

## THE BENEFIT OF 3D BOREHOLE RADAR FOR THE EXPLORATION AND EXPLOITATION OF SALT DOMES

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### Abstract

Exploring salt domes for further utilization is providing high challenges due to the characteristic silhouette and the distinctive nature of the geology. Typically, the exploration of an unknown salt dome is started from the Earth's surface with various geophysical and geological investigations. However, in most cases, no details of the internal structure and condition can be extracted from surface measurements and, in particular, the location of the salt dome flanks at depth cannot be resolved with sufficient accuracy.

More insight into evaporite stratigraphy of salt domes is typically provided by exploration drilling and an appropriate borehole logging program. Nevertheless these methods solely provide linear and spatially limited information in the immediate vicinity of the boreholes and cannot supply any details about the situation in greater distances to the borehole.

One very effective method to fully resolve structures within rock salt is Ground Penetrating Radar (GPR). Under opportune survey conditions lithological boundaries and other structural features can be identified within the salt structure up to a distance of several hundreds of meters from the investigation borehole.

A direction sensitive 3D borehole radar system has been specially designed for the application in boreholes drilled for the development of storage caverns. With this method comprehensive structural information about the geological information in 3D space can be provided. In the last decade, the service has been carried out in more than 60 boreholes.

In principle, 3D borehole radar measurements allow the identification of geological features in 3D space that are reflecting electromagnetic signals. Such features typically correspond to contrasts in material properties between rock salt and potassic, anhydritic or argillaceous rocks or the like or with sediments flanking domal salt. As a result, the 3D spatial information derived from borehole GPR surveys commonly facilitates:

- optimized targeting of exploration and production boreholes
- the development of a full 3D image/model of the salt formation
- the adjustment of the geometry of a planned cavern
- optimized development of a cavern field
- a more effective exploitation and utilization of the salt formation.

On the basis of case studies in different salt domes in Germany, the Netherlands and Poland the capabilities of the 3D borehole radar method are presented.

**Key words:** Salt Dome, Flank Imaging, Domal Boundary, Delineation, Cavern Development, Cavern Design, 3D Modeling, Internal Texture, GPR (Ground Penetrating Radar), Geophysics, Borehole, Exploration, High Resolution