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TECHNICAL NOTE:

MINE DRAINAGE CONTROL AND ENVIRONMENT PROTECTION BY USING GROUTING TECHNOLOGY AND THE HYDROGEOLOGICAL APPROACH

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INTRODUCTION

Any dewatering project needs to include a thorough understanding of the ground water regime affecting the mine. This means understanding the origin, movement, volume and hydrogeology of the country rock and the ore body.

DEWATERING

Significant cost savings can be made by diverting ground water before it reaches the mine workings. The main savings are in pumping costs and water treatment costs. If water is pumped away from the mine at the site of the major inflows pumping costs can be kept to a minimum. Ground water exposed to an ore body becomes polluted. It is therefore important to intercept excess water underground before it becomes contaminated.

Other reasons for diverting ground water are often site specific. Kimberlite swells and becomes very difficult to handle in the presence of even small amounts of moisture. It is therefore important to divert underground water from the ore body and ground passes. Underground water can be made up of both machine water brought into the mine and water flowing into the mine from local aquifers.

The success of controlling ground water inflows is dependent on a good understanding of where the water is coming from. This means determining the source of the ground water and the head driving the water into the workings. In Southern Africa the majority of aquifers are fractured rock aquifers. In Europe the majority of aquifers have primary permeability. This means that European techniques are not always applicable to African conditions. Fractured rock aquifers are best understood through a structural interpretation within a hydrogeological investigation.

HYDROGEOLOGICAL INVESTIGATION

An understanding of the hydrogeology of a mine can be achieved through a hydrogeological investigation and the siting of a few monitoring boreholes. The measurement of water levels in the mine and close to the mine will show the direction of ground water movement. Simple pumping tests either underground or from surface allow the calculation of the-volume of water in storage and the permeability characteristics of the country rock and the ore body.

Consideration of the rainfall and ground water recharge affecting the mine is an essential part of a ground water study.

Water quality analyses can be used to determine the origin of the ground water. Tritium and carbon 14 measurements can be used to date the ground water and therefore determine the origin of the ground water. Quality analyses will also provide useful information on the type of grout which will react best with the water during sealing activities.

If ground water levels are known a simple ground water model using Darcy's law can inexpensively calculate the potential volumes of inflow a mine can expect over it's active life and following closure. The model uses the shape of the cone of drawdown in the water table to determine the flow rates a mine can expect. The shape of the cone changes with rainfall events and as the mine expands or deepens.

Such a model was run for a diamond mine in the Northern Cape. The results showed that the mine could expect a 50% increase in ground water inflows when it deepened from it's present 650 m below surface to 1 000 m below surface. The model also calculated the anticipated increase in inflow if the average rainfall was exceeded over the life of the mine. The same model is capable of predicting the length of time the regional ground water levels would take to return the pre-mining levels following cessation of mining.

GROUTING

Historically mines have used tons of plain cement grout to seal areas with high inflows. Often the sealing has not worked. The main reason for failure is a lack of understanding of where the water is coming from. Where sealing has worked it has often taken an excessive amount of sealing product. Smaller amounts of grout can be used if the ground water regime is thoroughly understood prior to the sealing work being done.

In these times of recession mine management need to know that the correct amounts of grout are used without wastage or overkill. Knowledge of the ground water regime is essential to the control of mine inflows. The days of indiscriminate grouting are gone. The new rule is understand the ground water regime before you try to deal with it. A multi-disciplinary approach to controlling the underground water can lead to removing or diverting the bulk of the water problem then sealing the remaining water with a chemical grout.

The methods available for removing ground water have been dealt with elsewhere. Sometimes dewatering a mine does not remove all the water from the workings and in particular shafts. It is then necessary to seal specific areas using cement or chemical grouts.

Several chemical grouts are available. The choice of grout depends on the underground conditions, eg rock type, rock stresses, ground water quality, volumes of water, mining method and other factors. It is important that the correct grout is used as an incorrect grout will not seal a the water effectively.

The choice of method used to seal off a wet area is controlled by an understanding of the fracture pattern. The choice of site from which the grout is injected is important so that the grout penetration is optimised. Setting times for the grout must be selected with a thorough understanding of the type of fissures to be sealed. An example is a dolomite aquifer, although highly jointed the ground water occurrence is usually on the bedding planes not in the vertical joints. The bedding planes may be predominantly horizontal and therefore require a specific design of cover drilling to achieve maximum sealing effectiveness.

It is also important to determine the position of the water table in relation to the grouting site. If the wet area is in the unsaturated zone ie. above the water table, the ground water is moving through the formation and is unlikely to build up behind the grout. If it is below the water table pressure may build up and a stronger grout must be used.

The use of a cement grout is often a case of "using a sledge hammer to crack a nut", the selection of the correct chemical grout at the start of a sealing project can reduce grouting costs and standing times.

Modern uses of chemical grout include the sealing of sections of Northam platinum mine, shaft sealing of the dolomite aquifer at Vaal Reefs no 11 shaft, sealing of specific fissures in East Rand coal mines, sealing at Kombat copper mine, Amandelbult platinum mine and the sealing of major water bearing fissures at Phalaborwa copper mine. Several examples from South Africa can be used to illustrate the successful application of different grouts.

CONCLUSIONS

Successful dewatering and grouting require a thorough understanding of the hydrogeology of the mine and immediately surrounding. Without this knowledge any dewatering grouting is done in the dark with a high probability of using the wrong method, wrong grout and therefore incurring unnecessary costs with a low success rate.

There are many chemical grouts available that can replace the old fashioned method of pumping tons of cement grout into wet areas. Although chemical grouts are more expensive per kilogram than standard cement, correct use of the grout can result in successful sealing and significant cost savings.