

Global Geochemistry webinar “Generating geochemical information for society: sample analysis”

12-13/11/2025



Geochemical data: the basis of all scientific reasoning on soil chemistry

GEG EGS Philippe Negrel

support team GEG Anna Landenberger – Alecos Demetriades

November 13, 2025

Geochemistry Expert Group EGS – 2024-2025

- 63 official members, including the national delegates, representing 32 European countries.
- More than 40 external co-workers cooperating with the group:
 - in projects:
 - current
 - ongoing project design
 - in the publication of results.



- Publication of the EGS factsheet on soil



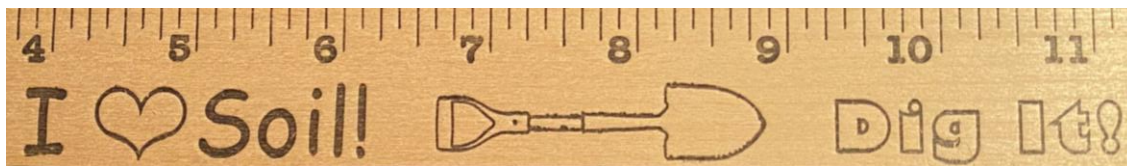
5. European Commission. Soil health – protecting, sustainably managing and restoring EU soils. European Commission – Help you see <https://ec.europa.eu/soil/en/soil-fact-sheet/soil-health-from-the-sky> (visited on 02/06/2022).
6. Eurofior for soils. Eurofior soils feedback on the proposed regulation for a Directive on Soil Monitoring and Resilience. Eurofior for soils <https://www.eurofior.eu/en/soil-monitoring-regs/soil-feedback-on-the-proposed-regulation-4> (visited on 02/06/2022).
7. FOMGOS – Geochemical Baseline Database. Instructions. <https://www.gfb.fr/pubs/geochemical-baseline-data.php>.
8. FOMGOS Project Home. <https://www.eurofior.eu/en/soil-monitoring-regs/soil-feedback-on-the-proposed-regulation-4>.

The Geological Surveys of Europe

Geochemistry at different scale, up to pan continental projects



FOREGS
*Forum of the
European Geological Surveys Directors*



Geochemistry: different approaches



Samples

- water
- Soil-sediment-rocks

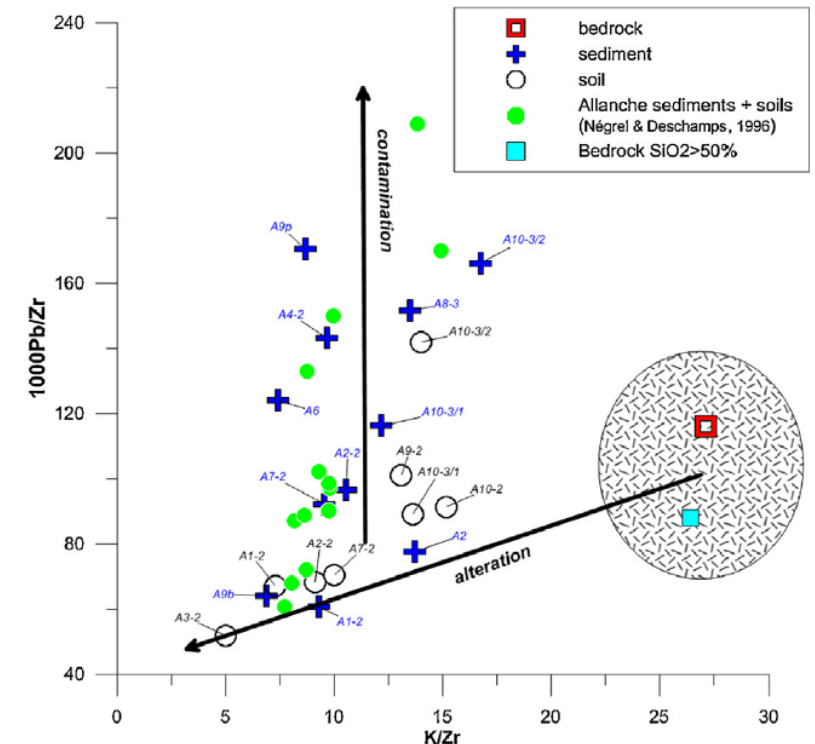
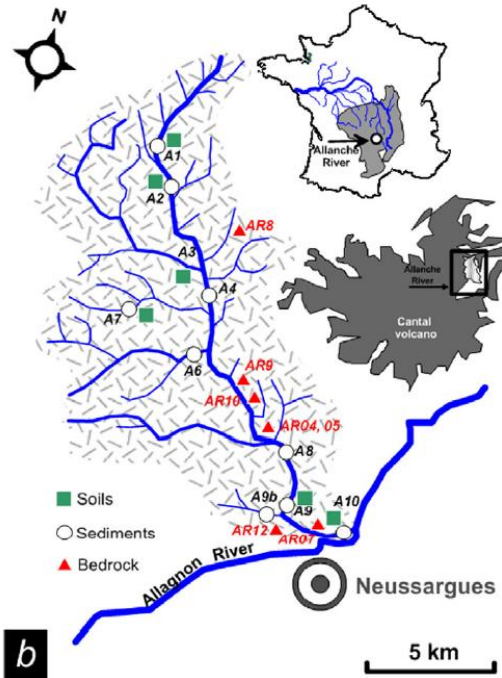


Fig. 3. (Color online.) Relationships between the 1000Pb/K vs. Zr/K ratios in Allanche bedrock, soil and sediment. Data for the bedrock with $\text{SiO}_2 > 50\%$ correspond to erratic blocs in the upstream part of the Allanche catchment (Négrel and Deschamps, 1996). Data referred to as "Allanche sediments + soils (Négrel and Deschamps, 1996)" correspond to sediment and soil data in the Allanche catchment in which no lead isotope

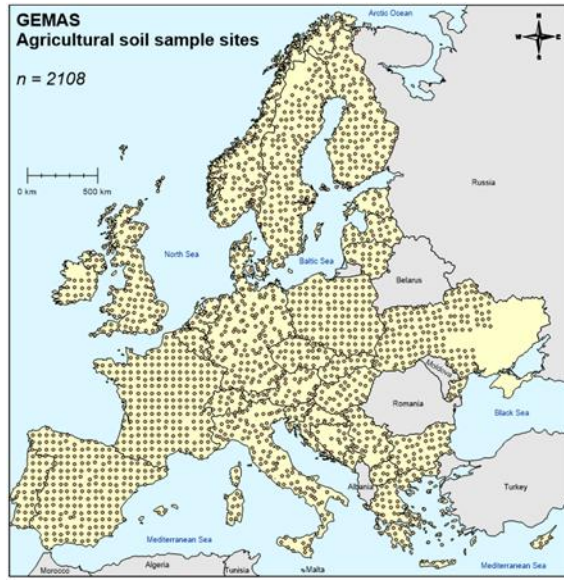
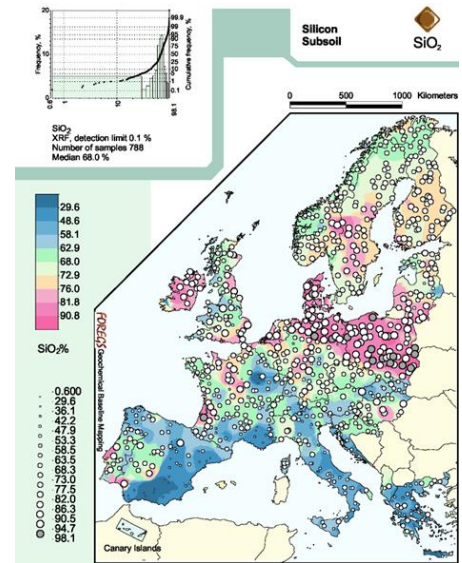
Name	$^{206}\text{Pb}/^{204}\text{Pb}$	$^{207}\text{Pb}/^{204}\text{Pb}$	$^{208}\text{Pb}/^{204}\text{Pb}$	Pb	SiO_2	K_2O	Zn	Zr
Sediments				Ref. 1	Ref. 1	Ref. 1	Ref. 1	Ref. 1
A2	19.42	15.67	40.21	27	43.73	1.15	127	348
A6	19.42	15.68	40.22	34	42.17	0.49	128	274

