

MINE WATER ABSTRACTS

Water Problems in Surface and Underground Mines

1. WATER PROBLEMS IN MINES

Dunn, R. B.
Inst. Min. Metall., Trans., Sect.A; 91; A161-A172 (Oct 1982)

Dealing with major quantities of water in the underground environment continues to be one of the many problems in the winning of coal. The author describes past, present and future trends in the control of outcrop and mines' water. The paper deals with the geological formations which produce the bulk of water inflows in UK mines, the methods and organisation in effective monitoring, ancient and modern pumping systems and the legislation and Acts of Parliament which have been progressively introduced to prevent accident or mishap. The need for dry shafts is discussed and types of modern shaft lining designs are illustrated. The use of well-point and deep-well pumping, and the application of grouting and freezing techniques to stabilise foundations prior to sinking operations, are highlighted. The final section of the paper described effluent disposal to surface watercourses and some of the methods applied to satisfy environmental control applied by the Water Authorities.

2. COAL MINING UNDER COMPLICATED HYDROGEOLOGIC CONDITIONS

Endel, K., Schejbalova, B.
Uhli; 30 (9); 350-355 (Sept 1982)

Evaluates the problem of underground coal mining under water bearing strata and under surface waters. In the present decade 3.5 Mt/year of coal will be mined in Czechoslovakia in seams situated under surface waters. In the future proportion of coal output from seams below water reservoirs could significantly grow, therefore, methods for determining safe mining conditions under water sources are analyzed. The minimum thickness of support pillars left under water sources and the minimum thickness of the rock layers separating underground workings from an overlying water source are discussed. Calculation methods used in the United Kingdom (undersea mining), in China, Japan, Hungary and the USSR for determining support pillar dimensions and thickness of separating rock strata are comparatively evaluated. Underground brown coal mining under water bearing strata in the North Bohemian basin is evaluated. The following measures are discussed: designing safe escape roads for miners, use of explosive fracturing schemes which reduce range of rock strata disturbed by blasting and later subsidence, reducing the number of miners at working places associated with increased water hazards, reducing dimensions of rooms during room and pillar mining in zones with increased hazards. (7 refs.) (In Czech).

3. HYDROLOGY OF THE SHR NORTH BOHEMIAN COAL BASIN AND PROBLEMS OF MINE DRAINING IN SURFACE MINING

Spora, A.
Uhli; 30 (9); 359-364 (Sept 1982)

Mine draining in brown coal surface mines of the SHR North Bohemian basin is evaluated. Effects of atmospheric precipitations on water

influx into surface mines are analyzed. Factors which influence influx intensity are evaluated: intensity of rain or snow fall, slope inclination, surface, duration of rainfall. Calculation methods for forecasting fluctuations of water influx are discussed. Equations used for forecasting are derived. Examples of determining water influx into surface brown coal mines are given. Problems associated with designing mine draining schemes for brown coal surface mines are evaluated: site selection for pump stations, use of mobile pump units, pump station relocation associated with mining advance, pump selection, digging of mine draining channels and their location. Examples of mine draining systems in the Most brown coal mines are evaluated. Efficiency of mine draining is evaluated. Draining of spoil banks (internal and external) is described: sites for draining channels, spoil bank height, the optimum slope inclination for spoil banks in the surface mine (1 to 6). Some recommendations on mine draining of surface mines are made. (In Czech).

4. SLURRY AIRLIFT FOR CLEANING SUMP WATER DRAINAGE SYSTEMS

Triller, E. A., Chernyshov, A. P.
Ugol Ukr., (7); 28-29 (July 1982)

Describes a system developed by the Krasnoarmeisk coal mines for removal of waste coal and rock from sumps of skip mine shafts. Coal and rock wastes accumulated at the sump bottom are removed by a 325 mm pipe system using compressed air. Airlift capacity amounts to 400 m³/h. Coal and rock grains are hoisted by the air lift to a working at the shaft bottom in which equipment for slurry dewatering is placed. Coal and rock slurry is loaded into a tank from which water flows out by a grate wall. Solid coal and rocks are hauled by a belt conveyor to a mine car which moves in a blind inclined shaft. From the mine car slurry is loaded into a skip or is stored underground. The evaluated waste disposal system has been tested for 6 years. Analyses show that it is economical and reliable. Design of the system is shown in a scheme. (In Russian).

5. PECULIARITIES OF WATER INFLUX DEVELOPMENT AND FORECASTING WATER INFLUX INTO COAL MINES

Kemerov, V. I.
Ugol; (7); 59-61 (July 1982)

Analyzes factors which influence water influx into underground coal mines. The analysis is based on the results of long term observations in Zuzbass mines with water influx particularly difficult to forecast. Three zones of water influx into a coal mine are characterized: development workings, longwall faces and the goaf. Static water resources in the coal seam being mined at the sources of water influx during drivage of development workings. Longwall mining with caving forms a system of fissures in the overlying rock strata. Water from the overlying water bearing strata flows through these fissures to a working face. Dynamic water resources are the main source of water influx into the goaf. Investigations carried out in the Kuzbass mines show that from 3 to 5% of water influx into a coal mine enters development workings, from 25 to 35% working faces and from 60 to 70% the goaf. A method for forecasting water influx into coal mines based on the analysis is described. Forecasting error does

not exceed 30% whereas error of other methods used in coal mines in the Kuzbass sometimes exceeds 200%. (2 refs.) (In Russian).

6. ACCESS TO COAL

Bornemann, E.
Min. Engr., V141, N248, May 1982, p.647-653.

Discusses methods of access to a new coalfield including the exploration work, the tests to be carried out and the assessment of seam quality and reserves. Comparisons are made between drifts and shafts, both in operation and construction. Methods of ground treatment through aquifers, supports for tunnel drive and linings for shafts are considered.

