CONTROL ID: 3910521

SUBMISSION TITLE: Electric resistivity tomography inversion guided by passive microtremor data for the detection of karst cavities

PREFERRED PRESENTATION TYPE: Oral Presentation

Participation Status: Yes

ABSTRACT BODY:

Objectives/Scope: Surface electric resistivity tomography (ERT) is employed to map the karst cavities to safely construct underground tunnels. However, the inversion result has a strong dependency on the initial model, as the imaged anomalies at depth may move around, complicating the decision making for drilling. We propose to add microtremor (passive seismic) data to constrain the ERT inversion. A rigorous joint inversion may fail in practice, so we derive a relative image of the subsurface solidity using H/V spectral ratio (HVSR), then use the HVSR image as a soft constraint to initiate the ERT inversion.

Methods, Procedures, Process: The ERT field survey is carried out along a line of 40 electrodes that are 5 m spaced. The array configuration is pole-pole, in which the B and N electrodes are a few hundred meters away.

At the same time, an array of 81 nodal seismic station is placed along the same line with a spacing of 2.5 m to collect the three components of the surface vibration caused by the passive source.

The ERT data are inverted in 2D using the open source python program SimPEG to obtain a cross section of resistivity. In most cases, ERT data are inverted with a uniform half-space as the initial and reference model, but we add information from seismic to ERT inversion. The passive seismic data are processed to generate a normalized HVSR image, on which high values indicate more solid rock, whereas low values represent cavities, fractures or weathered rock.

The HVSR image shows the relative solidity of the subsurface. Assuming a solid rock has high HVSR and high resistivity, and a cavity has low HVSR and low resistivity, we mapped the HVSR image onto a resistivity model through empirical relations. The resultant resistivity model is then used as the initial and reference model in the ERT inversion. The soft constraints from seismic HVSR does not require fitting seismic data, instead, it provides a guidance for the ERT, and the inversion tries its best to honor HVSR.

Results, Observations, Conclusions: We first invert the ERT data using a uniform half-space as the initial and reference model. The inversion recovers three low-resistivity anomalies in different sizes and at different depths. However, we found that when the half-space resistivity changes, the inversion results can vary significantly, although the existence of the low-resistivity cavities can be confirmed. The resistivity model shows there is one deep major cavity; there are also two small cavities, one of which may be connected with the major cavity. Unfortunately, the positions and depths of the imaged cavities are not consistent with drilling results.

The ERT inversion with the HVSR image as an initial guidance confirms the same general distribution of three cavities. The new resistivity model has the bottom of the anomalies much better delineated. It also reveals that the two low-resistivity objects in the middle of the cross section may not be connected, which is confirmed by follow-up drilling. The image of the small and isolated cavity is also much clearer in the new inversion model than in the previous one. We note that the ERT model has no obligation of strictly honor the HVSR image.

Significance/Novelty: Most resistivity inversions use a single homogeneous half-space as the initial model,

but the geometry of anomaly obtained from the inversion is strongly influenced by the initial model. Seismic data can provide additional constraints but need to be more straightforward to be integrated into ERT inversion. It only needs a relative HVSR image to guide the ERT, acknowledging that the HVSR information may contain both supplementary information and unknown errors. A field example shows that adding “soft” HVSR information improves the ERT's resolution at depth for the search of karst cavities.

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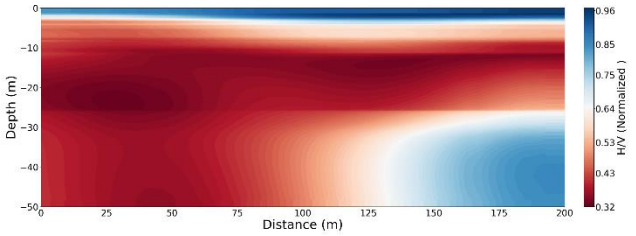
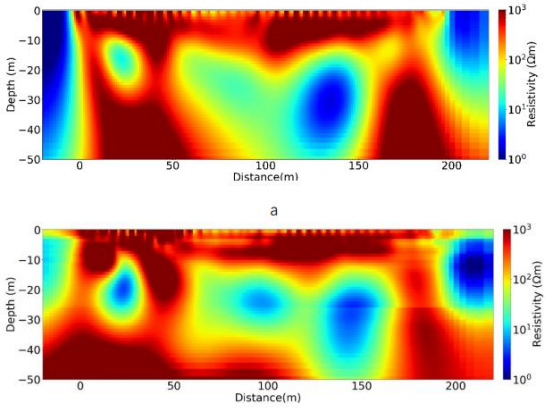


HVSR image



Comparison of ERT inversion models, with and without HVSR

IMAGE CAPTION:
HVSR image

Comparison of ERT inversion models, with and without HVSR

PRIMARY TOPIC: NS: Near Surface

SUBTOPIC: Urban, Geotechnical, and Archeological Applications

KEYWORDS: Electric resistivity tomography, H/V spectral ratio method, Inversion models.

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NO SHOW POLICY: I agree

MEMBERSHIP STATUS: None of the Above

Information for Speakers: English is the official language of the conference.

Information for Speakers: All speakers (and session chairs) must register to attend and present at IMAGE 2022.

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Expanded Abstract Submission (for information only): I will not submit an expanded abstract.