Changes to porosity and pore structure of mudstones resulting from reaction with CO_2 and brine

ALEXIS NAVARRE-SITCHLER[1], KATHERINE MOUZAKIS[1], JASON HEATH[2], TOM DEWERS[2], GERNOT ROTHER[3], XIUYU WANG[4], JOHN KASZUBA[4] AND JOHN MCCRAY[1]

[1]Environemntal Science and Engineering Division, Colorado School of Mines, Golden CO (asitchle@mines.edu)
[2]Sandia National Laboratory, Albuquerque NM
[3]Oak Ridge National Laboratory, Oak Ridge TN
[4]Department of Geology and Geophysics, University of Wyoming, Laramie WY

Modeling transport and reactivity of CO_2 at multiple scales is important for evaluating CO_2 sequestration or containment in geological formations. One limitation of modeling complex coupled reaction and flow processes at the pore scale is the challenge of describing the dynamic complex 3D pore structures of real rocks in a reactive environment. Stacked scanning electron microscopy (SEM) images, 3D pore reconstructions and small angle neutron scattering (SANS) provide quantitative information on pore networks at length scales inaccessible by other techniques such as x-ray computed tomography. Data from five CCS carock samples demonstrate the complex nature of the pore network.

Fractal dimensions (determined from SANS data) describing the pore network are similar for four of the five mudstones. These samples are described by a combination of mass and surface fractal dimensions. In contrast, a single mass fractal dimension describes the fifth sample. Differences in pore network geometry appear to be related to lithologic variations. Calculated volume, surface area and pore size distributions from SANS, image analysis and mercury intrusion porosimetry are in agreement.

Two of the caprock samples were reacted with CO_2 and brine at 160C and 150 bars for ~50 days to evaluate pore network changes in a reactive environment. Field-emission SEM images show a marked increase in pores at length scales ranging from 10s of nm to >1 µm. In some cases new precipitates have grown into this porespace. Dissolution features such as pitting and etching is observed on mineral grain faces. Changes in porosity and surface area are quantified with SANS, image analysis and gas adsorption techniques. SANS also provides a measure of changes to the fractal structure of the pore network at nm to 100's of nm length scales.

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the U.S. DOE under contract DE-ACOC4-94AL85000.

Field scale organic management of vineyard soils controls copper distribution and bioavailability at the micro-aggregate scale

ALINE NAVEL AND JEAN M.F. MARTINS

LTHE-CNRS-Univ. Grenoble I (UMR 5564), Domaine Universitaire BP 53, 38041 Grenoble Cedex 9, France (jean.martins@hmg.inpg.fr)

In this study we evaluated the effect of organic management of a vineyard soil on the distribution of copper at the micro-aggregate scale. The model vineyard soil used in this study (Macon, Burgundy, France) experienced a field experiment over twenty years that consisted in amendments and vegetations with various materials and plants. We studied specifically the effect of straw (S) and conifer compost (CC) organic amendments and clover (Cl) and fescue (F) vegetation on the fate of copper, used as fungicide, in the surface layer of this loamy soil (non amended, NA, control soil). These five soils were collected in June 2009 and immediately physically fractionated in order to obtain 5 granulometric subfractions, supposed to represent specific habitats for soil microorganisms as well as variable copper-reactive compartments. All soil fractions were quantitatively characterized in terms of contents of solid mass, total nitrogen and organic carbon, major inorganic elements and of copper (total, Ca-exchangeable, free and bioavailable to bacteria or plants). The results showed that each soil fraction presents a specific inorganic and organic composition. Indeed, whatever the treatment, amendment or vegetation, major elements and TOC distribution are highly variable in the soil sub-fractions and between soils. All soil treatments induced TOC increases, especially in Cl and CC soils (x1.8 and x2.8, respectively). Organic carbon accumulated preferentially in the 20-2μm fraction of the 5 soils (ranging from 6.3 to 10.3 mgC g^{-1}) and also in the coarser fraction (>250μm) where freshly added carbon first accumulates. Copper microscale distribution was shown to be different among the five soils. The amended soils accumulated more Cu in the coarser fractions, especially the CC soil, probably in relation with the reactivity increase of added recalcitrant carbon. The vegetated soils, and especially the Cl soil, accumulated much more Cu in the finest and micro-aggregated (20-2μm) subfractions, probably due to the increased rhizospheric development well known to increase soil micro-aggregation. This differential Cu accumulation was also shown to modify copper bioavailability to plants and soil bacteria. Altogether our results show that the field scale organic management clearly modifies the micro-scale Cu distribution and its bioavailability to living soil organisms.