S-wave reflection imaging of a tectonically determined cavern by use of next generation electro-mechanic vibrator

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The key objectives of a ground-based geophysical mapping during an On-site Inspection are to detect, locate and characterize the zones of rock damage associated with an underground nuclear explosion (UNE). The cavity, rubble zone and fracturized rock matrix are also common features in the close vicinity of a cave of karstic origin. The natural cavities are mainly developed within the weakest zones of the rock matrix. The connatural features with an UNE are important but the thermal and pressure effects are lacking in the case of natural origin. However, the similarities may justify the efforts to investigate the cavern and its surroundings by geophysical methods.

The oval shaped cavern with a diameter of 28 m located 70 m below the surface was discovered within a clay mine in N-Hungary. The deep basement is composed of Triassic limestone, the cavern is located in the overlying Oligocene sandstone formation. As a result of hydrothermal activity in the Pleistocene a cave formed in the limestone which may have collapsed over time. The opening of the deep part of the cave influenced the overlying sandstone formation but the collapse did not reach the surface.

As a consequence of a UNE the cracks and open fissures could provide a pathway for the radioactive gas to find its way near to the surface. The detection of these fracturized zones require the highest possible resolution of the seismic imaging of the subsurface. Therefore, we made a 2D survey above the cavern site and determined that the optimal method is to generate and detect horizontally polarized (SH) waves. The electro-mechanically driven vibrator has provided a bandwidth ranging from 5 to 200 Hz which can be extended up to 400 Hz. The use of the Lightning type vibrator has broadened the seismic bandwidth achieving the maximum penetration of 250 m with substantial increase of the resolution.

The joint interpretation of the seismic and geoelectric tomographic results with the SH-wave reflection section has provided a clear pattern of the tectonized rock matrix around the cavern.