Geochemistry: different approaches

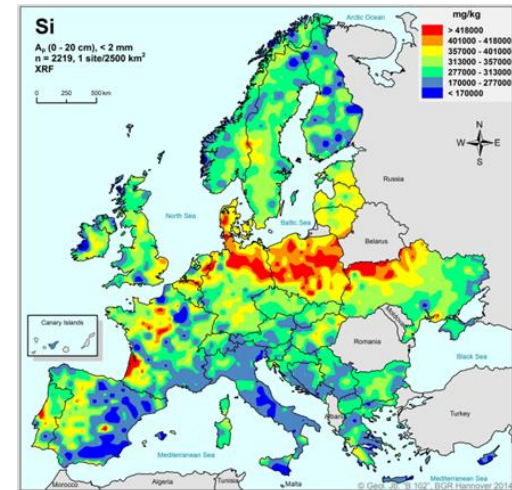


Samples

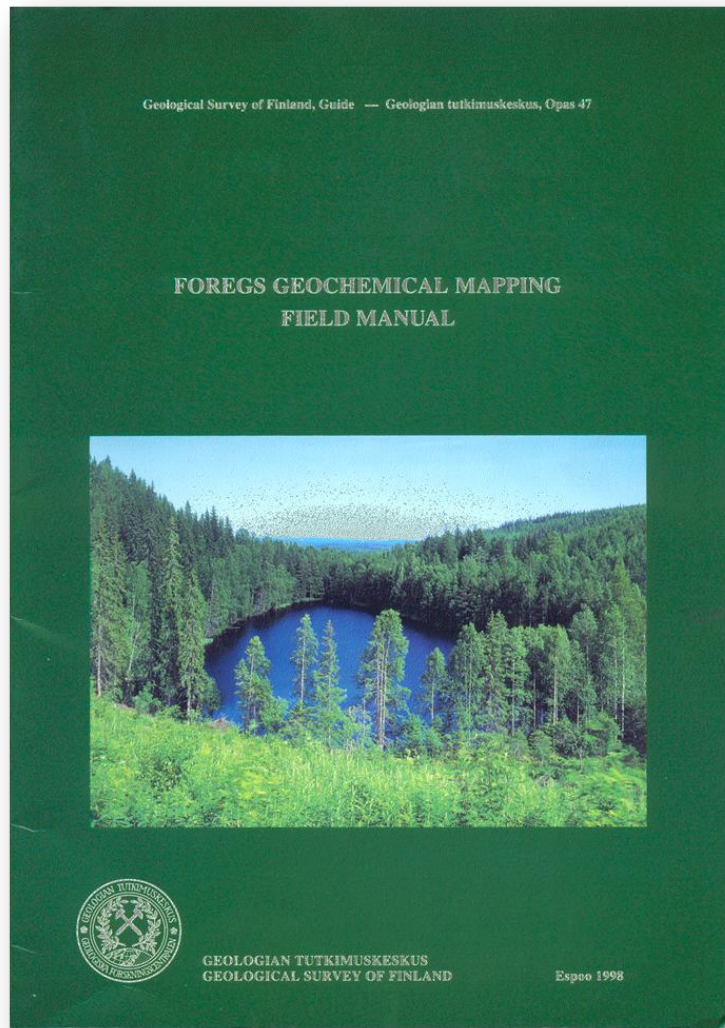
- Water (FOREGS)
- Soil (FOREGS/GEMAS)
- Sediment (FOREGS)



ID	COUNTRY	C_ID	TYPE	TYPE2	KC00	Y000	KLAA	YLA	ALT	CIA	sand	silt	clay	sand_silt_nor	clay_nor	soiltype	soilclass	climate	MeanTemp	hmm	PM	CEC	pH	CaCl2	TOC	Ag	Al	As	Au	B	Ba	Be	Bi	Ca	
3099	ITA	55	Ap	Ap	12.2636	42.4368	4007776	2123884	281	59.7	47	26	27			I	M	Medi	14.4	800	alt	16	6.68	11	0.0773	62480	11.275	0.00281	6.34	48.49	11.949	0.986	18.64		
3141	ITA	37	Ap	Ap	14.6144	40.9478	4711082	3995061	190	43.3	36	51	12			I	M	Medi	15.5	875	alt	22.6	6.87	9	0.0931	58088	12.208	0.00275	23.88	48.81	11.974	0.986	18.64		
3680	ITA	29	Ap	Ap	15.7408	40.4364	4809952	1945183	844	78.4	31	42	27			I	M	Medi	11.0	702	alt	30	7.57	10	0.0852	61223	11.275	0.00281	6.34	48.49	11.949	0.986	18.64		
3825	ITA	47	Ap	Ap	15.2008	41.7888	4762196	2089482	97	64.8	40	31	30			I	M	Medi	15.1	805	alt	36.7	6.57	13.019	20699	9.160	0.07845	7.00	25.318	24.313	0.2942	0.526	10.52		
3881	ITA	39	Ap	Ap	14.5333	41.1947	4701887	2021882	77	61.9	40	34	21			I	M	Medi	14.7	819	alt	36.7	6.57	13.019	20699	9.160	0.07845	7.00	25.318	24.313	0.2942	0.526	10.52		
3952	ITA	46	Ap	Ap	14.3275	41.6222	4662838	2088158	698	80.2	23	36	30			I	M	Medi	12.1	753	alt	39.9	6.39	12.0568	39989	14.098	0.02682	2.56	58.49	2.470	1.174	0.348	11.734		
4449	ITA	48	Ap	Ap	15.8819	41.9947	4795116	2085662	591	69.8	43	34	17			I	M	Medi	12.8	547	alt	29.5	6.92	24.951	54681	17.698	0.07681	7.00	25.318	24.313	0.2942	0.526	10.52		
4723	ITA	54	Ap	Ap	11.8787	41.3939	4477115	2145046	183	58.7	32	38	20			I	M	Medi	13.4	819	alt	39.9	6.39	12.0568	39989	14.098	0.02682	2.56	58.49	2.470	1.174	0.348	11.734		
4752	ITA	23	Ap	Ap	16.2531	38.5395	4868872	1745833	601	88.4	36	38	12			I	M	Medi	14.0	922	alt	11.9	4.86	1.0545	48040	9.940	0.07621	24.1	17.318	0.043	0.7832	1.295	12.93		
4882	ITA	38	Ap	Ap	14.1766	41.1888	4672718	2018987	73	44.8	39	30	10			I	M	Medi	13.0	896	alt	17.2	7.34	24.952	46838	9.940	0.07621	24.1	17.318	0.043	0.7832	1.295	12.93		
5259	ITA	52	Ap	Ap	13.0553	42.0567	4678076	2109939	638	81.5	38	40	13			I	M	Medi	13.3	940	alt	71.4	4.48	4.02004	4975	13.017	0.000313	5.17	33.418	0.081	0.761	1.295	12.93		
5350	ITA	24	Ap	Ap	16.3781	39.0728	4879005	1799315	728	81.9	61	36	1			I	M	Medi	13.3	940	alt	71.4	4.48	4.02004	4975	13.017	0.000313	5.17	33.418	0.081	0.761	1.295	12.93		
5376	ITA	38	Ap	Ap	14.6202	40.8812	4738003	1989402	488	58.4	33	43	6			I	M	Medi	13.3	940	alt	71.4	4.48	4.02004	4975	13.017	0.000313	5.17	33.418	0.081	0.761	1.295	12.93		
5021	ITA	104	Ap	Ap	38.9556	46.0121	4395133	2544708	250	74.1	30	46	17			I	M	Temp	14.87	874	temp	16.7	7.19	19.083	14657	9.724	0.000456	4.91	10.21	0.3619	0.729	0.585	10.52		
5031	SPA	81	Ap	Ap	-1.6328	41.3188	3947811	2099276	623	20.2	34	33	22			I	M	Medi	12.3	396	alt	16.5	7.55	17.0081	5667	8.813	0.02199	3.23	0.9424	0.383	0.908	0.729	0.585	10.52	
5032	ITA	62	Ap	Ap	12.6883	42.8886	4454281	2020252	216	76.9	10	13	27			I	M	Medi	13.4	896	alt	39.9	6.39	12.0568	39989	14.098	0.02682	2.56	58.49	2.470	1.174	0.348	11.734		
5033	CYP	4	Ap	Ap	32.8853	34.6558	6416753	1604837	8	65.1	33	32	27			I	M	Medi	13.87	426	alt	32.9	7.61	17.0501	20044	6.756	0.05112	13.89	0.205	0.184	0.908	0.729	0.585	10.52	
5058	SPA	152	Ap	Ap	-1.7709	39.0313	3300207	1850528	692	62.7	70	18	12			I	M	Medi	14.2	385	alt	22.1	7.55	17.0501	20044	6.756	0.05112	13.89	0.205	0.184	0.908	0.729	0.585	10.52	
5097	SPA	83	Ap	Ap	-6.385	41.4644	3453013	2100994	226	79.6	39	18	22			I	M	Medi	13.4	896	alt	39.9	6.39	12.0568	39989	14.098	0.02682	2.56	58.49	2.470	1.174	0.348	11.734		
5109	ITA	51	Ap	Ap	13.9968	42.0519	4619708	2124647	714	74.2	41	28	27			I	M	Medi	11.7	896	alt	36.7	7.47	1.0324	17027	9.768	0.02208	8.06	13.018	0.1238	0.4575	0.856	1.295	12.93	
5116	FRA	26	Ap	Ap	4.2256	49.0889	3999439	2900315	87	13.5	48	23	15			I	M	Temp	10.2	635	alt	18.6	7.42	24.952	46838	9.940	0.07621	24.1	17.318	0.043	0.7832	1.295	12.93		
5126	SPA	48	Ap	Ap	-2.1397	42.0983	3301782	2194105	999	23.6	52	24	15			I	M	Medi	12.4	896	alt	39.9	6.39	12.0568	39989	14.098	0.02682	2.56	58.49	2.470	1.174	0.348	11.734		
5138	HEL	22	Ap	Ap	21.3839	40.2892	5288058	1882992	670	56	13	48	27			I	M	Temp	11.6	710	alt	38.7	7.34	14.0227	2885	4.635	0.000080	7.95	40.7	0.077	0.1077	0.351	0.7832	1.295	
5155	SPA	49	Ap	Ap	-1.8025	42.2501	3346258	2204336	528	78.5	58	28	19			I	M	Medi	13.4	896	alt	39.9	6.39	12.0568	39989	14.098	0.02682	2.56	58.49	2.470	1.174	0.348	11.734		
5168	SPA	128	Ap	Ap	-1.3708	39.9794	3348898	1949133	1150	41.7	40	35	20			I	M	Medi	11.1	484	alt	22.4	7.46	15.0327	18416	9.556	0.051036	6.34	48.49	11.949	0.986	18.64	0.7792	0.1238	0.4575
5178	HEL	46	Ap	Ap	22.4347	38.4411	5408334	1795208	15	72.1	10	65	30			I	M	Temp	17.6	673	alt	29.5	7.53	14.9627	22126	7.628	0.000019	6.96	10.4	0.6072	0.202	0.845	0.729	0.585	10.52
5187	AUS	29	Ap	Ap	15.1822	48.2095	4705973	3810563	259	71.6	58	21	21			I	M	Medi	12.8	547	alt	29.5	7.53	14.9627	22126	7.628	0.000019	6.96	10.4	0.6072	0.202	0.845	0.729	0.585	10.52
5207	FRA	159	Ap	Ap	1.533	44.8152	3651669	2449521	245	82.6	51	31	13			I	Temp	12.2	824	alt	36.7	7.23	46.0742	22133	14.953	0.02323	4.98	10.26	1.4216	0.3444	0.719	0.351	0.7832	1.295	
5224	PTG	29	Ap	Ap	-7.9833	38.05	2746780	1849581	185	39.8	56	11	23			I	M	Medi	14.6	563	alt	34.8	7.47	23.074	20310	9.921	0.07059	3.1	0.23	0.231	0.351	0.7832	1.295		
5245	SPA	111	Ap	Ap	-9.1796	40.2338	3200050	1999941	780	32.2	51	33	27			I	M	Medi	12.8	547	alt	29.5	7.53	14.9627	22126	7.628	0.000019	6.96	10.4	0.6072	0.202	0.845	0.729	0.585	10.52

