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Bioavailable concentrations of germanium and rare earth elements in soil fractions

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As there is an increasing demand for germanium and the rare earth elements due to their diverse application in modern technologies (optical cables, permanent magnets in wind power stations), there is an interest to investigate a new approach to extract these ubiquitous but disperse existing elements - via Phytomining. But before this method can be established, a thorough understanding of processes regarding the intake of germanium (Ge) and the rare earth elements (REEs) is necessary.
The aim of this work was to get insights or hints on correlations between the concentrations and the fractionation of Ge and REEs in the soil and the concentrations in plants – in other words we wanted to conduct research on bioavailable concentrations of Ge and REEs in soil fractions. On 18 sites situated around Freiberg, Saxony we took samples of soil and plants. To extract the elements from the plant material a decomposition with hydrofluoric acid was used. The soil samples was examined by a sequential extraction with seven steps (mobile, carbonatic, oxidisable, amorphic oxides, crystalline oxides, phytoliths and secondary clay minerals, residual or siliceous). The amounts of the REEs showed a high correlation between each other, so neodymium can be regarded as a proxy for all REEs.
The average total amount of Ge in the soil samples was around 1.45 mg/kg, the one of neodymium (Nd) was around 25 mg/kg. Both values equal the overall average in the earth crust. Concerning the Ge concentration in soil the residual siliceous fractions constituted for 70% of total, whereas the fractions V and VI – dedicated as crystalline oxides and phytoliths/secondary clay minerals – made out for 25%. Only 5% of the total amount of Ge in soil accounted for the fractions I to IV. There was found a statistical significant correlation between the absolute Ge concentrations in these latter soil fractions with the Ge concentration in plant material of the same site. Therefore it seems that the fractions I to IV could be regarded as a proxy for the bioavailable pool of Ge in soils.
Concerning Nd the residual siliceous fractions made out for 60% of the total, whereas the fraction III (oxidisable) constitutes for 30%. The remaining 10% accounted for the other soil fractions. No correlation between the concentration in one soil fraction and the concentration in plant material from the same site could be found. There was also no correlation between the total amount in soil and the concentration in plant material from the same site neither for the REEs nor for Ge.
These results can give only hints on the processes regarding the mobilisation of the bioavailable pool of Ge and REEs. Further investigations are necessary and will be taken in the PhytoGerm project.