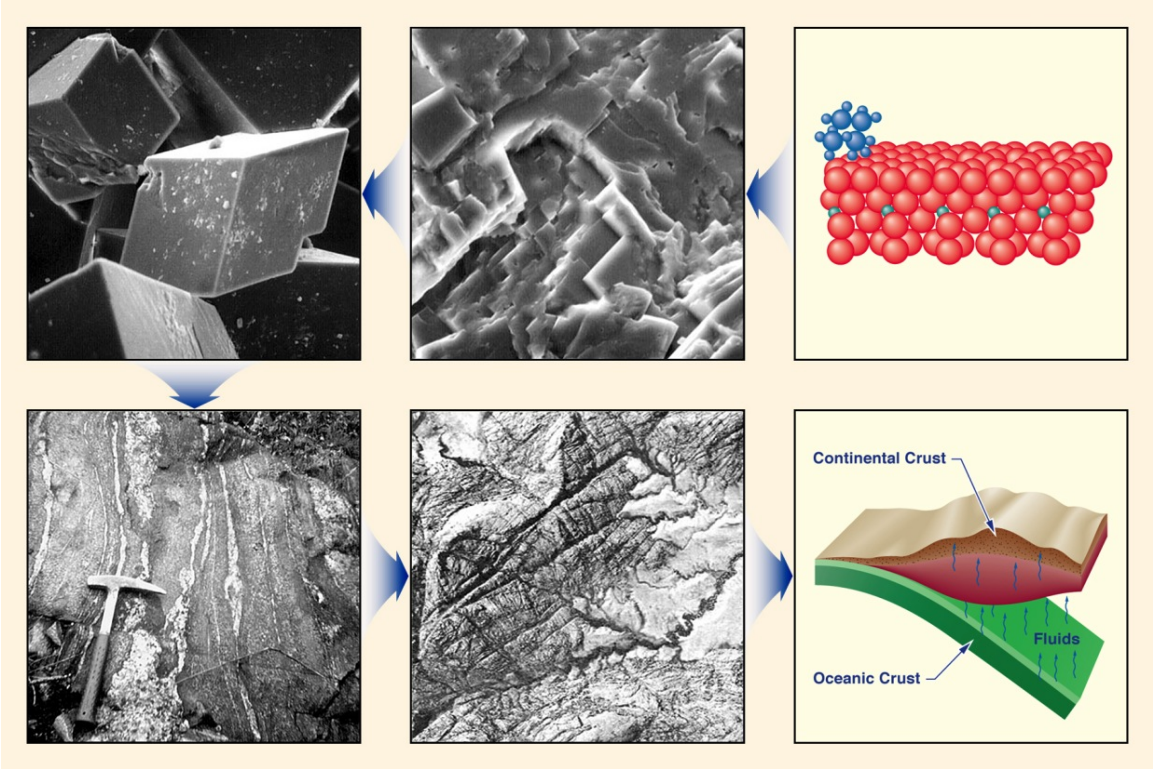
Cole Group – Research Overview

The principal research theme of the Cole group involves the geochemical behavior of fluid/mineral interactions at a variety of length and time scales with an emphasis on analytical, experimental and theoretical aspects of interactions occurring on surfaces, within pores or along planar features such as fractures, grain boundaries or dislocations common to subsurface energy systems. Research efforts impact practical problem areas such as waste water injection, geologic CO_2 sequestration, formation, migration and trapping of hydrocarbons in tight formations, the consequences of hydraulic fracturing of gas shale, and geothermal assessment and exploitation.

A fundamental understanding of interactions of fluids and solids within these types of structures is central to issues such as fluid transport, element mobility, initiation of recrystallization (e.g. calcite mineral trapping), natural chemical chromatography, and catalysis (both natural and engineered) to name a few. Research targets the role of pore-scale confinement on the molecular behavior of fluids (both polar and non-polar); how fluids react at interfaces in a 3-D environment, what controls the dynamics of molecular motion, reactivity and the attainment of equilibrium.

Problems of particular interest that remain largely unsolved include: (a) the reaction mechanism(s) and speciation of C-O-H-N fluids, and their role in the formation of point defects and modification of the structural properties of the solid, (b) the wetting, adsorption, motion and reactivity of H_2O, electrolytes and hydrocarbons under confinement, (c) the mechanism(s), speciation and rates of major, minor and trace element reaction and/or transport on and within clays and non-silicates such as carbonates and oxides, (d) rates and mechanisms of dissolution and precipitation near- and far from equilibrium, and (e) the behavior of light elements (O, H) and cation exchange during coupled reaction-diffusion in silicate and carbonate systems. A number of sophisticated tools are required to quantitatively assess these problems including the ion microprobe, SEM, TEM, NMR, isotope ratio mass spectrometry, neutron and X-ray scattering, etc., some of which can take advantage of isotopic doping (at high enrichments) or labeling of the light elements and select cations. Equilibrium isotope fractionation factors and rates of isotopic exchange (via diffusion or mineral transformation mechanisms) are logical spin-offs from many of theses studies. Access to facilities not available at OSU can be done via collaborative contacts already established or instrument user proposals (neutron and X-ray scattering).

The Cole Group studies water-rock interactions across many length and time scales.



Currently funded projects and the funding source:

Characterization of nanoporosity in representative caprocks (Cole-PI)
Department of Energy (DOE) Basic Energy Sciences (BES)/Energy Frontier Research Center –Nanoscale Control of Geologic CO_2 (LBNL lead institution)
Years: 2011-2014

Nanopore confinement of C-H-O mixed volatile fluids relevant to subsurface energy systems (Cole-PI)
DOE/Basic Energy Sciences – Geosciences Research Program
Years: 2011-2014

Reduced carbon the Earth's crust and mantle I: Abiogenic versus biogenic origin (Cole-PI)
Deep Carbon Observatory/A.P. Sloan Foundation
Years: 2011-2014

Reduce carbon in Earth: Origin and distribution of abiotic hydrocarbons (Cole-PI)
Deep Carbon Observatory/A.P. Sloan Foundation
Years: 2013-2015

Deep Carbon Observatory – Deep Energy Community (Cole-PI)
Carnegie Institution for Washington
Years: 2011-2014

Microbial biodiversity and functionality of deep shale and its interfaces (Cole-coPI)
National Science Foundation, Division of Environmental Biology
2014-2017

Monitoring of geological CO_2 sequestration using isotopes and PF tracers (Cole-PI)
DOE/NETL -/UT-Battelle
Years: 2012-2014

Geochemical tracer applications to the Michigan CO_2 injection CCole-PI)
DOE/NETL - Battelle Memorial
Years: 2012-2014

Physical-chemical response to geomechanical processes during geologic sequestration of $scCO_2$ (Cole-coPI)
Carbon Management Canada via U of Toronto
Years: 2013-2015

Geochemical Fluid Tracers and Characterization of the Utica/Pt. Pleasant Formation (Cole-PI)
Gulfport Energy
2014-2016

Volatile volcanic and geothermal fluxes in the Ethiopian Afar region (Cole-coPI)
Lounsbery Foundation
2014-2016