GSA DATA REPOSITORY 2013052 Montross et al.

WEATHERING EXPERIMENT MATERIALS AND METHODS

Waters (8L) and stream sediments (10kg) were sampled aseptically ~ 10m inside the tunnel formed by the subglacial outlet stream of the Haut Glacier d' Arolla in October 2004. Waters and sediments were stored at < 4°C in the field, frozen within ~ 8 hours of collection and shipped and stored frozen. Sediments and water were melted at 4°C and the sediments homogenized on ice. 40g of sediment and 70ml of water were added aseptically in a laminar flow hood to combusted (550°C for 8 hrs) 125ml glass vials and capped with butyl rubber septa for the oxic samples and in an anaerobic chamber for the anoxic samples. The vials were flushed for 15 minutes using 0.1um filtered air to ensure oxic conditions or 0.1um filtered N_2 to ensure anoxic conditions. Sterile abiotic controls were prepared by autoclaving the capped vials with the sediment-water mixture for 45 minutes at 121°C. All sample bottles were incubated at 2°C ± 0.8°C in the dark for 100 days. Anoxic sample bottles were stored inside an anaerobic vessel, that was replenished with N_2 at each sampling point, inside the fridge. All sample vials were manually inverted and gently shaken at a sampling timepoint to generate a free-flowing slurry in the sample bottle. Water samples were taken from triplicate biotic and triplicate abiotic control vials after 0, 7, 14, 21, 28, 35, 45, 60 and 100 days incubation and 0.45um filtered. pH was measured on the filtrate using a pH papers and the anion and cation concentrations via ion chromatography on a Metrohm Peak ion chromatograph. The mineral composition of the sediments was determined by XRD and CHNS concentrations via LECO analyzer. Full methodological details are described in Montross (2007). Samples for particle-size analysis were prepared and analyzed using a Beckman Coulter LS200 particle-size counter following the methods outlined in Tompkins and Lamoureux (2005).

Proglacial stream sediments were sampled aseptically ~ 30m from the Bodalsbreen glacier terminus, in July 2000, dried at 105°C for 12 hours, crushed and homogenized using a Pulverisette 2 grinder and 6g was dispensed into 48 x 10ml glass vials. The vials with sediment were dry heat sterilized twice (2 x 8 hrs @ 140°C). Supraglacial (2L) subglacial (1.7L) and proglacial water sediment slurry (0.3L) were sampled aseptically from the glacier (July), transported and stored at 2°C for 9 months, and then mixed on ice prior to dispensing in a laminar flow hood. 6 ml of meltwater was added to each vial capped and mixed. Sterile abiotic controls were prepared by sequentially filtering the meltwater through a combusted GF/C filter, sterile 0.2um and then 0.1um filters prior to addition to the vials. The biotic and abiotic vials were incubated under oxic conditions at 1.6 - 2.6°C in the dark for 298 days. The vials were mixed manually using a Whirlmixer once a week. Water samples were taken from triplicate biotic and triplicate abiotic control vials after 0, 4, 17, 34, 63, 133, 203 and 298 days incubation and 0.45um filtered. pH was measured on the filtrate using a microelectrode and the anion and cation concentrations via ion chromatography on a Dionex ion chromatograph. The mineral composition of the sediments was determined by XRD and CHNS concentrations via LECO analyzer. Full methodological details are described in Kivimaki (2005).

SUPPLEMENTAL DISCUSSION

Sodium and potassium concentrations increase by 12 and 16 ueq L^{-1} respectively over the 100 day biotic incubations of Arolla sediment slurries under oxic conditions (Figure DR1). Si concentrations do not show a significant increasing trend in the biotic incubations over that time period suggesting incongruent dissolution of silicate minerals Tranter et al. (1997). No significant change is observed in potassium concentrations under abiotic conditions over the 100 day incubation and there is minor decrease (~ 4 ueq L^{-1}) in sodium concentrations. Thus enhanced release of sodium and potassium from silicate minerals in the biotic incubations or Arolla sediment slurries appears to be a least an order of magnitude greater than in the abiotic controls. There is no significant increase in the release of base cations in the biotic relative to the abiotic incubation of Arolla sediments under anoxic conditions at 2^{o}C in the dark. (Table DR3). It remains unknown why potassium concentrations decline in both the biotic and abiotic anoxic incubations.

Arolla sediments were not ground and exhibited a wide variability in grain size distribution in each of incubation bottles, median diameter, (d50) = 39 – 273 μm and surface areas 1000 – 3275 cm^2 g^{-1} (n = 7) relative to the freshly ground (< 300 μm) and more homogenized Bodalsbreen sediments with d50 = 66 μm and surface area of 1760 cm^2 g^{-1}(*3*). There is no systematic variation in grain size distribution with incubation time point in the Arolla sediments (Figure DR2) yet dissolution progressed with incubation time. This indicates that the enhanced microbial dissolution in oxic incubations of Arolla sediment is largely independent of the grain size of this particular sediment. This may be due to the fact that even in the coarsest sediment (Day 100, biotic) the specific surface area is 1000 cm^2 g^{-1} and over 10% of the sediment by weight is in the < 10um size fraction resulting in adequate reactive surface area.

