ENVIRONMENTAL GEOCHEMISTRY AND HEALTH ISSUES IN HUNGARY

Barbara KEREK, Ubul FUGEDI, Gyozo JORDAN, Jozsef VATAI, Tamas MULLER

Geological Institute of Hungary

Abstract: The geochemical exploration of the Geological Institute of Hungary made clear, that the country is geochemically not uniform, but 4 regions can be divided. Those environmental-geochemical circumstances which connected to health issues in Hungary is coming from the lack of certain elements, rather than having too much from them. From the literature that is known that the bigger part of the country is suffer from the lack of I, Se, F and Mo, and this results already some health consequences in humans, animals or plants. Other kind of geochemical anomalies occur in the eastern region which was separated because of the mining-heavy industrial contamination of the area, so there are more non-ferrous metals with concentration significantly over the contamination limit value (mainly Cd). To find out whether these heavy metals could get into the food chain or not, it will be one of our future research topics.

Key words: environmental geochemistry, health, geochemical regions, Hungary.

Introduction

The study area (Hungary) is situated in the Pannonian Basin surrounded by the Carpathian Mountains chain. The 90 % of the surface of the country is covered by young sediments: in the big river valleys there are alluvial sediments and between them on the ranges there are eluvial sediments (sand and loess). Between the redeposition times the sediments went through pedogenesis, and the frequent chemical weathering degraded the most of the original minerals. In the surrounding mountains chain (in the Eastern Carpathian and in Slovakia) are the oldest European precious- and non-ferrous metal deposits (worked since Roman- or Medieval times).

Materials and methods

Datasets coming from different surveys (detailed below) were used for the research.

Geochemical explorations in the Geological Institute of Hungary or results coming from participation in EU projects:

- Low density geochemical survey (1991–1995) → Atlas, scale 1:500.000, 196 catchment basins, flood plain deposits, depth 0-10 cm and 50-60 cm, 25 elements;
- Geochemical survey in mountainous and hilly regions (1992-1998) → Atlas, scale 1:50.000, stream sediments, 32 elements;
- FOREGS geochemical exploration (1998-), Geochemical Atlas of Europe, scale 1:5.000.000, big catchment basin - flood plain deposit, small catchment basin - stream sediment, surface water, soil, humus, 62 elements;
- GEMAS geochemical exploration (2009-), soil samples, arable land and pasture.

The sampling, preparation and analysis followed the methods adequate in the certain program or project (references appear in the same order, as the surveyes listed above: Ódor et al., 1997; Fügedi et al., 2007; Salminen et al., 2005; Reimann et al., 2011).

Results and discussions

In Hungary there is not a single background because the territory is divided into four geochemical regions (fig. 1) with different characteristics (table 1, Ódor et al., 1997). The larger part of the country (the "main" region 1) does not show a characteristic association of elements, i.e. the dominant part of the variations resulted from processes of accumulation and leaching. In Central Hungary (the "limy" region 2) the association of Ca–Mg–Sr–CO_3^{2-}–PO_4^{3-}–SO_4^{2-} reflects the presence of limy soils. Near the western border line (the "ferrous" region 3) the iron alloy metals Co–Cr–Ni–Fe are originating from basic and ultrabasic rocks of the Alpine belt. In the flood-plain deposits of rivers discharging from Transylvanian mining areas and from some heavy industrial centres ("eastern" region 4) we can find characteristic Ag–Au–Cd–Pb–(Cu–Zn) anomalies in the overbank sediments of lower courses, and also Hg originates from the processing of ore from low- to medium-temperature hydrothermal ore deposits.

