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Stages in the History of Brines in the Creede, Colorado Hydrothermal System From Laser Microprobe Noble Gas Mass Spectrometry of K, Cl, Br, I, Ar, Kr, and Xe in Fluid Inclusions.

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Previously published Laser Microprobe Noble Gas Mass Spectrometry (LMNGMS) analyses of fluid inclusions (FI) at Creede are evaluated in the context of the extensive data base for halogen and noble gas abundances in rocks, fluids, FI, and the geology of the Creede system published after the FI data. Representative FI from Creede stages B, C, D, the Bondholder district, and the North Amethyst vein were studied by standard micro-thermometric techniques prior to pile irradiation, laser targeting, and mass spectrometry. Creede FI are large, aqueous, primary or pseudosecondary assemblages, nearly ideal for the technique employed. The range and mean Br/Cl in all the FI studied is 1.5- 2.08 x 10^{-3} and 1.84 x 10^{-3} molar, respectively, similar to FI in porphyries and volcanic calderas in the western U.S., but I/Cl in B, C, and D stage FI is an order of magnitude less than in these systems (1 - 4.4 x 10^{-6}). This level of Iodine depletion is caused by removal of I from brine by organic matter, which must have occurred in the Creede moat. B-stage FI contain ^{36}Ar and ^{84}Kr concentrations equal to fresh air saturated water (ASW; 6.7 x 10^{-8} molal ^{36}Ar, $^{84}Kr/^{36}Ar$ = 0.035). FI in C-stage fluorite from Bulldog Mountain and D-stage sphalerite from the OH vein contain substantially less ^{36}Ar and ^{84}Kr than fresh ASW and B-stage FI (1.5 and 0.74 x 10^{-8} molal ^{36}Ar, $^{84}Kr/^{36}Ar$ of 0.036 and 0.027 respectively), equal to some liquids in Norris Geyser Basin (NGB) at Yellowstone, a system studied specifically because of its history of boiling. The liquids at NGB that contain the same gas concentrations as the Creede FI are a product of early boiling and subsequent mixing with ASW, processes also known to be associated with mineralization in these stages. Sphalerite from the Bondholder district contains FI with Br/Cl within the range of magmas (1.92 x 10^{-3}) but I/Cl greater than other stages, (1.39 x 10^{-5}), evidence of a different fluid history. ^{36}Ar and ^{84}Kr abundances are much less than in fresh ASW and a factor of ~3 less than in C and D-stage FI (~0.2 x 10^{-8} molal), similar to the lowest gas concentrations measured in the NGB system. The North Amethyst vein contains FI that are mostly vapor. ^{36}Ar and ^{84}Kr in these FI are much higher than any others in this system (^{36}Ar > 50 x 10^{-8} molal), similar to the vapor phase in some modern systems. $^{84}Kr/^{36}Ar$ is less than ASW (0.03), as expected for the vapor phase of a fluid that boiled. Stages in the history of fluids in this system include the following: 1) some FI originated or had a stage as fresh ASW, 2) halogens in the Creede moat were acquired from a magmatic source, 3) Iodine was removed from these fluids by reaction with organic matter in the moat, 4) boiling of fluids occurred prior to trapping, and 5) some fluids that boiled were subsequently mixed with ASW. A sequence of stages is implied.