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Effects of elevated CO2 concentrations on denitrifying and nitrifying popualtions at terrestrial CO2 leakeage analogous sites

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CO2 capture and geological storage (CCS) is recognized to be an important option for carbon abatement in Europe. One of the risks of CCS is the leakage from storage site. A laboratory was conducted on soil samples sampled near-surface from a CO2 leakage analogous site (Latera, Italy) in order to evaluate the impact of an elevated soil CO2 concentration on terrestrial bacterial ecosystems form near surface terrestrial environments and to determine a potential bacterial indicator of CO2 leakage from storage site. Surveys were conducted along a 50m long transect across the vent centre, providing a spectrum of CO2 flux rates, soil gas concentrations and compositions (Beaubien et al., 2007). A bacterial diversity studies, performed by CE-SSCP technique, on a soil profile with increasing CO2 soil concentrations (from 0.3% to 100%) showed that a change on bacterial diversity was noted when CO2 concentration was above 50 % of CO2. From this result, 3 soil samples were taken at 70 cm depth in 3 distinct zones (background soil CO2 content, soil CO2 content of 20% and soil CO2 content of 50%). Then theses soil samples were incubated under closed jars flushed with different air atmospheres (20, 50 and 90 % of CO2) during 18 months. At initial, 3, 6, 12 and 18 months, some soil samples were collected in order to estimate the denitrifying, nitrifying activities as a function of CO2 concentration content and times. Theses enzymatic activities were chosen because one occurs under anaerobic conditions (denitrification) and the other occurs under aerobic conditions (nitrification). Both of them were involved in the nitrogen cycle and are major actors of soil function and groundwater quality preservation. Metabolic diversity using BIOLOG Ecoplates was determined on every soil samples. Physico-chemical parameters (e.g. pH, bulk chemistry, mineralogy) were analyzed to have some information about the evolution of the soil during the incubation with increasing soil CO2 concentrations.
Statistical analyses were performed to correlate microbiological measures and physico-chemical parameters. For the soil sampled in a zone with background CO2 content, incubation under an atmosphere with 20% of CO2, induce a sharp decrease of denitrifying activity after 6 months of incubation and only after 3 months with an atmosphere of 50% of CO2. On the contrary, concerning the soil sampled in a zone with 25.5% of CO2, incubation with an atmosphere of 50% has no effect on denitrifying activity and moreover this activity was stimulated with an atmosphere of 90% of CO2.Last, with the soil sampled in an area with 65.8% of CO2, denitrifying activity was negatively impacted from the 3th month of incubation with 90% CO2.and the activity was 2 fold lower after 12th of incubation. Concerning the nitrifying activity, soil sampled in an area with background CO2 content, this one remains little affected by increasing CO2 incubation. At initial times, soil sampled in the areas with 25.5 and 65.8 % of CO2 showed low level of nitrifying activities and further CO2 incubations have no effect on these activities. At the end, denitrifying activities seems to be more sensitive to CO2 concentrations evolution in the soil.
More studies need to be done as incubation with lower CO2 content (< 10%) in order to determine the threshold of CO2 that can affect the near-surface bacterial activities and identify a possible candidate of CO2 leakage from deep reservoirs.