7. BRITISH SOLVE DEVELOPMENT PROBLEMS AT SELBY, EUROPE'S LARGEST UNDERGROUND MINE

Buntain, D.
Coal Min.Process, v.19, N5, May 1982, p.54-59.

Presents a case study of tunnelling and driving at the Selby mine, Yorkshire, UK. Ground freezing and injection of grouting cement were used to overcome the problems of tunnelling and shaft sinking through water-bearing strata.

8. DRIFTING THROUGH WATER-BEARING STRATA

Pocock, J.
Min. Engr., v.141, N249, June 1982, p.707-715.

Describes the methods employed and experience gained in driving surface drifts at 3 Yorkshire collieries: Kiveton Park, Treeton and Shireoaks collieries. Particular emphasis is placed on measures adopted when traversing water-bearing strata. These measures included cement grouting, cone grouting and shotcreting.

9. STRATA DISTURBANCE PREDICTION FOR MINING BENEATH SURFACE WATER AND WASTE IMPOUNDMENTS

Singh, M. M., Kendorski, F. S.
Proc. 1st Conference on Ground Control in Mining, Morgantown, 27-29 July 1981, p.76-89. Publ. Morgantown: West Virginia University, 1981.

Modes of strata disturbance induced by underground mining are first discussed: surface subsidence, sinkhole phenomena, subsurface strata movement, changes in permeability due to strata movement and surface crack closure. The mechanics of strata disturbance for mining beneath surface bodies of water are then considered.

10. HOW OLD BEN NO 1 SURFACE MINE BAILED OUT OF WATER PROBLEMS

Coal Min. Process, v.19, N7, July 1982, p.84-85.

Flooding of the Old Ben No.1 West Field pit, Oakland City, Indiana, USA, has become troublesome, mostly due to the downward slope of the lower seam and the impermeable strata beneath. The installation of pumps has considerably reduced this.

11. SOIL DRAINAGE AND STABILITY OF SLOPES

Fedorov, B. S., Arutjunjan, R. N.
Proc. 10th International Conference on Soil Mechanics and Foundation
Engineering, Stockholm, 15-19 June 1981, v.1, p.415-416. Publ.
Rotterdam: A. A. Malkema, 1981.

Describes the techniques of electroosmosis and soil vacuuming for use
in soil stabilisation. Electroosmosis is particularly useful for water-
saturated clay soils.

Water Problems in Civil Engineering Tunnels and Excavations

12. HADES AND RHODES WATER TUNNELS ARE STREETS AHEAD OF SCHEDULE

Martin, D.
Tunn Tunnlg., v.15, N1, Jan. 1983, p.18-19.

Two water aqueduct tunnels have been successfully driven through shales
and limestones in north eastern Utah, USA, using a Robbins TBM. A split
heading technique was used in very soft ground. A number of problems
were encountered including squeezing ground, an area of fine running sand
and an inflow of spring run-off water to a depth of 3 feet.

13. UNDERSEA TUNNELS CARRY NORWEGIAN 'PLUTO' ASHORE

Martin, D.
Tunn. Tunnlg., v.14, N11, Dec. 1982, p.24-26.

Three largely unlined hard rock tunnels totalling 12 km in length are
being driven using drill and blast techniques through mixed hard rock
geology under three of Norway's largest fjords. The tunnels will dip
to a maximum 180 m below mean sea level, where leakage water will be
pumped to the surface. Systematic grouting ahead of the face is being
carried out to prevent possible water inflow and improve tunnel
stability.

14. HYDRO-DYNAMIC BEHAVIOR OF GROUND WATER IN CONFINED AND UNCONFINED LAYERS
WITH CUT-OFF WALL

Sato, K
Soils Found., v.22, N1, March 1982, p.14-22.

This paper presents some theoretical and experimental results on hydro-
dynamic behaviour of ground water in horizontally confined and unconfined
layers with the cut-off wall, based on Dupuit's assumption and approximate
equation in cases of steady flow. Hydraulic quantities obtained theoret-
ically and experimentally are the change of piezometric head at both
boundaries of the cut-off wall, change of flow rate and storage volume
change in both upstream and downstream aquifers. Auth.

15. TBMS DEFY WATER AND BAD GROUND TO DRIVE 21 KM IN THE AUSTRIAN ALPS

Martin, D.

Tunn. Tunnlg., v.14, N10, Nov. 1982, p.11-14.

Bad ground, with many faults, and large inflows of water have caused difficulties in the driving of the 21 km long Walgau water tunnel (using a full face TBM). Rock support methods being used include : rock bolts and/or mesh and shotcrete, and steel ribs. Only one collapse, at the side of the tunnel, occurred: the void was filled with concrete and steel rings installed.

16. CONSTRUCTING THE UNDERSEA SECTION OF THE SEIKAN TUNNEL

Fujita, M., Nishimura, T., Kitamura, A.

Tunn. Tunnlg., v.14, N8, Sept. 1982, p.31-33.

Presents a case study of the construction of the 23.3 km long undersea section of the Seikan Tunnel, Japan. Pilot boring, and grouting to strengthen loosened zones were carried out. Difficulties overcome included four inflows of sea water and high soil pressures.

17. ON THE ANALYSIS OF DEWATERING SYSTEMS

White, J. K.

Proc. 10th International Conference on Soil Mechanics and Foundation Engineering, Stockholm, 15-19 June 1981, v.1, p.511-516. Publ. Rotterdam: A. A. Balkema, 1981.

The demand for greater analytical support for dewatering system design is identified, and specific areas are discussed with reference to wellpoint and deep well methods. These areas include the effect of partial penetration, the estimation of the boundary conditions and the influence of sheet piles. Auth.

Mine Water Inflow Predictions (Analytical and Numerical Models)

18. TRANSIENT TWO-DIMENSIONAL GROUNDWATER FLOW

Nguyen, V. U., Raudkivi, A. J.

Hydrological Sciences Journal 4, 12/1982, p.427-438.

