Geophysical Research Abstracts
Vol. 12, EGU2010-13009-1, 2010
EGU General Assembly 2010

Impact on the deep biosphere of CO_2 geological sequestration in (ultra)mafic rocks and retroactive consequences on its fate

Bénédicte Ménez (1,2), Emmanuelle Gérard (1,2), Céline Rommevaux-Jestin (1,2), Sébastien Dupraz (1,2,3), François Guyot (1,2), Helgi Arnar Alfreðsson (4), Sigurður Reynir Gíslason (4), and Hólmfríður Sigurðardóttir (5)

(1) Equipe Géobiosphère actuelle et Primitive, IPGP/IMPMC, CNRS UMR7154, Paris, France (menez@ipgp.jussieu.fr), (2) Centre de Recherches sur le Stockage Géologique du CO2 (IPGP/TOTAL/SCHLUMBERGER/ADEME), (3) Bureau de Recherches Géologiques et Minières (BRGM), Orléans, France, (4) Institute of Earth Sciences, University of Iceland, Reykjavik, Iceland, (5) Reykjavik Energy, Reykjavik, Iceland

Due to their reactivity and high potential of carbonation, mafic and ultramafic rocks constitute targets of great interest to safely and permanently sequestrate anthropogenic CO_2 and thus, limit the potential major environmental consequences of its increasing atmospheric level. In addition, subsurface (ultra)mafic environments are recognized to harbor diverse and active microbial populations that may be stimulated or decimated following CO_2 injection ($\pm$ impurities) and subsequent acidification. However, the nature and amplitude of the involved biogeochemical pathways are still unknown. To avoid unforeseen consequences at all time scales (e.g. reservoir souring and clogging, bioproduction of H_2S and CH_4), the impact of CO_2 injection on deep biota with unknown ecology, and their retroactive effects on the capacity and long-term stability of CO_2 storage sites, have to be determined. We present here combined field and experimental investigations focused on the Icelandic pilot site, implemented in the Hengill area (SW Iceland) at the Hellisheidi geothermal power plant (thanks to the CarbFix program, a consortium between the University of Iceland, Reykjavik Energy, the French CNRS of Toulouse and Columbia University in N.Y., U.S.A. and to the companion French ANR-CO_2FIX project). This field scale injection of CO_2 charged water is here designed to study the feasibility of storing permanently CO_2 in basaltic rocks and to optimize industrial methods. Prior to the injection, the microbiological initial state was characterized through regular sampling at various seasons (i.e., October '08, July '09, February '10). DNA was extracted and amplified from the deep and shallow observatory wells, after filtration of 20 to 30 liters of groundwater collected in the depth interval 400-980 m using a specifically developed sampling protocol aiming at reducing contamination risks. An inventory of living indigenous bacteria and archaea was then done using molecular methods based on the amplification of small subunit ribosomal RNA genes (SSU rDNAs). The stratigraphic levels targeted to store the injected CO_2 as aqueous phase harbor numerous new species close to cultivable species belonging to the genus *Thermus* or Proteobacteria species known to be linked in particular with the hydrogen and iron cycles. After injection, the evolution of these microbial communities will be monitored using the Denaturing Gradient Gel Electrophoresis technique. Beyond the ecological impact of storing high levels of CO_2 in deep environments, particularly important is the ability of intraterrestrial microbes to potentially interact with the injected fluids. For example, carbonation has been shown to be strongly influenced by microbiological activities that can locally modify pH and induce nucleation of solid carbonates. To improve the understanding of these processes and to better constrain the influence of deep biota on the evolving chemical and petrophysical properties of the reservoir, an experimental and numerical modeling is carried out in parallel, using model strains representative of the subsurface (including acetogens, sulphate and iron reducing bacteria), as single-species or consortia. A set of batch experiments in presence of crushed olivine or basalts was especially designed to evaluate how microbial activity could overcome the slow kinetics of mineral-fluid reactions and reduce the energy needed to hasten the carbonation process.