

## Cyanide-promoted mineral weathering in a glacier forefield

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### Abstract

Granite rock materials were sampled from the most recent postglacial zone of the Damma glacier, Switzerland, to study the processes at the mineral-water interface where aqueous solutes act directly as dissolution-promoting agents. An interdisciplinary research project was initiated to gain insights on rock weathering through a linkage of mineralogy, chemistry and microbiology with special emphasis on cyanide as ligand and complexing agent. In previous work, Gärtner *et al.* [1] found the effects of cyanide on granite dissolution using batch reactors at pH 5.5 and pH 6. The presence of cyanide leads to increased dissolution of phosphate and essential trace elements (silica, magnesium, calcium) and precipitation of iron and manganese.

Many *Pseudomonas* species that are able to produce cyanide have been found in soil sampled from the Damma glacier forefield [2]. Hummel [3] suggested that the formation of iron cyanides is an important and strongly pH-depending factor influencing indirectly the concentration of dissolved phosphate. Therefore, cyanide-producing bacteria might make use of several advantages where cyanide can act as dissolution-promoting ligand in order to mobilize nutrients and trace elements and help to control competitors.

This study aims at the chemistry of cyanide and the microbiological aspects resulting in dissolution of minerals and soil formation. A systematic investigation including modeling will be carried out under various conditions to study intrinsic effects (dissolution kinetics) and extrinsic effects (pH, Temperature, concentration of cyanide) on the cyanide-promoted dissolution. The weathering potential of biogenic cyanide will be assessed with respect to cyanide-producing microorganisms isolated from glacier forefield soils.

[1] Gärtner (2007). Diploma Thesis, Dept. of Env. Engin. Sci., ETH Zurich, Switzerland. [2] Edwards *et al.* (2006) *Microbial Ecology* **52**, 679-692. [3] Hummel (2004) *Environmental Geology* **45**, 633-646.

## Lead was strongly partitioned into Earth's core and not lost to space

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Both <sup>207/206</sup>Pb-<sup>235/238</sup>U [1] and <sup>129</sup>I-<sup>129</sup>Xe [2] chronology yield apparent ages of loss of the daughter isotopes from silicate Earth at about 100 Ma after the origin of the solar system. Although Xe removal is generally assumed to be due to atmospheric loss associated with impacts such as that which formed the Moon, the causes of Pb loss are more contentious with opinion divided between Pb being atmophile and lost with Xe or siderophile and added to the core.

Recent experimental data [3, 4] purport to show that Pb is insufficiently siderophile to explain either the observed <sup>238</sup>U/<sup>204</sup>Pb ( $\mu$ ) or Pb isotopic composition of the silicate Earth. An overall partition coefficient  $D_{Pb}(\text{metal/silicate})$  of about 25 would be needed to explain the change of  $\mu$  from ~0.7 to ~10 by core formation alone [1]. Since experimentally determined partitioning is about 2 orders of magnitude lower, Lagos *et al.* [4] assert that an alternative mechanism of Pb loss from the silicate Earth is required. The most likely would be that Pb was atmophile and lost with the noble gases at around the time of the Moon-forming impact.

Our experimental results show that there are problems with the data of [3] and [4] and that Pb, in contrast to the conclusions of the earlier authors, is strongly siderophile at high pressures and temperatures. Volatile loss can therefore be excluded as a mechanism of Pb loss from the silicate Earth. The current Pb isotopic composition of the silicate Earth dates a late stage of core formation at around 100 Ma.

[1] Allègre, Manhès & Gopel (1995) *Geochim. Cosmochim. Acta* **59**, 1445-1456. [2] Porcelli, Woolum & Cassen (2001) *Earth and Planetary Science Letters* **193**, 237-251. [3] Malavergne *et al.* (2007) *Geochim. Cosmochim. Acta* **71**, 2637-2655. [4] Lagos *et al.* (2008) *Nature* **456**, 89-92.