Engineered nanomaterials in rivers – exposure scenarios for Switzerland at high spatial and temporal resolution

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Introduction and methods

Two models, one based on probabilistic material flow analysis [1] and one based on graph theory [2], were combined to calculate predicted environmental concentrations (PECs) of engineered nanomaterials (ENMs) in rivers at local resolution. PECs for nano-TiO_2, nano-ZnO and nano-Ag were modeled for river sections downstream from 543 sewage treatment plants (STPs) at base flow conditions. Flow measurements over a 20-year period (1988–2007) at 20 selected locations were used to assess temporal variation. Due to the absence or ambiguity of available data on ENM dissolution behavior or agglomeration/sedimentation rates two “extreme” transport scenarios were considered: (i) a reactive scenario *with rapid (complete)* ENM *transformation* or sedimentation in rivers between two STPs and a conservative scenario *without any* ENM removal from the liquid phase.

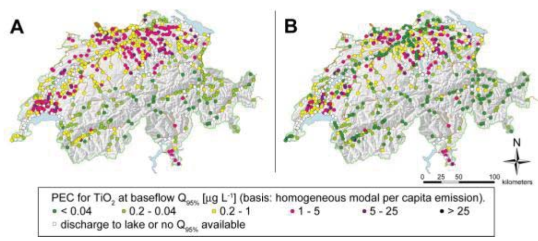

Figure 1: PECs of nano-Ag in Swiss rivers at base flow conditions (A: conservative scenario, B: reactive scenario).

Results

The highest concentrations were found in the midlands or near urban centers. Rural, alpine and pre-alpine values were negligibly small (Fig. 1). Temporal variation of PECs was evaluated by considering a whole range of “typical cases”: small to large rivers (highly variable to more attenuated flow rates) and predominantly alpine to urban catchments (low to high ENM input). The alpine Rhine showed the smallest concentrations: the nano-Ag PECs ranged from 0.01 ng L^{-1} to 0.6 ng L^{-1} (conservative scenario). Some of the highest concentrations were observed within a lowland river section: 0.3 ng L^{-1} to 60 ng L^{-1} nano-Ag (conservative scenario).

[1] Gottschalk et al. (2010) Environ. Model. Softw. **25**, 320-332.
[2] Ort et al. (2009) Environ. Sci. Technol. **43**, 3214-3220.

Ultrapotassic lava flows from Colli Albani Volcanic District (Central Italy) give insights into the crystallization of magmatic calcite in effusive rocks

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Calcite crystals are relatively common in alkalic hypoabyssalite and kimberlite rocks, but rarely documented in effusive rocks (e.g. alkaline lava flows). Magmatic calcite in effusive rocks has been usually related to mantle-origine carbonate; only in very few cases, it has been explained throughout magma-sediments interaction.

The ultrapotassic Colli Albani Volcanic District (Central Italy) represents one of the most peculiar volcanic districts on the Earth because of its liquid line of descent characterized by differentiated, low silica ($SiO_2 \leq 45$wt%), K-foiditic magmas. Field, geochemical, and experimental studies have demonstrated that such a differentiation trend, starting from trachybasaltic parental magma, is mainly due to magma-carbonate sediments interaction. One of the most intriguing question concerning Colli Albani petrology is the occurrence of calcite crystals in the groundmass of some lava flows. In general, Colli Albani lava flows are made up of leucite and clinopyroxene phenocrysts and the groundmass contains leucite, clinopyroxene, and Ti-magnetite. More evolved products may also contain calcite, usually associated with nepheline. A detailed microtextural study of these calcite-bearing lava flows has shown that calcite occurs as follows: i) interstitially, associated with clinopyroxene, nepheline and phlogopite; ii) in ocelli, associated with fluorite and tangentially arranged clinopyroxene; iii) in coronitic reaction zone around K-feldspar xenocrysts. These microtextural features clearly indicate that calcite crystallized under magmatic conditions. Moreover, the high $\delta^{18}O$ (25-29‰ SMOW) and low $\delta^{13}C$ (down to -19‰ PDB) values of calcite crystals prove the sedimentary origin of the carbonate involved in the process. Finally, the occurrence of limestone fragments in the lava flows accounts for a syn-eruptive assimilation of the carbonate sediments.
The high activity of fluorine in the Colli Albani magmas, as demonstrated by the occurrence of F-rich mineral phases (i.e, amphibole and mica), associated with fast crystallization due to the low magma viscosity, can have played a central role on the subsistence of sedimentary carbonate melt (then calcite crystals) at atmospheric pressure. This study may help unravelling the formation processes of the so-called “pseudocarbonatites”, i.e. carbonated rocks related to the anatexis of crustal limestone.