Solution Mining Research Institute Spring 2017 Technical Conference
Albuquerque, New Mexico, 23 – 26 April 2017

Analysis of a Comprehensive Suite of Microgravity Measurements Conducted over the South Y Brine Operation Site

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Abstract

A brine production operation comprising an injection and abstraction well dipole, was conducted for about 30 years within the city limits of Carlsbad, NM, possibly creating a potentially large dissolution cavity. The site is located at the intersection of two state highways in the southern part of the city, known locally as the "South Y," and the cavity poses a major hazard. Given its age, presumed size from incomplete brine production records, geologic setting, and similarity to other brine operations in southeastern New Mexico where cavities have collapsed to form sinkholes, the State of New Mexico recommended that the operators halt brine production at the South Y site. Both the State of New Mexico and the City of Carlsbad immediately began a program to characterize the size and geometry of the dissolution cavity with a view to determining its likelihood of caving in, and to determine what actions could be taken to stop or mitigate the risk associated with a potential collapse. To that end, a number of different direct measurements, numerical analyses, and geophysical methods have been used to characterize the subsurface at the site. These include a 2-D seismic survey, borehole sonar logs in the brine abstraction well (Eugenie 1), back-analysis of pressure data obtained during the last sonar logging attempt, high-resolution magnetotelluric surveys, and an electrical resistivity survey. Unfortunately, the compilation of these measurements and analyses has not yielded a clear picture of the cavity characteristics.

Sandia National Laboratories suggested performing microgravity measurements, another geophysical method, over the South Y site. Microgravity measurements were made over, and slightly beyond, the entire area thought to be underlain by possible brine cavity based predominantly on the results of the original magnetotelluric survey. Contour plotting of the Bouguer anomaly over the site shows a sudden and dramatic decrease in the corrected measured gravity centered about the freshwater injection well, Eugenie 2. The characteristics of this low gravity anomaly, including its magnitude and elliptical shape, suggest that this is the probable location of the solution cavity. An estimated cavity volume that would cause the observed gravity anomaly based on a simplified spherical cavity model suggests a size slightly larger than the volume estimated from brine production records. The cavity inferred in this study is centered about Eugenie 2 where freshwater injection occurred for a period of 20 years. Eugenie 1 was primarily used for brine abstraction. Whereas most previous studies suggest a cavity centered about Eugenie 1, or approximately at the midpoint between the two wells, the results obtained from microgravity appear to support the hypothesis that dissolution, due to freshwater injection, occurred in the neighborhood of Eugenie 2. It should also be noted that, the low gravity region lies within the general high probability boundaries delineated by the other geophysical methods.

Key words: microgravity, cavern mapping, solution mining facility