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LAWRENCE BERKELEY LABORATORY
Room: 128 Bldg.: 70 Ext.: 6241

November 6, 1980

TO: Charles Grua, Brian Harney, and Art Hartstein

FROM: Peter Persoff, Bill Hall, Mohsen Mehran, and Phyllis Fox

RE: Monthly Progress Report for October
Control Technology for In-Situ Oil Shale Retorts
LBID-309

TASK 3. BARRIER OPTIONS

Preparation of Grout and Grouted Core Samples

A second series of samples of grouts and grouted cores has been prepared (the first series is described in the February report, LBID-177). Grout recipes are shown in Table 1. In this series, lignosulfonate fluidizer and fly ash were used to obtain adequate flow properties and some strength development.

Specimens were made both with coarse aggregate, for compressive strength tests, and without, for permeability tests. The coarse aggregate is spent shale from LETC's retort run S-55, which was crushed and sieved to -3/8" + 1/4", and used in a saturated, surface-dry condition. The method of sample preparation is the same as for the first series of grouts. Rheological measurements were also taken on grouts R-4 and R-5; analysis of these data is under way.

TASK 5. LEACHING OPTION

Leaching of Organics from Spent Shale

The planned series of leaching experiments using spent oil shale in 11.5-cm columns is nearing completion. During this month, batch and column leaching of S-55 and L-2 spent shales continued. As discussed in the September monthly report, column leaching is being conducted in two steps. The first step is conventional column leaching in which the fluid phase is passed

Table 1. Formulae of experimental grouts.

	R-1	R-2	R-3	R-4	R-5
Lurgi spent shale[a], g	2500	2500	2500	2403	2403
Lignosulfonate fluidizer, CZ 503, g	12.5	6.25	0	0	0
Lignosulfonate fluidizer, CZ 512, g	0	0	6.25	6.675	6.675
Wyodak fly ash, g	0	0	0	253.65	0
Gypsum, g	0	0	0	13.35	0
Craig fly ash, g	0	0	0	0	267
Distilled water, mL	1750	1875	1800	1850	1700
Water-solids ratio	0.697	0.748	0.718	0.691	0.635
Flow cone time, sec[b]	16.6	16.1	17.9	22.2	22.4
Grout density, g/mL	--	1.57	1.57	1.59	1.62

[a]material collected in electrostatic precipitator from Lurgi run 9 (1976).

[b]standard grout flow cone as specified in US Army Corps of Engineers standard CRD-C 79.

through a fixed bed of shale. In the second, the leachate lies quiescent in the pores of the bed. The first step is terminated and the second begun when the TOC concentration in the column effluent approaches zero. This two-part technique allows us to: 1) estimate the mass transfer coefficient at the interface between the solid and liquid phases from the results of the first step and 2) determine from the data of the second step the magnitude of the diffusion of TOC within the solid boundaries.

At the beginning of the month, quiescent leaching of two columns of S-55 shale was under way. The leachate did not reach equilibrium with the solid phase in either column. In order to free a column for additional studies, a 2-liter portion of spent shale from the column was placed in a flask along with 1 pore volumn of the associated leachate. Monitoring of the change in TOC levels in the leachate in the flask and in the remaining column will continue until the liquid reaches equilibrium with the solid phase. Similar long-term leaching experiments are available for reference to determine when equilibrium has been reached. At the completion of runs 3 and 7 about 18 months ago, leached shale together with leachate were placed in flasks and stored at room temperature.

The empty column was filled with spent shale from LLL's run L-2 crushed and sieved to the -4 to +8 size range. This column was operated in the same manner previously used for the S-55 shale. The first phase, flow leaching, has been completed and monitoring of the second step, quiescent leaching, has begun. Preliminary results show that the leaching pattern of the L-2 shale is similar to that of the S-55 material.

We are now analyzing data and preparing a draft of the final report of this phase of the project.

TASK 6. GEOHYDROLOGIC MODIFICATIONS

Dewatering and Reinvasion Calculations.

Previous work under this task has shown the importance of unsaturated flow in dewatering and reinvasion, especially the

reduction in hydraulic conductivity that results from desaturation. At negative pressure heads (that is, at locations above the phreatic surface), water drains from larger pores by gravity, but is held in smaller pores by surface tension; drained pores do not contribute to hydraulic conductivity.

Previously, we assumed reasonable relationships between saturation and negative pressure head and between hydraulic conductivity and negative pressure head (see report for April 1980, LBID-206). This month, we eliminated the need for a second assumption by applying the Millington-Quirk formula (1959, 1961) which relates hydraulic conductivity to pore size. The assumed relationship between saturation and negative pressure head is shown in Figure 1; this is equivalent to assuming a pore-size distribution. From this and the Millington-Quirk formula, the second relationship is calculated as shown in Figure 2.

