TECHNOGENIC GEOLOGY – A NEW BRANCH OF EARTH SCIENCES

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Huge quantities of industrial wastes have been accumulated in many countries of the world. Up to now, 2–3 x 10^{12} t of industrial wastes have accumulated all over the world. Wastes cover an area of approximately 16 x 10^{6} hectares. Its quantity increases by 10^{10} t every year, 10^{6} t every hour.

The wastes are objects of geological study, because geological processes (mainly weathering; in coal mine waste dumps also reduction) take place in them. The study of wastes must form a new branch of earth sciences, which we offer to call technogenic geology. General task of this science is the studying of geological processes in wastes. In that frame we can list several processes, among others those which depend on the composition (wastes of coal, ore, metallurgical and other industry) and on climate (humid, arid etc), those which provoke the generation of mobile chemical compounds. The new branch can be further subdivided for e.g. technogenic geochemistry (studying migration and accumulation laws), technogenic mineralogy (formation of new minerals as it takes place e.g. in burning coal mine waste dumps), technogenic economic geology and metallogeny (studying the concentration of elements etc. of industrial importance), technogenic geoecology (studying the concentration of toxic elements).

Wastes may be the "technological" deposits of elements of major economic importance (e.g. workable concentrations of scandium, germanium, lithium, silver and other elements have been discovered in coal ashes), but may also be sources of environment pollution (by arsenic, lead, molybdenum and other toxic elements).

We worked out methods for the evaluation of wastes (usefulness/toxicity).

The offered estimation methods are based on the establishment of useful and toxic indices and the determination of several parameters. The useful and toxic indices are the general number, composition, quantity, sum and mean of specific frequencies of occurrence, sum and mean of the excess multiple of limiting-allowable concentration for toxic elements (industrial concentration for useful elements), ranges of useful and toxic indices, mean combined index (rating). The general number of toxic (useful) elements is the sum of those chemical elements the contents of which exceed the limiting-allowable concentration (minimum industrial concentration). The specific frequency of occurrence shows how frequently the element is present in the analyses. The sum of specific frequencies of occurrence is obtained by summing the specific occurrence frequencies of all elements in the analyses, while the average is the result of the division of the sum by the number of toxic (useful) elements. The excess multiple of limiting-allowable concentration (industrial concentration) shows how many times the content of the toxic (useful) element exceeds the limiting-allowable concentration (industrial concentration). The sum is the result of summing the excess multiples of all toxic (useful) elements in the analysis, average is obtained by the division of the sum by the number of the toxic (useful) elements. The chemical type of toxicity is defined by the most widespread element followed by its prevalence to a class and then subclass. Toxity (usefulness) can be presented as the formula of the three most widespread elements among toxic (useful) elements. The chemical symbol is surrounded by some parameters: the coefficient showing specific frequency of occurrence the element is disposed in front of the chemical symbol; behind, in subscript the excess multiple of limiting-allowable concentration (industrial concentration); behind, in superscript the element role among others. The graphical plot consists of the general number of elements on the vertical axis and the excess multiples on the horizontal axis. The received indices allow to determine the typomorphism, model, metallogenic speciation of useful elements and the chemical composition (type, class and subclass) of toxic elements, quantities, comparison maps, chemical formulae and diagrams.

We studied the chemical composition of industrial wastes (containing rocks, rock-coal mixture, pure coal and coal ashes of Donbass mines, dumps, slags, slimes, soils around Donbass metallurgical plants and slags of some power stations). We found very high concentrations of useful and toxic elements (scandium up to 700 g/t, germanium up to 2000 g/t, lithium over 10000 g/t, arsenic up to 5000 g/t in coal ashes and others). In the Northern Donbass mines coal ashes "reserves" of antimony, beryllium, yttrium, cadmium, niobium and silver are estimated to be around thousands of tons; bismuth, zinc, copper, cobalt, molybdenum, vanadium, germanium, strontium, zirconium, scandium, gallium and ytterbium around tens of thousands of tons; titanium and lithium around hundreds of thousands of tons. In reality the stocks can be even higher (by 25–30%).

It is possible to recover some metals simultaneously by one technology. In some coal mine fields up to 10 metals have been revealed. Economic profit is obvious. If we assume that 1 t of coal contains 20–30% coal ashes, in which scandium content is 300 g/t, we can extract 60–90 g of scandium from the ashes of 1t coal. The minimum price of 1 g of scandium is 10 USD. The price of 1 t coal is 20–25 USD, while that of the extracted scandium is 600–900 USD.