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COMMERCIAL PROPOSAL

UNDERGROUND LEACHING OF GOLD DEPOSITS OF DIFFICULT ACCESSIBLE REGIONS

The offer is addressed to gold mining companies operating in alluvial compacted and large-clastic deposits with water cut or without massif of rocks of a productive formation. It takes into account the inaccessibility of the mining area, the difficulty of delivering mining equipment to the fields, supplying it with fuel and lubricants, complete impassability and lack of infrastructure.

Underground leaching (UL) is a modern economically viable and promising innovative technology for the extraction and production of noble and non-ferrous metals. Compared with traditional methods of mining, for example, gold, its leaching from the seams directly at the place of their occurrence allows to reduce production costs by more than 2-2.5 times by eliminating overburden operations, mechanical mining and transportation of ore, its crushing, grinding, pre-concentration , tailings storage, reclamation, etc. UL creates an opportunity to significantly reduce the conditions for the content of the useful component in the ore, to involve poor and off-balance ores, small and deep-lying ore and reservoir bodies in processing. Underground leaching provides comfortable working conditions and minimal environmental impact.

Underground leaching of placers and ores is widely used in the uranium and copper industries of Russia, Australia, Canada, USA, South Africa. To date, intensified work on the application of this technology to gold ore, especially in Central Africa, Suriname, Central Asia.

The world's first tests of the UL method were carried out in 1976-1978 in the association "Severovostokzoloto" on placers of the "Experimental" mine in the Magadan Region, in 1986-1988 at the “Marjanbulak” mine in Uzbekistan, a set of work was carried out to organize and conduct pilot industrial testing of gold UL technology from ores with chlorine-chloride solutions (Cl_2 + NaCl + HCl), with the deposition of gold from solutions on carbon batting.

Underground leaching can be subjected to the following types of gold and reservoir deposits (including man-made):

- weathering crust ores containing free gold in porous mineral structures and underlain by dense rocks acting as a natural water barrier;
- some ore bodies of rock type under condition of concentration of gold in them on cracks and macropores;
- residual (“bottomhole”) gold in previously mined mines (including flooded mine water) and ore materials: tailings, substandard ores and rocks used as a mine laying;
- gold-bearing sands of deep-lying (buried) and permafrost placers with an economically acceptable metal content.

At the pilot block of Underground Leaching with a solution capacity of 15-25 m^3/h, taking into account the hydrogeological conditions of the site, an infiltration-filtration system for borehole mining of the ore / formation massif with airlift elevation of productive solutions was developed and implemented. Coal sorption technology has been adopted to extract gold from solutions.

Continuous testing determined the consumption of chlorine 3.5 kg per 1 g of extracted metal while ensuring complete safety of work on UL. Technological regulations have been developed for the design of an enterprise for the underground leaching of gold from oxidized ores of the deposit using advanced chloride-chloride technology, with gold production volumes of 250-280 kg, its expected cost will be about $ 4 per 1 g.

This topic is especially relevant for the gold deposits of the Central African group. To start work on a dedicated allotment of the African continent, a program is being developed that includes the following main areas of work:

- assessment of the resource base of the deposit for the possibility of gold mining by the UL method;
- the possibility of improving the basic technology of chlorination UL (including solvent regeneration);
- the possibility of introducing an alternative hydrochlorination process of bromination UL, characterized by a higher dissolution rate of the metal and other technological advantages.

Production work on a gold deposit, considered as an object for the use of UL, should be preceded by laboratory studies to determine the mineral, chemical, granulometric composition of the sample, and then technological research. At the first stage of technological research, in order to accelerate the experimental work and save ore material, a series of experiments is carried out on the static (agitation) leaching of the studied sample. Such experiments make it possible to establish a close to optimal leaching solution composition on a small volume of ore material and to establish the maximum achievable degree of metal extraction from a particular ore. As a rule, the time sufficient to achieve equilibrium concentrations of the reacting substances does not exceed 24 hours. At the end of the experiments, the rate of metal extraction from ore is calculated for all solutions. The characteristics of the consumption of reagents according to the data of static experiments is established only tentatively. The results of laboratory studies of leaching are a guideline for the choice of solvents and the range of their concentrations, with which the ore is then tested in the filtration mode of leaching.

Filtration leaching consists in filtering the solvent through a sample of gold-containing material, fixing the dynamics of the removal of the useful component from it and the yield of the solvent in the filtered solution. At the same stage, studies are conducted on the extraction of gold from solutions by sorption or precipitation methods.

Laboratory tests determine the indicators of geotechnological properties of gold-containing material, which include: filtration coefficient; the degree of extraction of metal from ore; the ratio of the volume of the solution to the solid mass, necessary for the maximum possible extraction of metal; solvent costs (in kilograms per 1 g of extracted metal, in kilograms per 1 ton of mined ore mass); average metal concentration in productive solutions, mg/l.