A set of simple analytical solutions are presented for estimation of drawdowns and groundwater flow rates into two-dimensional excavations, such as those in open-cut strip mines, for confined, leaky and unconfined aquifers.

Ground Water Control (Freezing and Grouting)

19. GROUND FREEZING TECHNOLOGY ADVANCES WITH SPEED

Jones, M. B.

Tunn. Tunnlg., v.14, N11, Dec. 1982, p.31-35.

Discusses recent developments in the technique of ground freezing. Freeze design factors are considered. The present use of ground freezing in the UK, USA, West Germany, Scandinavia, USSR, South Africa and Japan is illustrated with examples.

20. GROUTING FOR DAMS AND TUNNELS

Kennard, M. F.

Int. Water Power Dam Constr., v.34, N5, May 1982, p.50.

A brief summary of papers presented at the Grouting in Geotechnical Engineering Conference, held in the USA, February 1982.

21. EXCAVATION OF A MINE SHAFT THROUGH DEEP OVERBURDEN BY NATURAL FREEZING

Medd, M., De La Vergne, J.

CIM Bull., v.75, N840, April 1982, p.135-141.

This paper describes the sinking of a circular concrete ventilation shaft through 110 feet of water-bearing overburden. The brine circulation freezing method was used to stabilize the walls during excavation. In order to take advantage of the cold winter weather, a custom-built heat exchanger (natural radiator) was installed in place of the standard mechanical refrigeration plant. Auth.

22. GASCOIGNE WOOD SURFACE DRIFTS

Robertson, J. T.

Colliery Guard, v.230, N3, March 1982, p.127-128.

Site investigation of Gascoigne Wood, part of Selby mine, UK, revealed 4 main problems: (1) the driving of drifts through alluvium, (2) control of water in the Bunter sandstone of the shafts, (3) control of water in the Lower Magnesian Limestone in the shafts and drifts, and (4) the sinking and driving through basal sands. It was decided that a combination of freezing and grouting would be the best method of water control in the shafts and drifts. Stabilisation of the alluvium was achieved by freezing and by dewatering, and a shield was used for the whole drive. Freezing and grouting was also used during drive through the basal sands.

23. JETGROUTING COMES TO BRITAIN

Ground Engng., v.15, N2, March 1982, p.32-33.

Describes the ground treatment process of jet grouting which has been developed in Japan and is being tried out in the UK. A guidehole is sunk and the 'monitor' lowered into it. The monitor is rotated and slowly raised as a high speed water jet forms a void, spoil is airlifted to the surface via the borehole, and another jet (lower down the monitor) injects cement slurry into the void.

24. GROUND FREEZING 1980 (DEVELOPMENTS IN GEOTECHNICAL ENGINEERING, VOL.28)

Frivik, P. E. (editor), Janbu, N. (editor), Saetersdal, R. (editor)

Amsterdam : Elsevier, 1982, 420p.

Selected papers from the 2nd International Symposium on Ground Freezing, Thronheim, 24-26 June 1980, reprinted from Engineering Geology, Vol.18, Nos.1-4, 1981.

25. QUANTITATIVE RELATIONSHIP OF GROUTING TO THE REDUCTION OF GROUNDWATER FLOW THROUGH ROCK FOUNDATIONS

Klosterman, M. J., Wolff, T. F., Jahren, N. G.
Bull. Assoc. Engng. Geol., v.19, n.1, Feb. 1982, p.15-24.

A test grout programme was carried out, involving the grouting of two areas using two different methods: a modified stage-grouting method and a modified stop-grouting method. Pregroutings and post grouting pumping tests were carried out from water wells completely surrounded by a 50 ft grout curtain. This provided quantitative data on the amount of seepage occurring. A 97 per cent reduction in the specific capacity of the test well after grouting was established indicating that grouting effectively reduces groundwater flow. Placing a grout curtain beneath a dam is the traditional way of reducing seepage and this quantitative study has demonstrated the method's effectiveness.

26. SELBY DRIFTS: GROUND TREATMENT WITH PARTICULAR REFERENCE TO FREEZING TECHNIQUE

Forrest, W.
In : Tunnelling 82, Proceedings of the 3rd International Symposium, Brighton, 7-11 June 1982, p.117-120. Publ. London : IMM, 1982.

Describes the driving of surface drifts at Gascoigne Wood through difficult strata with large quantities of water present, with particular reference to the progress of the drifts through grouted Lower Magnesian Limestone and the frozen Basal Sands. The eventual thawing of the Basal Sands and the monitoring of ice wall decay and the physical effect on the drifts themselves are analysed.

27. MODERN GROUTS AND THEIR USES

Dodd, M.
Tunn. Tunnlg., v.14, n.10, Nov.1982, p.20-21.

Different types of grouts and their applications are described. Brief case studies are used to illustrate the use of the Geoseal range of resin grouts.

28. APPLICATION OF HORIZONTAL GROUND FREEZING IN TUNNEL CONSTRUCTION - TWO CASE RECORDS

Lake, L. M., Norie, E. H.
Tunnelling, 1982, Institute of Mining & Metallurgy, London, Tunnelling Symposium, Brighton 1982, pp.283-290.

The successful application of horizontal ground freezing with different refrigerants for the construction of two quite different tunnelling projects is described. The first case relates to tunnelling through a buried valley for the metro in Helsinki and the second is concerned with a tunnelling operation designed to join existing tunnels beneath the River Mersey and the Manchester Ship Canal and install a steel pressure lining. Both projects involved working in variable and potentially hazardous water-bearing soils in which failure could have had catastrophic repercussions. In addition to an outline of the construction and ground treatment options considered, an account is given of the methods adopted, some of the problems experienced and an indication of cost.

29. WEYMOUTH AND PORTLAND LONG SEA OUTFALL TUNNEL

Roberts, D. G. M., Flint, G. R.
Tunnelling Conference, Brighton 1982, p.265-270.

