GEMAS: Geochemical mapping of agricultural and grazing land soil at the continental scale

Clemens Reimann and the GEMAS Project Team
GEMAS – The Project Team

REACH Selenium & Tellurium Consortium
**Geochemical Mapping of Agricultural Soil (GEMAS)**

**2007: Eurometaux contacts EuroGeoSurveys:**

Land-use related geochemical data needed at the European scale for **REACH** (Registration, Evaluation, Authorisation and restriction of Chemical substances)

- Grazing land soil, 0-10 cm
- 2 sample materials at 1 site/2500 km²
- <2 mm fraction
- Aqua regia extraction

- Agricultural soil ($A_p$-horizon), 0-20 cm
Agricultural soils (A_p) 0-20 cm

Grazing land soils (Gr) 0-10 cm

GEMAS - 2008

N = 2108

N = 2024

33 countries - 5.6 million km² - 4132 samples in total
GEMAS – total concentration, major elements

(A_p) 0-20 cm

Calcium, XRF: limestones, note Fennoscandia

Silicon, XRF: sandstones, coarse grained, sandy soils

Geology is the driving force behind most of the patterns
Soil parent material
(based on the European Soil Geographical Data Base 1:1 Million)

- alluvium/colluvium
- calcearous rocks
- clayey materials
- crystalline rocks
- detrital formations
- glaciofluvial materials
- loamy/silty
- marl
- other/organic
- sandstone/flysch/molasse
- sandy materials
- schists
- volcanic rocks
Lead: Two independent sample materials show comparable patterns. Large difference between N- and S-Europe.
Agricultural soils ($A_p$) 0-20 cm

Ore deposits: 1, 3, 7, 8, 9, 12, 13, 14, 15, 16, 18, 19, 21, 24, 25, 26, 27, 20, 31, 33, 34, 35, 36, 37, 38, 39, 42, 44, 47, 53

Geology: 5, 20, 28, 29, 40, 41, 43, 46, 48

Cities: 2, 10, 11, 23, 49

Contamination: 6, 17, 32, 50, 51, 52

Unexplained: 4, 22, 45
(A_p) 0-20 cm

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Mercury: natural sources (ore deposits, volcanoes), some cities, border of last glaciation – with regards to metals: EUROPE´S SOIL IS SURPRISINGLY CLEAN!
GEMAS: local vs. continental scale

78 x 58 km, 3736 samples, ca. 4500 km²

Mercury in topsoil 0-10 cm, Berlin, Germany

(Birke, M. & Rauch, U., 1997)
**GEMAS 2010-2013**

**Ap 0-20 cm**

**Zr, aqua regia:** note the Italian alkaline volcanics

**Zr, XRF:** the central European loess belt is visible
Pinatubo, eruption 1991, within 2 days:

10,000,000,000 t magma
20,000,000 t $\text{SO}_2$
2,000,000 t Zn
1,000,000 t Cu
550,000 t Cr
300,000 t Ni
100,000 t Pb
5,500 t Cd
800 t Hg
Element deficiency needs attention

- Copper, aqua regia: >10% of all values <10 mg/kg
- Zinc, aqua regia: 5% of all values <12 mg/kg
Sulphur, aqua regia: coast and organic material in soil

Selenium, aqua regia: strong coastal effect

Climate has an important impact on the observed patterns!
GEMAS – Analytical Program

| H | Li | Be | Na | Mg | K | Ca | Sc | Ti | V | Cr | Mn | Fe | Co | Ni | Cu | Zn | Ga | Ge | As | Se | Br | Kr | Rb | Sr | Y | Zr | Nb | Mo | Tc | Ru | Rh | Pd | Ag | Cd | In | Sn | Sb | Te | I | Xe | Cs | Ba | La | Hf | Ta | W | Re | Os | Ir | Pt | Au | Hg | Tl | Pb | Bi | Po | At | Rn |
|   | B | C | N | O | F | Ne | Al | Si | P | S | Cl | Ar | K | Ca | Sc | Ti | V | Cr | Mn | Fe | Co | Ni | Cu | Zn | Ga | Ge | As | Se | Br | Kr | Rb | Sr | Y | Zr | Nb | Mo | Tc | Ru | Rh | Pd | Ag | Cd | In | Sn | Sb | Te | I | Xe | Cs | Ba | La | Hf | Ta | W | Re | Os | Ir | Pt | Au | Hg | Tl | Pb | Bi | Po | At | Rn |
| Ce | Pr | Nd | Pm | Sm | Eu | Gd | Tb | Dy | Ho | Er | Tm | Yb | Lu | Th | Pa | U | Np | Pu | Am | Cm | Bk | Cf | Es | Fm | Md | No | Lr |

+ \( \text{pH}_{\text{CaCl}_2} \), CEC, TOC, LOI, grain size
\( \text{Pb isotopes} \), \( 7N \) HNO\(_3 \) extraction, Ap samples
\( \text{Sr isotopes} \), in progress
Magnetic susceptibility, Ap samples
Kd-values, 14 metals
MIR spectra
GEMAS

- Evidence for diffuse industrial contamination?
- Evidence of other anthropogenic impacts?
- What levels of potentially harmful elements?
- Element deficiencies?
- Differences between the European countries?
- Geology and/or Climate reflected?
- Is European agricultural soil of good chemical quality?
GEMAS history – 1950ies to 2013
For more details join us at the EuroGeoSurveys GEMAS workshop this afternoon

Thank you for your attention!