Low temperature rare earth element transport by hydrocarbon bearing brines

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El Hammam, Morocco, is a REE-rich fluorite deposit characterized by carbonate + fluorite + base-metal sulfide veins along a major shear zone that cuts through metapelites and limestones. Fluids responsible for fluorite precipitation at El Hammam are REE-rich hydrocarbon-bearing brines. The REE concentrations and fluid/fluorite partition coefficients measured from primary hydrocarbon-bearing brine inclusions in fluorite are orders of magnitude higher than those expected for chlorine-dominated fluids. While scarce experimental data is available on the literature for potential transport of REE as hydrocarbon complexes at hydrothermal conditions, the results from this study suggest that hydrocarbon complexing of rare earth elements may help mobilize these elements in aqueous fluids at relatively low temperatures (100-160°C).

The mineralogical similarity of El Hammam to Mississippi Valley Type deposits and the temperature and concentration of major cations in the fluid (Na, Ca, Mg) suggest that the fluids mobilizing REE are likely basinal brines. In contrast, the occurrence of high lithium, boron, fluorine, and REE in the fluid suggests a significant element input from a magmatic source. However, no magmatic source (for fluid or heat) coeval with vein formation has been identified in the region thus far. Lamprophyres and S-type granites predating the formation of El Hammam occur spatially related with this deposit. The trace element signature in the fluid seems to have been inherited from interaction of a basinal brine with these pre-existing intrusives further supporting transport of REE by hydrocarbon-bearing brines and post-dating magmatic activity.