The design of the long sea outfall tunnel and the main problems that were encountered in driving it through a sub-stratum of the Corallian Series known as the Sandsfoot Grits and through the Kimmeridge Clay stratum are described briefly, and the various solutions that were adopted to overcome these problems are outlined. These include basic borehole dewatering and compressed air techniques for driving through Sandsfoot Grits.

30. CONSTRUCTION OF A SECTION OF THE DU TOITSKLOOF TUNNEL BY USE OF GROUND FREEZING

Cockcroft, T. N., Denne, R. J., Harvey, S. J.
Tunnelling Conference, Brighton 1982, pp.105-116.

As a result of the construction problems that were experienced in the western heading of the pilot bore, ground freezing is again being used for the excavation of the 168-m western heading of the main Du Toitskloof tunnel through the saturated decomposed granite. A two-phase tendering system was adopted in which contractors were first asked to submit prequalification applications that gave details of their construction methods and programme before pricing. These applications were evaluated with particular regard to freezing plant, equipment and time scheduling and only the accepted consortia were asked to submit tender prices. Excavation of the first 32 m of stage I of the tunnel has been completed and details are given of the construction work. Results from the extensive monitoring programme undertaken during the freezing and excavation cycles are compared with similar data obtained from the pilot bore construction work. (Authors)

31. SELBY DRIFTS : GROUND TREATMENT WITH PARTICULAR REFERENCE TO FREEZING TECHNIQUE

Forrest, W.
Tunnelling Conf., Brighton 1982, p.117-126.

The surface drifts at Gascoigne Wood have been driven through strata that in mining and civil engineering terms may be considered to be extremely difficult. The nature of the rocks, coupled with the presence of water in large quantities, mostly of an artesian nature, presented a great challenge to the National Coal Board. The initial hydrogeological investigation of the Permian rocks and glacial deposits is reviewed. The design implications that resulted from this investigation are discussed and the evolution of the final design and mining techniques is described. The physical operations are detailed, particularly with reference to the progress of the drifts through the grouted Lower Magnesian Limestone and the frozen Basal Sands, and the eventual thawing of the Basal Sands and the monitoring of the ice wall decay and the physical effect on the drifts themselves are analysed. (Author).

Hydrogeology

32. CONTAMINANT MIGRATION IN A SAND AQUIFER NEAR AN INACTIVE URANIUM TAILINGS EMPOUNDMENT, ELLIOT LAKE, ONTARIO

Morin, K. A., Cherry, J. A., Lim, T. P.
Can. Geotech. J., v.19, N1, Feb. 1982, p.49-62.

Multilevel bundle-type piezometers were installed around the edge of the tailings impoundment. Chemical analysis of water samples from these piezometers indicate a major contaminant plume extending through the sand aquifer, with two distinct segments: the inner core and the outer zone. Data shows that the inner core is advancing only a few metres per year, caused by neutralisation of the acidic groundwater.

33. HYDROGEOLOGY OF KARST-TYPE COALFIELDS IN CHINA (IN CHINESE)

Wang Mengyu
Coal Sci. Technol., n.12, Dec. 1982, p.28-34.

Chinese coalfields can be divided into 6 hydrogeological regions, according to geotectonics, manner of coal deposition, hydrogeological conditions, and water control in mines. The hydrogeological characteristics in areas with water inflow problems are discussed, with methods of controlling water in mines.

34. HYDROGEOLOGICAL PROBLEMS CAUSED BY MINING AND QUARRYING

Brassington, F. C.
Trans. Inst. Min. Metall (Sect.B Appl. Earth Sci.), v.91, Feb. 1982, p.21-25.

Quarrying and mining operations in geological formations which also form aquifers can result in major changes in aquifer characteristics, which, in turn, can modify directions of groundwater flow and alter groundwater chemistry. These changes may be of fundamental significance to water supply schemes, but they can often be avoided by appropriate early action. Various examples of such changes are cited, together with suggestions as to how these problems may be foreseen and avoided. 37 refs.

35. STATIONARY LEVEL METHOD FOR MEASURING IN-SITU KH AND S

Holeyman, A.
Proc. 10th International Conference on Soil Mechanics and Foundation Engineering, Stockholm, 15-19 June 1981, v.1, p.417-420. Publ. Rotterdam : A. A. Balkema, 1981.

A new method for quickly estimating the in situ transmissivity (kH) and the storage coefficient (S) of a confined aquifer is described : the Stationary Level Method. This is based on an analysis of the piezometric response to a pumping signal of limited period. A simple chart allows quick interpretation of data and determination of kH and S. The method is faster than conventional pumping tests.

16. INITIAL GRADIENT IN A DENSE GLACIAL TILL

Law, K. T., Lee, C. F.
Proc. 10th International Conference on Soil Mechanics and Foundation Engineering, Stockholm, 15-19 June 1981, v.1, p.441-446. Publ. Rotterdam : A. A. Balkema, 1981.

Permeability tests, using a special apparatus, were carried out on a dense till from the Bruce Nuclear Power Development site, Ontario, Canada as part of investigations into nuclear waste containment. Non-Darcian flow was noted and the results showed that there exists an initial hydraulic gradient below which the permeability gradient is either zero or significantly smaller than that at higher gradients. This behaviour was found to be consistent with tritium profiles measured on the site.

37. AN IMPROVED UNDERSTANDING OF FLOW IN A LIMESTONE AQUIFER USING FIELD EVIDENCE AND MATHEMATICAL MODELS

Rushton, K. R., Smith, E. J., Tomlinson, L. M.
Journal of the Institution of Water Engineers and Scientists, vol.36, n.5, Oct. 1982, pp.369-387.

