# The relationship between a mineral network and migration of $CO_2$ and noble gases for leakage models

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Continuing R&D efforts are put on the long term tracing of CO2 through reservoir or very impermeable cap rocks. Gas diffusion in water saturated pores of natural shales follows studies by Giannesini *et al*. [1]. Results focus on CO2 and noble gas migration through clays from different petroleum seal rocks. The experiments used non supercritical carbon dioxide with traces of helium, neon and krypton in the CO2 main gas phase. The process is diffusion driven by a concentration gradient that does not create any notable pressure buildup. Diffusion alone does not qualify entirely to explain each gas effective mobility measured repeatedly and which is slower than theorized by Ficks and Henry's laws in pure water. The fit of the proper diffusivities by a 1D diffusion model allows us to determine the influence of different factors like porosity, tortuosity, time and thicknesses as gas traverses the rock pores. The model underlines the adsorption and compound size effects without being able today to separate the impact of one another. Certain ratios of noble gas productions obtained during months long experiments may well be determinant in adjusting leakage models of CO2 transport through sediments of complex mineralogies containing micro fractures that may enhance transport of dissolved or gaseous species at different regimes, to be monitored above or below CO2 storage sites.

[1] Giannesini *et al*. (2008) submitted to *Applied Geochemistry*.

# Rapid identification and quantification of soil organic carbon forms using pyrolysis molecular beam mass spectrometry

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## Rapid Soil Organic Carbon Analysis

A critical need exists to better understand both the amount of soil organic carbon (SOC) as a result of land use and management practices and its chemical (and structural/molecular) composition. Rapid quantitative analysis of soil carbon and SOC is required for assessing and monitoring managed agricultural and forest land. This need is not currently being met and instrumentation and methods must be developed so that SOC inventories can be measured, quantitated, and monitored. We are using analytical pyrolysis coupled with molecular beam mass spectrometry (py-MBMS) and multivariate statistical analysis to rapidly analyze (5-minutes) and quantify SOC in well-characterized agricultural soils (from eleven Midwestern states) provided by the United States Department of Agriculture (USDA) National Soils Laboratory in Lincoln, NE.

## Analytical Results

Multivariate statistical analysis of the mass spectral and associated characterization data demonstrate that carbon contained in the particulate organic matter (POM), mineral (Cmin), and microbial biomass (SMBC) soil fractions can be measured as a metric expressed as μg-g fraction/g soil. We have used this technique to assess impacts on SOM accumulation in agricultural soils under the USDA's Conservation Reserve Program (CRP) management and clearly show that eighteen-year old CRP soils have not yet reached native SOC or total carbon content. Additional work with forest soils subjected to periodic disturbance shows that soil chemistry, depths, and location can easily be distinguished based on mass spectral signatures. We are using these results to develop data based models to predict soil carbon content in SMBC, POM, and Cmin soil fractions that can then be used in assessing carbon sequestration pathways and progress.