# THE BRINE SAMPLING AND EVALUATION PROGRAM (BSEP) AT WIPP:RESULTS OF FOUR YEARS OF BRINE SEEPAGE DATA

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## ABSTRACT

The Permian salt beds of the WIPP facility are virtually dry. The amount of water present in the rocks exposed in the excavations that is free to migrate under pressure gradients was estimated by heating salt samples to 95°C and measuring weight loss. Clear balite contains about 0.22 weight percent water and the more argillaceous units average about 0.75 percent. Measurements made since 1984 as part of the Brine Sampling and Evaluation Program (BSEP) indicate that small amounts of this brine can migrate into the excavations and does accumulate in the underground environment. Brine seepage into drillholes monitored since they were drilled show that brine seepage decreases with time and that many have dried up entirely. "Weeping" of brine from the walls of the repository excavations also decreases after two or more years. Chemical analyses of the brines shows that they are sodium-chloride saturated and magnesium-rich.

## INTRODUCTION

The Permian salt beds of the WIPP facility are considered to be "dry" in that inflow of brine is virtually nonexistent. Measurements of brine encountered in the underground workings over the past four years, however, indicate that brine can and does accumulate in the underground environment. The Brine Sampling and Evaluation Program (BSEP) at the WIPP project (a U. S. Department of Energy sponsored project) was designed as a multifaceted program to describe and quantify brine occurrences and to provide a basis for understanding this parameter which may have potential significance for the long-term performance of the repository. The general purpose of the BSEP is to investigate the origin, hydraulic characteristics, extent, and composition of brine occurrences in the excavations for the WIPP repository in the Salado Formation. The measurement of brine accumulation rates is especially challenging because they are so minor; nevertheless the program has been effective in its efforts to provide this type of data in a geologic environment. The activities of the BSEP to date include:

- Measurement of brine inflow into upholes and downholes
- Observations of weeps and oozes on ribs (walls)
- Observations and monitoring of the isolated wet spots on drift floors
- Geochemical sampling of brines as a function of stratigraphy and location
- Quantification of moisture contents of repository horizon rocks.

## BRINE SAMPLING ACTIVITIES

The BSEP activities include monitoring of brine inflow into holes drilled from the facility horizon in upward, downward, and horizontal directions. In addition, description of weeps or oozes occurring on the ribs (walls) of the repository as well as surficial accumulations on the floors are made. The geochemical differences of the brine in relation to their occurrences in upholes or downholes is being documented as part of the ongoing program as well as characterization of the water contents of rock samples taken from drifts, storage rooms, and drill holes from the repository workings.

The upholes and downholes drilled from the facility horizon differ significantly in volumes of brine accumulation measured by the BSEP activities. As of 7/87, a total of 1331.5 liters of brine were removed from 35 monitored downholes for an average of 38 liters/hole. The 17 monitored upholes, however, produced only 56 liters of brine for an average of 3.29 liters/hole. Many of the upholes monitored never produced any brine at all, and the maximum cumulative production by any one hole was 18 liters over a 4.5 year time span. The great disparity of cumulative production between upholes and downholes may be the result of several competing processes that may overemphasize the contribution of downholes and underemphasize the contributions of upholes. For instance, as a result of difficulties in fitting collection devices, upholes tend to undergo more evaporation and more leakage around the collars and may underestimate the actual inflow. Accumulation of brine in downholes may be enhanced by fracturing around the drifts due to stress relief which channels flow away from upholes and into downhole locations. Brine may also be added to downholes via routine operations wherein water is distributed along the floors of the drift to reduce dust and to consolidate muck on the floors. All of the brine distributed in this manner is foreign to the repository horizon and

cannot be considered as part of the brine inflow from the repository horizon stratigraphy.

Observations of weeps or ooze occurrences demonstrate that they begin almost immediately after excavation, generally as point sources of wet areas on the ribs. During the early time period, the moist areas are best developed in the argillaceous halite unit above the Orange Marker Band (OMB) that is the stratigraphic layer to which repository construction is keyed. Later development of the moist areas extends to the Orange Marker Band itself and may constitute slightly more moisture content in the final analysis. Because of the evaporation by ventilation air, the wet wares develop small "buttons" of salt precipitate, which often coelesce to form larger encrustations on the ribs. After two or more years, the rate of formation of these salt encrustations appears to decrease, probably due to either the reduction in the transient flow that originally caused them, stress relief fracturing concentric to the workings that separate the encrustations from their source of supply, or both.

The brines from the drill holes are sodium chloride saturated and magnesium-rich. Typically, the magnesium content of brine varies between 16,900 and 20,900 ppm and the potassium content between 16,800 and 19,100 ppm. The chemistry of the brine collected from monitored drill holes is significantly different from brine associated with fluid inclusions in the halite (Stein and Krumhansl, 1986), varying primarily in the calcium, sulphate, potassium, and magnesium content. Elements that are not saturated in the brine, such as strontium, tend to occur in higher concentrations in upholes than in downholes. Preliminary results indicate that variations in chemistry between upholes and downholes may be partially explained by preferential evaporation of the uphole samples in comparison to the downhole measurement.

Evaluation of the distribution of potential brine that might act as a source of brine inflow is being accomplished via a moisture content sampling program of the repository horizon rocks. Under this program, quantification of the free water exclusive of fluid inclusions, as opposed to bound water in clays, is determined based upon stratigraphic, areal, and time from original excavation relationships. Representative samples have been collected from all areas of the facility and have been heated to 95 degrees Celsius and weighed to determine water loss. The water lost at 95 degrees Celsius is taken to be that component of the brine that is most easily moved as a function of the sampling parameters of stratigraphy, location, and time. The samples collected to date show no clear relationship between sample locations within the facility and do not appear to be affected by time up to 1740 days after excavation. Water contents derived from 240 samples taken from more argillaceous halite units above and below the Orange Marker Band of the facility horizon averaged 0.75 percent, whereas 132 samples from clear halite units directly above the OMB averaged only 0.22 weight percent water. As of the present time results for the entire program clearly show the direct relationship of clay content to water content between the lithologies. To further examine the effect of time and stratigraphy, an ongoing program exists for sampling drill core immediately after it is taken.

## CONCLUSIONS

The net result of these operations has been to carefully document the magnitude of brine occurrences at the WIPP facility. The small amounts of brine have necessitated the development of unique methods of measurement, but overall the Brine Sampling and Evaluation Program has been successful in providing quantitative estimates of brine inflow into some of the major sections of the underground.