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Sinkholes Associated with Petroleum Boreholes Drilled Through Salt Deposits in the USA

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Abstract.—Salt deposits underlie portions of 25 of the 48 contiguous United States, occurring mainly in the same sedimentary basins that also host the nation's major oil and gas resources. As a result, a great number of petroleum boreholes have been drilled into and through salt deposits, and at some sites this has led to unintentional salt dissolution and cavity development around a borehole. Several factors that may allow unsaturated water to encounter and dissolve the salt are: use of fresh-water drilling fluids; poor casing or cement jobs through the salt deposit; and corrosion or removal of casing in the later life of a well. Where a dissolution cavity was large enough and shallow enough, successive roof failures may cause the water-filled void to migrate upward and result in land subsidence or catastrophic collapse. In this way, petroleum activity can cause development of sinkholes similar to those that occasionally accompany solution-mining activity.

Among the well-documented subsidence/collapse features resulting from petroleum activity are: Wink sink, near Wink in west Texas (formed in 1980); Panning sink, in Barber County, Kansas (1959); and Gorham oil-field subsidence features, in Russell County, Kansas (started about 1960). These sinkholes and collapse features typically formed around petroleum boreholes drilled long ago, before development of proper engineering safeguards that isolate the salt from salt-dissolving fluids. On the other hand, the Jefferson Island salt-dome sinkhole, which formed near New Iberia, Louisiana (1980), resulted from accidental penetration of a room-and-pillar salt mine by an active oil rig.

Lessons learned through the study of sinkholes associated with petroleum activity can be applied to a better understanding of collapse in solution-mining operations.

INTRODUCTION

Salt deposits underlie a portion of 25 of the 48 contiguous states (Fig. 1). Some of the deposits are extensive, such as the Salina Group salts of the Michigan and Appalachian basins, the Permian salts of the Permian basin, and the Louann salt and salt domes of the Gulf Coast basin. These deposits rank among the greatest salt deposits of the world. Data on salt deposits of the United States were compiled by Pierce and Rich (1962), Halbouty (1967), Lefond (1969), and Johnson and Gonzales (1978).

These great salt basins, and other salt basins in the United States, also host some of the nation's major oil and gas resources. By exploring for, and producing, these petroleum resources, a great number of boreholes have been drilled into and through the salt deposits. At several sites, this has led to unintentional dissolution of the salt around a borehole, and eventual creation of a solution cavity that collapsed to form a sinkhole or subsidence feature that impacted the land surface. Petroleum activity, therefore, can cause accidental development of sinkholes similar to those that occasionally accompany solution-mining activity. Summaries of natural dissolution of these salt deposits and development of natural sinkholes, collapse structures, and subsidence features are given in earlier reports by Johnson (1997b, 2000) and by Martinez and others (1998). Some of the reports dealing with catastrophic effects of human-induced salt dissolution are those by Dunrud and Nevins (1982), Ege (1984), and Coates and