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Detection of cavities in carbonate-cemented fossil eolian sand dunes using DC electrical resistivity survey, Bozcaada Island, Turkey

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This study aims at detection of weathering cavities within a carbonate-laden late Pleistocene coastal dune sequence, located on south coast of the Bozcaada Island, northwest Anatolian part of Turkey. The island is situated in 4 km west of the Biga Peninsula (western Turkey) and constitutes a geological prolongation of that peninsula. The so-called N30E-trending Cape Zunguma is comprised of carbonate dunes or eolianites with a total surface area of 32120 m2. The 220-m long eolianite overlies clay-bearing Miocene marine deposits and extends in northeast-southwest direction. Coastal karst that developed on both surface and subsurface of the eolianite with high porosity and permeability is represented by numerous solution pits and cavities. The governing factors of enhanced solution of eolianite are mainly weathering-prone mineral content and cross-bedded structure of the host rock as well as salt crystallization that becomes effective during dry summers when evaporative conditions favor the precipitation of sea salts (sodium-chloride and gypsum, particularly). Although the exposed uppermost surface of eolianite is dominated by numerous solution pits and natural pools, mostly coinciding with planes of cross-beds partly, subsurface of the rock is mostly represented by circular and ellipsoidal cavities with more than a few meters in diameter.

We performed 2D DC resistivity imaging survey to delineate the nature of the Late Pleistocene eolianite. The apparent resistivity data were acquired along a survey line of 35 electrodes with a spacing of 3 m, to give a total length of the line of 102 m. 266 apparent resistivity data were gathered using Wenner-Schlumberger electrode configuration for 14 data levels. Although the surface topography of the surveyed line is relatively gentle, topographic changes at the locations of each electrode points were determined by using optical leveling technique for a more accurate calculation and interpretation. We used RES2DINV software for processing and interpretation of the gathered data. Blocky or robust (L1 norm) formulation was used in the inversion process. Robust inversion scheme was thought to produce desired solution since we expected a sharp and distinct resistivity contrast between the eolianite body and the Upper Miocene marine deposits. The topographical data were directly incorporated into the modeling mesh used in the inversion scheme. Inversion process produced model resistivity section after six iterations with an Abs. error of 3 %. The SW-NE trending 2D resistivity image displayed a depth range of $\sim$17 m and showed a strong resistivity contrast. The overall resistivity range in the image is $\sim$5-3580 ohm.m. The eolianite unit was distinctly identified in the inverse model section with very high resistivities in proportion to the underlying Upper Miocene marine deposits, defined by low resistivities. The high resistivity variation in eolianite ranging between $\sim$700-3580 ohm.m is likely associated with the presence of weathered cavities in different sizes. The eolianite with weathered cavities having different sizes was found to have a thickness of $\sim$4-7 m, which thickens towards to end of the survey line, i.e. leeward.

Keywords: Eolianite, cavities, resistivity, inversion, marine deposits, Bozcaada Island-Turkey