The role of hydrogeology in developing effective mine water control programs in fractured porous rocks

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Many open pit and underground mining sites are characterized by overburden of variable thickness that is underlain by fractured bedrock. Fractures or discontinuities in these bedrock units exist at different scales, including large scale to intermediate scale structures such as faults and shear zones, that range in length from tens of metres to kilometres, intermediate to small scale features such as bedding planes and joints that range from metres to tens of metres in length and the small scale fissures that have length scales of mm to cm. In fractured porous rocks, where the matrix can have significant porosity and permeability, the fracture system usually provides the main conduits for flow while the combined matrix and fracture system provides the storage.

The flow properties of fractured porous rocks are highly dependent on fracture type, effective stress conditions, stress history, and the geometry of the fracture system. The highly variable nature of the fracture system generally produces strong anisotropy and heterogeneity in the fracture transmissivity over the area of interest. Interpretation of rock mass transmissivities from wells completed in these rock masses must reference models other than the classical radial flow models. Properly located observation wells are essential to both the interpretation of the well test data and to the assessment of the extent and shape of the effective dewatering zone and the magnitude of optimum well interference effects. In addition, the concentration of the rock mass transmissivity in a few fractures can produce high fluid velocity and significant "skin effects" or wellbore losses that significantly reduces the efficiency of the water control wells. Effective mine dewatering or mine water control in such rock masses requires careful well location, proper well design and construction followed by vigorous well development to minimize well losses.

In complex hydrogeologic settings, such as those presented by most fractured rock masses, 3-D numerical flow and transport models are essential for proper decision making in locating water control wells and in determining operating efficiencies. Numerical models provide estimates of groundwater flowpaths and, when used in conjunction with groundwater geochemistry and isotope data, identify sources of recharge and provide the possibility of either remediation, control or management by modifying the local groundwater gradients.