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Novel In-Situ Stress Measurement Technique for Cavern Design

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Abstract

To properly design and operate solution-mined caverns, the in-situ stress of the salt and overlying caprock need to be well understood. Often, the maximum principal stress (σ_1) is assumed vertical, while σ_2 and σ_3 are assumed to be equal in magnitude and horizontal. These assumptions are generally true in extensional tectonic settings, but they are not always true in compressional tectonic settings. Failure to understand the in-situ stress in the vicinity of a cavern may lead to difficulties while drilling and subsequent casing deformation or loss of integrity after the cavern has been developed.

Traditionally, hydrofracturing, hydrojacking, and mini-frac testing are used to quantify the magnitude of the in-situ stress regime in wells. When these techniques are used in conjunction with borehole breakout analysis, the orientation of the principal stresses may be estimated. However, this approach typically assumes two of the principal stresses are orthogonal to the wellbore when, in fact, the true orientation of the principal stress may not be orthogonal to the wellbore. In shallow exploration holes (less than 492 feet (ft) [150 meters (m)]), overcoring techniques are commonly employed to provide both magnitude and orientation of the in-situ stress regime in three dimensions. Unfortunately, most overcoring equipment is limited to very shallow depths.

The Sigra In-situ Stress Tool (IST, the “Tool”) uses an overcoring technique to measure the in-situ stress regime, in three dimensions, at depths of up to 6562 ft (2000m). This Tool has been utilized in mines throughout Australia, Europe, Canada, and the United States of America. Results from the Tool are comparable to those obtained using other methods, such as hydrofracturing, but provide useful additional data to help further understand the stress field for a given location.

This paper describes the theoretical basis for measuring in-situ stresses using overcoring techniques, the technology used in deep-hole IST testing, the testing methodology, and results obtained from recently conducted tests.

Key words: in-situ stress, principal stress, casing deformation, overcoring, laboratory testing, rock mechanics