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Integrated Geophysical Tools for Sinkholes Study along the Dead Sea Shoreline

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Identification of cavities, fractures and collapse zones is one of the most difficult subsurface investigations: it's like finding a real needle in the haystack. It is known today that Dead Sea sinkholes at the surface are caused by development of dissolution cavities forming in the salt layers located at a depth of 40-50meters from surface. Development of karstic cavities causes variations in properties and structure of both salt and its overlain sediments: density, porosity, electrical conductivity, seismic velocity etc. Fractures and faults are formed in the shallow subsurface. These variations in properties and structure can be detected by different geophysical instruments such as Seismic Refraction and Reflection methods, Electric Resistivity Tomography (ERT), Ground Penetrating Radar (GPR), Microgravity and Magnitometry etc.

That is why variety of geophysical methods, which measured different physical parameter (changes in dielectric constant, Electrical resistivity, variations in bulk Density, and changes in velocity) for shallow and deep investigation nave been applied for sinkholes assessment and delineation. The integration of different geophysical studies has a capability of detecting geologic conditions including the continuity of the deeper strata, lateral variations in an unconformity, discontinuities, cavities, zones of paleo-sinkholes collapse and hydro geological conditions.

All geophysical methods address geologic questions. With geophysical applications, a volume of the subsurface is measured. It is necessary to recognize the physical properties of the feature being measured as well as the effective volume of measurement in order to define survey objectives.

Data from a wide variety of sources and measurements could be integrated to improve our understanding of site conditions and provide a powerful base of information in which to evaluate subsurface conditions, design and execute a remediation for the site and enable a reasonably accurate risk assessment to be made.

The geophysical methods used for sinkholes assessment and identification are as follow:

Seismic refraction method: is used for mapping of salt layer

Electrical resistivity tomography (ERT), facilitate detection of high resistivity zones associated with the air filled cavities and decompaction.

Ground penetrating radar (GPR): allows detection of subsurface faults and buried voids and sinkholes

Electromagnetic Radiation (EMR): The method measures the electromagnetic

Radiation (EMR) emitted from cracks which dimensions in micro-scales (mm–cm)

Within rocks and estimates the active faults and cracks along the surveyed profiles.

Time domain electromagnetic (TDEM): Time domain systems are employed in the sinkhole problem to reveal fresh-saline water interface and search less conductive zones within DS brine.

Magnetic resonance sounding (MRS): is used for ground water detection from the surface, and to estimate the water content of saturated and unsaturated zones of the earth's subsurface. It can estimates the aquifer properties like, porosity, permeability, and transmissivity.

Microgravity and Magnitometry methods are used for search of zones with the mass deficit and zones of magnetic anomalies. These zones are considered as zones of karst.

Nano-Seismic: technique was developed to detect extremely low-energy signals generated by soil falling into cavities. These signals are used for predicting future sinkholes.

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