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Sinkhole process interpretation based on shear wave seismic reflection results at Ghor Al Haditha, Dead Sea

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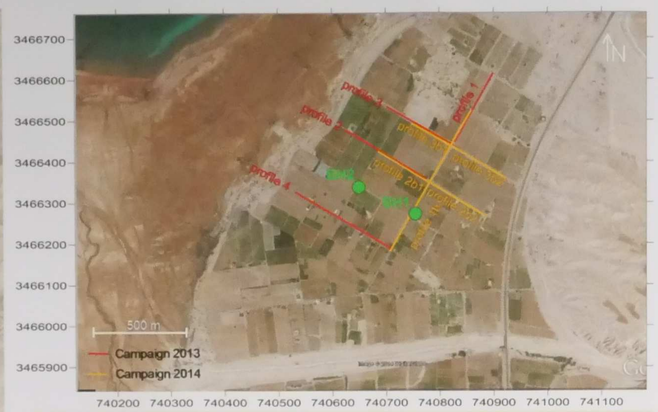
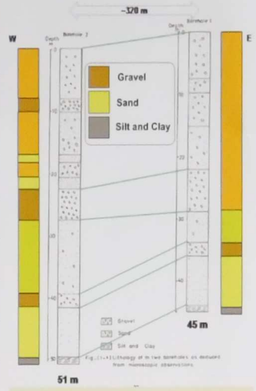
Study area: Ghor Al Haditha Sinkhole area, Dead Sea, Jordan



Profiling geometries October 2013 and October 2014, and the location map of the boreholes BH1 and BH2 within the survey area regarding to the El-Isa et al. (1995) report.



Lithology of boreholes BH1 and BH2 modified after El-Isa and et al., 1995.

Reflection seismic data processing

- Pre-processing
- Pre-stack processing
- Geometry processing
- Amplitude scaling
- Frequency filtering
- FK (frequency wave number) filtering
- CMP common mid point processing
- Velocity analysis
- CMP stacking
- Post stack processing
- FX Deconvolution
- FD Migration
- Final time sections
- Depth migration
- Conversion to depth sections (Final result)

Aims and objectives

Applying S wave reflection investigation was expected to achieve the following targets:

1. Determine the underground layers up to depth more than 100 meter.
2. Detect the disturbed zones in the area.
3. Map the topography (geomorphology) of the proposed rock salt layer in the depth of 35-45 m to detect local synclines which can act as pathways of the current freshwater flow.

Conclusions

The main results of the S wave reflection investigation can be concluded as the following:

Stratigraphic changes in the study area show a sequences of unconsolidated alluvial fans dominated at all of the depth cross sections (0m- unknown depth (more than 250 m), overlaying at the farm units by blanket of soil.

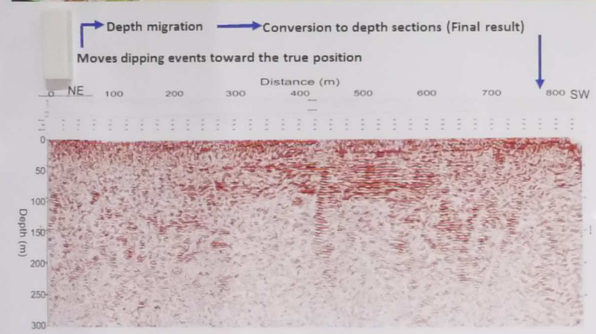
the alluvial fans divided with depth into two main zones:

The upper zone or the washed zone of depth 25-70 m coarse clastic grains, gravel and sand. flushed seasonally by Wdi Ibn-Hammad floods. The cavities, sinkholes subsidence and the sub-surface channels appear in this zone, unstable zone affected by fractures and listric normal faults, which developed to landslides.

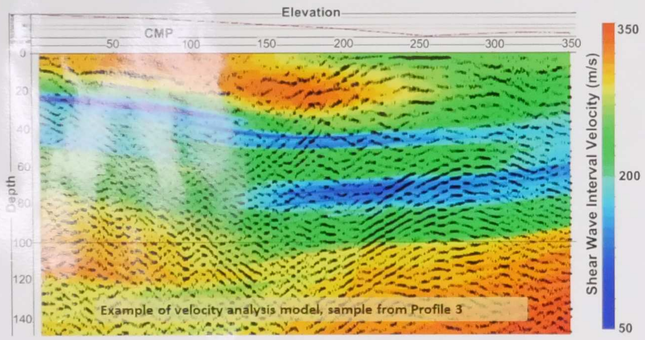
The lower zone overlaying by the upper zone and continue to unknown depth at least more than 250 m. for now this zone still stable consist of fine clastic grains, mostly clay and silt.

The profiling correlation indicating of two subsurface water pathways located at the bottom of the upper zone of the alluvial fans with diameter about 15-20 m crossing the area at NW-SE direction, from Wdi Ibn-Hammad towards the Dead Sea shoreline. At present, these water pathways are most probably one of the main reasons of expanding the sinkholes area limits.