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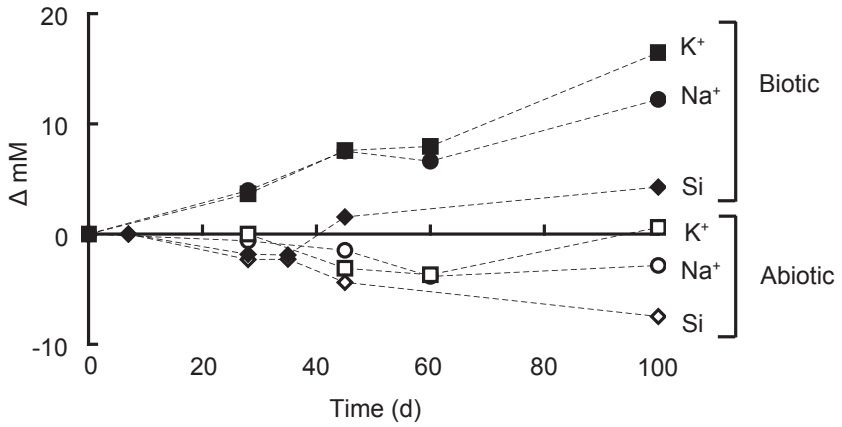

Figure DR1. Change in sodium, potassium and silica concentrations in aqueous extracts from oxic, dark incubations of Arolla sediment slurries at 2^{o}C over 100 days incubation. Biotic; solid symbols, abiotic; open symbols, square, potassium, circle, sodium; diamond, silica. Sodium, potassium and silica concentrations for each time point are expressed as the change relative to the day 0 value for either the biotic or abiotic incubation conditions since autoclaving the abiotic control bottles resulted in higher initial (day 0) sodium, potassium and silica concentrations relative to the biotic bottles. 1 s.d. error on analyses for sodium and potassium concentrations from triplicate bottles was ± 1.2 ueq L^{-1}

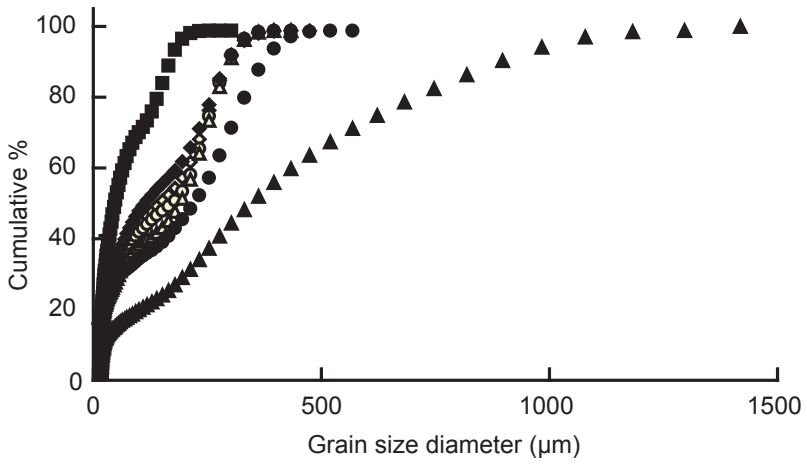

Figure DR2. Grain-size distribution for Arolla sediments in biotic and abiotic incubations under oxic conditions. Biotic, day 0, open diamond; day 45, open circle; day 60, open square; day 100, open triangle. Abiotic; day 0, solid diamond; day 45, solid circle; day 100, solid triangle.

TABLE DR1. CHANGE IN CATION CONCENTRATIONS (ueq L^{-1}) FROM DAY 0-100
IN ANOXIC INCUBATIONS OF AROLLA SEDIMENTS

Incubation conditions	Na^+	K^+	Mg^{2+}	Ca^{2+}
Biotic	-9.6	-15.3	23.0	303.7
Abiotic	-1.4	-14.3	22.9	286.2

TABLE DR2. MICROBIAL RESPIRATION RATES IN OXIC INCUBATIONS OF AROLLA AND BODALSBREEN SEDIMENT SLURRIES

	Arolla	Bodalsbreen
H^+ generated via carbonation reaction (μM)	887	858
H^+ generated via carbonation reaction/bottle (μM)	35.5	5.1
Respired CO_2 produced/bottle (μM)	35.5	5.1
Respired CO_2 produced/bottle/day (μM)	0.355	0.017
Biomass on final day of experiment (cells g^{-1} sediment)	*26000	†315000
Biomass on final day of experiment (cells/bottle)	1820000	18900000
§Respired CO_2/cell/day (μM)	2.00E-07	2.30E-10
§Respired CO_2/cell/day (pM)	0.2	0.0002
Organic carbon oxidized to generate CO_2 (mg)	0.43	0.06
Organic carbon oxidized (wt% of sediment)	0.0006	0.001

*Live cells as determined by Live-Dead assay was 50% of total cells.

†Total cell number divided by 2 for comparison with Arolla dataset. Planktonic cells were not measured separately and are thus not included in these calculations.

§It is assumed all live biomass is actively respiring thus the values represent maximum respiration rates per cell per day.