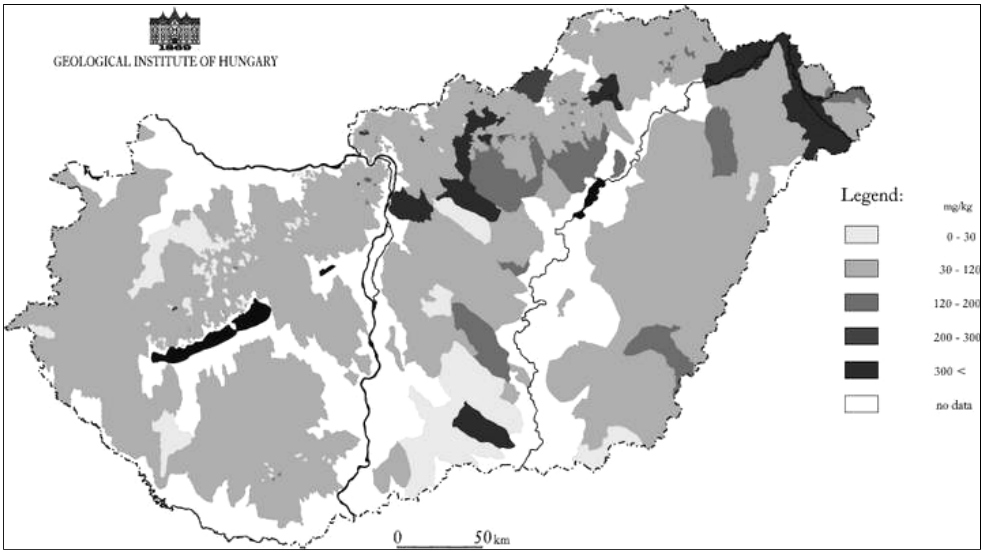

Fig. 1. Geochemical regions of Hungary

Table 1

Medians of the concentrations of some metals (mg/kg) in the geochemical regions

No. of region → **Metal conc. ↓**	**1**	**2**	**3**	**4**
As	7.3	6.3	8	12
Co	9	5.7	12.8	11.1
Cu	19	15	24	40
Pb	17	13	18	46
Zn	65	46	82	132

In the bigger part of the central region (the “limy” region 2) the Cu, Zn and other essential elements show lower concentration than the minimum necessary for plants (fig. 2). Searching the geological reasons, it was found, that the purpose of this is the lime accumulation, which is typical in this region. In the ice-age, when the precipitation was fewer than nowadays and the vegetation set the soil less, the wind blew the dust of carbonate rocks cowered the main part of the Transdanubian Range far away, and it was deposited mixed with loess and wind-blown sand. The crystalline limestone- and dolomite dust gradually dissolve in the unsaturated zone and it precipitates in the pores as amorphous carbonate. In the superficial loose sediments Ca, Mg, Sr (and Ba) accumulate among the cations, and CO_3 (SO_4 and PO_4 too) among the anions. All the other elements are crowded out, so the micro-nutrient supply of the soil became deficient.

From the literature that is known that the bigger part of the country is suffer from the lack of I, Se, F and Mo, and this results already some health consequences in humans, animals or plants. Based on the WHO database for urinary iodine, Hungary belongs to those countries with mild iodine deficiency (50-99 μg/l, instead of optimal 100-199 μg/l). The main factor responsible for iodine deficiency is a low dietary supply of iodine. It occurs in populations living in areas where the soil has low iodine content as a result of past glaciation or the repeated leaching effects of snow, water and heavy rainfall. Crops grown in this soil, therefore, do not provide adequate amounts of iodine when consumed (http://whqlibdoc.who.int/publications/2004/9241592001.pdf). The health consequence of the lack of iodine caused by geological reasons, eating habits (i.e. low intake from marine food, table 2) and the lack of proper information about this problem is goitre in certain regions (NE and the central part of W) of Hungary.

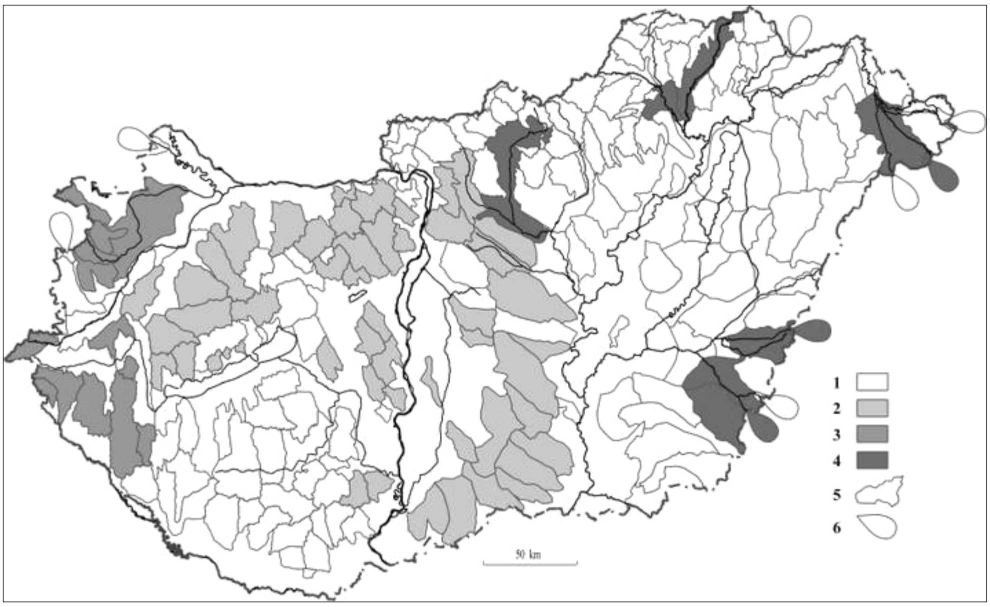

Fig. 2. Zn (mg/kg) in the overbank sediments of Hungary

Table 2

Average iodine-concentration in terrestrial and marine foodstuff (mg/kg)

Terrestrial		Marine	
Foodstuff	**Iodine conc.**	**Foodstuff**	**Iodine conc.**
rye-bread	85	haddock	2430
white bread	58	Atlantic cod	1200
oat-flakes	40	sea perch	1245
potato	38	herring	665
rice	22	common dab	281
pork liver	140	alga	< 2400

