FACTSHEET:

Uranium mining and milling

Overview

The largest uranium ore deposits are found in Asia, Canada, Australia and Africa. Most of the world's uranium is mined in these countries. There are some uranium ore deposits in the UK but they are too small to be economic and so no commercial mining happens in this country.

Uranium ore is often extracted from the ground in conventional open cast mines, that are essentially just very large open pits, or in deep mines where tunnels are excavated underground.

When the uranium is deep below ground, it is sometimes extracted using in-situ leaching (solution mining). This involves pumping acidic water into the ore to dissolve the uranium, and pumping the uranium-rich water back to the surface.

Milling is a process to separate the uranium from the other metals and minerals in the rock, and to collect the concentrated uranium ore. The product is a fine yellow powder known as yellowcake, which is the basic raw material for manufacturing nuclear fuel.

Even in the richest ore deposits, uranium makes up less than 20% of the total rock. In most deposits it is much less abundant.

This means that both mining and milling produce very large amounts of waste rock, and contaminated waters and sludges. The waste rock is known as mill tailings, and the contaminated water and sludge is held in ponds at the mine and mill sites. These are classed as naturally-occurring radioactive material (NORM) wastes.

What is uranium ore and where is it mined?

There are many different uranium minerals and only a few of these are mined commercially. Many of the mined ores contain uraninite, a uranium-rich ore made mainly from uranium oxide.

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How uranium is mined

The method used to mine uranium depends primarily on how deep the ore is and its grade (the concentration of uranium in the ore). The three main options include open cast mining, underground mining and in-situ leaching (solution mining).

Open cast mining

The most common form of mine is an open cast mine and many different rocks and minerals are extracted in this way around the world, including clay and coal. An open cast mine is effectively a large open pit dug into the ground surface.

An open cast mine is usually excavated using explosive blasting and the broken rock removed with excavators. Often this material is used to screen the mine to reduce its visual impact.

Open cast mining is usually the simplest, safest and most cost-effective way to extract ore that is relatively close to the surface, but it does have a relatively high environmental impact. In order to access the uranium ore body, very large amounts of material may need to be excavated, including any soil, vegetation and rock.

Deep mining

Deep mining involves excavating vertical shafts and horizontal or inclined tunnels from the surface to the ore. Much less rock needs to be removed to access the ore compared to open cast mining but the rate of excavation tends to be slower and the process is more hazardous for miners.

In-situ leaching

In-situ leaching (also known as solution mining) is used for extracting uranium from some of the deeper ore deposits and from lower grade ores.

In-situ leaching involves dissolving the uranium contained within the ore underground. The uranium-rich solution is then pumped back to the surface for processing.

This method of mining has the advantage that only the uranium is extracted from the ground. No bulk waste rock is produced and there is much less disturbance to the surface environment than happens with an open cast mine.

The method is only suitable for some types of ore which are contained in porous rock formations that allow the mining solution to flow through them. The ore also needs to be contained within impermeable layers of clay or rock to avoid contamination of the surrounding groundwater aquifers.

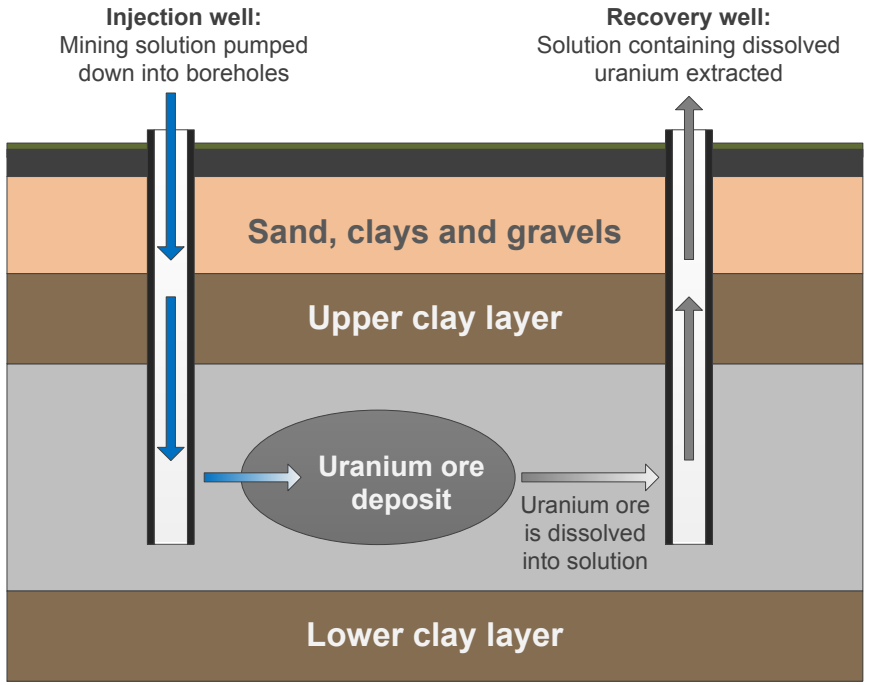

Image: Illustration of in-situ leaching of uranium.

Uranium milling

Milling is the process used to extract the uranium from the mined ore or from the mining solution used in-situ leaching.

The first stage of milling is to crush the rock and ore until it is roughly the grain size of sand. Sulphuric acid is then used to leach the uranium from the crushed rock.

A multi-stage chemical process follows to precipitate the uranium from solution or to extract it using ion-exchange resins.

The concentrated uranium is then heated to remove any residual liquid. The final solid product from milling is a fine yellow powder of uranium oxide (predominantly U_3O_8) that is known as yellowcake. Yellowcake contains the different isotopes of uranium in their natural proportions.

Image: The tank farm at the White Mesa Hill uranium mine and mill in the USA. Source www.energyfuels.com

Radioactive wastes produced by uranium mining and milling

Uranium mining and milling produces very large amounts of waste, primarily in the form of excavated rock, ores that contain too little uranium to be profitable and mill tailings.

Mill tailings are produced during the processing of uranium ore. They are sand-like, crushed rock residues, which are left over after the uranium has been extracted. The tailings contain all of the natural, radioactive radium that was present in the original ore, and so produce radioactive radon gas.

Large ponds of waste slurry are also produced because significant volumes of water are used in the milling process. These ponds are usually dammed to contain the slurry and are allowed to dry by natural evaporation.

These wastes are classed as naturally occurring radioactive material (NORM) wastes.

The mill tailings and the slurry ponds have the potential to be damaging to the environment due to their radioactivity and chemistry. Great care is needed to contain these wastes, particularly to avoid spills of contaminated water.

There are no commercial uranium mining or milling operations in the UK, and no wastes from uranium mining or milling are produced here.