

In-situ leach

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In-situ leaching (ISL), also called in-situ recovery (ISR) or solution mining, is a process of recovering minerals such as copper and uranium through boreholes drilled into the deposit.

The process initially involves drilling of holes into the ore deposit.

Explosive or hydraulic fracturing may be used to create open

pathways in the deposit for solution to penetrate. Leaching solution is pumped into the deposit where it makes contact with

the ore. The solution bearing the dissolved ore content is then

pumped to the surface and processed. This process allows the

extraction of metals and salts from an ore body without the need

for conventional mining involving drill-and-blast, open-cut or

underground mining.

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Process

In-situ leach mining involves pumping of a leachate solution into the ore body via a borehole, which circulates through the porous rock dissolving the ore and is extracted via a second borehole.

The leachate solution varies according to the ore deposit - for salt deposits the leachate can be fresh water into which salts can readily dissolve. For copper, acids are generally needed to enhance solubility of the ore minerals within the solution. For uranium ores, the leachate may be acid or sodium bicarbonate.

[edit] Soluble salts

In-situ leach is widely used to extract deposits of water-soluble salts such as sylvite (potash), halite (rock salt, sodium chloride), and sodium sulfate. It has been used in the US state of Colorado to extract nahcolite (sodium

bicarbonate).[1] In-situ leaching is often used when the deposits are too deep, or the beds too thin for conventional underground mining.

[edit] Uranium

Solutions used to dissolve uranium are acid (sulfuric acid, or less commonly nitric acid) or sodium bicarbonate [baking soda]. Ammonium solutions have been pilot-tested, but have not been reported used in commercial-scale mining. ISL of uranium ores started in the United States and the Soviet Union in the early 1960s. The first uranium ISL in the US was in the Shirley Basin in the state of Wyoming, which operated from 1961-1970 using sulfuric acid. Since 1970, all commercial-scale ISL mines in the US have used sodium bicarbonate solutions.[1]

There are currently five in-situ leaching uranium mines operating in the United States, operated by Cameco, Mestena and Uranium Resources Company, all using sodium bicarbonate. ISL produces 90% of the uranium mined in the US. Two more ISL projects are in licensing and proposal stages in the US, and two in reclamation in 2006.[2]

Significant ISL mines are operating in Kazakhstan and Australia. The Beverley uranium mine in Australia uses in-situ leaching. ISL mining produces around 21% of the world's uranium production.[3]

[edit] Examples of in-situ uranium mines

- * The Beverley Uranium Mine, South Australia, is an operating ISL uranium mine and Australia's first such mine.
- * The Honeymoon Uranium Mine, South Australia, due 2008, will be Australia's second ISL uranium mine.
- * Crow Butte (operating), Christensen Ranch (reclamation), Irigaray (reclamation), Churchrock (proposed), Crownpoint (proposed), Alta Mesa (operating), Hobson (standby), La Palangana (development), Kingsville Dome (operating), Rosita (standby) and Vasquez (operating) are ISL uranium operations in the United States.

[edit] Copper

In-situ leaching of copper was done by the Chinese by 977 AD, and perhaps as early as 177 BC.[1] Copper is usually leached using acid (sulfuric acid or hydrochloric acid), then recovered from solution by solvent extraction electrowinning (SX-EW) or by chemical precipitation.

Ores most amenable to leaching include the copper carbonates malachite and azurite, the oxide tenorite, and the silicate chrysocolla. Other copper minerals, such as the oxide cuprite and the sulfide chalcocite may require addition of oxidizing agents such as ferric sulfate and oxygen to the leachate before the minerals are dissolved.

The ores with the highest sulfide contents, such as bornite and chalcopyrite will require more oxidants and will dissolve more slowly. Sometimes oxidation is speeded by the bacteria *Thiobacillus ferrooxidans*, which feeds on sulfide compounds.

Copper ISL is often done by stope leaching, in which broken low-grade ore is leached in a current or former conventional underground mine. The leaching may take place in backfilled stopes or caved areas. In 1994, stope leaching of copper was reported at 16 mines in the US. At the San Manuel mine in the US state of Arizona, ISL, underground mining, and open-pit mining were being done simultaneously in different parts of the same ore body.[4]

[edit] Gold

In-situ leaching has not been used on a commercial scale for gold mining. A three-year pilot program was undertaken in the 1970s to in-situ leach gold ore at the Ajax mine in the Cripple Creek district in the US, using a chloride and iodide solution. After obtaining poor results, perhaps because of the complex telluride ore, the test was halted.[5]

[edit] Controversies

Remains of uranium in-situ leaching in Stráž pod Ralskem, Czech Republic

In-situ leach techniques are often controversial, sometimes because of acid leachate solution.

The concerns of environmental groups and landholders centre around;

- * Acidification of groundwaters
- * Mobilisation of potentially hazardous heavy metals and, in the case of uranium, radioactive heavy metals.[6]
- * Disturbance of the groundwater table, mixing of groundwater aquifers and general disturbance of the land atop the ore body
- * Destruction of habitat for stygofauna and other rock-inhabiting organisms, bacteria, et cetera.
- * Potential spills of acidic and metal-bearing or salt-bearing leachates upon the surface

[edit] See also

- * Mining
- * Mineral exploration
- * Uranium ore deposits
- * Copper extraction

[edit] External links

* Heathgate Resources Acid Leach Infopage

[edit] References

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3. ^ <http://www.uic.com.au/nip40.htm> Overview of ISL uranium mines, 2006.
4. ^ Extraction and beneficiation of ores and minerals, v. 4, (1994) US Environmental Protection Agency, EPA 530-R-94-031.
5. ^ Peter G. Chamberlain and Michael G. Pojar (1984) Gold and silver leaching practices in the United States, US Bureau of Mines, Information Circular 8969, p.24.
6. ^ <http://www.heathgateresources.com.au/contentmine.jsp?xciid=117> Heathgate Resources Ltd. Concerns Surrounding Beverley Uranium Mine potential for contamination.

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