Geochemical background for soils – concepts, benefits and limitations

Tło geochemiczne dla gleb – pojęcia, korzyści i ograniczenia

Cezary Kabała

Institute of Soil Science and Environmental Protection,
Wrocław University of Environmental and Life Sciences,
e-mail: cezary.kabala@up.wroc.pl

The term geochemical background comes originally from exploration geochemistry and was defined as normal abundance of an element in barren earth material. The concept was introduced to differentiate between the normal element concentrations and anomalies (both positive and negative). Through decades, it became several new and broader meanings, and presently it is widely used in environmental sciences to indicate "natural" concentration of elements in soil versus the enhanced concentration resulted from an anthropogenic pollution. The geochemical background (or baseline) concept differ from the regulatory levels (action levels, maximum admissible concentration values etc.) set on the basis of ecotoxicological studies and risk assessments. In most cases, the regulatory levels are higher (sometimes much higher) than the geochemical background. Although the regulatory levels have a larger legal importance, the geochemical background is commonly used to evaluate the degree of anthropogenic transformation or relative level of pollution, often below regulatory levels. Several approaches were proposed to evaluate geochemical background. In general, a distinction between geochemical and statistical methods can be made. The "geochemical methods" base on the global marine "shale standard", any of the upper crust averages (including Clark values), as well as pre-industrial formations on a local or regional scale (such as limnic and marine sediments, river sediments, cave sediments, etc.). However, the values fixed for all these "soil parent materials" ignore the natural post-sedimentary processes (weathering, denudation etc.) and near-surface element cycling referred to as "soil forming processes", which may result in naturally reduced or elevated levels of particular elements in the topsoil as compared to parent material. The "pedogenic" approach to geochemical background requires, therefore, consideration of several variables as soil type, texture, organic matter content, soil pH etc. The other approach, widely developed at present, uses statistics oriented specifically on the particular soil layers/horizons; in most applications on the topsoil layer. The most simple identification includes the concentration ranges (i.e. the normal range of a sample as defined by the mean ± 2 x standard deviation; ca. 95% of the samples is within this range) or upper values (threshold level; e.g., mean + 2 x standard deviation; ca. 97% of the samples lie below this value). The results of the statistical approach highly depend on the sample size (number of observations) and the normality of the distribution. The presentation will include a case study for the Sudetes Mountains, rich in different magmatic, sedimentary, and metamorphic rocks, as well as subjected to local and regional contamination with trace metals and metalloids.