Estimation of the Required Amount of Hydrological Exploration in Lignite Mining Areas on the Basis of Hypothetical Hydrogeological Models

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ABSTRACT

Mine drainage is a necessary but very costly precaution for open-pit lignite mining in sandy aquifers. Consequently, the minimization of the number of drainage wells and their optimal operation become important tasks in designing mine drainage systems. Comprehensive groundwater flow models have to be used, both, for the design of drainage wells, and for the analysis of water management strategies in mining areas. The accuracy of computations with such models depends on the precision of the underlying hydrogeological informations. In order to get these informations detailed and costly hydrogeological explorations have to be done in the mining regions.

The basic informations are obtained using exploration drilling. The cost for hydrogeological exploration are approximately a linear function of the number of exploration bore holes. Therefore the reduction of drilling gets a key role in reducing costs of exploration. This might be done by:
- increased use of geophysical exploration methods,
- complex analysis of exploration results using mathematical statistical methods,
- precise estimation of the required amount of hydrogeological informations.

The paper describes a mathematical approach to support the complex decision making procedure of estimating the optimal amount of hydrogeological exploration with respect to a given mine drainage goal.
For 1985 in the German Democratic Republic (GDR) an annual lignite production of 300 Millions / annum is planned. The principal mining technology is open-pit mining. The lignite seams are embedded in quaternary/tertiary aquifer systems. These aquifer systems have to be drained to satisfy the geomechanical stability of the slopes of the open-pit mines. In 1984 about 1.7 Bill. m³ mine drainage water has been pumped out, operating more then 7000 drainage wells. Therefore, approximately 17 % of the total mining cost are required [1]. Consequently, the minimization of the number of drainage wells and their optimal operation become important tasks in designing mine drainage systems.

The extensive mine drainage causes manifold impacts on the water resources in mining areas and significant conflicts between different water users, [2]. Groundwater flow models have to be used, both, for the design of drainage wells, and for the analysis of water management strategies in mining areas [3].

The accuracy of computations with comprehensive groundwater flow models depends on the precision of the underlying hydrogeological informations. In order to get these informations detailed and costly hydrogeological explorations have to be done. Generally, hydrogeological exploration is based on the following techniques:

- **exploration drilling** for exploration including the collection and analysis of samples of the material in the bore hole, resulting in point informations on the hydrogeological structure,
- **pumping tests** for the estimation of transmissivities and specific yields being representative for a small region of the aquifer (a few 100 m²),
- **geophysical methods** to get detailed informations within bore holes, and above all using surface methods and remote sensing techniques in order to obtain local and regional informations on the geohydrological system.

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- precise estimation of the required amount of hydrogeological informations.

In the paper we will concentrate on the last mentioned alternative.

At present, in the GDR the following tools are used for the estimation of the required amount of hydrogeological exploration:

a) standard values in the field of lignite exploration according to several stages of exploration and according to the type of the coal seam and deposit [4], see Figure 1a.

b) catalogue of groundwater deposits [5]; the parameters of the deposits are characterized by statistical values (mean, dispersion, variance). Assuming a required precision of exploration, the required amount of exploration can be estimated, see Figure 1b.

Both the tools give only rough estimates and they do not consider the aim of exploration, its role in the complex economic system of exploration - mine drainage - mining. Principally, the amount of exploration is estimated by experts taking into the account this complexity, but more or less on a subjective basis, see Figure 1c.

Obviously, the objectives to minimize mine drainage cost (e.g. minimizing the number of drainage wells) and to minimize exploration cost (e.g. minimizing the number of exploration drillings) are contradictory. - The less hydrogeological