

## **MICROBIAL GENERATION OF ACID DRAINAGE WATERS IN A URANIUM DEPOSIT**

**GROUDEV, S.N., GEORGIEV, P.S., SPASOVA, I.I., NICOLOVA, M.V. & ANGELOV, A.T.** (Department of Engineering Geoecology, University of Mining and Geology, Sofia, Bulgaria)

The uranium ore deposit Curilo is located in Western Bulgaria, about 35 km north from Sofia. Uraninite (“nasturane” and “pitchblende”) and torbernite are the main uranium minerals in the ore. Some copper is present in the form of minerals such as chalcopyrite, covellite and chalcocite. The ore is rich in pyrite and different iron hydroxides.

For a long period of time the deposit was a site of intensive mining activities, initially by both open-pit and underground mining of high-grade ores and later, by in situ leaching of low-grade ores by means of diluted solutions of sulphuric acid. The uranium recovery was stopped in 1990 but since that time the acid drainage waters generated in the abandoned mines and dumps consisting of mining wastes have been a persistent environmental problem. These waters have a pH in the range of about 2.0–3.5 and contain radioactive elements (uranium, radium, thorium), toxic heavy metals (copper, cadmium, manganese, iron), arsenic and sulphates in concentrations much higher than the relevant permissible levels in waters intended for use in agriculture and/or industry.

The formation of the acid drainage waters was connected with the oxidative activity of the acidophilic chemolithotrophic bacteria which inhabited the uranium deposit. *Thiobacillus ferrooxidans* and *Leptospirillum ferrooxidans* were the most widely distributed and the most numerous species in this microbial community. Their densities in some parts of the deposit exceeded  $10^8$  cells per g of ore and per ml of drainage waters. Some of the strains of these bacteria differed markedly from each other with respect to their ability to oxidize sulphide minerals, ferrous iron, tetravalent uranium and sulphur. *Thiobacillus thiooxidans* and *Thiobacillus acidophilus* as well as some moderately thermophilic bacteria related to *Sulphobacillus thermosulphidooxidans* and the genus *Thiobacillus* were also found but almost always in lower numbers than *T. ferrooxidans* and *L. ferrooxidans*. The extremely thermophilic chemolithotrophic bacteria related to the genera *Sulphotobus* and *Acidianus* were not detected in the deposit. Several heterotrophic microorganisms were found but it seemed that only those related to the genus *Acidiphilium* were typical members of the microbial community inhabiting the uranium deposit.

It was found that the microbial activity depended on some essential environmental factors such as humidity of the ore, presence of oxygen inside the ore mass, pH and composition of the waters percolating through the ore, and ambient temperature. It was possible to change this activity by suitable changes in the levels of these environmental factors.