Dr. Susan Welch, a Research Scientist in the School of Earth Sciences at The Ohio State University, along with Drs. David Cole and Julie Sheets, completed an Ohio WRC project funded via OWDA and OEE sub-awards titled **"Remediation of Hydraulic Fracturing Flowback Fluids by Trace Element Extraction"**. The goal of this project was to understand the evolution of the major and trace element composition of flowback/produced fluids (FP fluids) and investigate strategies to actively remove potentially toxic or economically important elements. The results of these experiments could eventually be scaled up and applied to hydraulic FP fluids storage facilities to potentially recover economically valuable metals from this waste product.

Dr. Welch's conducted experiments with FP fluids to determine the extent to which different species would be partitioned into secondary mineral phases, either by allowing the solutions to age and oxidize, or by adding different amendments to induce mineralization, such as sodium carbonate and phosphate and sulfate rich solutions. The geochemical behavior of trace elements in these experiments was complex. Naturally aged FP fluids precipitate akaganeite (β- FeO(OH,Cl)) (Figure 1), but most trace metals measured (Rb, Cs, Ni, Cu, Zn, Pb) were not co-precipitated with this phase, however Si, U and Th were scavenged from solution.

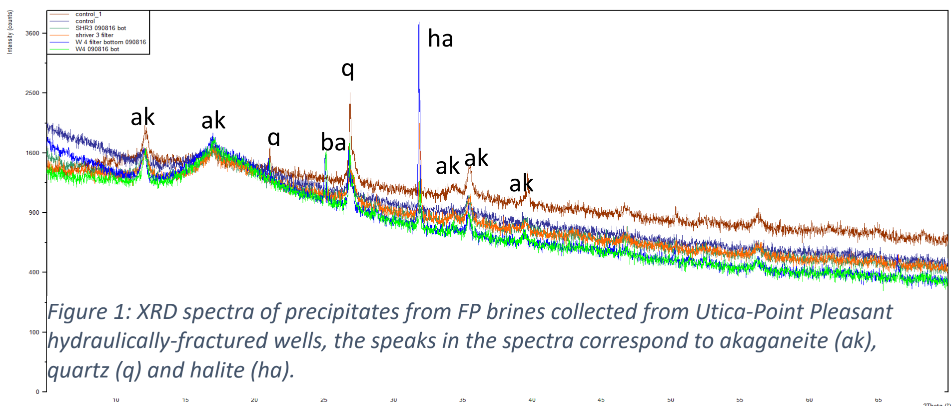


*Figure 1: XRD spectra of precipitates from FP brines collected from Utica-Point Pleasant hydraulically-fractured wells, the speaks in the spectra correspond to akaganeite (ak), quartz (q) and halite (ha).*

The results showed that carbonate addition removed Ca as calcium carbonate, as well as other trace metals, but only small amounts (~ 10s %) of Sr and Ba were removed. Addition of sulfuric acid or simulated acid mine waste resulted in the formation of barite-celestite and gypsum phases, and removal of Ca, Ba, Sr, Ra and some trace metals (La, Cu, Zn) from solution; however, mineralogy depended on the concentration of sulfate added. For example low levels of sulfate resulted in the formation of small barite roses without significant Sr removal from solution. On the other hand, intermediate levels of sulfate resulted in the precipitation of euhedral Sr-bearing barite crystals, as well as celestite with elongate crystal habit and removal of Ba and Ra from solution.

<u>Researcher Profile:</u> Dr. Susan Welch graduated from the University of New Hampshire with B.S. in Geology and B.A. in Chemistry and attended graduate school at the University of Delaware, where she received her Ph.D. in Oceanography. She is a Research Scientist at the School of Earth Science, OSU. She works as an analytical geochemist with expertise in analyzing water and sediment samples. Her research interests are in the field of Low Temperature Geochemistry and Biogeochemistry. Her current work focuses on CO2 sequestration, and the reactivity of trace mineral phases on the geochemistry of natural waters.

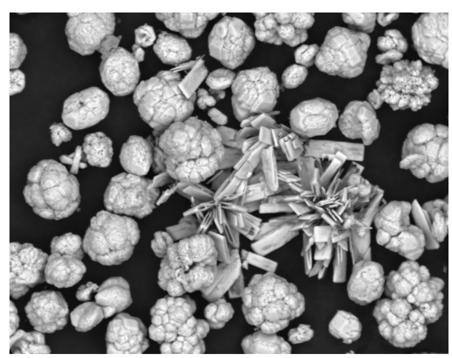

*Figure 2 SEM images of barite (Ba(Sr)SO4) precipitates from the low sulfate treatment*