

Arsenic in the Netherlands: processes, spatial distribution and risk

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High concentrations of arsenic (As) are frequently encountered in the (shallow) subsurface of the Netherlands, in sediments as well as in groundwater. The sediments and aquifers involved consist generally of fine-grained Holocene fluvial and marine deposits overlying Pleistocene coarse-grained fluvial sediments. To deal with these occurrences, it is necessary to determine the spatial characteristics of the As enrichments and the types of risks involved. For this, information is needed on the processes that cause the occurrences of high As-values, and on the mineralogical form in which solid-phase As occurs.

In solid phase, high concentrations of As are either associated with accumulations of Fe(hydr)oxides (values up to 1000 mg/kg As), or with high concentrations of As-rich pyrite (values up to 1500 mg/kg As). Accumulations of Fe(hydr)oxides are most common in the form of so-called bog-iron ore; iron-rich deposits that were formed by upward seeping groundwater. They are often, but not exclusively, found in river valleys and -terrace edges, around ice-pushed ridges and inside ice-pushed ridges as part of the ice-pushed material. The ratio $As / Fe_{(reactive)}$ is usually constant around 1:1 000. Accumulations of pyrite-related As almost exclusively occur in peat layers. In peat, the concentration of As and the weight-ratio As reactive-Fe shows considerable variation, with values around or above 1: 1000. Peat with elevated As is probably formed by a large influx of Fe (and As), due to exfiltration of Fe-rich groundwater during peat formation. These Fe-rich groundwaters formed through the dissolution of buried bog-iron ore deposits and/or iron-oxide coatings in the aquifer substrate. The As-rich pyrite-bearing peat layers usually only release As to groundwater in problematic quantities when they become disturbed by human activities (e.g. building, polders).

The above findings indicate that areas with increased risk for high As concentrations can be delineated on the basis of geo-data on landscape evolution, (paleo-)hydrogeology and a limited amount of geochemical data. Therefore a study is carried out of the regional behaviour of As in the Netherlands, as part of a larger project that aims at providing government bodies with tools to deal with occurring high As-concentrations.

PGEs in Icelandic picrites

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Platinum group elements (PGEs: Os, Ir, Ru, Pt, Pd) are highly siderophile elements, that behave compatibly (Os, Ir, Ru) to mildly incompatibly (Pt, Pd) during mantle differentiation. Puchtel and Humayun (2000) emphasized the importance of using high-degree partial melts such as komatiites to constrain the geochemical behavior of the PGEs. Here, the behavior of PGEs in a different type of high-Mg mantle melt, picrite, is explored.

Picrite samples from post-glacial eruptions in Iceland were studied for ^{186,187}Os isotope compositions, lithophile element (Brandon et al., this vol.) and PGE abundances. PGEs were determined by ID-ICP-MS using a mixed spike optimized for komatiite-picrite compositions and carius tube digestions. Based on $(La/Sm)_N$, the picrites fall into 4 groups which vary in composition from melts derived from a source comparably depleted in LREE to MORB, to those from a source with REE abundances similar to Primitive Mantle (PM). The degree of partial melting is highest in picrites from depleted sources (Groups I, II: 30%, 20%), and lower in those from PM sources (Group III, IV: 10%, 5%). Compared to komatiites, Os, Ir and Ru are 1.5-3x lower in Iceland picrites, which also have superchondritic Os/Ir ratios. In Group I-III picrites, Pt and Pd are similar in abundances and incompatibility to komatiites. However, Pd abundances do not correlate with any lithophile trace element, but decrease systematically with decreasing degree of partial melting (increasing La/Sm ratio), being lower than PM in Group IV picrites ($\approx 5\%$ melts). This effect is likely caused by retention of PGEs by sulfide during low degree partial melting. The Pd/Ti ratio, often proposed as a constant interelement ratio, varies significantly as Pd increases while Ti decreases with degree of melting, making Pd/Ti unsuitable for examining issues of source composition, e.g., core-mantle interaction.

Analyses of hand picked olivine and chromite grains show that PGEs were incompatible in olivine, while Os, Ir and Ru were compatible in chromite, similar to results obtained on komatiites (Puchtel and Humayun, 2001). Olivine and chromite both exhibit superchondritic Os/Ir. Thus, the observed superchondritic Os/Ir ratio of many picrites can be understood in terms of ol+chr accumulation. Complementary Os/Ir ratios are also found in some picrites.

References

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