A long-term study of the Southern Lincolnshire Limestone aquifer is described. An understanding of the flow processes within the aquifer has been gained from an interplay between field evidence and a mathematical model of the aquifer. The drought of 1976 followed by the very wet winter of 1976-77 provided valuable information which means that the mathematical model can be used with confidence to predict aquifer behaviour in times of high and low flows. Water balances for the confined region illustrate the interaction between the various inflows and outflows. Principles deduced from this study have applications for other aquifer problems.

Seepage Erosion and Piping

38. SEEPAGE EROSION ANALYSES OF STRUCTURES

Van Zyl, D., Harr, M. E.
Proc. 10th International Conference on Soil Mechanics and Foundation Engineering, Stockholm, 15-19 June 1981, v.1, p.503-509. Publ. Rotterdam : A. A. Balkema, 1981.

Reviews methods of seepage erosion analysis of granular soil deposits subjected to confined flow : the global gradient approach, heave, and the exit gradient approach. Seepage erosion failures are classified in 3 modes : heave, piping, and internal erosion. Results from laboratory tests show that the failure gradient of a soil is higher than the critical gradient, and that both these gradients are random variables.

39. LABORATORY TESTING ON PIPING

de Wit, J. M., Sellmeijer, J. B., Penning, A.
Proc. 10th International Conference on Soil Mechanics and Foundation
Engineering, Stockholm, 15-19 June 1981, v.1, p.517-520. Publ.
Rotterdam : A. A. Blakema, 1981.

A laboratory investigation was carried out on scale models of dams on permeable foundations to determine criteria to prevent piping. The determination of scale rules between the models and prototype is essential. Measured pore pressures are in good agreement with calculations using the Laplacian equation of steady flow. Also, pore pressures in the areas sensitive to piping are equal in models of different scales provided the sensitive area has the same geometry in each model. This means the results obtained from model tests can be extrapolated to prototype situations.

Groundwater

40. WATER DRAINAGE THROUGH WASTE DUMPS AT FORDING COAL LIMITED

Nicols, R. S., Rutledge, A. L.
CIM Bull. v.75, n.844, Aug. 1982, p.74-77.

Four case examples are used to illustrate water flow through waste dumps of varied lithology and maturity. It is concluded that end dumping of waste rock on sloping foundations creates a long term, naturally free-draining dump.

41. WATER MIGRATION INDUCED BY THERMAL LOADING OF A GRANITIC ROCK MASS.
TECHNICAL NOTE

Nelson, P. H., Rachiele, R.
Int. J. Rock Mech. Min. Sci., v.19, n.6, Dec. 1982, p.353-359.

Water inflow into instrumentation and heater boreholes was monitored for nearly 2 years during 2 thermomechanical experiments at Stripa, Sweden, as part of research into the safe storage of nuclear waste. The inflow records indicate the presence of 2 flow components : a transient component related to the changing thermally induced stress, and a background component due to the in situ hydrological pressure gradient. A crack-closure hypothesis is suggested to explain the water flow observations.

42. PROPOSED MODEL FOR MULTIPHASE FLOW THROUGH NATURALLY FRACTURED RESERVOIRS

Evans, R. D.
Soc. Petr. Engr. J., v.22, n.5, Oct. 1982, p.669-680.

In the model the reservoir is treated as a heterogeneous double-porosity medium of isotropic rock matrix and anisotropic fractures coupled by a transient fluid interaction term.

43. THEORY OF NON-LINEAR SEEPAGE

Barends, F. B. J.

Proc. 10th International Conference on Soil Mechanics and Foundation Engineering, Stockholm, 15-19 June 1981, v.1, p.375-378. Publ. Rotterdam : A. A. Balkema, 1981.

An attempt is made to extend the contemporary theory, applicable to either saturated deformable or to unsaturated undeformable porous media, to pore fluid flow in a semi-saturated, deformable medium including entrapped air bubbles. Variations of the permeability and the viscosity due to pore pressure fluctuations are taken into account. The flow process considered can be formulated in a simple form revealing similarity with the familiar potential equation but in terms of the exponential of the flow potential multiplied by the so-called coefficient of non-linearity, which contains all the non-linear effects concerned.

44. DRAWDOWN CAPACITY OF GROUNDWATER WELLS

Brauns, J.

Proc. 10th International Conference on Soil Mechanics and Foundation Engineering, Stockholm, 15-19 June 1981, v.1, p.391-396. Publ. Rotterdam : A. A. Balkema, 1981.

The drawdown of the groundwater surface near a well is restricted due to the needs of the groundwater flow towards the cylindrical face of the well. There is no explicit solution for the actual drawdown at the surface of a drained well, since the phreatic line does not correspond to that after Dupuit. Results of numerical analyses (finite element method) are presented in the form of a quantitative relation between the actual drawdown in the mantle of a fully drained well and the relevant parameters such as radius of well, radius of influence, and height of aquifer. The results, obtained for the conditions of steady flow (fixed radius of influence) and a fully penetrating well, are given in graphical form and include the influence of anisotropy.

45. GROUNDWATER DRAINAGE SYSTEM - ANALYSIS OF SYSTEM PERFORMANCE

Mercurio, W. F., Bain, G. L.

Proc. 10th International Conference on Soil Mechanics and Foundation Engineering, Stockholm, 15-19 June 1981, v.1, p.453-456. Publ. Rotterdam : A. A. Balkema, 1981.

The passive design of a permanent ground water drainage system for a Nuclear Power Plant is presented. Included is a description of the drainage system, design philosophy, performance measurements and its effect on adjacent ground water levels. Original predictions of drawdown from a hydraulic model are compared to actual observed hydrologic conditions using monitoring piezometers and system flows. A full scale test program was implemented by mechanically plugging the system and recording measurements of water table with respect to time.

Ground Water Models

46. MODELS FOR PREDICTING GROUND WATER LEVEL

Uno, T., Arai, H., Shibayama, M.
Proc. 10th International Conference on Soil Mechanics and Foundation Engineering, Stockholm, 15-19 June 1981, p.495-498. Publ. Rotterdam: A. A. Balkema, 1981.

