MICROBES VERSUS GEOCHEMISTRY AND THE MEASURED RESPONSE TO A CO_2 FLUX IN SOIL

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Abstract

The detection of anomalous leakage of CO_2 at the earth's surface has been investigated in relation to mineral exploration (Polito et al., 2002; Klusman, 2009) and environmental monitoring (Opperman et al., 2010; Noble et al., 2012) particularly for geosequestion CCS (Carbon Capture and Storage). High fluxes of CO_2 may cause major ecological shifts in the soil microbial community (Opperman et al., 2010). At Ginninderra shallow CO_2 injection facility (Canberra, Australia), we sampled six sites to test the microbial and geochemical responses to CO_2 injection. Numerous other methods for detecting CO_2 were also tested and reported elsewhere (Feitz et al., in press). Soils were sampled from 10 cm depth, before, during and 10 days after CO_2 injection at depth (2 m). All samples were measured for pH and subject to partial extractions to assess element mobility. Elements were measured using ICP-MS/OES. DNA was extracted and analysed by GeoChip® for nearly 4,000 genetic functional groups and for phylogenetic relationships (16S RNA) using next generation sequencing. Background results show seasonal influence, but shifts in the microbial community relate to a switch from aerobic to anaerobic respiration for sites near the CO_2 injection point. Concentrations of some elements including Zn and K increased due to the excess CO_2 (Figure 1). An increase in abundance of *Nitrospira* and *Firmicutes* phyla was observed after the CO_2 increase (Figure 2). These phyla are anaerobic and more acid/metal tolerant, consistent with the observed increase in functional genes related to metal resistance and bioleaching. The pH did not change significantly suggesting that microbial responses can be more sensitive than geochemical responses; this may be valuable for future mineral exploration for subtle signatures in deep cover. The observed microbial changes could be used to develop biosensors for CCS and mineral exploration.

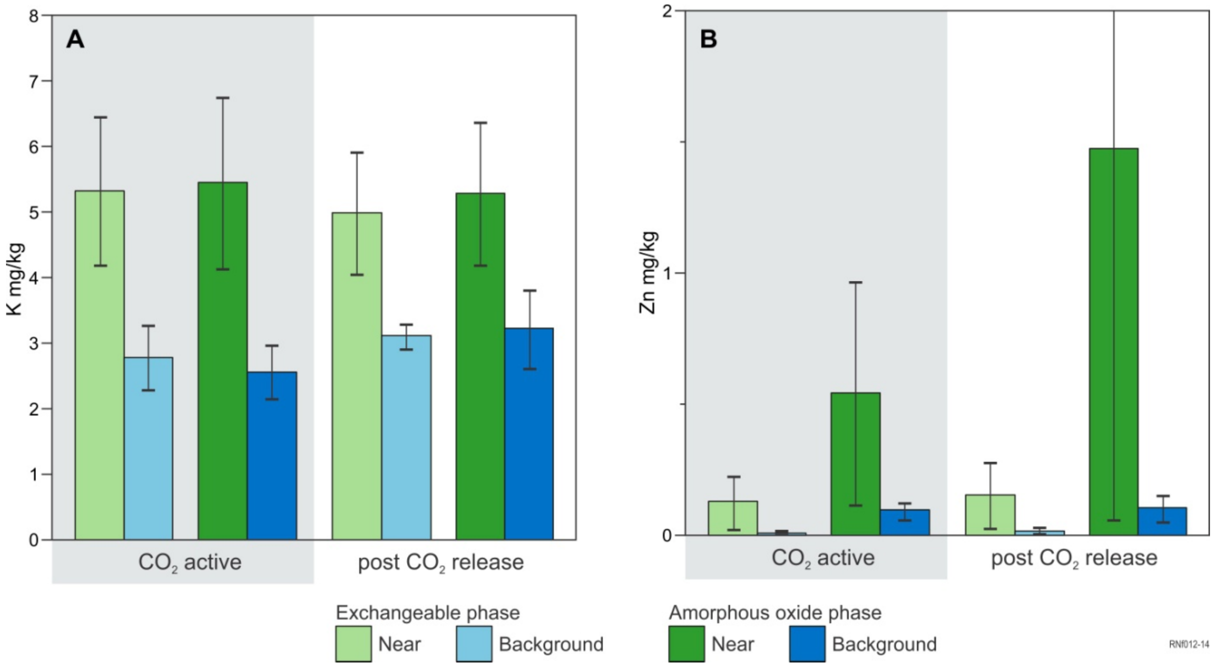

Figure 1. Potassium (A) and Zn (B) associated with the exchangeable and amorphous oxide phases liberated during and after CO_2 injection. Error bars represent the standard deviation of the mean (n=3).

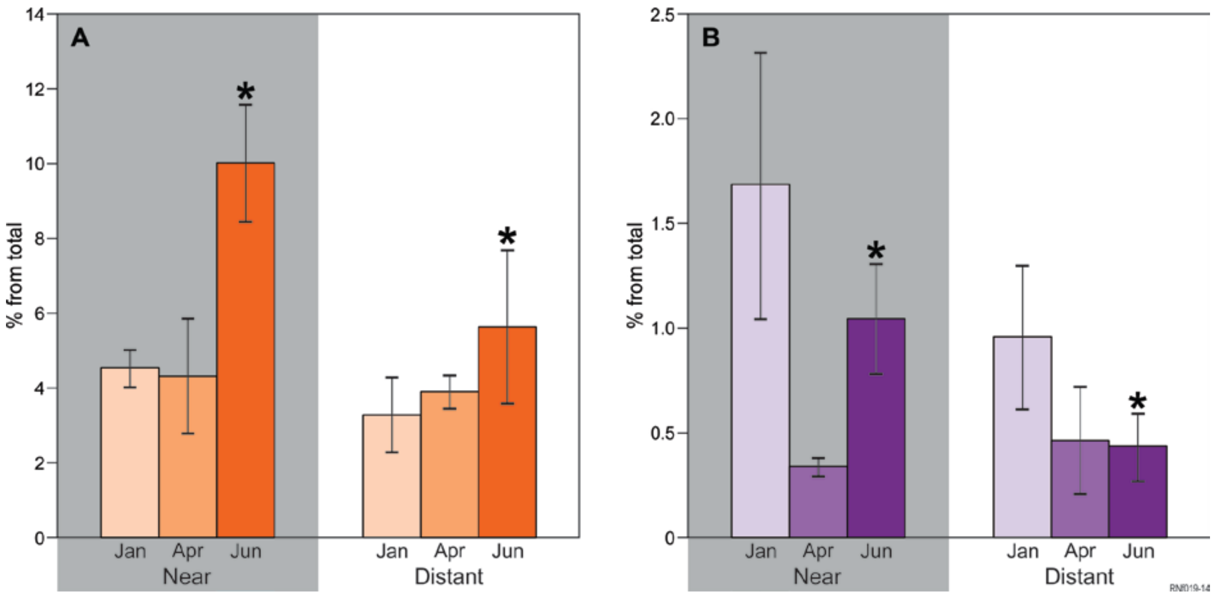

Figure 2. Abundance (% from total number) of Firmicutes (A) and Nitrospira (B) in soil samples proximal (shaded) and distal to the CO2 leak. The abundance (% total) is the mean of 3 replicates. Error bars represent the standard deviation of the mean. * indicates significant difference ($p<0.05$).

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