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GEMAS: Concentrations and origin of indium in agricultural soil of Europe

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Indium is classified as a critical metal, urgently needed in the electronics industry, especially for the production of solar panels and LCD screens. It is a volatile chalcophile rare element and its primary sources are different types of sulphide ore deposits. Although sphalerite is the main host mineral for indium, chalcopyrite-rich ores usually contain the highest contents of this element. Apart from common sulphides, higher indium concentrations can occur in cassiterite, wolframite and magnetite, in addition to few known indium minerals such as roquesite.
Indium is a very rare element and its determination needs a technique with very low detection limits. Data for In are hardly ever provided in geochemical data sets due to its function as an internal standard when using the ICP-MS for analysis. Within the GEMAS project, over 4000 samples of agricultural (Ap) and grazing land (Gr) soil have been collected, and indium concentrations have been measured by ICP-MS in an aqua regia extraction.
The median value of aqua regia extractable In in European soil is 0.0176 mg/kg in the Ap and 0.0177 mg/kg in the Gr samples. The most striking pattern on an In distribution map of Europe in an aqua regia extraction is the large difference between northern (low - median 0.012 mg/kg In in the Ap samples) and southern Europe (high - median 0.021 mg/kg In in the Ap samples). The boundary between predominantly high and low concentrations follows exactly the southernmost limit of the last glaciation.
In southern Scandinavia, clay-rich soil is indicated by In anomalies, as is the Oslo Rift and the old silver mine at Kongsberg (Norway). Generally, distinct In anomalies mark many of the famous old mining areas of the continent, typically those featuring relatively young hydrothermal deposits (northern Portugal, Iberian Pyrite Belt, Cornwall in the UK, Harz in Germany and Erzgebirge at the German/Czech border), and granitic intrusions (probably related to associated Sn and skarn mineralisation). The Roman and Neapolitan volcanic provinces in Italy are indicated by distinct In anomalies, and one of the most extensive anomalies in Europe occurs over the karst in Croatia, Slovenia, Bosnia and Herzegovina and Montenegro.
At the European scale, an additional air-borne deposition of In, originating from the metal smelting industry and coal combustion, has not been recognised.