kt fluorite, 3.6 kt Pb, 2.7 kt Zn and 1.98 t Ag since its discovery in 1876. In the southern part of the district, Fluorite Ridge and the northern part, Northern Cooke's district veins are dominantly fluorite with minor base and precious metals and their formation has been classified by recent workers as Rio Grande Rift type deposits formed within the last 10 Ma. The Central and Hadley districts have a higher proportion of base and precious metals and commonly show several generations of fluorite, which have been attributed to hydrothermal systems related to the emplacement of the Cooke's Peak Granodiorite, or other Eocene magmatism. Here we present LA-ICP-MS trace element signatures in different fluorite samples in combination with fluid inclusion petrography and microthermometry to provide a comprehensive ore formation model of the Cooke's Peak Pb-Zn-Ag-F district. Fluid inclusions that were identified include two phase liquid-vapor (8-10 and vol%. vapor) with ice melting temperatures of -2.0 to -0.1 °C indicating the presence of low salinity aqueous fluids (3.74-0.2 wt.% NaCl) with homogenization temperatures ranging from 150 to 190 °C. Five fluorite types were characterized using cathodoluminescence and petrographic observations, and their trace metal signatures show REE patterns that are distinct by generation and district. Heavy and light REE fractionation is observed on a regional trend in fluorite from Fluorite Ridge, Northern, and the early generation from the Central district. In the Central district, heavy REE are increasingly depleted from early to late fluorite generations. Lead, zinc copper and silver are higher in the early fluorite in the Central zone and abundant at Fluorite Ridge indicating that those fluorite generations might be associated with magmatic-hydrothermal base and precious metal mineralization.