In the process of laboratory tests, the scheme for processing productive solutions is specified. In addition to laboratory research, studying filtration heterogeneity of rocks of the productive horizon, affecting the hydrodynamics of the filtration flow, geotechnological mapping, modeling the hydrodynamics of technological solutions, mass transfer in the three-dimensional region are carried out.

The results of laboratory studies and modeling of geofiltration processes are used in the preparation of the project work on the pilot site UL, followed by pilot work, and then industrial operation.

Underground leaching of gold for the first time in Russia began at the Gagarsky deposit. According to its geological and geological characteristics, the Gagarskoye field is an ideal target for UL. Ore filtration coefficient is within 1-3 m/day. The thickness of oxidized ores in the circuit of production blocks reaches 40 m. The entire productive horizon is flooded. Gold is predominantly small. To date, about 500 kg of gold has been mined here. Chlorine water is used as a reagent.

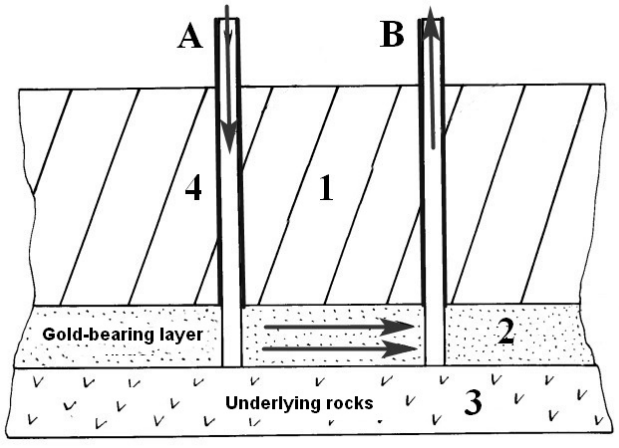
Underground leaching according to the mining and geological conditions of Central African deposits can be effectively used in the extraction of placer gold from large-clastic, compacted and time-cemented formations.

Initially, wells are drilled through an array of overburden and a gold containing formation. Solutions of sodium oxychloride and stabilizing additives ($MgSO_4$, $NaSiO_3$, H_3BO_3, H_2SO_4, etc.) are fed into the latter.

UL in the deposits of Central Africa has a number of features associated with their geographical location, inaccessibility and obstruction of large equipment, lack of roads. The technical embodiment of the method of underground leaching of gold in Africa includes drilling a cluster of technological wells with a mini-rig transported by an SUV or other high-cross-country equipment, casing drilled wells, equipping wells with heads, a pump and a compressor, fracturing a useful formation, acidifying a producing formation of a gold-bearing massif and supplying a solution of active agents to gold-bearing stratum through injection wells, pumping of gold-containing solutions through pumping wells.

Leaching is carried out with solutions of alkali and alkaline earth metal oxychloride and additives stabilizing it.

The UL method on a gold placer is as follows.



Initially, in the array 1, a bush of technological wells A and B is drilled, opening the formation 2 of compacted gold-bearing rocks to the underlying rocks 3. The wells are cased with pipes 4, equipped with heads, hydraulic fracturing between wells A and B of formation 2 and acidification are carried out. Then, efficient and environmentally friendly solutions of alkali and alkaline earth metal oxychloride are

fed into wells A together with solution stabilizing additives. In this case, intensive and environmentally friendly leaching of gold from the formation of 2 gold-bearing rocks occurs.

The diameter of the drilling of technological wells for medium-power fields and their estimated effective ordinary grid is 155 mm. As casing pipes are used steel or resistant to aggressive environment modern light PPR-pipes. Row A of wells serves as injection wells, while Row B serves as injection wells. Wells are equipped with filters such as KDF-120-08 and heads.

Drilling of wells is carried out by a self-propelled diesel mini-rig transported on a trailer, an analog of the legendary in Russia BU-20-2VIII. The annulus of the wells is filled with waterproofing material. Then, hydraulic fracturing of the formation is carried out 2. For this, the annulus of the casing (well) A is cemented. Under the shoe of the string, the whole pillar is opened with a 145 mm bit to a depth of 0.2-0.4 m. Then, a head with a hose is connected to the casing and, by feeding fluids under pressure above 6 MPa carry out hydraulic fracturing of formation 2.

After hydraulic fracturing, it is acidified by supplying H_2SO_4 solutions. After that, solutions of sodium oxychloride, which are an effective and harmless gold solvent, are fed into well A together with solvent stabilizing additives ($MgSO_4$, $NaSiO_3$, H_3BO_3, H_2SO_4, etc.).

