COLOR, ITS CAUSE, AND RELATION TO REE CHEMISTRY AND PARAGENESIS OF FLUORITES FROM THE HANSONBURG MINING DISTRICT IN BINGHAM, NM.

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Introduction: The cause of color in fluorite has been studied and debated for almost 100 years. Several enduring theories have arisen for some of the numerous colors in which fluorite occurs. These include electron transitions on structural defect centers, specifically Frenkel defects, impurity-associated defect centers (i.e. REE coordinated F centers), and impurity ions, such as divalent REE, themselves [1].

Fluorites of the Hansonburg Mining District, Bingham, NM exhibit various colors, including colorless, green, blue and purple, in a continuum of shades. Recent work done on these fluorites by Bosze and Rakovan [2] on the sectoral zoning of REE reveals compositional heterogeneities with respect to the lanthanides between symmetrically nonequivalent sectors within single crystals. In this study cathodoluminescence and synchrotron X-ray fluorescence microanalysis were used to determine REE concentration and distribution. In both analyses irradiation caused distinct purple coloration of the exposed regions of the crystals. This is most likely due to the generation of Frenkel defects. Furthermore, the color intensity and hue created by electron and X-ray irradiation are heterogeneous and correlate directly with different sectors, suggesting an influence of REE on the generated F centers (Fig. 1). The exact nature of the natural and induced color of these samples is being investigated with electron paramagnetic resonance spectroscopy (EPR), optical absorption (OA) spectroscopy, and various luminescence techniques.

Paragenetic relationships were inferred from different REE patterns for two separate color groups of fluorite in Bingham, NM [3]. One group consists of the green and colorless fluorite, while the other consists of the blue and purple fluorite. Calculated Dy/La ratios, earlier fluid inclusion studies [3], and field observations all indicate that the green and colorless fluorite represent an earlier generation from a less-fractionated fluid, as opposed to a later, more fractionated generation of blue and purple fluorites. The use of color to indicate paragenesis of Hansonburg and other fluorites, based on the distinctly different REE patterns for the different colors, becomes a possibility. Studies [4] by other authors have indicated that a trend in intensity of paramagnetic centers from one color of fluorite to another can indicate different generations, with the evolution of the fluorite-precipitating fluids and the decreasing influence of ionizing radiation from incorporated trace elements. It could also indicate fluorite precipitation from fluids of different sources. EPR and OA data may also contain information about the oxidation states of the various lanthanides, allowing us to investigate the relationship, if any, between the divalent REE implicated in the coloration of some fluorites and the different proposed generations of fluorite at Bingham. Hence, the oxidation state of the REE revealed by EPR and OA, if different among the proposed generations of fluorite at Bingham, could further constrain their paragenetic history and differences in the redox conditions of the fluids from which they precipitated.

References: [1] Bill H. and Calas G. (1978) *Physics and Chemistry of Minerals*, 3, 117-131. [2] Bosze, S. and Rakovan, J. (in review) *Geochim. Cosmochim. Acta*. [3] Bosze, S., Rakovan, J., and Lueth, V. (in prep.) [4] Morozov M. et al. (1996) *Granite-Related Ore Deposits of Central Kazakhstan and Adjacent Areas*, 359-369.

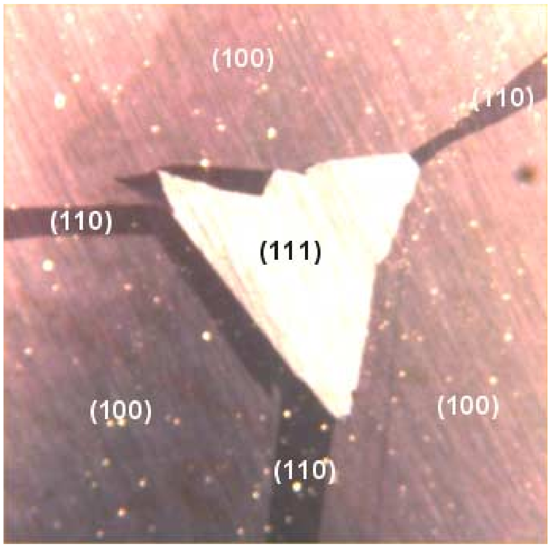

Fig. 1 Transmitted light photomicrograph of optically sector-zoned fluorite, Sunshine #2 Mine, Bingham, NM. Color created by electron irradiation.