Subsurface Views

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Airplane through the Runway

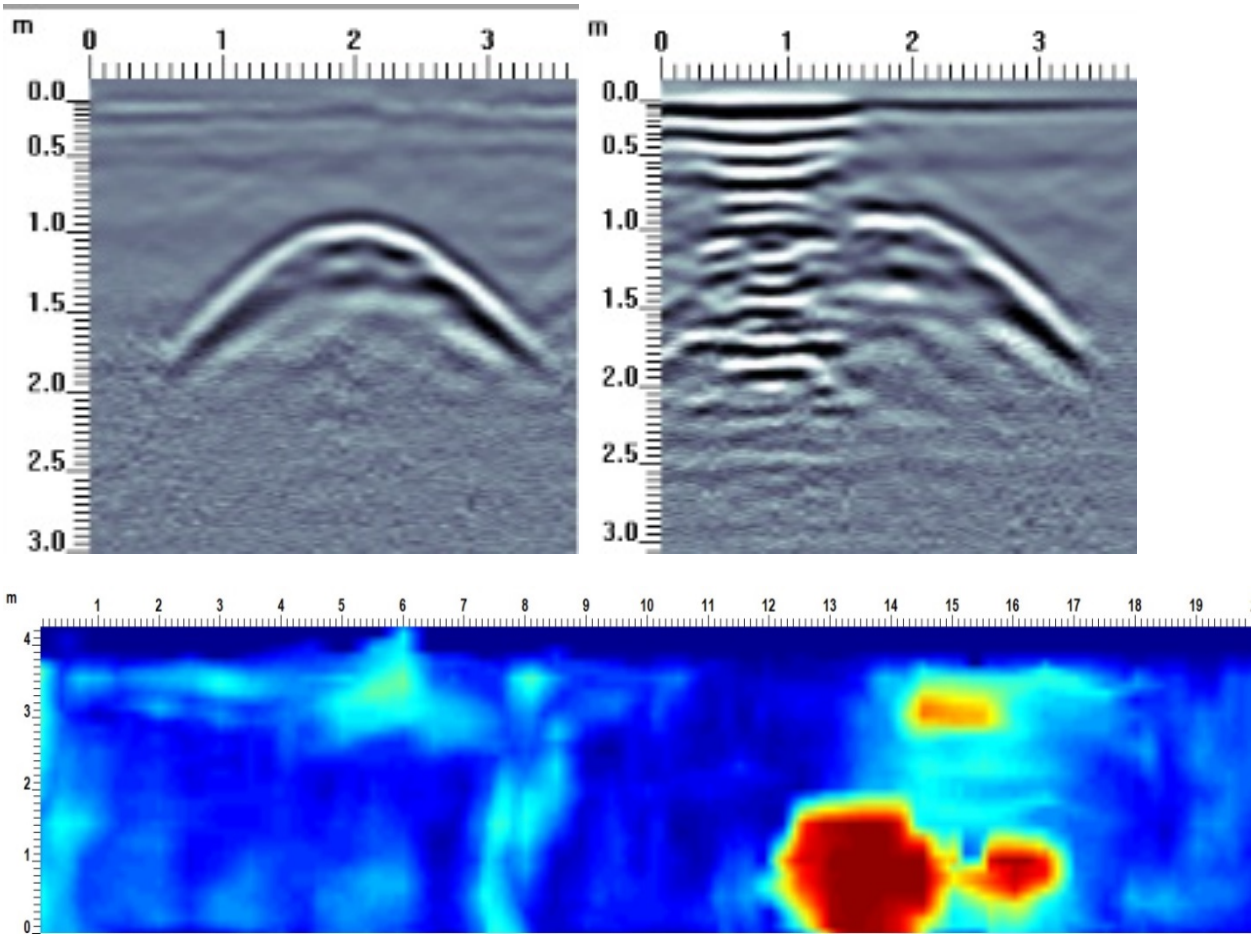
The picture tells the story. Officials at the Mid Delta Regional Airport (former Greenville Air Force Base) in Mississippi were shocked when the wheels of a refurbished Airbus A300 suddenly dropped through the concrete taxiway, causing $1.5 million damage to the aircraft (Figure 1a left). A large void was discovered underneath the taxiway (Figure 1b right).

Geologists speculated that subsurface processes, associated with the flooding of the nearby Mississippi River the previous spring, caused voids to form under the concrete.

Nearby Greenwood-Leflore Airport was alerted to the incident. Obviously, officials at an airport that conducts flight operations annually were concerned there may be voids at their airport, endangering people, airplanes as well as airport equipment that regularly cross runways and taxiways.

A GPR service provider, TeaCo Geophysical, was hired to demonstrate the efficacy of using GPR for mapping voids. Airport engineers decided to survey 2 areas over top of a 56”-diameter, bricked storm drain that crossed a taxiway and runway; a location they felt would most likely be susceptible to voids (Figure 2).

Both areas were surveyed using a pulseEKKO PRO system with 250 MHz transducers on a SmartCart configuration. Survey Area 1 was 60x5 meters with lines spaced every 0.5m in both the X and Y directions for total survey line length of 1.3 km. Figure 4a (left) shows a typical cross-section over the pipe; a hyperbola revealing the location and depth of the pipe. One of the cross-sections over a suspected void is shown in Figure 4b (right); the strong, shallow, horizontal responses from the void on the left masking the side of the hyperbola from the pipe. A depth slice image from all the cross-sectional lines in the grid reveals the areal extent of the void; high amplitude responses are plotted in red Figure 4c (below).



Geologists suspect that the historic flood in the spring of 2011 was a contributing factor to the cause of the voids at both airports. Ironically, at a time when the entire central and southern regions around the Mississippi River were experiencing drought conditions, the river flooded due to record winter snowfalls and heavy rains in the northern portions of the river. The strength of the increased hydraulic gradient caused subsurface sediments in the areas adjacent to the river to be removed in a process called "piping". Basically, fine sediments (silts and clays) are removed by groundwater carried down gradient in subsurface channels or "pipes", reducing the compressive strength of the sediment matrix. Given

repeated flooding events and enough time, these small features grow in size and manifest themselves as voids.

From the pilot survey at Greenwood-Leflore Airport, it is not clear whether the voids were caused by the piping phenomenon or was a result of preferential water flow along the gravity fed storm drain conduit. More surveys at the airport in areas away from the pipe are recommended to determine this. In either event, voids in the area are a direct function of the unconsolidated nature of the local Mississippi Alluvial Aquifer system; groundwater flow causes the finest sediments to be removed.

Photos and data courtesy of Mark Teague, TeaCo Geophysical.