The final result of a sequential UL process on a gold-bearing compacted or large-detrital African placer:

1. opening a gold-bearing formation, construction of technological wells, providing the possibility of circulation of solutions, the supply and pumping of leaching solutions. As materializing solutions, solutions of alkali and alkaline earth metal oxychloride in the presence of stabilizing additives are fed.
2. as alkali metal oxychloride for leaching solutions using sodium oxychloride.
3. as stabilizing additives of a solution of sodium oxychloride use solutions of sulfuric acid.
4. magnesium sulfate is used as stabilizing additives of sodium oxychloride.
5. as a stabilizer of solutions of sodium oxychloride use sodium silicate.

Optimal: thickness of overburden from 0 to 120 m, useful layer from 2 to 16 m and more.

Package Included:

1. technical design and equipment specification (for the possibility of substituting analogues with manufacturers of other countries at the place of work),

2. the technological regulations for the production of work at a specific field for specific mining and geological properties of overburden and containing mineral deposits) and the technical task of the customer,

3. set of equipment:

- drilling rig for driving technological wells (self-propelled diesel, also transported on a trailer to an SUV)

- borehole production set of UL (injection, pumping, hoses, filters, ACS TP, reagent tanks, tanks of finished solutions, well heads, casing pipes, tools)

4. product passports, product warranties.

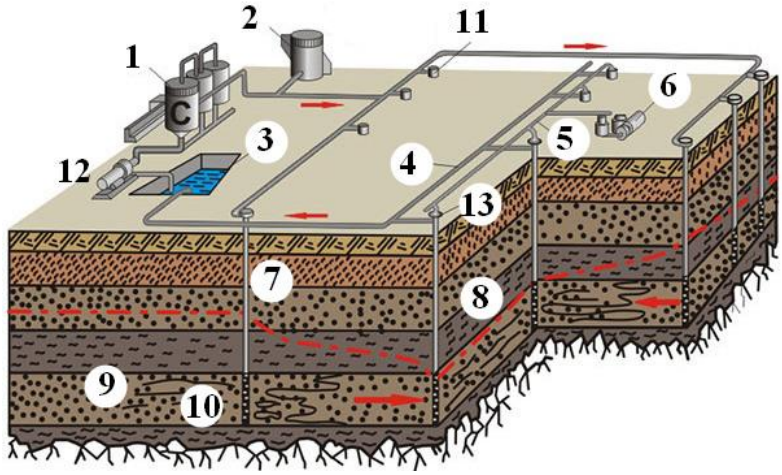
The transfer of technological support and equipment from the manufacturer to the customer is carried out under the contract:
- with an advance payment of 100% under paragraphs 1 and 2 of the description above. As a result, you acquire technological development inherent only in your field and belonging only to you, a detailed description of the technology of work and equipment specifications. Terms of preparation of the material - 2.5-2 months.

The cost of this stage is US $ 47,620. We transfer the materials by downloading from a file hosting service or Yandex disk via a link (text in Pdf, Word; graphic material and drawings in Pdf). Execution on paper or CD carriers is possible (by order).

- after you have no questions or want to add (modify) something on the first part of the transferred material, we begin to manufacture equipment for your order. This happens with an advance payment of 60%. Terms of production and equipment configuration - 2.5-3.5 months. The cost is determined by the specification from the accepted and approved technical project prepared according to the standard of the Customs Union on the basis of Order of the Ministry of Natural Resources of the Russian Federation dated June 25, 2010 No. 218 "On approval of requirements for the structure and design documentation for the development of solid mineral deposits, the elimination and conservation of mining and primary mineral processing "(Registered in the Ministry of Justice of the Russian Federation on 08/10/2010 N18104).

- as soon as the equipment is ready at the factory, we will take a picture of it, make a video application on it and bill you for the remaining 40% of the payment, after which we will invite your representative to the factory to accept the equipment, in workshop conditions he will be trained to work on the equipment with our specialists.

- we will sign the acceptance certificate of the order and transfer it to you in ownership.



1, 2 - tanks for reagent and solutions, 3 - primary solution storage, 4 - piping of technological wells, 5 - well head, 6 - pump and compressor group, 7 - technological well, 8 - dynamic level of the solution in the formation, 9 - reservoir, 10 - well filter, 11 - injection wells, 12 - pump, 13 - pumping wells

If desired, a group of designers (2 people), by an additional agreement, can advise the customer during the installation and start of operation of this type of equipment in the field, observe the correctness of the mining technology, and carry out architectural supervision of the design decision.

The cost (exact) of a set of equipment is determined after receiving from you the technical specifications and the geological conditions of the borehole hydraulic production at the field, taking into account your wishes for the convenience of the process, delivery and type of movement of mini-equipment, etc.

The cost of the supplied analogue of equipment for gold UL at the Far Eastern deposit of Russia under agreement No. 23-17 of April 15, 2015 for a specific order (for orientation): $ 242,000.

For Russian customers, all payments are made in rubles.

Video: **https://youtu.be/3QHa9QFNRCE**