

ISR mining of uranium in the permafrost zone, Khiagda Mine (Russian Federation)

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The “Khiagda” mine in the Republic of Buryatia is the only ISR mine in the world where ore mining is performed in a permafrost region. Its raw material source is deposits of the Khiagdinsky ore field having geological reserves of uranium to 48 thousand tonnes. The ore field is a part of the Vitimsky Uranium ore district with reserves of 100 thousand tonnes. This is the most promising region in Russia where the deposits may be extracted by the ISR technique.

Throughout a year, the air temperatures varies from +35 to -50 °C. Permafrost is developed everywhere to the 90 m depth.

The Khiagdinsky ore field includes 8 deposits. The ore-bearing paleovalleys down-cut the slopes of the granite rise. The ore accumulations are localised in alluvial sandy water-saturated Miocene deposits overlaying the crust formations of the granite basement. They are overlapped by the cover of basalts and volcanogenic sedimentary deposits. The ore accumulations occurrence under the cover of frozen basalts at the depths 90 to 280 m.

Uranium in ores is presented by ningyoite; it is significantly reduced, comprising up to 90-100% U(IV). Mining of such ores by the acidic ISR without an oxidant is of low effectiveness. The ore-bearing sands are quartzfeldspar and practically noncalcareous. The acid consumption caused by chlorites and montmorillonites is at the medium level, 90 kg/tonne.

The ore-bearing deposits, according to the filtration tests, have the filtration coefficient (hydraulic conductivity) of 2.1 (1.4-3.7) m/day and water transmissivity of 50 (24-105) m²/day. The accumulations are inundated irregularly. In the lower reaches of the paleovalleys, the output of the pumping-out wells varies from 5 to 9 m³/hour, and in the upper reaches it ranges from 2 to 5 m³/hour. The temperature of the formation waters is 1 to 4 °C.

The rigorous climatic conditions, high degree of uranium reduction in ores, complicated hydrogeological conditions and high viscosity of the very cold groundwater caused low uranium recovery at the initial stage of development. The extensive scientific and research works carried out to increase the uranium content in the productive solutions, and in particular, the use of an oxidant, gave the possibility to bring the Khiagda mine to the world second place in terms of this indicant.

Research is planned aiming to improve the control of groundwater resources inside the paleovalleys and between the paleovalleys, decrease the leaching solutions viscosity and improve the design of the technological wells.

Implementation of the planned researches, despite the harsh climate and complicated geological and production settings, will bring the Khiagda mine to a world-leading position, and it will gain competitiveness with the ISR enterprises of Kazakhstan and Uzbekistan.

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