

## Chemistry of Europe's agricultural soils - the GEMAS project

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Geochemical Mapping of Agricultural and grazing land Soil (GEMAS) is a cooperative project between the Geochemistry Expert Group of EuroGeoSurveys and Eurometaux. During 2008 and until early 2009, a total of 2108 samples of agricultural (ploughed land, 0-20 cm) and 2023 samples of grazing land (0-10 cm) soil were collected at a density of 1 site/2500 km<sup>2</sup> each from 33 European countries, covering an area of 5,600,000 km<sup>2</sup>. All samples were analysed for 52 chemical elements following an aqua regia extraction, 41 elements by XRF (total), and soil properties, like CEC, TOC, pH (CaCl<sub>2</sub>), following tight external quality control procedures. In addition, the agricultural soil samples were analysed for 57 elements in a mobile metal ion (MMI<sup>®</sup>) extraction, Pb isotopes and magnetic susceptibility. The GEMAS project thus provides for the first time fully harmonised data for element concentrations and soil properties known to influence the bioavailability and toxicity of the elements at the continental (European) scale. The provided database is fully in compliance with the requirements of the European REACH Regulation (Registration, Evaluation, Authorisation and Restriction of Chemicals). It also provides valuable information for other European pieces of legislation related to metals in soil.

The results demonstrate that robust geochemical maps of Europe can be constructed based on low density sampling. At the European scale element distribution patterns are still governed by natural processes, most often a combination of geology and climate.

## An Iceland-like Setting for Generation of Earth's Earliest Known Crust

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The Acasta Gneiss Complex (AGC) contains the oldest rocks on Earth with U-Pb zircon ages indicating crust formation between 3.6-4.03 Ga [1-3]. Here we report whole rock geochemistry along with SIMS U-Pb, trace element, and O-isotope compositions of zircon from a >4.0 Ga tonalite unit identified during detailed mapping of the AGC.

Unlike typical Archean TTGs [4], this unit is characterized by moderate silica contents (58-62 wt % SiO<sub>2</sub>), strong Fe-enrichment (12-15 wt% FeO), and low Mg numbers (13-18). REE patterns are relatively unfractionated (La/Yb<sub>N</sub> ~2.5) and contain a significant negative Eu anomaly. These features strongly suggest that, unlike deep-seated Archean TTG magmas [4], the evolution of this AGC tonalite was dominated by shallow-level fractionation processes involving plagioclase.

Zircons from this well preserved unit document complex morphological patterns, very similar to previously described pre-4.0 Ga zircons from the AGC [1]. Two phases of igneous zircon growth, centers and mantles, are compositionally distinct but record indistinguishable U-Pb ages >4.01 Ga. Oxygen isotopic compositions from zircon centers and mantles document a decrease in δ<sup>18</sup>O from a mean of 5.6±0.1‰ to a mean of 4.7±0.1‰. This center to mantle decrease in δ<sup>18</sup>O can be explained by late-stage assimilation of hydrothermally altered crust.

Collectively, these data for the >4.0 Ga AGC tonalite are strikingly similar to those reported for intermediate rocks from Iceland (e.g., icelandites), which are thought to have formed by a combination of shallow-level basaltic magma fractionation and assimilation of surface-water altered crust [e.g., 5]. Thus, Iceland may serve as a suitable analogue for the generation of Earth's earliest proto-continental crust.

[1] Bowring & Williams, (1999) *Cont. Min. Petro.* **134**, 3-16.  
[2] Stern & Bleeker, (1999) *Geosci Can* **25**, 28-31. [3] Iizuka *et al.*, (2007) *Precambrian Research* **153**, 179-208. [4] Moyen & Martin, (2012) *Lithos* **148**, 312-336. [5] Wood, (1978) *Journal of Petrology* **19**, 393-436