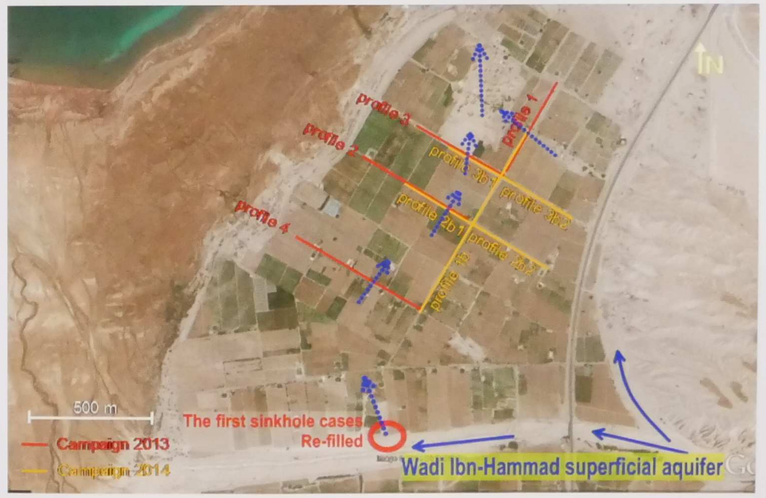
The profiling results also give no evidence for a massive salt layer in the shallow subsurface up to 250 m, which would be result in strong seismic reflection responses due to the expected shear wave velocity of nearly 2500-3100 m/s for massive salt compared to the velocities of nearly 50-350 m/s found during the profiling.

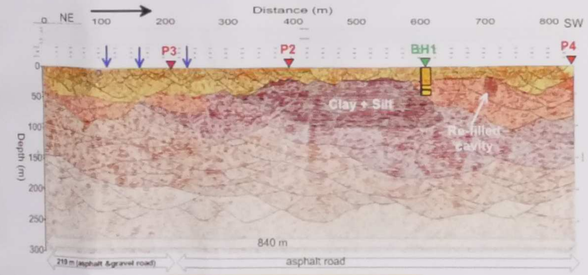


The final S wave depth section result of Profile 1

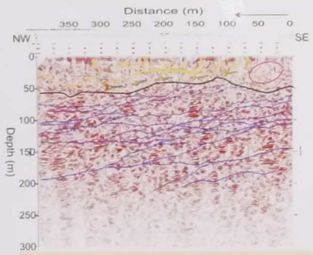


Example of velocity analysis model, sample from Profile 3

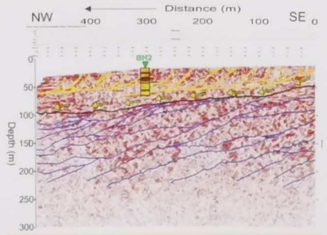




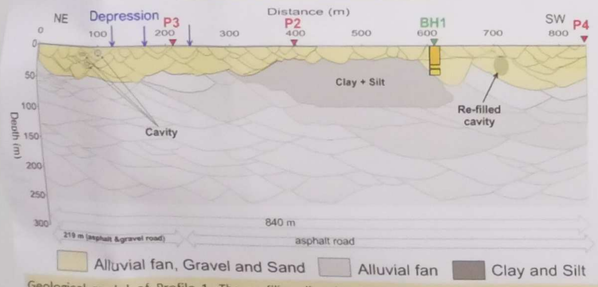
The interpretation results of Profile 1



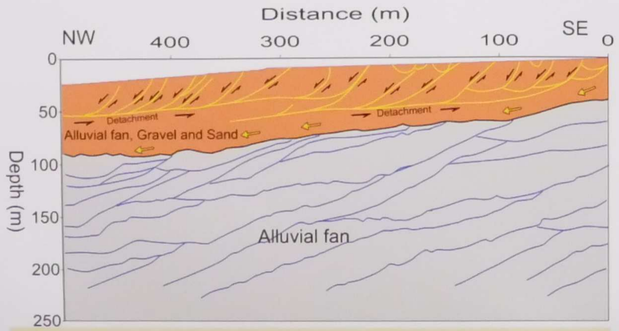
interpretation results of Profile 3 in 2013



Interpretation results of Profile 2 in 2013

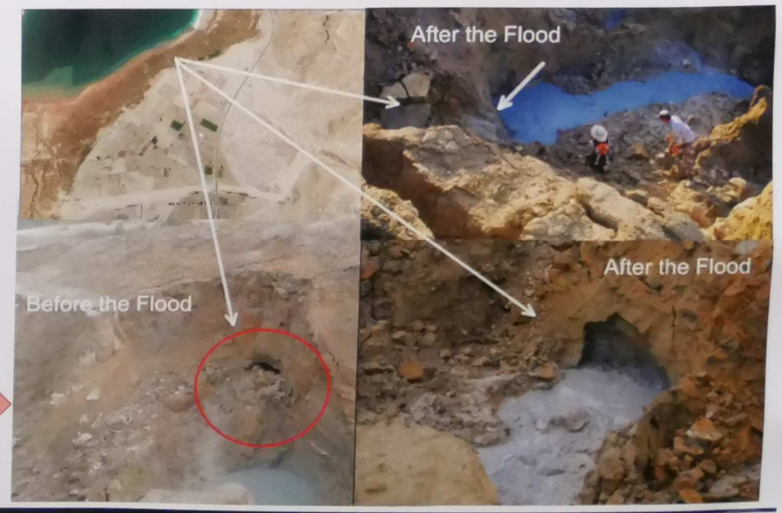


Geological model of Profile 1. The profiling direction is perpendicular to the main current flow direction of the Wadi Ibn



Geological model for Profile 2 of the 2013 survey. The profile direction is parallel with the current flow direction of the Wadi Ibn Hammad.

In October 2015 a proof of the existence of such a subsurface channel could be observed during field work in the area. Until rainy days on the high lands east of the Ghor Al Haditha area, a collection of photos were taken in the West of the study area. These pictures show a large flow of freshwater with high flood current energy through a channel which appeared at an outcrop at the boarder of the alluvial fan. The water current came out from the channel in a very turbid manner with a high content of fine material, which seemed like clay regarding its tight grey color



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