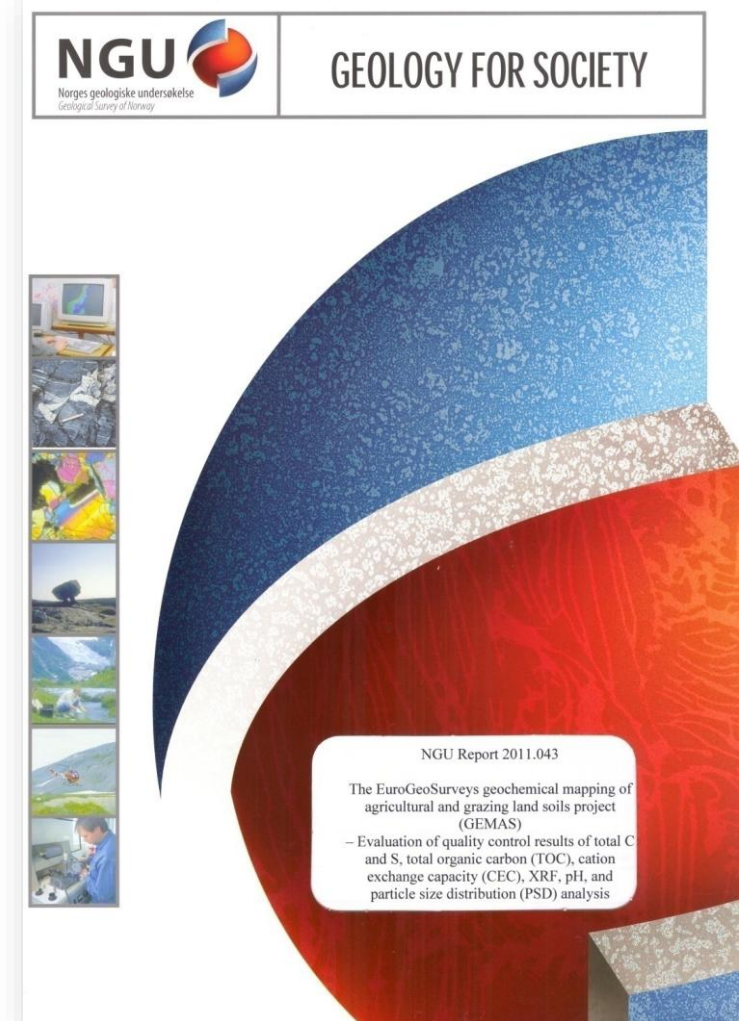


Preparing the survey: need to build on solid foundations.



https://tupa.gtk.fi/julkaisu/opas/op_047.pdf

→
The GEMAS Field Manual



https://static.ngu.no/upload/Publikasjoner/Rapporter/2008/2008_038.pdf

←
**The FOREGS
Geochemical Mapping
Field Manual**



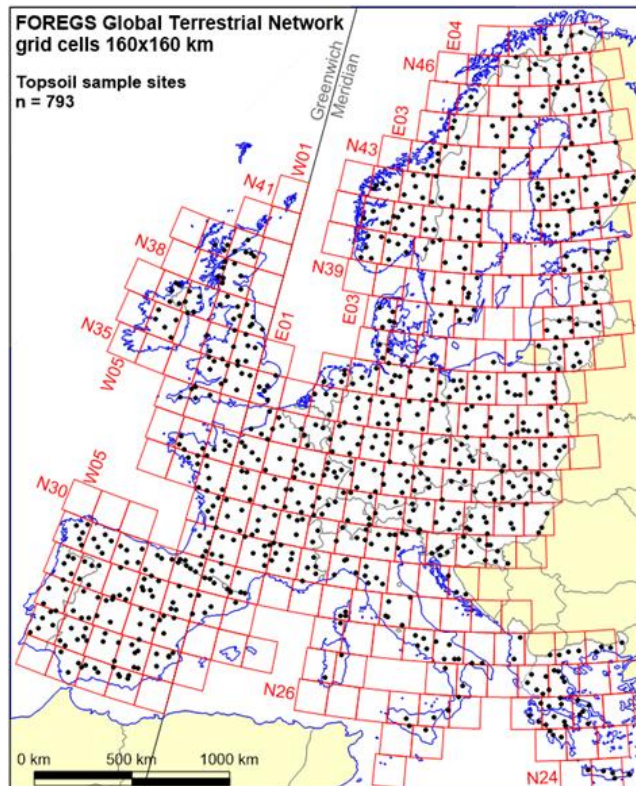
EuroGeoSurveys - The Geological Surveys of Europe



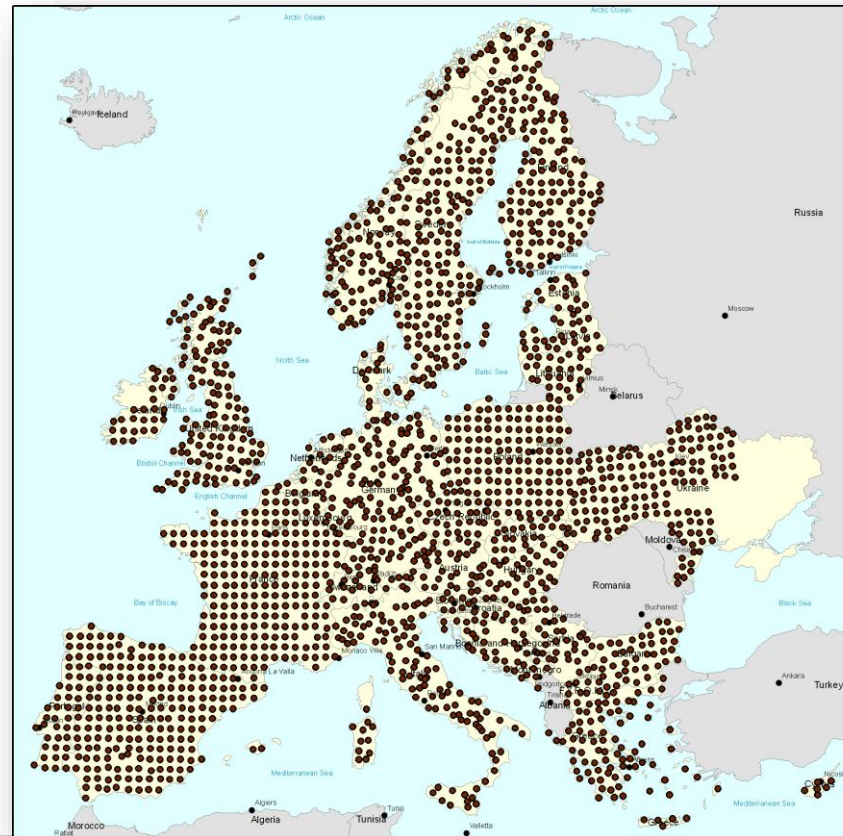
Geochemistry Expert Group => pan continental projects

FOREGS survey: soil, sediments, water at a sampling density of 1 site/4800 km²
905 soil samples

