Title

MONTHLY PROGRESS REPROT FOR AUGUST - CONTROL TECHNOLOGY FOR IN-SITU OIL SHALE RETORRS

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Publication Date

1980-09-01

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LBID-288 c.1

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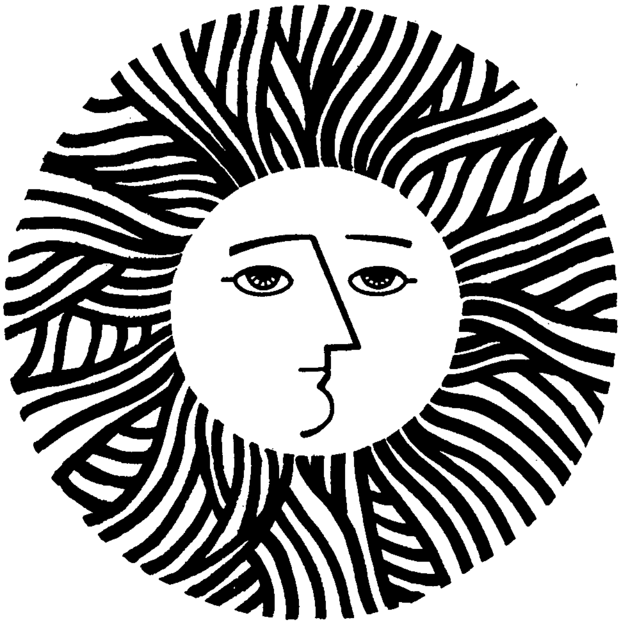

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September 16, 1980

TO: Charles Grua, Brian Harney, and Art Hartstein

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

RE: Monthly Progress Report for August
Control Technology for In-Situ Oil Shale Retorts
LBID-288

TASK 3. BARRIER OPTIONS

Grout Permeability Measurements

Electrical conductivity measurements on grout samples during saturation had to be discontinued due to an electronic equipment failure. However, a two-week period was considered adequate for complete saturation of the specimens and permeability measurements are now in progress on grout Q-1 (containing 2½% portland cement). Preliminary results indicate a permeability of less than 2×10^{-6} cm/sec at a confining pressure of 100 psi and less than 1×10^{-6} cm/sec at a confining pressure of 200 psi.

Development of a mathematical model for penetration of non-Newtonian fluids through beds of packed particles.

For successful grouting of abandoned MIS retorts, grout would be required to penetrate a specified distance through in-situ rubble. Particulate (as opposed to solution) grouts, such as those studied here, are non-Newtonian fluids. This limits their penetration through a network of fine pores. A model to predict penetration of non-Newtonian grouts through porous media was proposed by Raffle and Greenwood (1961). This model states that the limit of penetration is given by

$$L = \frac{h\,r}{2\tau_0}$$

where L is the distance of penetration (L)
h is the injection head, expressed as pressure (MLT^{-2})
r is the effective pore radius (L)
τ_0 is the yield stress (MLT^{-2})

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and that the effective pore radius is related to the permeability and void fraction of the porous medium by

$$r = \sqrt{\frac{8\,k}{e}}$$

where k is the permeability (L^2)

e is the void fraction (a pure number)

During FY 1979, grouts of Lurgi spent shale and water were characterized and pumped into packed particles of L-2 spent shale. The observed penetrations were much less than predicted by the model (Persoff et al., 1980). This discrepancy suggested that a new model is needed, and should be verified experimentally.

In response to this need, a program has been started to construct and verify a new model. Literature survey and theoretical analysis showed that a likely source of the discrepancy noted above was the use of Darcy permeability (which assumes Newtonian flow) to predict non-Newtonian behavior. No analytical solution was obtained corresponding to equations (1) and (2), so an empirical approach will be used.

As a first step, test fluids are being characterized. Type III (fine grain) portland cement has been selected for model development, as it is more reproducible than spent shale. Slurries of this material (as well as of spent shale) are thixotropic, meaning that the rheological properties depend upon the history of the fluid. All fluids will be tested after a specified period of shearing at a specified rate, to normalize this effect.

The next steps in this program will consist of injection of test fluids into circular and non-circular capillaries and packed uniform spheres. Penetration data from these experiments will then be used to construct a predictive model relating penetration to injection pressure, back pressure, fluid properties (τ_0 and other constants describing the fluid) and porous medium properties (specific surface, pore radius, hydraulic radius, permeability, void ratio, tortuosity, and particle shape factor).

TASK 5. LEACHING OPTIONS

Leaching of Organics From Spent Oil Shale

Work continued on the development of the leaching and transport model.

A new series of leaching experiments was started in the 11.5 cm columns to provide data for model testing. Each run in the series was made under similar conditions with leachate pore velocity as the only variable. Columns were loaded with LETC 10-ton spent shale from run S-55 in the 1/2 to 1/8 inch size range. Leachate pore velocities of 0.08, 0.20, 0.63, 0.84 cm/min were established in the downward direction. Each experiment in this series was started with the pores full of water following two hours of contact with the spent shale. This allows the TOC concentrations in the water to stabilize after initial contact with the shale. This method of filling is necessary to minimize the effects of free convection currents in the pore system that would occur if the experiments were started with the pores empty.

Samples were taken at frequent intervals until the effluent TOC approached that of the influent. At this time the pumps controlling the flow of the distilled water were shut off since the readily soluble TOC had been removed from the surface of the shale. Since the only remaining source of solute is presumed to be in the interior of the shale particle, we will be able to calculate the rate of diffusion within the solid phase. Rates so determined will be compared with values obtained by batch tests of large single pieces of shale.

