

Public Abstract

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Title: Composition of fluid inclusions from the Cave-in-Rock bedded-replacement fluorite deposits in the Illinois-Kentucky district.

The stable mid-continent of the United States host some of the world's largest and well known Mississippi Valley-type (MVT) ore deposits, which are a substantial source of base metals such as lead, zinc, and copper. Most of the MVT deposits within the central United States are divided between two physiographic provinces called the Ozark Plateau and the Interior Low Plateau. The Ozark Plateau has historically been studied more thoroughly, however the Interior Low Plateau, while hosting three economically important mineral districts, has been less studied. This present study focuses on the Illinois-Kentucky district, a district within the Interior Low Plateau, which has been an important domestic source of fluorine and base metals for the majority of the 20th century. The present study focuses on characterizing the fluids that formed the deposit by analyzing micrometer-sized trapped pockets of mineralizing fluid called fluid inclusions. Analyses of fluid inclusions was done using precise in situ methods such as microthermometry, laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS), and laser Raman spectroscopy.

The present study has shown that the fluids that formed the Illinois-Kentucky district are distinct from fluids that formed the adjacent Ozark Plateau. Microthermometry and LA-ICP-MS lend evidence to the idea that at least three chemically different fluids were involved in the formation of the Illinois-Kentucky district ore deposits. Two of the fluids were hotter, had a moderately high salinity, and were chemically similar with respect to major elements such as, K, Ca, Mg, and Na. The third fluid was significantly cooler and less saline than the others. The concentrations of economically important base metals in the mineralizing fluids from these deposits are always an important question. The metals lead, zinc, copper, and iron were successfully quantified and were found to be abundant compared to the surrounding rocks and the earth's crust. Metal concentrations varied by an order of magnitude from 10s to 1000s of parts per million (ppm). This broad range of metal concentrations is another piece of evidence suggesting that there was mixing of multiple fluids when the Illinois-Kentucky district formed, and this indicates that at least one fluid involved in the formation of the Illinois-Kentucky district was likely metal-rich. Raman microprobe analysis yielded information about the concentration of methane within fluids inclusions, and using certain mathematical correlations, formation pressures and depths of mineralization were determined. Raman analyses showed that the deposits formed between the depths of 100 and 1500 m with a calculated mean of 680 m.

The present study has given further insight into the chemistry of the fluids that formed the ore deposits in the Illinois-Kentucky district and has advanced the overall geologic understanding of the MVT ore deposits within the Interior Low Plateau. The information on how MVT deposits formed could assist in future prospecting ventures seeking domestic sources of economically important minerals that provide key raw materials for modern industry.