Natural Dissolution of Salt in the United States

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Abstract.—Natural dissolution of salt occurs at many places in the United States. Some of the principles of natural dissolution are applicable to understanding the development of subsidence and collapse features above solution-mined caverns. The four requirements for natural dissolution of salt are: 1) a deposit of salt against which, or through which, water can flow; 2) a supply of water unsaturated with respect to NaCl; 3) an outlet whereby the resulting brine can escape; and 4) energy (such as a hydrostatic head) to cause water to flow through the system. When all four requirements are met, dissolution of salt can be quite rapid.

Salt deposits underlie portions of 25 of the 48 contiguous states. Some of the deposits are extensive, such as the Salina Group salts in the Michigan and Appalachian Basins, the Permian salts of the Permian Basin, and the salt domes of the Gulf Coast Basin. These salts rank among the greatest salts deposits of the world. Evidence of modern natural dissolution or paleodissolution of salt has been found in almost every one of the 25 states, and therefore salt dissolution is a more widespread phenomenon than commonly suspected.

Among the areas with more pronounced examples of natural salt dissolution are the Permian Basin (west Texas, eastern New Mexico, Texas Panhandle, and western Oklahoma) and the Holbrook Basin (northeast Arizona). The Permian Basin contains lateral and vertical dissolution features, subsidence troughs, collapse structures, breccia pipes, sinks, and other disturbed zones. Salt dissolution continues even today, as shown by natural emission of high-salinity brines on the Pecos River, Red River, and Arkansas River. The Holbrook Basin contains more than 500 sinkholes, fissures, depressions, and other disturbance features that result from past and ongoing dissolution of Permian-age salts. The salt-dissolution front is migrating downdip to the northeast, causing overlying strata to collapse chaotically into the dissolution cavities. Other basins with evidence of major salt-dissolution histories are the Michigan Basin, Gulf Coast Basin, Williston Basin, Wyoming Basins, and Paradox Basin.

The principles governing natural dissolution of salt also apply to man-made dissolution cavities, whether they are created intentionally (as in solution mining) or unintentionally (as in petroleum activity). If the four basic requirements for salt dissolution are met, cavities of substantial size can be created. And if the dissolution cavity is large enough and shallow enough, successive roof failures can cause the water-filled void to migrate upward; this can result in land subsidence or catastrophic collapse.

INTRODUCTION

Deposits of rock salt (halite) are widespread in the United States, and they underlie portions of 25 of the 48 contiguous states. Salt is the most soluble of the common rock types, and thus there are many areas in the Nation where these salts have been partially dissolved by natural processes. When ground water, unsatured with respect to NaCl, comes in contact with salt, the salt is partially dissolved and a dissolution cavity is formed.

The current report provides an overview and summary of the following: (1) general processes involved in natural dissolution of salt; (2) distribution of salt deposits in the United States; (3) several examples of well-documented natural salt dissolution; and (4) application of these studies to human-induced salt-dissolution cavities. It is based largly upon earlier studies by Johnson and Gonzales (1978), Johnson (1981, 1997b), Quinlan and others (1986), Martinez and others (1998). Some of this report is reproduced, with minor changes, from an article published in *Carbonates and Evaporites* by Johnson (1997b).

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NATURAL SALT-DISSOLUTION PROCESSES

Salt is extremely soluble in ground water, and salt-dissolution features can be present in any salt deposit in the United States. The process for natural dissolution of salt was described earlier by Johnson (1981). He pointed out that ground water in contact with a salt deposit will dissolve some of the rock, providing the water is not already saturated with NaCl. For extensive dissolution to occur, it is necessary for the brine thus formed to be removed from the salt deposit; otherwise, the water becomes saturated,