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DISCUSSION ON AQUIFER RESTORATION AT URANIUM IN SITU LEACH SITES

by F. S. Anastasi and R. E. Williams

I am writing to place on record some discussion on the paper of Anastasi and Williams. My comments are as follows.

Many workers in the field of mining engineering believe that solution mining or in situ leach mining represents the next quantum leap in mining technology. Many problems are yet to be overcome in the application of this technology amongst which are the identification of more highly specific solution reagents (lixivients) and the development of techniques for aquifer restoration or at least reasonable mining residue containment.

The paper by Anastasi and Williams (I.M.W.A. Vol.3 (4), 1984, 29-37) exemplifies and demonstrates the problems we have inherited from the early years of solution mining. The authors correctly identify the processes involved and describe the difficulties of restoration. It seems to me however that they have not identified all the reasons that result in groundwater sweep/surface treatment restoration processes failing after a period of time. They speculate on the possibilities of hydraulic and physical characteristics being the cause, and their speculations may well be contributory, but other more fundamental problems exist.

Experience of experimental solution mining operations in Australia for both gold and uranium and of waste water (second sewage effluents) infiltration and contaminant hydrology in general has elucidated some interesting and relevant phenomena.

(i) In the process of solution mining concentrated lixivients are injected under pressure into the aquifer and under go diffusion and dispersion into the aquifer skeleton following both chemical concentration as well as hydraulic gradients. As a result some lixivient will enter fine and blind pore spaces under chemical concentration gradients, even though no hydraulic conductivity exists. Such dispersion is reversed when the concentration gradient is reversed by pump out of the lixivient or groundwater sweep operations but the reemergence process is slow. For ions which are highly mobile and which are only tolerable at low levels in natural waters the effect is to produce a delayed upset of apparent restoration.

(ii) Lixivients which include ammonia in high concentrations have the power to replace other cations (iron, calcium, magnesium, sodium and even potassium) in and around clay, chlorite and mica lattices. The adsorbtion of ammonia is however quite weak and when hydrochemical conditions change, as during restoration, the ion is easily replaced by other cations. Simple change in pH is adequate to ellutriate much ammonia. Again the release which is slow upsets the apparent restoration.

(iii) Similar problems occur with ions which are mobilized by the lixivient, for example ferric ion generated by oxidizing acid lixivients will precipitate as the acids are exhausted and will scavenge heavy metals in the process, e.g. arsenic, manganese, radium, etc., uranium, but as the ferric hydroxide is converted back to ferrous ion many of the scavenged heavy metal ions are remobilized again.

The authors correctly identify that the heterogeneity of the systems is a problem not often adequately addressed in the past. We would stress that it is very important to know more of the chemistry of the systems in situ.

This may require extensive and careful coring and core handling programmes to obtain and preserve in situ conditions. Leaching tests undertaken with realistic hydrostatic pressures applying will need to be done and lixivients will have to be developed which are more specific in their mobilization effects.

Restoration must seek to not only remove as much of the lixivient as possible, but, as with all mine wastes must seek to fix and contain the potential contaminants generated in the worked out ore body. In some cases restoration may be achieved by using the area for a purpose which is commensurate with the water resource present which is beneficial in achieving full restoration long term. For example where ammonia has been used in uranium leaching long term rehabilitation by irrigation is generally both desirable and profitable where other factors are not limiting.

If a mining technique such as in situ leach which has few visible environmental results, it is important that it be planned from the outset of investigation to have minimal hidden environmental hazards. This means that not only must the mining technique be efficient in recovering valuable resources at the surface, but it must also be capable of being contained or restored on completion. The latter is as much a part of miners responsibility as is the efficient utilization of the earth's resources.

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