ABSTRACT

Surface subsidence analysis is performed to ensure that surface subsidence measurements met two objectives: (1) to fulfill regulatory requirements for measuring subsidence and (2) to provide indirect (but informative) rock mechanics-related measurements of cavern field (or mine) and overburden behavior. All too often, surface subsidence surveys are routinely performed over mining operations and cavern storage facilities simply because of regulatory requirements. Information from these surveys is then plotted and used to demonstrate that "normal" subsidence is occurring without recourse to understanding what the normal subsidence should be. An interpretive analysis is required to get full rock mechanics benefit from current subsidence information by including interpretation of past subsidence using numerical models such as those in the SMRI-sponsored subsidence-analysis software **SALT_SUBSID**. In this type of modeling, interpretations of measured subsidence are correlated to three-dimensional mining patterns, extraction sequences, and time-dependent deformation of the salt structures. After the analysis of historical subsidence, the now site-specific subsidence model can be used to predict future subsidence over the facility based on projected mining patterns and sequences. The subsidence model is useful in planning benchmark locations, so new benchmarks are located where a comparison of measured and predicted subsidence patterns will reveal the most information about actual mine and overburden behavior. The documented subsidence predictions and the subsidence model itself can be simply updated to account for actual mining sequences or changes in mining pattern within the new area to determine if the measured subsidence is still as expected.

INTRODUCTION

At its simplest, surface subsidence is the natural downward motion of the earth's surface in response to the removal of rock (hence, support) underground. First, there is an instantaneous (i.e., elastic) subsidence attributable to the change in stresses because of the excavation. For most salt and potash mines, the instantaneous subsidence is relatively small. Second, a time-dependent subsidence occurs that may become large (1 meter, or more, is possible) and continues for tens or hundreds of years. The time-dependent subsidence is a direct consequence of salt creeping into and toward the excavated opening. Such creep will continue until the openings are completely closed and all stresses have returned to their lithostatic values. The rate at which subsidence accumulates depends on the geometry of the openings within the mining horizon (extraction ratio, pillar or web size and shape, depth, etc.) and the characteristics of the rock above the mining horizon.

The ultimate surface subsidence over a salt mine or storage cavern (i.e., after the openings have closed) may eventually approximate the volume of rock removed from the underground. The rate of subsidence is directly related to the rate of closure of the opening, which is exponentially related to the stress concentration resulting from the extraction. Therefore, the fastest subsidence occurs over the areas with the highest extraction and soon after mining. The