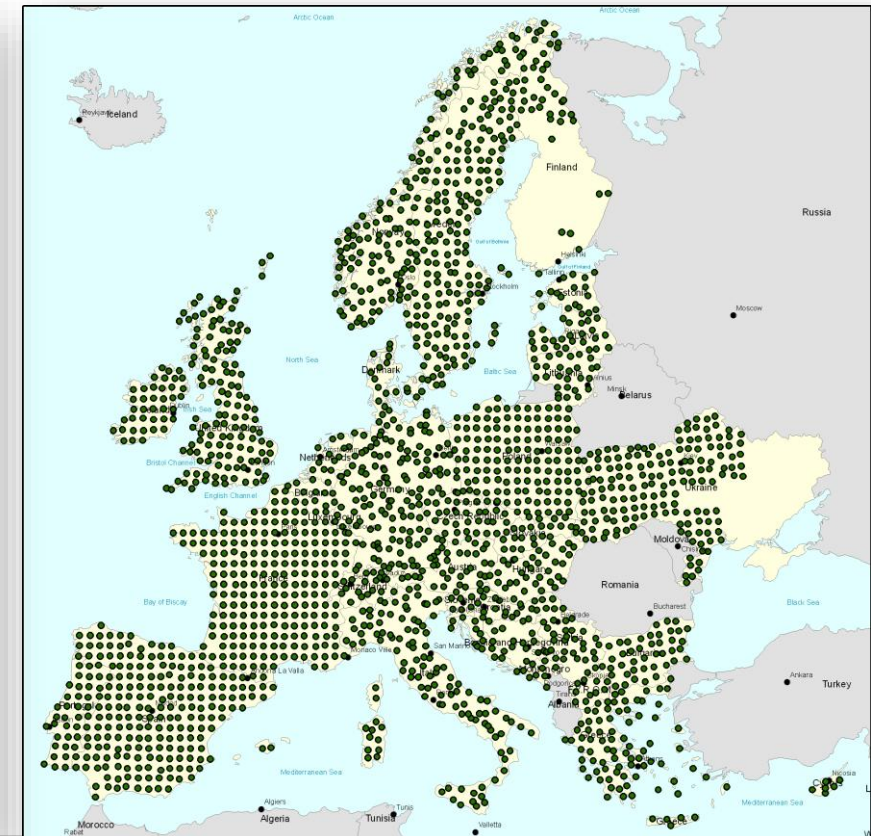
GEMAS surveys: two different soil samples collected at a sampling density of 1 site/2500 km²



Agricultural soil (A_p) 0-20 cm (N = 2108)



Grazing land soil (Gr) 0-10 cm (N = 2024)



EuroGeoSurveys - The Geological Surveys of Europe

GEMAS — GGeochemical Mapping of Agricultural and grazing land Soil of Europe

GEMAS project – Analytical Programme

- **ACME commercial laboratory:** Hot aqua regia extraction on 15 g aliquot of <2 mm soil fraction (53 elements) and determination by ICP-MS/AES:
Ag, Al, As, Au, B, Ba, Be, Bi, Ca, Cd, Ce, Co, Cr, Cs, Cu, Fe, Ga, Ge, Hf, Hg, In, K, La, Li, Mg, Mn, Mo, Na, Nb, Ni, P, Pb, Pd, Pt, Rb, Re, S, Sb, Sc, Se, Sn, Sr, Ta, Te, Th, Ti, Tl, U, V, W, Y, Zn and Zr.
-
- **BGR, Germany, Total element concentrations by X-Ray Fluorescence (41 determinands):** SiO₂, TiO₂, Al₂O₃, Fe₂O₃, MnO, MgO, CaO, Na₂O, K₂O, P₂O₅, SO₃, LOI, Cl, F, As, Ba, Bi, Ce, Co, Cr, Cs, Cu, Ga, Hf, La, Mo, Nb, Ni, Pb, Rb, Sb, Sc, Sn, Sr, Ta, Th, U, V, W, Y, Zn and Zr.
- **SGS (Canada) – Extraction by cold Mobile Metal Ion (MMI®)** on the agricultural soil samples only (53 elements) and determination by ICP-MS: Au, Ba, Bi, Ca, Cd, Ce, Co, Cr, Cs, Cu, Dy, Er, Eu, Fe, Ga, Gd, Hg, In, K, La, Li, Mg, Mn, Mo, Nb, Nd, Ni, P, Pb, Pd, Pr, Pt, Rb, S, Sb, Sc, Se, Sm, Sn, Sr, Ta, Tb, Te, Th, Ti, Tl, U, V, W, Y, Yb, Zn and Zr.



GEMAS — GGeochemical Mapping of Agricultural and grazing land Soil of Europe

➤ **Geological Survey of Norway:**

➤ pH-CaCl₂

➤ (*determinations on the agricultural (Ap) soil samples only*): Total Carbon and Sulphur, Pb isotopes (²⁰⁶Pb/²⁰⁷Pb, ²⁰⁶Pb/²⁰⁸Pb, ²⁰⁷Pb/²⁰⁸Pb), Magnetic susceptibility, soil colour on dry and wet samples.

➤ **Geological Survey of Slovakia:** Cation Exchange Capacity (CEC).

➤ **FUGRO (now KIWA):** Total Organic Carbon (TOC) and grain size.

➤ **Copenhagen & Canberra Universities:** Sr isotopes (*agricultural soil only*).

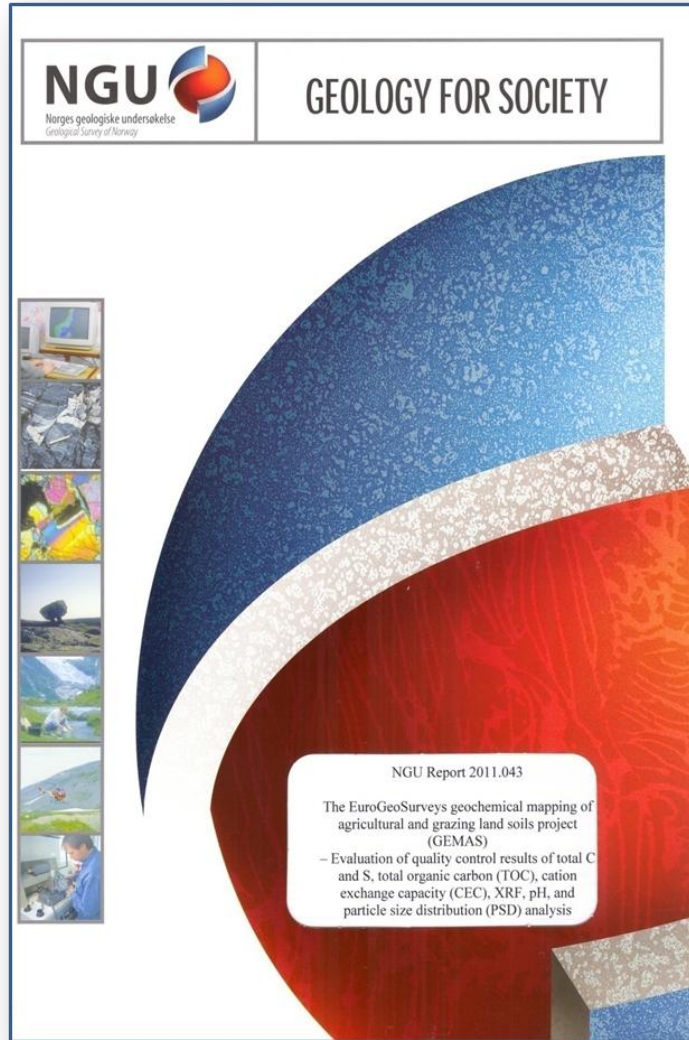
➤ **TU Bergakademie Freiberg:** Total C, N, S (*agricultural soil only*).

➤ **Kazan Federal University, Tartastan, Russia:** Magnetic measurements (*agricultural soil only*).

➤ **CSIRO Land and Water, Adelaide, Australia:** Determination of Partitioning coefficients (K_d) for Ag, B, Co, Cu, Mo, Mn, Ni, Pb, Sb, Se, Sn, Te, V, and Zn by Mid-Infrared Diffuse Reflectance Spectroscopy (MIR).