A simulation model and a statistical model were constructed to predict variations in ground water level in the Gifu locality of Japan. Comparison with field observations shows good agreement with the models, especially the statistical model.

47. PREDICTION OF A HIGHLY VARIABLE WATER TABLE (IN FRENCH)

Tcheng, Y., Mosse, J.
Proc. 10th International Conference on Soil Mechanics and Foundation Engineering, Stockholm, 15-19 June 1981, v.1, p.491-494. Publ. Rotterdam: A. A. Balkema, 1981.

A simple method to determine the maximum theoretical level of a water table in the subsoils under buildings is presented. The method is based on the correlation of in situ piezometric levels over several months with water table levels in a reference well over a period of 10 years.

48. SEEPAGE INTERACTION IN SAND AND CLAY

Runesson, K., Tagnfors, H., Wiberg, N. E.
Proc. 10th International Conference on Soil Mechanics and Foundation Engineering, Stockholm, 15-19 June 1981, v.1, p.477-480. Publ. Rotterdam: A. A. Balkema, 1981.

Seepage interaction between media with highly different consolidation coefficients has to be considered in the analysis of many subsurface engineering problems. Use of finite element methods for such problems is discussed. Different approaches including coupled and uncoupled displacement-pore pressure analysis are compared. Two case studies of seepage interaction are presented: a sand aquifer on impervious rock confined by clay, and sand layers embedded in clay.

Permeability, Capillarity and Aquifer Testing

49. DESIGN CRITERIA FOR LABORATORY MEASUREMENTS OF LOW PERMEABILITY ROCKS

Trimmer, D. A.
Geophys. Res. Lett., v.8, n.9, Sept. 1981, p.973-975.

The advantages and limitations of two versions of the pulse technique for laboratory measurements of low permeabilities are discussed. The transient pulse technique developed by Brace et al. (1968) is the preferred method because of the ease of data reduction. The modified transient pulse technique developed by Trimmer et al. (1980) can be used when the assumptions inherent in the transient pulse technique are invalid. Criteria are also presented for optimizing the experimental configuration for measurement durations as well as ease of data reduction.

50. EFFECT OF SIZE ON FLUID MOVEMENT IN ROCK FRACTURES

Witherspoon, P. A.
Geophys. Res. Lett., v.8, n.7, July 1981, p.659-661.

Laboratory studies on fluid flow in single fractures in rock samples up to a metre in size suggest that there is a definite problem of scale. Seemingly contradictory results may simply be a manifestation of the effects of fracture surface roughness. The investigations that are envisioned to attack this problem will only be possible on rock samples that are much larger than the conventional size.

51. NEW METHOD TO MEASURE DIRECTIONAL PERMEABILITY

Rose, W. D.
J. Pet. Technol., v.34, n.5, May 1982, p.1142-1144.

The new method is for two-dimensional cases of anisotropy and uses a special form of Darcy's Law. Three measurements are made on a laboratory sample to calculate the minimum and maximum permeability: two angles showing the direction of flow with respect to the directions of maximum permeability and the driving force gradient, and one component of the resistivity tensor appearing in Darcy's Law.

52. PRESERVATION OF POROSITY IN THE DEEP WOODBINE/TUSCALOOSA TREND, LOUISIANA

Thomson, A.
J. Pet. Technol., v.34, n.5, May 1982, p.1156-1162.

Cores of the Woodbine/Tuscaloosa formation contain certain sandstones from 6562 m with anomalously high porosities (greater than 25 per cent) and permeabilities (as high as 200 md). Scanning electron microscopy has shown that individual grains of the sandstone are coated with chlorite. Grains with well-developed coatings were found to have few secondary quartz overgrowths and to be compacted only slightly, whereas poorly coated grains tended to be well cemented and highly compacted. These effects may have allowed the sandstones to be buried at great depth without appreciably reducing porosity.

53. DENSITY AND POROSITY LOGGING IN THE IRDP HOLE, ICELAND

Jonsson, G., Stefansson, V.
J. Geophys. Res., v.87, n.B8, 10 Aug. 1982, p.6619-6630.

Results from a gamma-gamma density log and a neutron-neutron porosity log in the continuously cored Iceland Research Drilling Project hole are presented. Logging data for densities were found to be in agreement with lab measurements on core samples. For porosity, the laboratory data were found to be lower than those obtained from the logs.

54. PARAMETRIC ANALYSES OF THE TRANSIENT METHOD OF MEASURING PERMEABILITY

Lin, W.

J. Geophys. Res., v.87, n.B2, 10 Feb. 1982, p.1055-1060.

Two approaches for the use of the transient method to determine the permeability of reservoir rocks are compared: the simplified method where the fluid storage in a rock sample is neglected and the pressure decay in the upstream reservoir is approximated by an exponential function of time, and the numerical version using the finite difference method. The numerical version is found to fit observed data very well and the permeability value calculated tends to be less than that from the simplified version. The difference between these two is found to depend on many factors including rock properties, sample size and reservoir volumes.

55. APPROACHES TO EVALUATING THE PERMEABILITY AND POROSITY OF FRACTURED ROCK MASSES

Doe, T. W., Long, J. C. S., Endo, H. K.

Proc. 23rd Symposium on Rock Mechanics, Berkeley, 25-27 August 1982, p.30-38. Publ. New York: AIME, 1982.

An approach to treating flow through fractured rocks is presented which involves (1) determining statistical distributions for fracture area, density, orientation, and aperture from field data, (2) computer generation of fracture systems from the statistical distributions, and (3) analysis of the permeability and porosity of the fracture systems. The fracture density and orientation data may come from core logging or mapping. The hydraulically appropriate apertures and areas of the fractures come from transient flow analyses of single fracture well tests. These tests may also yield information on fracture deformability. Analysis of flow through computer generated fracture systems shows that an equivalent porous medium permeability can be defined for some fracture systems if a large number of fractures is taken into account. Auth.

