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GROUNDWATER IN MINING – PILBARA, WA

Water table
Water table is the upper surface of groundwater in the aquifers.

Dewatering
Dewatering is the active removal of groundwater to lower the water table.

Sustainable yield:
The groundwater extraction regime, measured over a specified planning timeframe, that allows acceptable levels of stress and protects the higher value uses that have a dependency on the water.

Mine Water Management

Mines are usually located far from piped scheme water. Mining companies usually require large volumes of water for processing the mined materials, dust suppression, and maintenance of workshops and camps. Management of available water is vital to the operation of the mines. Almost all mines rely on groundwater for their operation.

FIGURE 1 AN EXPLORATION CAMP IN THE PILBARA.

Hydrogeologists are employed to explore for groundwater and manage dewatering of the mine. Drawing water from the ground requires an understanding of site hydrogeology. Hydrogeologists are required to estimate the sustainable yield and assess the extent and impacts of lowering the water table and the impacts on vegetation and other groundwater users.

Water is recycled where possible to minimize impacts on the environment. Some mines require water to be piped in from aquifers located away from the mine.

Many mines in Australia have minerals below the water table. Mining below the water table involves lowering the water table below the mine floor for safety and ease of mining.

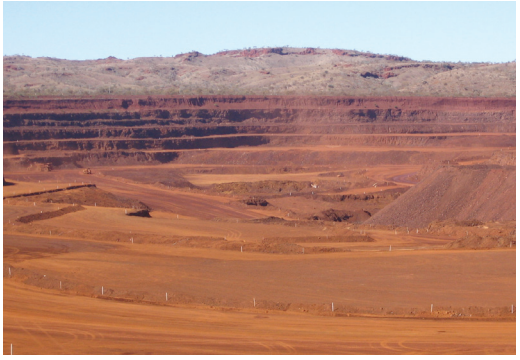

FIGURE 2 AN OPEN-CUT MINE IN THE PILBARA. THIS MINE GOES BELOW THE WATER TABLE. DEWATERING BORES WERE INSTALLED TO KEEP THE MINE DRY.

Going further

How might groundwater cause a safety hazard for mines? (Hint: Think about how water might affect stability of soils and rocks, and also about working in wet conditions.)

Aquifers in the Pilbara region of Western Australia consist of Quaternary and Tertiary age sediments, weathered and fractured rocks of the Proterozoic basement and the iron mineralized orebody. The enrichment of iron to form an ore body is a process which involves the percolation of groundwater through iron rich rocks over millions of years. The orebodies themselves usually form good aquifers. Groundwater salinity in these aquifers is usually fresh (less than 500mg/L total dissolved solids).

FIGURE 3 IRON ORE. THE UNEVEN SURFACE ALLOWS GROUNDWATER TO FLOW.

Rain water replenishes the aquifers. The majority of rainfall in the Pilbara comes from rain in summer associated with tropical lows and cyclones. The replenished groundwater flows from higher elevation such as hills and rises to lower elevation such as creeks and rivers. Mining companies have to prepare for these summer rainfall events to prevent inundation of the mines, but also to maintain water flow to creeks and rivers throughout the year.

FIGURE 4 A TYPICAL CREEK IN THE PILBARA. A VARIETY OF GUM AND ECULATUS TREES STRIVE ALONG THE CREEK.

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Going further

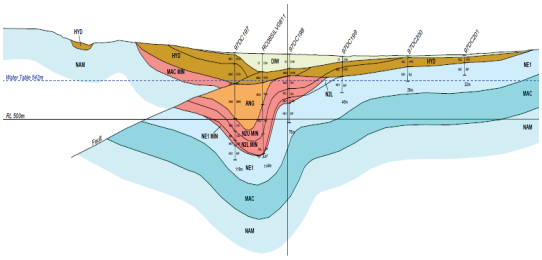
Research on or more of the mines of the Pilbara Region in northwestern Australia. Is there information on their mine water use? (Hint: look for annual reports, in the environment or sustainability sections). What does this information tell you about the mines water needs. How much is from groundwater?

Mine Dewatering

Mine dewatering involves drilling holes in the ground and equipping them with pumps to remove groundwater. As the groundwater is removed, the watertable in the aquifer from which the water is pumped will be drawn down. Other aquifers above and below the pumped aquifer may also start to dewater as water leaks between the aquifers. This can often be a slow process! Determining how best to dewater aquifers to allow mining is the role of the hydrogeologist.

It is common for mines to have more water than they require from the dewatering. Surplus water is either discharged to the environment, re-injected into the aquifers or stored in evaporation ponds for it to evaporate to the atmosphere.

FIGURE 5 A GEOLOGICAL CROSS-SECTION OF THE MINERALIZED OREBODY BELOW THE WATERTABLE.



Mines operate with schedules specifying how quickly and how deep the mine progresses. Lowering the water table to meet the schedule requires predicting the water table elevation a few years ahead of time. Hydrogeologist use computer models to help them estimate the dewatering requirements. The challenge for hydrogeologists is to minimise the amount of water pumped out, minimize impacts to the environment and yet be able to keep the mine dry and safe for operation.

FIGURE 5 A A DRILLING RIG DRILLING FOR A DEWATERING BORE. AIR FROM A LARGE AIR COMPRESSOR IS INJECTED INTO THE HOLE BELOW THE AQUIFERS LIFTING WATER OUT OF THE HOLE.