Quality control reports



Quality control reports were written for each set of analytical results received



GEMAS Quality control report on the aqua regia extraction analysis results

https://static.ngu.no/upload/Publikasjoner/Rapporter/2009/2009_049.pdf

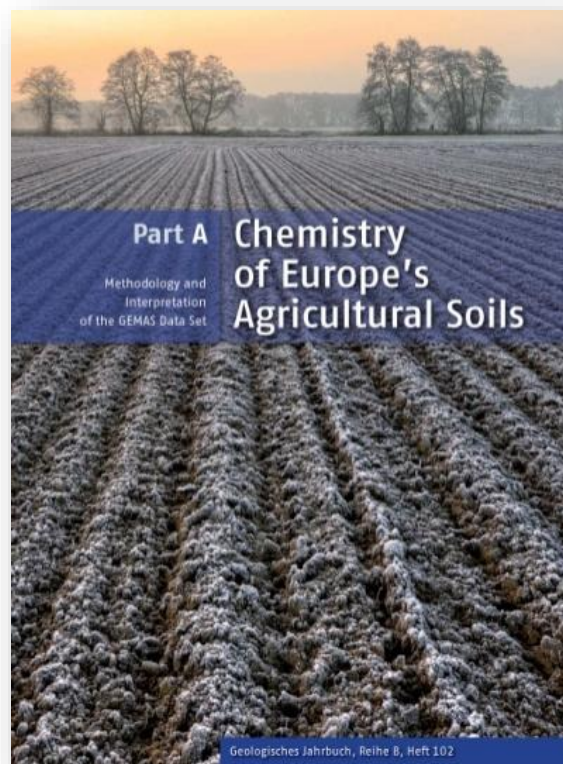
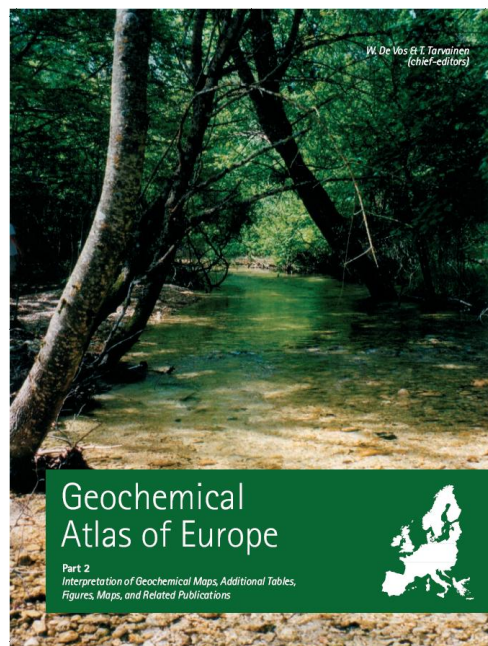
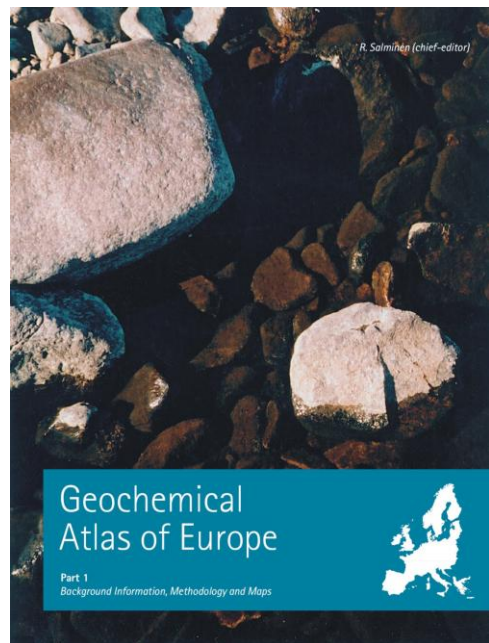
sound reasoning based on sound data



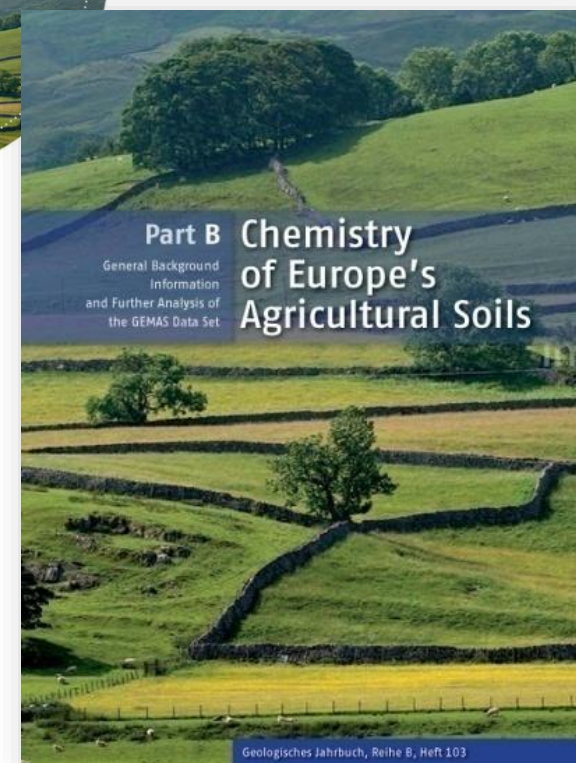
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Printed Publications



Reimann *et al.* (2014a)



Reimann *et al.* (2014b)

<http://www.schweizerbart.de/publications/detail/isbn/9783510968466>

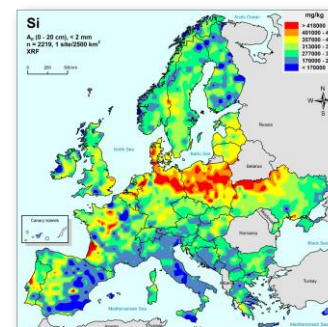
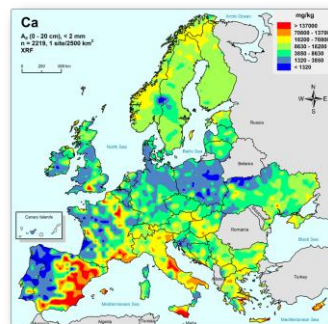


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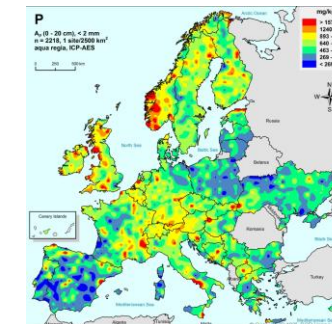


GEMAS highlights - I

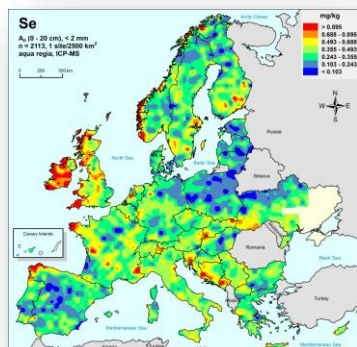
The impact of geology or rather lithology



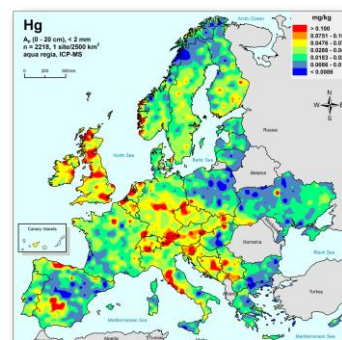
The nutrients fate



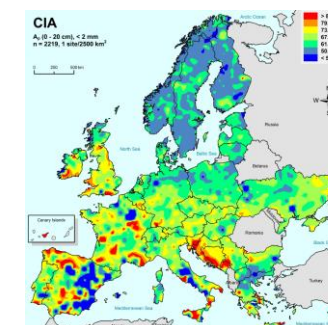
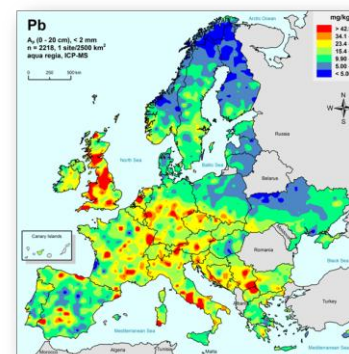
The impact of climate



The impact of human activities



The weathering processes



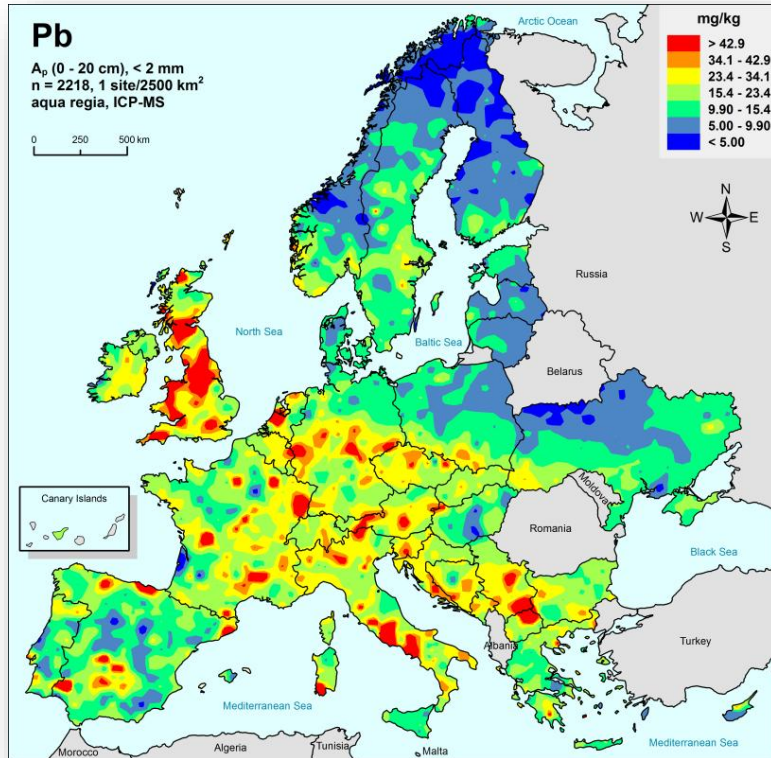
$$CIA = [Al_2O_3 / (Al_2O_3 + CaO^* + Na_2O + K_2O)] \times 100$$