56. PERMEABILITY, PERCOLATION AND STATISTICAL CRACK MECHANICS

Dienes, J. K.

Proc. 23rd Symposium on Rock Mechanics, Berkeley, 25-27 August 1982, p.86-94. Publ. New York: AIME, 1982.

A theory of permeability in rock is developed which involves 3 factors: the average fluid flux per crack, the number of cracks per unit area, and the fraction of cracks that are not isolated. Probabilistic theory is used together with the hydrodynamic theory of flow through a single crack to develop an integral expression for permeability. The results have the form of Darcy's Law for anisotropic media.

57. PHYSICAL CONTROLS OF WATER MOVEMENT IN THE UNSATURATED ZONE

Wellings, S. R., Bell, J. P.

Q. J. Engng. Geol., v.15, n.3, 1982, p.235-241.

Traditional hydrogeological concepts of the unsaturated zone imply that the water is essentially static, and do not take account of the

dynamic nature of the annual water cycle in the field. The basic concepts of water content, water potential and unsaturated hydraulic conductivity are defined as they are developed in soil physics and applied to the flow of water in the unsaturated zone. The emphasis is on a practical and non-numerical description of what happens in the field.

58. IN SITU PERMEABILITY OF A FRACTURED ROCK FORMATION

Durgunoglu, H. T., Tezcan, S. S., Acar, Y.
Proc. 10th International Conference on Soil Mechanics and Foundation Engineering, Stockholm, 15-19 June 1981, v.1, p.411-414. Publ. Rotterdam: A. A. Balkema, 1981.

Extensive water pressure tests were performed in many borings for the determination of the permeability of a fractured rock formation at a nuclear power plant site. At zones where high water losses were encountered, the permeabilities were further determined using the Lefranc testing procedure. Correlation of the subsurface permeabilities and geological features present was carried out and it was found that in zones with a high degree of jointing or karstification, the Lugeon values obtained were high. The subsurface permeability was also correlated with rock quality designation, and permeabilities from water pressure and Lefranc tests were compared.

59. EVALUATION OF PORE GEOMETRY OF SOME LOW-PERMEABILITY SANDSTONES - UINTA BASIN

Keighin, C. W., Sampath, K.
J. Pet. Technol., v.34, n.1, Jan. 1982, p.65-70.

A study of the permeability/porosity characteristics and petrographic properties of some low-permeability sandstones indicates that the permeability reduction in these sandstones due to confining pressure is much more significant than porosity reduction. The sandstones were fine grained, and most pores were secondary and small: the few large pores present usually were filled with authigenic kaolinite.

60. STUDY OF INTERGRANULAR AND FISSURE PERMEABILITY IN CHALK AND PERMIAN AQUIFERS, USING DOUBLE-PACKER INJECTION TESTING

Pric, M., Morris, B., Robertson, A.
J. Hydrol., v.54, n.4, Jan. 1982, p.401-423.

Double-packer injection tests have been carried out in boreholes in chalk and sandstone, in the UK. The tests have been supplemented by borehole logging and television inspections and by laboratory measurements on cores. A new mathematical treatment has enabled results to be calculated for injection test intervals containing fissures. In both formations, transmissivity immediately around the borehole is dominated by a few major fissures. In the Penrith Sandstone there is good agreement between intergranular hydraulic conductivity measurements and packer-test results in the portions of the borehole which do not contain major fissures. In the chalk, the packer-test values are always higher than the intergranular measurements, suggesting that some degree of fissuring is present throughout.

61. EFFECTS OF FRACTURE TYPE (INDUCED VERSUS NATURAL) ON THE STRESS-FRACTURE CLOSURE-FRACTURE PERMEABILITY RELATIONSHIPS

Gale, J. E.

Proc. 23rd Symposium on Rock Mechanics, Berkeley, 25-27 August 1982, p.290-298. Publ. New York: AIME, 1982.

Seven 15 cm diameter cores of gneissic granite, four containing induced fractures and three containing natural fractures all oriented normal to the core axis, were tested in a uniaxial compression mode over a range of 0 to 30 MPa. At given normal stress increments, over two or three loading and unloading cycles, the flow rates and changes in fracture aperture were measured. The induced fractures gave lower initial (at low stresses) and lower final flow rates (at maximum stress) than the natural fractures. Both types of fracture exhibited permanent fracture deformation between loading cycles as well as highly nonlinear, with distinct hysteresis, loading and unloading flow rate-stress curves. A significant finding of this study is the breakdown of the cubic law for fracture flow in induced fractures subjected to normal stresses greater than 20 MPa, with the breakdown occurring at much lower stresses in natural fractures. Auth.

62. EVALUATION OF OPENING AND HYDRAULIC CONDUCTIVITY OF ROCK DISCONTINUITIES

Cruz, P. T., Quadros, E., Correa, D.

Proc. 23rd Symposium on Rock Mechanics, Berkeley, 25-27 August 1982, p.769-777. Publ. New York: AIME, 1982.

Describes a laboratory and field test programme to determine the hydraulic characteristics of rock masses and discontinuities. Simple conductivity tests on natural rock joints were carried out in the laboratory and pumping tests were carried out in the field.

63. DISTRIBUTION OF POROSITY IN COMPACTED CLAYS

Bhasin, R. N., Lovell, C. W.

Proc. 10th International Conference on Soil Mechanics and Foundation Engineering, Stockholm, 15-19 June 1981, v.1, p.563-566. Publ. Rotterdam: A. A. Balkema, 1981.

Describes the measurement of the pore size distribution in compacted samples of a plastic kaolin and a silty clay, using the mercury intrusion method. For each soil a relatively fixed content of pores is present for smaller pore sizes below 0.1 micrometre, regardless of how the soil is manipulated. These pores occur within individual grains or within clay clusters of roughly face to face oriented clay particles. The distribution of larger pores, lying between the grains and clay clusters, is dependent on moulding, water content and compactive effort.

