

High degradation efficiency of deicing chemicals affects the natural redox system in airfield soils

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Large amounts of the deicing chemicals (DIC) propylene glycol (PG) and formate are spread for removal of snow and ice on the aircrafts and airfields every winter. A considerable amount of these chemicals are carried into surrounding areas, where they mix with snow and infiltrate in the soil during snowmelt. Even though DIC are easily degradable, the high mobility and the high biological oxygen demand of PG in particular can influence the hydrogeochemistry of the unsaturated and saturated zone. The aims of the study were to evaluate and quantify transport of deicing chemicals during snowmelt under field conditions, and to study effects of DIC degradation on the hydrogeochemistry of the unsaturated zone. Eight undisturbed soil cores (0.3 m x 1 m, 0.071 m³) were retrieved at the Gardermoen Airport, Norway, and installed as non-weighable small scale lysimeters at a nearby field site. Before snowmelt in March 2010, a mix of snow containing 350 g/m² PG, 71 g/m² formate, and 17 g/m² of bromide were added to the lysimeters. To determine the fate and transport of PG we monitored PG and its metabolites, bromide, manganese, and iron in the seepage water.

High cumulative infiltration and marginal degradation of PG during the snowmelt period allowed up to 50 % of the PG to leave the upper, microbially most active, region of the soil. Only marginal concentrations of formate were analysed in all lysimeters, indicating fast degradation and favoured metabolism by soil bacteria compared to PG. Low contents of metabolites and the concurrent breakthrough of PG and Br in the seepage water even imply that PG was not significantly degraded before June. Redox values down to 200 mV in April, the detection of propionate and manganese, as well as a rise in pH, suggest partially anaerobic localities in the soil, not only during high soil water saturation in April and May but also during summer when PG degradation was very efficient. In the longterm, the intense depletion of secondary electron acceptors such as Mn (hydr)oxides lowers the potential of the unsaturated zone to buffer high loads of DIC. Therefore, it is necessary to carefully assess the buffering capacity of the soil and to develop suitable remediation techniques to sustain the natural redox buffer system.

Melting in the peridotite and eclogite, coexisting with reduced C-O-H fluid at 3-16 GPa

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Melting phase relations of peridotite and eclogite systems coexisting with reduced C-O-H fluid has been studied at 3-16 GPa and 1200-1600°C. In order to perform these experiments the double-capsule technique with f_{O_2} control by outer Mo- or Fe-buffer capsule was designed and developed for multianvil experiments at pressures above 3 GPa. The inner capsule contained silicate starting material with an addition of 8-10 wt% stearic acid, which served as a fluid source, whereas outer capsule contained talc, which served as a hydrogen transmitting medium to maximize fH_2 in the inner capsule.

Silicate phase assemblages resemble those in volatile-free lithologies. Melting was detected by appearance of quenched crystals of pyroxene, feldspar and glassy silica. Abundant voids indicate presence of fluid in all runs. The fluid composition was not measured, but should correspond to CH₄-H₂O-bearing one, according to estimations from equations of state. The compositions of partial melt were estimated from mass-balances. The partial melt from peridotite runs has CaO-poor (6-9 wt%) basaltic composition with 44-47 wt% SiO₂ and 1.1-1.6 wt% Na₂O (recalculated to 100% of dry residue). Eclogitic melts contain more SiO₂ (47-49 wt%) and are enriched in CaO (9-15 wt%), Na₂O (9-14 wt%), and K₂O (1.3-2.2 wt%). All runs contained graphite or diamond crystals along with porous carbon aggregate with microinclusions of silicate phases.

The solidi have relatively steep slope in the pressure range between 3 and 16 GPa. Estimated solidus temperatures for peridotite+C-O-H-fluid with f_{O_2} control by Fe-FeO buffer are 1200°C at 3 GPa and 1700°C at 16 GPa. The solidus of the system with f_{O_2} control by Mo-MoO₂ buffer was about 100°C lower. Solidi in the eclogite systems are located at another 100°C lower than peridotitic ones for both buffers. The obtained solidi are much higher (300-500°C) than those for peridotite/eclogite systems with H₂O and CO₂. However, they are still about 300°C lower than solidi of volatile-free peridotite and eclogite at 12-16 GPa. Thus, we provide new direct evidences for redox melting by change of oxidation state across a mantle section.