EuroGeoSurveys - The Geological Surveys of Europe

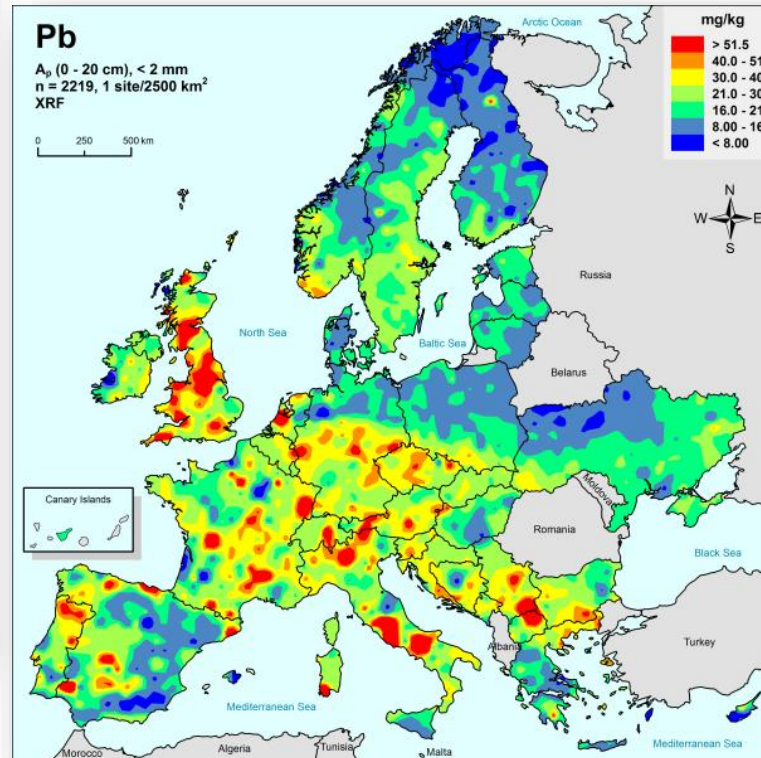
GEMAS highlights - II

Hot aqua regia extraction



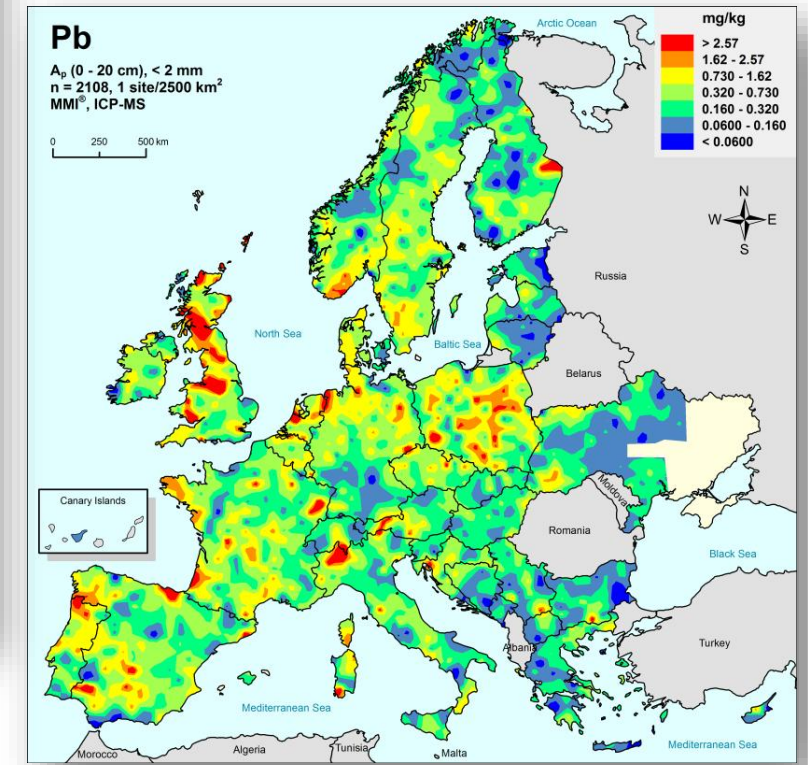
Source: Reimann *et al.*, 2014a

Total (XRF)



Source: Reimann *et al.*, 2014a

Cold Mobile Metal Ion (MMI[®]) extraction



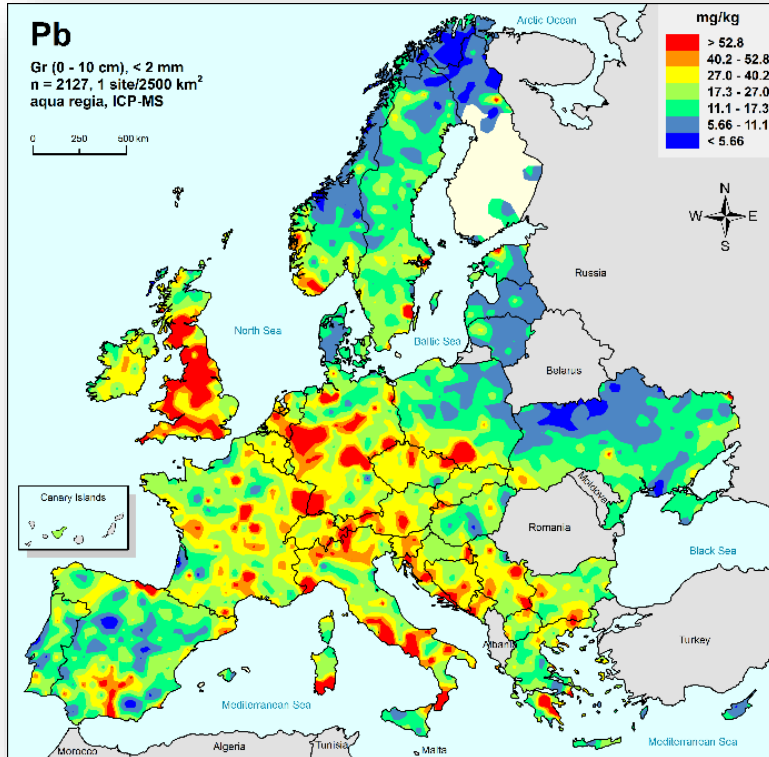
Source: Reimann *et al.*, 2014a



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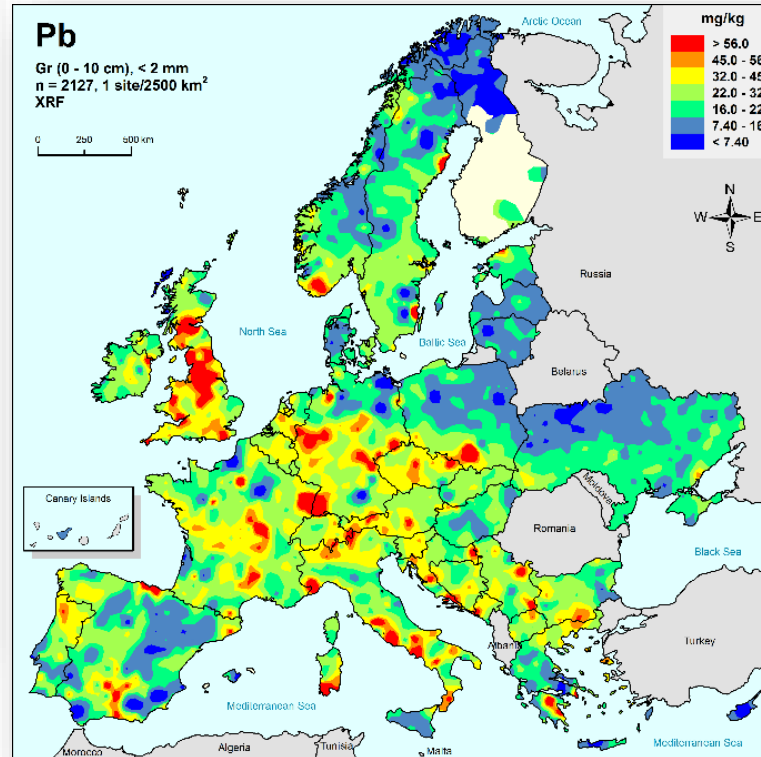
GEMAS highlights - III

Hot aqua regia extraction



Source: Reimann *et al.*, 2014a

Total (XRF)