64. LABORATORY PERMEABILITY TESTS WITH ANNULAR SEALS

Hawley, J. G., Northey, R. D.

Proc. 10th International Conference on Soil Mechanics and Foundation Engineering, Stockholm, 15-19 June 1981, v.1, p.617-620. Publ. Rotterdam : A. A. Balkema, 1981.

Laboratory hydraulic permeability measurements are prone to large and unknown errors due to leakage at the boundary between soil and container.

65. IN SITU VARIABLE HEAD PERMEABILITY TESTS (IN FRENCH)

Chapuis, R. P., Pare, J. J., Lavallee, J. G.
Proc. 10th International Conference on Soil Mechanics and Foundation
Engineering, Stockholm, 15-19 June 1981, v.1, p.401-406. Publ.
Rotterdam : A. A. Balkema, 1981.

The use of the diagrams of velocity for in situ variable head permeability tests allows determination of local piezometric heads and modelling of groundwater flow. The method eliminates errors in the estimation of the piezometric head caused during drilling.

66. PUMPING TESTS IN COIMBRA DAM ALLUVIAL FOUNDATION

Maranha das Neves, E., Correia, R., e Pinto, P. S.
Proc. 10th International Conference on Soil Mechanics and Foundation
Engineering, Stockholm, 15-19 June 1981, v.1, p.447-451. Publ.
Rotterdam : A. A. Balkema, 1981.

Pumping tests in a very pervious unconfined sandy aquifer were made and the results are analysed for steady and transient states and for changes on the boundary conditions by both analytical and finite element methods. Correlations between in situ permeability and grain size characteristics of the sands are also presented. Auth.

67. THE USE OF FLOW RESTRICTORS IN BOREHOLE PERMEABILITY TESTING

Telling, R. M.,
Ground Engineering, v.15, n.12, Oct. 1982, p.28-33.

The paper considers the use of restrictors in reducing the rate of flow when constant head and falling head in situ permeability tests are carried out in cased boreholes installed in highly permeable soils. An appraisal is made of three types of restrictors, namely the fitted orifice plate, suspended plate and placed soil plug. On the basis of theoretical and practical considerations and some comparative data from a worked example it is concluded that the orifice plate and soil plug would have the widest application in practice.

68. PRESSURE-HEAD TESTING

Whartman, R. L.
Bull. Assoc. Engng. EOL, v.19, n.1, Feb. 1982, p.87-94.

Determination of pressure heads in groundwater systems by means of short-term tests, i.e. pressure-head testing, is discussed. Three types of pressure-head testing, defined by access-hole condition, are described: open hole, cased hole, and packers used in open or cased holes. Case studies are used to illustrate the use of pressure-head testing.

69. GEOTECHNICAL EFFECTS OF CHANGES IN GROUNDWATER LEVEL

Rethati, L.
Proc. 10th International Conference on Soil Mechanics and Foundation
Engineering, Stockholm, 15-19 June 1981, v.1, p.471-476. Publ.
Rotterdam : A. A. Balkema, 1981.

Change in position of the water table and the connected capillary

fringe causes a change in numerous physical characteristics of the soil. Thus the position of the water table exerts a considerable influence on the bearing capacity and deformation of the soil, on the stability and solidity of foundations and on the method of construction or earthworks. Theoretical considerations and examples taken from practice prove that most geotechnical problems can be solved only with hydrological data.

Permeability and Capillarity (Numerical and Analytical Models)

70. INFLUENCE OF COMMON SEDIMENTARY STRUCTURES ON FLUID FLOW IN RESERVOIR MODELS

Weber, K. J.
J. Pet. Technol., v.34, n.3, March 1982, p.665-672.

Summarises the state-of-the-art of deriving detailed permeability-distribution models on the basis of cores, sidewall samples and logs. The relationship between diagenesis and sand-body properties (permeability-porosity) is discussed. The effects of reservoir heterogeneities such as clay intercalations, cross bedding, sand laminations, slumping and burrowing on the horizontal and vertical permeabilities are examined.

71. PULSE DECAY PERMEABILITY : ANALYTICAL SOLUTION AND EXPERIMENTAL TEST

Bourbie, T., Walls, J.
Soc. Petr. Engr. J., v.22, n.5, Oct. 1982, p.719-721.

A new analytical solution is presented for the laboratory pulse decay permeability problem. Permeability of the core sample can be calculated from the decay rate of a pressure pulse applied to one end of the sample. Theoretical and experimental pulse decay curves are compared for a tight sandstone.

72. POROSITY PREDICTION FROM SEISMIC DATA

Angeleri, G. P., Carpi, R.
Geophys. Prospect, v.30, n.5, Oct. 1982, p.580-607.

A method of computing porosity distribution from interval velocity information extracted from seismic data is described. Three examples are used to illustrate the application of the method: evaluation of porosity distribution between two wells in clastic rock, a carbonate reservoir, and a complex carbonate reservoir where both primary and secondary porosity are present.

73. SPATIAL DISTRIBUTION OF PERMEABILITY AROUND CSM/ONWI ROOM, EDGAR MINE, IDAHO SPRINGS, COLORADO

Montazer, P., Chitombo, G., King, R.
Proc. 23rd Symposium on Rock Mechanics, Berkeley, 25-27 August 1982, p.47-56. Publ. New York : AIME, 1982.

Presents the results of a study to define the spatial distribution of permeability within a 5 m thick envelope around the CSM/ONWI room. Steady-state air and water injection techniques together with pulse testing and pressure decay tests were used in all boreholes to identify and characterise conductive fractures. Through analysing the distribution of permeability and fracture index around the room a zone of blast damage of approximately 0.5 m thickness was delineated.