Computer Modelling

Predicting the required dewatering to meet mine schedule or impacts on the environment usually require a computer model. The movement of groundwater can be very complex when dewatering bores are turned on. Computer models can deal with these complexities.

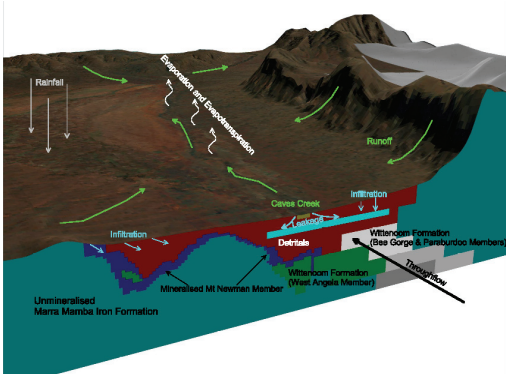


FIGURE 6 A CONCEPTUAL HYDROGEOLOGICAL MODEL.

Groundwater models are discretised representation of the site hydrogeology. Mathematical equations in the computer software solves for the movement of groundwater. Groundwater modelers are hydrogeologists trained to use the software to predict the impacts of dewatering and estimate the dewatering requirements needed to meet the mine schedule. Groundwater models also help hydrogeologists to confirm their understanding of groundwater flow.

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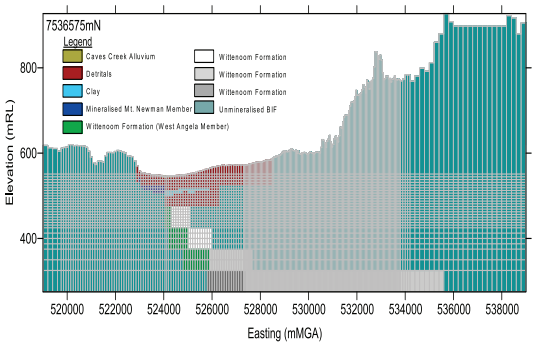

FIGURE 7 DISCRETISED REPRESENTATION OF THE HYDROGEOLOGY.

Mine planning is important. Applying for regulatory approvals takes time to prepare. Regulatory agencies usually want to know the impacts of the mining operations for the life of the mine. Financial commitment in mining is usually a very large undertaking. Mine managers need a plan.

Geological information from surface geological mapping, drill holes samples and logs, geophysics and water level measurements are used to formulate models.

Modeling relies on mathematical equations that approximate groundwater flow and an interpretation of subsurface structure. Thus they represent predictive tools for guiding management decisions and are critical component of below water table mining.

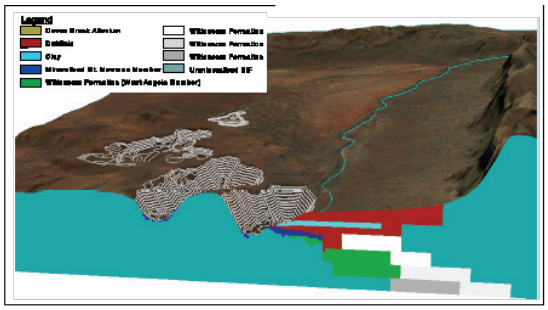

FIGURE 8 OPEN-CUT MINE TARGETING THE MINERALIZED ORE.

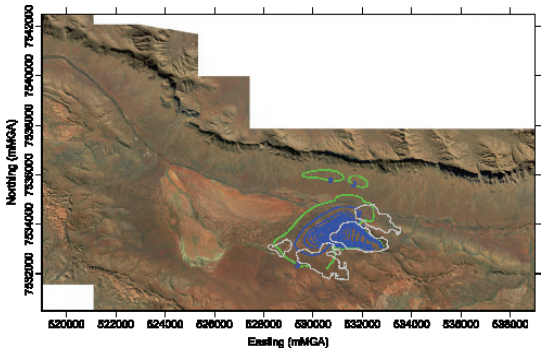

FIGURE 9 SIMULATED WATER TABLE CONTOURS AFTER 2 YEARS OF DEWATERING.

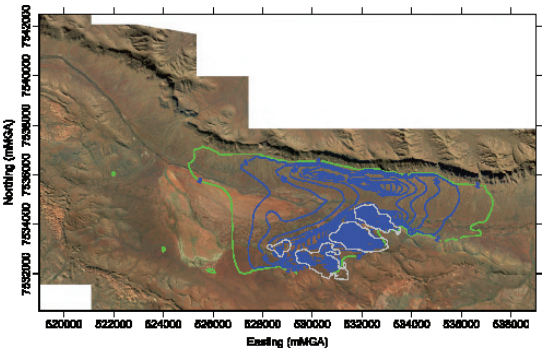

FIGURE 10 SIMULATED WATER TABLE CONTOURS AFTER 4 YEARS OF DEWATERING.

Mining companies such as Rio Tinto Iron Ore has a team of hydrogeologists to manage groundwater for their mines. Other mining companies employ consultants with hydrogeologists to help them.

Going further

What are some of the questions in operating a mine site that you might use a numerical model to answer? (Hint: Look carefully at the text above and identify all the key requirements of a mine). Do the questions you ask affect how you might construct a model?

Prepared by Rio Tinto.
Further information on Rio Tinto mining operations in the Pilbara can be found at http://www.riotinto.com/index_ourapproach.asp

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