3D dynamic Electrical Resistivity Tomography in a marine environment

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Abstract

The Electrical Resistivity Tomography (ERT) is a widely used geophysical method for mapping on land buried antiquities, although its usage in reconstructing the cultural relics in littoral and ultra shallow marine environments is rather limited. In practice there are two ways for employing marine ERT survey. The static mode where the cable and the electrodes remain stable in fixed position during data acquisition and the dynamic mode where the electrodes are constantly moving along profiles. In both cases, the sea water layer is a crucial parameter that controls the final resolving capabilities of the inversion resistivity images. The resolving capabilities of marine dynamic three dimensional ERT was evaluated through extensive numerical modeling and inversion of synthtic data sets. The applicability of the method was actually validated using a respective data set collected from a submerged Early Bronze Age settlement in the Bay of Kiladha, Greece. The submerged dynamic ERT lines from Lambayanna posed specific challenges for the data processing. A novel algorithm that simulated the movement of the underwater cable was developed in order to reconstruct the global coordinates of the electrodes from all the lines with a certain degree of accuracy. This involved the location of more than 216,000 different electrode positions and more than 166,500 data points describing the 3-D variation of the apparent resistivity below the sea bottom at the submerge archaeological site at Lambayanna was created. The final 3D resistivity inversion model below the seabed outlined few linear resistive segments as well as compact resistive regions are
likely to be related to walls or roads of the submerged prehistoric town. The results of this work signify the importance to apply dynamic electric resistivity tomography method to archaeological shallow-water contexts. Although the processing of such data presented some challenges and required the creation of novel algorithm and customization of commonly used software, the final results support such efforts and provide useful information. Ultimately, the results of this work can be regarded as a step toward the development of an effective method that could be applied to similar archaeological surveys in coastal or shallow-water environments.

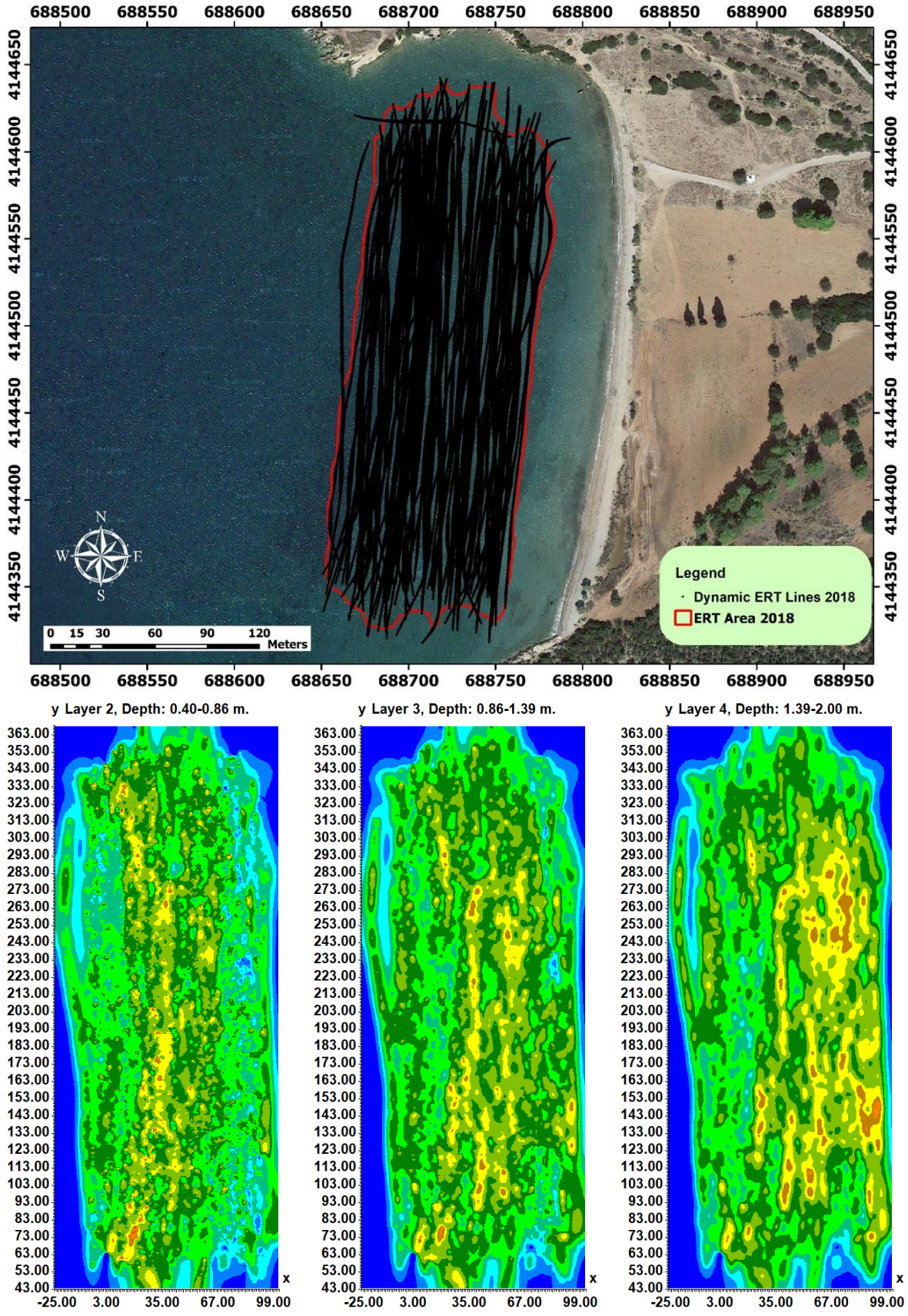

Figure 1 Area covered with 3-D electrical resistivity tomography (red polygon) and the individual dynamic ERT lines during 2018 field season in Lambayanna (top). Horizontal depth slices extracted from the 3-D robust resistivity inversion model from Lambayanna using the dynamic dipole-dipole measurements (bottom).