Results of the column leaching runs are still preliminary. It is noted, however, that for the columns with pore velocities of 0.20 and 0.63 cm/min the passage of the first two pore volumes of leachate reduced the initial concentration of TOC in the leachate by about 90 percent.

TASK 6. GEOHYDROLOGIC MODIFICATION

Dewatering calculations for tract C-b have been refined to include the effects of recharge, which had previously been ignored. A recharge rate of 10^6 m^3/yr was distributed uniformly over an annular area between 5 km and 10 km radius (Fig. 1). This recharge rate corresponds to an average recharge rate of 1 m^3/sec over the entire basin, as estimated by Weeks et al. (1974). The uniform annular distribution of recharge is needed for axisymmetric modeling of the dewatering problem.

After a two year simulation period, significant drawdown has not reached the inner boundary of the recharge area, so the effect of recharge is not seen. At longer time periods, the effect of recharge is expected to be noticeable. Simulation results for longer time periods will be reported next month.

While dewatering scenarios for tract C-a are in progress, a draft of the report "An Investigation of Dewatering Scenarios for Tract C-b, Piceance Creek Basin, Colorado" is being prepared and should be completed in September.

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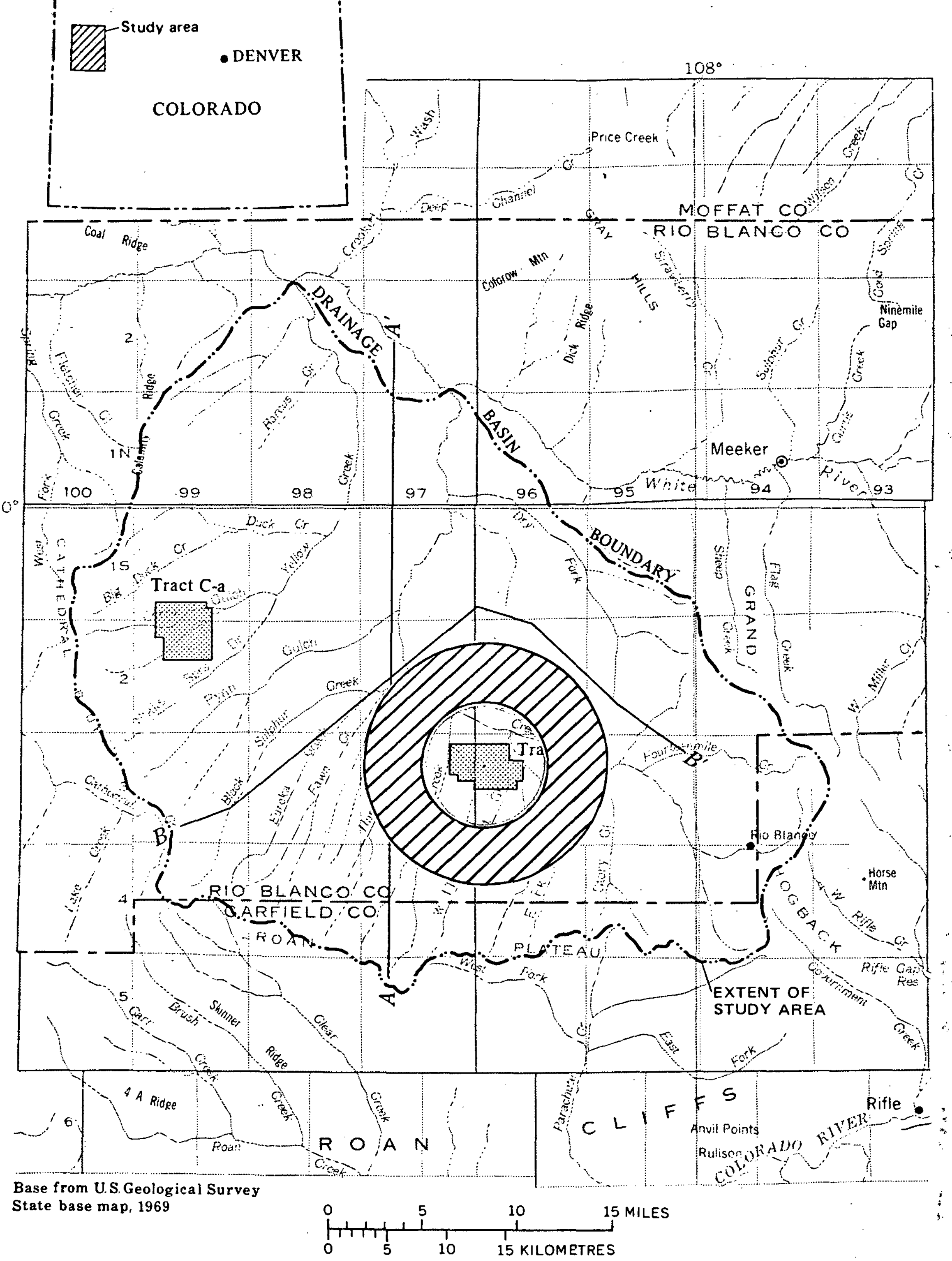

Base from U.S. Geological Survey
State base map, 1969

Figure 1. Location of the Piceance Creek Basin and tracts C-a and C-b. Axisymmetric model boundary is the outer circle. Annulus is recharge area.

Base map from Weeks et al. (1974)