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Soil CO_2 dynamics in a polar desert: Using stable C isotopes to differentiate between biotic and abiotic contributions to CO_2 fluxes, Taylor Valley, Antarctica

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The global terrestrial inorganic carbon pool is dominated by pedogenic (soil-formed) calcium carbonate, predominantly stored in arid and semi-arid regions around the planet. This C pool is estimated to contain 940 Pg C (Eswaran et al. 2000; Schlesinger, 1985), being smaller only than the terrestrial soil organic C pool at c. 1,500 Pg, and the oceanic C pool (c. 38,000 Pg). The Dry Valleys of Antarctica provide a unique natural laboratory in which CO_2 dynamics in arid ecosystems can be investigated without the interference of vascular plants. Soils are characterised by low levels of organic carbon (0.02 – 0.03%), low moisture content, coarse textures and the presence of soluble salts. Inorganic carbon, though its abundance is not widely documented, is the largest terrestrial carbon pool in Antarctic ice-free areas. However, the dynamics of this pool and implications for carbon storage under future climate scenarios are poorly understood.

Soil respiration studies in the McMurdo Dry Valleys have focused on determining surface fluxes in order to understand aspects of organic carbon cycling in these polar deserts. None of these studies have investigated inorganic carbon cycling; only one study has considered soil profile CO_2. Surface CO_2 fluxes range from approximately -0.1 to 0.15 μmol CO_2 m^2 s^{-1} (e.g. Burkins et al. 2001; Parsons et al. 2004; Ball et al. 2009), although at sites with higher C and moisture contents, rates can be as high as 0.78 μmol CO_2 m^{-2} s^{-1} (Gregorich et al., 2006). The observed negative CO_2 fluxes indicate uptake of CO_2 into organic or inorganic forms, but the mechanisms involved have not been well explored.

During the 2008/09 austral summer, we sampled surface CO_2 fluxes and subsurface CO_2 profiles (to 30 cm - depth of ice-cement) at the warmest and coolest times of the day in central Taylor Valley. Preliminary data show varying CO_2 concentration depth-profiles, reflecting influx and efflux of CO_2 on a daily basis, which was corroborated by surface flux measurements. The isotopic composition of subsoil CO_2 is consistent with dissolution of CO_2 in soil water and formation of bicarbonate. Field work to be completed during the 2009/10 austral summer aims to increase the frequency of surface CO_2 fluxes and subsurface CO_2 depth-profiles over several diel cycles. Concentration and isotopic composition of soil CO_2 samples will be determined in order to discriminate between biotic and abiotic contributions to soil CO_2 fluxes, and to evaluate net CO_2 storage or release. Soil chemical characterisation will further aid interpretation of inorganic C dynamics and determination of whether or not net carbon storage is occurring through formation of pedogenic calcium carbonate.

Ball, B.A., Virginia, R.A., Barrett, J.E., Parsons, A.N. and Wall, D.H., 2009. Interactions between physical and biotic factors influence CO_2 flux in Antarctic dry valley soils. Soil Biology & Biochemistry, 41(7): 1510-1517.

Burkins, M.B., Virginia, R.A. and Wall, D.H., 2001. Organic carbon cycling in Taylor Valley, Antarctica: quantifying soil reservoirs and soil respiration. Global Change Biology, 7: 113-125.

Eswaran, H. et al., 2000. Global Carbon Stocks. In: R. Lal, J.M. Kimble, H. Eswaran and B.A. Stewart (Editors), Global climate change and pedogenic carbonates. CRC Press, Florida, pp. 15-26.

Gregorich, E.G., Hopkins, D. W., Elberling, B., Sparrow, A. D., Novis, P., Greenfield, L. G., Rochette, P., 2006. Emission of CO_2, CH_4 and N_2O from lakeshore soils in an Antarctic dry valley. Soil Biology & Biochemistry, 38(10): 3120-3129.

Parsons, A.N., Barrett, J.E., Wall, D.H. and Virginia, R.A., 2004. Soil carbon dioxide flux in Antarctic dry valley ecosystems. Ecosystems, 7(3): 286-295.

Schlesinger, W.H., 1985. The Formation of Caliche in Soils of the Mojave-Desert, California. Geochimica Et Cosmochimica Acta, 49(1): 57-66.