Another problem is the regional lack of selenium (Selinus et al., 2005), proved by a research of Semmelweis Medical University. They checked selenium concentration in blood serum and finger- and toe nails, and they found it lower, than optimal, even in the case of adults (Bogye, 1999). Selenium is toxic in large doses, but essential for humans and animals. This element normally acts as an antioxidant, so low levels of it may increase oxidative stress on the immune system. As FAO summarised ”Selenium has been implicated in the protection of body tissues against oxidative stress, maintenance of defences against infection, and modulation of growth and development.”(www.fao.org). The suggested intake based on different standards for dosage recommendations for daily consumption is between 55-70 μg, and it could be taken from nuts, cereals, meat, mushrooms, fish and eggs. In our institution the biggest problem is in this case is the detection limit, because with ICPMS generally it is 1-2 μg/l.

Fluorine is probably an essential element for humans, necessary for the calcium-metabolism, for the strength of bones and its role in prevention of tooth decay is well-established (Olivares and Uauy, 2004). We get most of it from the drinking water, not from the food that we eat, and in the bigger part of the country the water has lower content from it, than the optimal (about 1 mg/l). Around 98 % of the population does not get enough fluorine for the prevention of tooth decay. Fluorine shortage could be also made up by fluoride toothpaste, tea, lettuce, potato and nuts.

Molybdenum is an immobile nutrient and most active in roots and seeds. In Hungary the lack of that element affect just plants in quite big territories, mainly in the central geochemical region. Symptoms of molybdenum deficiency in plants: encourages nitrogen shortage, older leaves yellow, middle-ages leaves yellow, interveinal chlorosis, yellowed leaves becomes cupped, leaf margins roll up, leaves become twisted, die, and drop and stunted plant growth (fig. 3). Molybdenum causes yield decline and quality deterioration, mainly in the case of alfalfa (Radics, 1994).

Fig. 3. Symptoms of molybdenum deficiency in the case of marrow (http://aggie-horticulture.tamu.edu/publications/cucurbitproblemsolver/leaf/molybdenum.html)

Conclusion

Those environmental–geochemical circumstances connected to health issues in Hungary is coming from the lack of certain elements, rather than having too much from them. From the literature that is known that the bigger part of the country is suffer from the lack of I, Se, F and Mo. The first 3 could cause health problems for humans and animals, and the last one for plants. Knowing the geochemical background of an agricultural area can help to find out, which element could be missing from the plants growing in that area. This information could be important for protecting living creatures from deficiency disease in the future.

References

1. Bogye G., 1991 - *Szelénhiány Magyarországon - táplálkozástani és klinikai vonatkozások,* PhD thesis, Budapest, SOTE Doktori Iskola

2. Fügedi U., Horváth I., Ódor L., 2007 - *Geokémiai háttérértékek Magyarország hegyvidéki területein,* Földtani Közlöny 137(1):63-74, Budapest

3. Olivares M., Uauy R., 2004 - *Essential nutrients in drinking water (draft),* WHO. http://www.who.int/water_sanitation_health/dwq/en/nutoverview.pdf. Retrieved 2008-12-30

4. Ódor L., Horváth I., Fügedi U., 1997 - *Low-density geochemical mapping in Hungary.* In: K. Marsina & K. Vrana (Editors), Environmental Geochemical Baseline Mapping in Europe. Special Issue, Journal of Geochemical Exploration, 60(1):55-66

5. Radics L. (ed.), 1994 - *Szántóföldi növénytermesztéstan,* Kertészeti és Élelmiszeripari Egyetem, Kertészeti Kar, Budapest, 200 p.

6. Reimann C., Demetriades A., Eggen O. A., Filzmoser P., the EuroGeoSurveys Geochemistry Expert Group, 2011 - *The EuroGeoSurveys Geochemical mapping of Agricultural and grazing land Soils* (GEMAS) – NGU Report 2011.043, 92 p., http://www.ngu.no/upload/Publikasjoner/Rapporter/2011/2011_043.pdf

7. Salminen R., Demetriades A., Reeder S., 2005 - *Introduction.* In: Salminen R. (Chief-editor): Geochemical atlas of Europe. Part 1. Background information, methodology and maps. Geological Survey of Finland, Espoo, 392 p.

8. Selinus O., Alloway B., Centeno J. A., Finkelman R. B., Fuge R., Lindh U., Smedley P. (ed.) 2005 - *Essentials of Medical Geology*, Elsevier Academic Press, 812 p.

9. *** http://whqlibdoc.who.int/publications/2004/9241592001.pdf

10. *** http://www.fao.org/DOCREP/004/Y2809E/y2809e0l.htm#bm21.1

11. *** http://www.squidoo.com/hydroponic-nutrients-deficiencies

Contact data

Barbara KEREK: Geological Institute of Hungary, 1143 Budapest, Stefánia út 14., e-mail: kerek@mafi.hu