Using these relationships and material properties available in the literature, long-term simulations of dewatering have been carried out for tracts C-a and C-b. Results of these calculations, including drawdown beneath Piceance and Yellow Creeks, and dewatering flows, will be available next month.

REFERENCES

Millington, R. and J. Quirk. 1959. Permeability of Porous Media. Nature 183: 387-88.

Millington, R. and J. Quirk. 1961. Permeability of Porous Solids. Trans. Faraday Soc. 57: 1200-07.

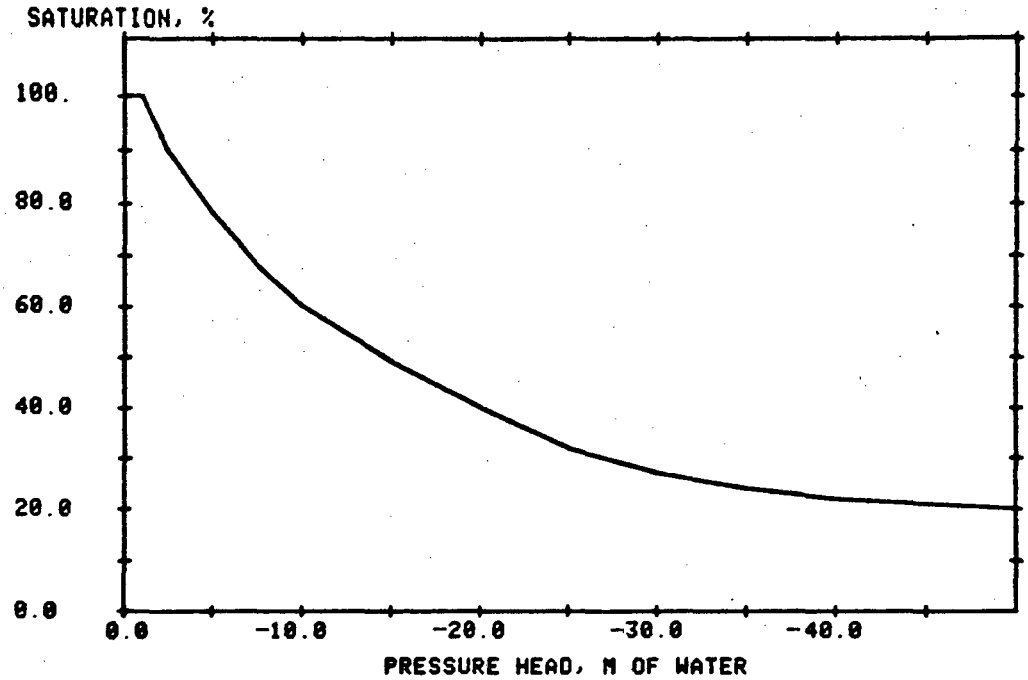

Figure 1. Assumed relationship between saturation and negative pressure head for upper aquifer.

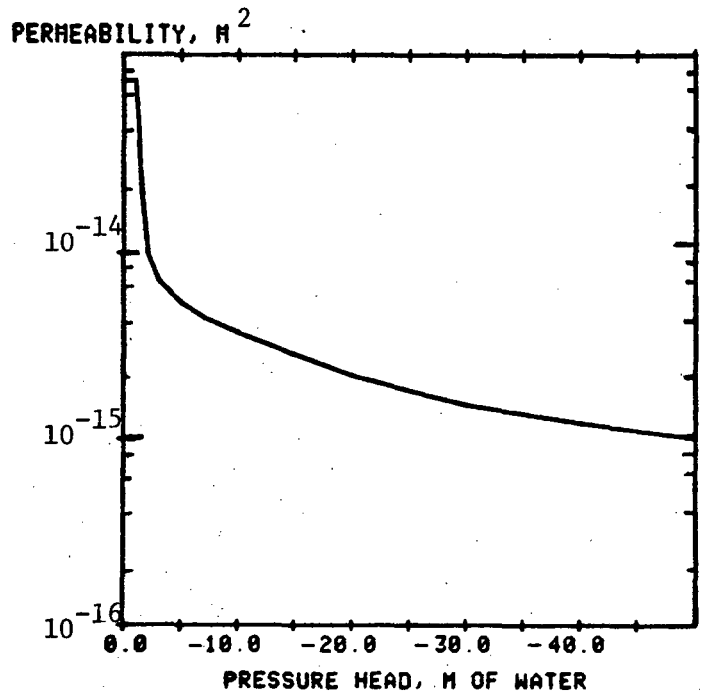

Figure 2. Relationship between permeability and negative pressure head calculated from Figure 1 and the Millington-Quirk formula.

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