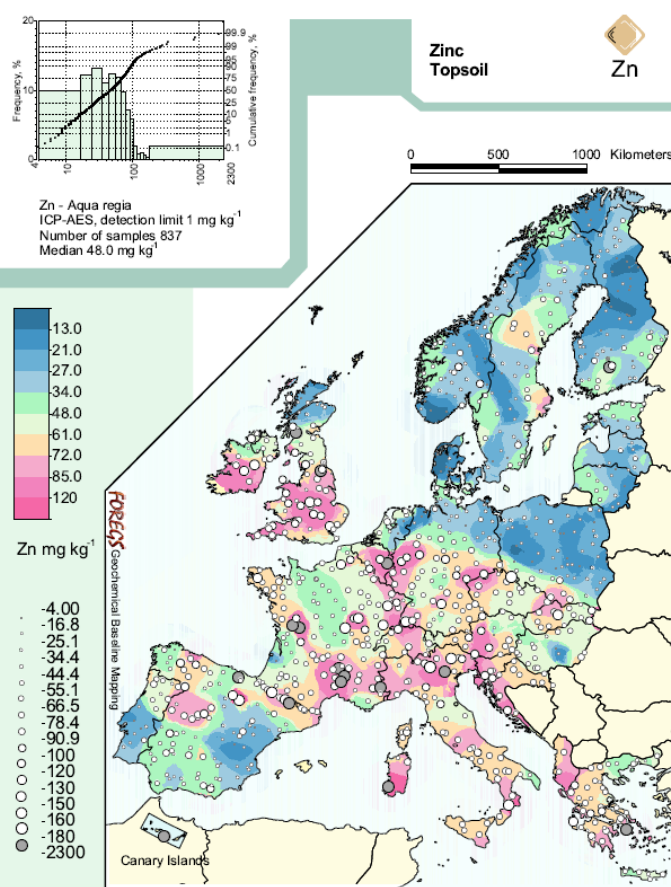
Source: Reimann *et al.*, 2014a



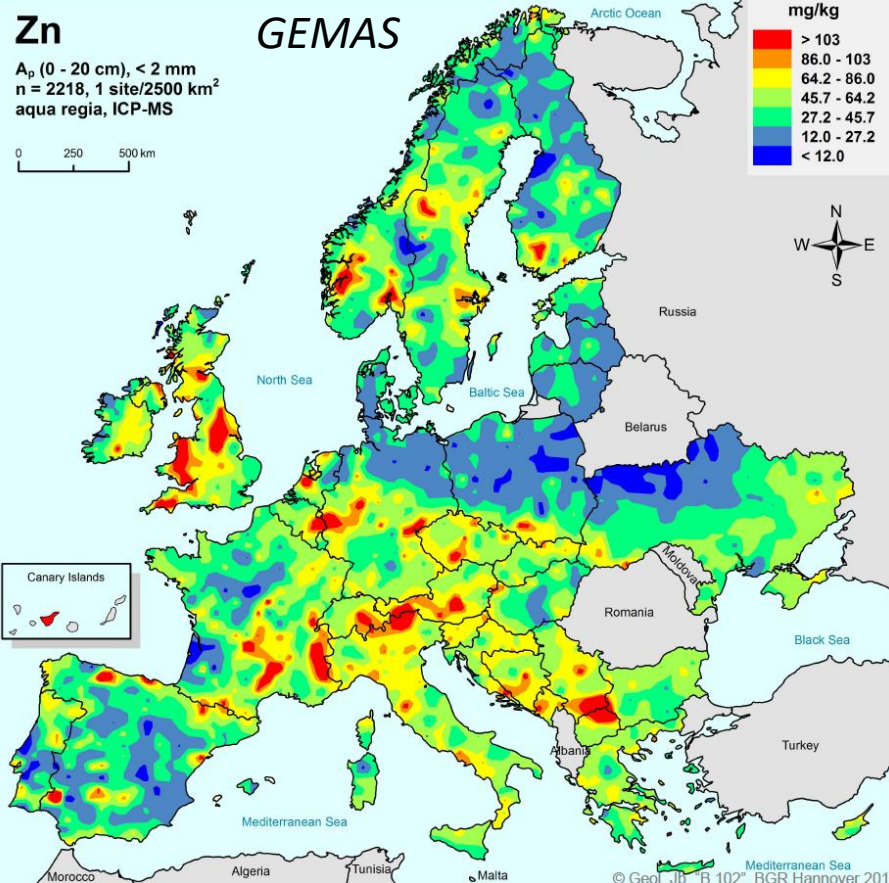
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Comparing low to high density surveys: is it worth the effort?

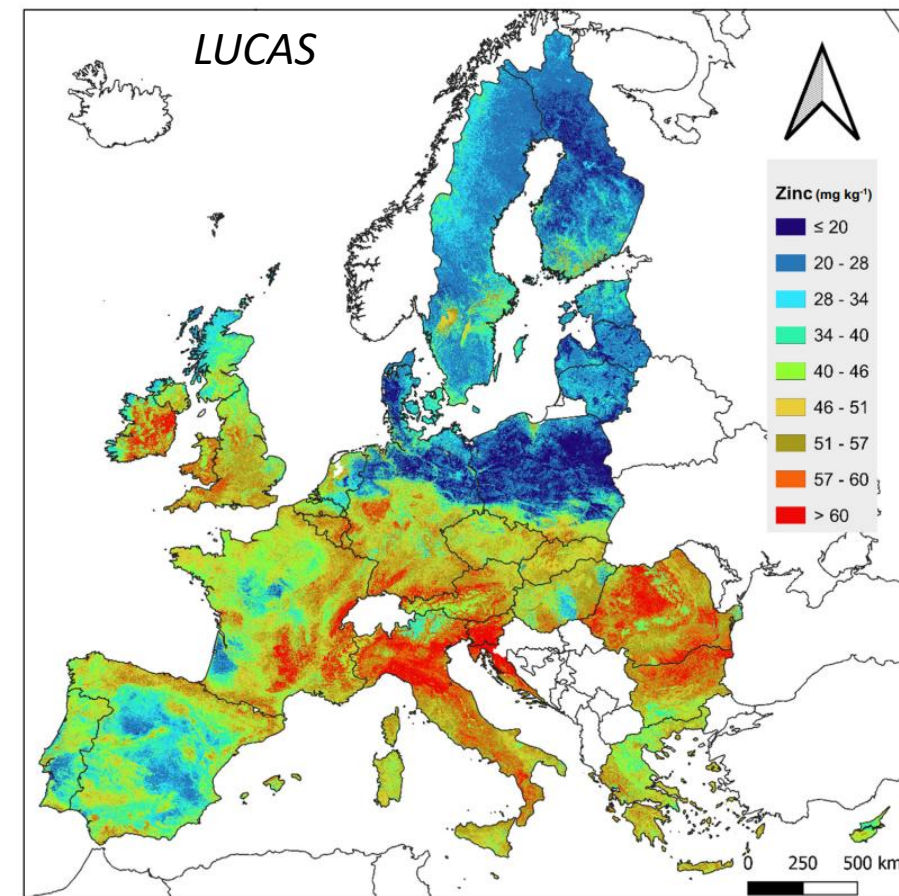
FOREGS



~1000



~2000



>20000

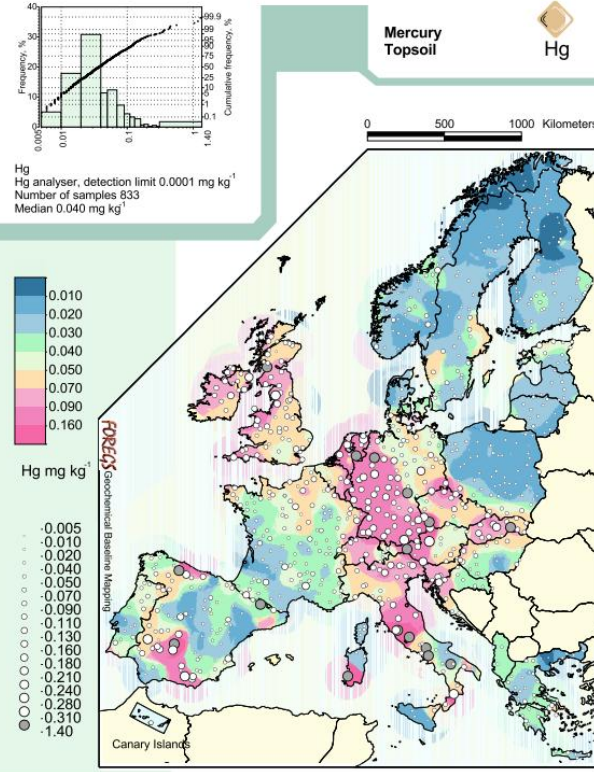
Increasing number of samples



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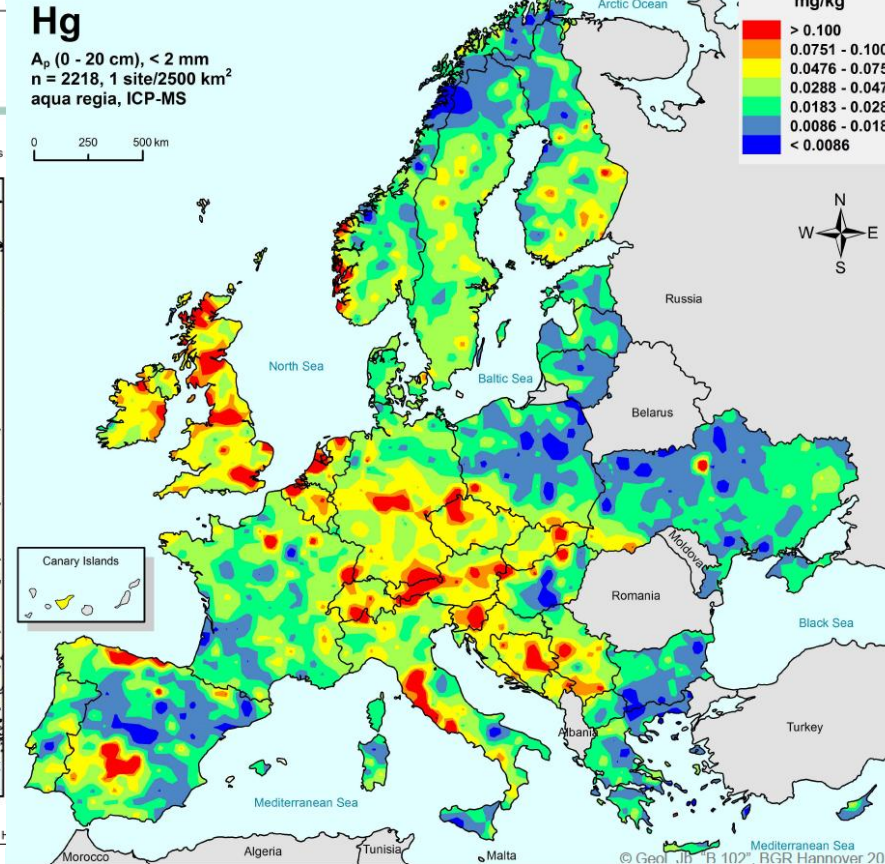
Comparing low to high density surveys: is it worth the effort?

