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Definition of Buried Karstic Cavities with a New 3D GPR Imaging Technique in Akkopru Dam Reservoir Area in Dalaman, Mugla-Turkey

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The study area is Dalaman Akkopru Dam and Hydroelectric plant, which lies 24km East of Koycegiz, near the village of Bayobasi, in the Southwestern Turkey, on the Mediterranean sea cost. The study area is a very famous touristic city as well as famous fertile agricultural area.. General properties of the area could be summarised as: There are several water bodies including 3 lakes (the largest lake is the Köyceğiz Lake), 10 streams and a channel network connected to each other. Approximate area of the watershed is 1200 km2. The area has a relatively heterogeneous geological structure and geomorphology. The watershed itself is considered as a tectonic depression zone. There are alluvial and karstic regions and several streams having geologically interesting features such as hot and cold water springs.

The dam will be the 5th largest in Turkey and stand some 112.5 m high and create a mass of water 24km long over area coverage of 8.92km. This dam and hydroelectic plant project is very important for the region. However, the dam is located in a 1st degree earthquake zone and the feasibility study concluded that the construction and additional weight of water would not pressure fault lines and create an earthquake. The geological survey of the dam basin revealed that the area is a porous limestone. We conducted a large GPR survey to locate the karstic cavities in the reservoir area. The area was divided into nine segments named A, B, C, D, E, F, G, GH, HI respectively. Each segment was 100m Total study area was 696x100 m. We used PulseEKKO100A GPR equipment (Sensor and Software) with 25 MHz unshielded antenna. Transmitter-receiver antennas placed perpendicular to profile direction with zero offset configuration. The antenna separation was set 4 m which also is the antenna length. Profile interval was 2m. Each profile had 201 traces with a trace spacing of 0.5 m and 640 time samples with 1.6 ns sampling interval per trace. After processing and interpretation, we determined 283 cavities had different starting depth and different size. Nine locations were selected for test drilling. 7 drillings ended in the cavities at given depths, 2 drillings encountered with a big fractured zone.

Generally parallel 2D profile data is acquired in the civil engineering area. 3D data imaging obtained from by lining parallel 2D profile data sets is used for slices of time at a constant depth. The locations and the depth of the target in the study area can be determined with the slices of the 3D data volume. Therefore the GPR method gives more precise results than other geophysical methods. However, the obtained results and their interpretation can be further improved when the data set is visualized as a transparent volumetric rendering of the buried objects such as a cavity. Thus anybody can imagine how that the cavity shape changing according to depth and x-y locations by looking into the 3D image. Such imaging may be simulated by a transparent half bird's-eye view into the 3D data volume or its sub-volumes, We attempted to realize this imaging by weighting the amplitude scale according to the time range and appointing an opaque interval to the weighted amplitude scale for each time range or depth range in order to define the cavities in the reservoir area. We re-visualized the data with our new 3D imaging technique and compared them the drilling results. We found very deep cavities in the study area. We also mapped the cavities and colored them according to the starting depths. We also reported that some of the cavities could be very dangerous for the the dam and for Akkopru residents. Additionally water could be just seep away after any mid size earthquake, The Turkish General Directorate of State Hydraulic Works (DSI) which governed the dam and plant decided that the area were sealed using huge concrete slabs. Seales targets the cavities which we located. The result of such sealing and in turn our survey will be seen after water level has risen to 60m in the area.