TRACER TESTS PERFORMED IN THE FIELD FOR WIPP IN SOUTHEASTERN NEW MEXICO*

Don Diego Gonzalez and Leslie R. Hill

Sandia Laboratories
Albuquerque, New Mexico 87185

INTRODUCTION

A two-well recirculating tracer test began in October, 1979, to define as accurately as possible the hydraulic character of a fractured carbonate aquifer, the Culebra dolomite member of the Rustler Formation at the WIPP site in Eddy and Lee Counties, New Mexico. The Culebra dolomite overlies a zone planned for isolation of transuranic contaminated waste generated by the United States defense programs. The storage zone of the proposed facility is in nearly pure halite and about 1400 feet (427 meters) below the Culebra dolomite, the most likely pathway for the migration of radionuclides to the biosphere in the event the repository is breached by groundwater.

Included in the definition of the hydraulic character of the Culebra aquifer are natural groundwater velocities, aquifer porosity and components of dispersivity.

This paper describes the proposed tracer test using sodium benzoate, a homologous series of chlorofluoromethanes and pentafluorobenzoic acid as tracers. Results of the test will be reported at a later date.

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DESCRIPTION OF THE TRACER SITE

The tracer test will be conducted at a site 0.75 mi (1.2 km) southwest of the center of the proposed WIPP facility. The three major water bearing zones within the stratigraphic section above the proposed facility are two dolomite members in the Rustler Formation and the contact zone between the Rustler and Salado Formations[1]. The site designated as Hydro-2, consists of three holes spaced in a right triangle array, 50, 75 and 90 feet (15.2, 22.9 and 27.4 meters) apart. The holes have been designated H-2a, penetrating the upper dolomite section, the Magenta; H-2b, penetrating the lower dolomite section, the Culebra; and finally, H-2c penetrating the Rustler Salado contact[1]. Holes H-2b and H-2c spaced 75 feet (22.9 meters) apart have been completed to accomodate the two-well tracer test by penetrating the Culebra at a depth of 623 feet below land surface. The aquifer thickness has been determined as 19 feet (5.8 meters)[2], with hydraulic conductivities estimated as ranging from 0.01 feet/day to 0.05 feet per day[3].

DESCRIPTION OF THE PROPOSED TRACER TEST

Initially, the test will be designed on a conservative (low) estimate of hydraulic conductivity, using a withdrawal injection flow rate of 0.2 gallons per minute (0.76 liters per second). After steady state conditions have been reached and the results of a two-well pump test have been analyzed, better estimates for flow rates, injection concentrations, rates and sampling schedules can be made. The injection and recovery system will consist of a positive displacement pump suited to continuous use at low flow rates. The water and tracer flow will be monitored with a recording flow rate meter and a totalizing flow meter. Head measurements will be made throughout the test in packed-off horizons and in the wellbore above packers in both pumping and injection wells. The measurement of these parameters is essential to a two-well pumping test in that flow rates and heads represent boundary conditions in the flow equation and total volume pumped is necessary in the calculation of porosity. Tracer injection will be accomplished by a micro-metering pump and a pressure tank with diaphragm. The tracer injection system can simultaneously deliver tracers from three separate storage tanks, if necessary.

Water samples for tracer analysis will be collected both upstream and downstream from the injection point. Fluorocarbon analysis will be accomplished through use of a Varian 3700 gas-chromatograph equipped with a ^{63}Ni electron capture detector. The analysis for benzoate and pentafluorobenzoic will utilize a high performance liquid chromatograph with UV adsorption detection.

Quantitative interpretation of the results will utilize the analytical solution of Grove and Beetem[4] and a variety of recent numerical methods. Computer analysis will be performed as well as comparisons with existing models. Dr's. G. Thompson, University of Arizona and H. Bentley, Hydro Geo Chem Inc., will serve as principal consultants for the program in its entirety.

TRACERS

Sodium benzoate will be used as the principal tracer from which the aquifer parameters will be determined. Groundwater tests with this compound show benzoate to exhibit little or no adsorption, however, its stability at low concentrations in water is questionable. Fluorocarbons will be injected as a backup to the benzoate tracer in the event the benzoate is degraded in the aquifer; if this occurs, the more sorbed but stable fluorocarbons can be used for the interpretive work.

The use of pentafluorobenzoic acid (PFB) as a tracer will provide an independent analysis for the determination of aquifer parameters that is less likely to be affected by degradation (sodium benzoate tracer runs a reasonable risk of biological degradation during the test). Further, by including two compounds as tracers with essentially the same sorptive properties (PFB and sodium benzoate) but significantly different molecular weights may enable interpretation of the test results in terms of matrix porosity. In principle, this is possible because the heavier anion PFB (molecular weight = 212) will exhibit a defusivity less than benzoate anion (molecular weight = 121) by an amount approximately proportional to the difference in molecular weights.

REFERENCES

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