FOREGS

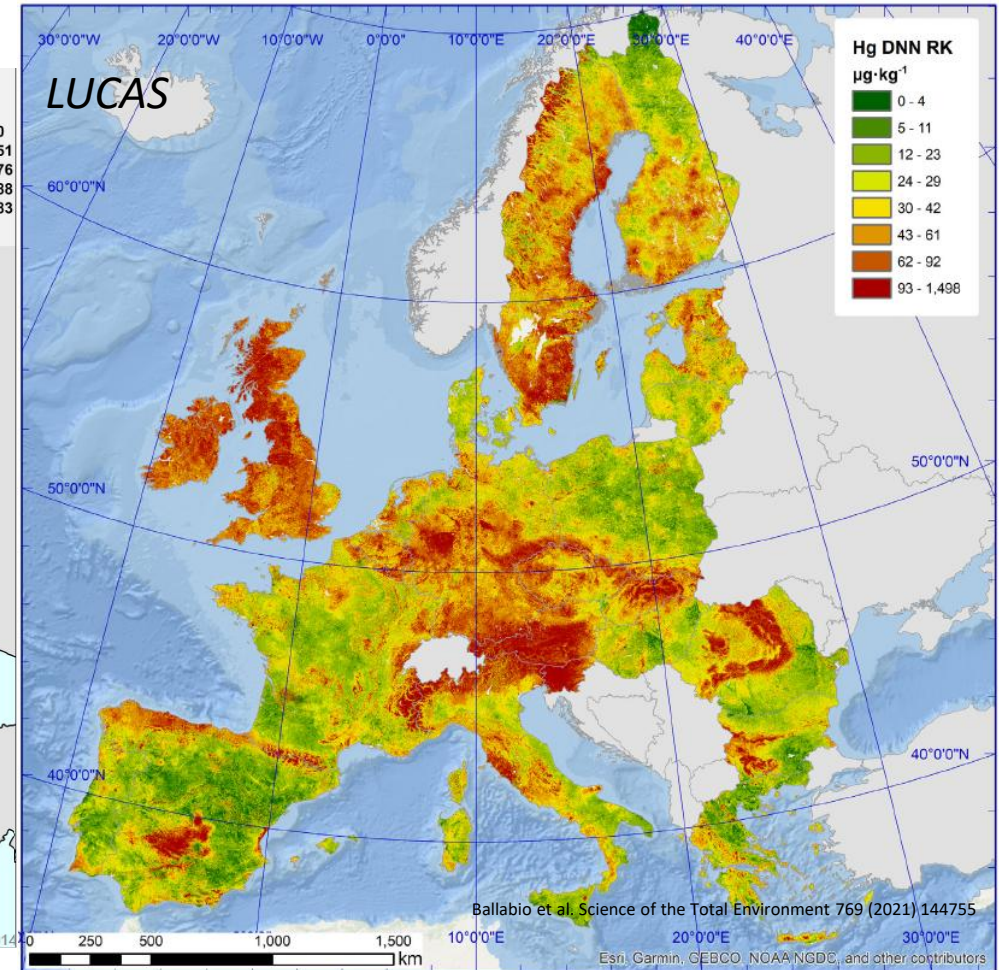


~1000

GEMAS



~2000



>20000

Increasing number of samples

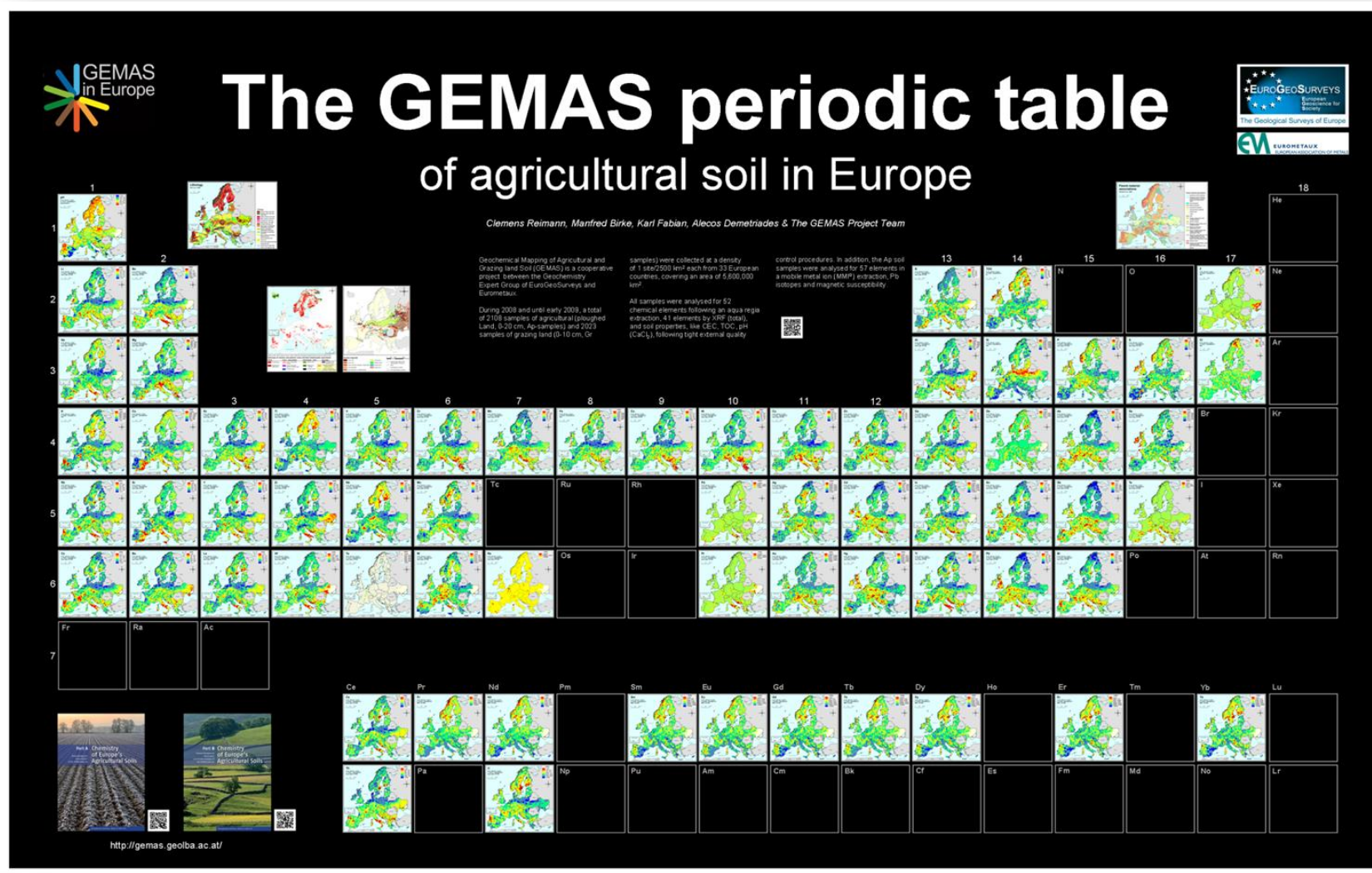


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FOREGS periodic table

[illegible]

GEMAS periodic table



To conclude - I

**International Union of Geological Sciences
Manual of
Standard Methods for Establishing the
Global Geochemical Reference Network**

edited by
Alecos Demetriades, Christopher C. Johnson, David B. Smith,
Anna Ladenberger, Paula Adánez Sanjuan, Ariadne Argyraki,
Christina Stouraiti, Patrice de Caritat, Kate V. Knights,
Gloria Prieto Rincón and Gloria Namwi Simubali

This Manual presents, for the first time a comprehensive overview of the standardised methods that should be employed across the land surface of the Earth to map the distribution of chemical elements in rock, soil, sediment and water.

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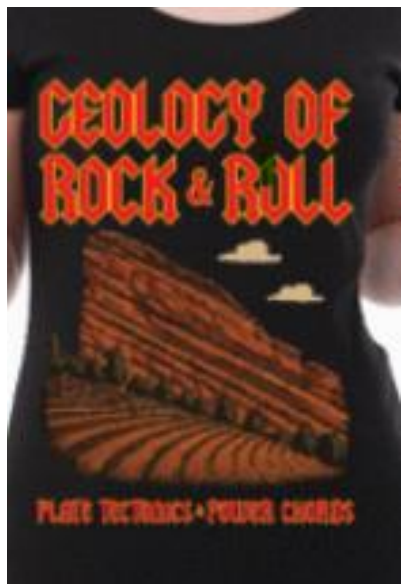


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<https://doi.org/10.5281/zenodo.7307696>

To conclude - II



Wonderful encounters in
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Thank you for your attention

40 Years Listening to the Beat of the Earth