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Using ERT and GPR methods to detect shallow subsurface targets

E. Eshaghi (1), A. Kamkar Rouhani (2), M. Esteki (2), and A. arabamiri (2)
(1) Geological Survey of Iran (GSI) , Tehran, Iran, (2) Shahrood University of Technology, Shahrood, Iran

One of common problems in interpretation of geophysical data is the unreliability or ambiguity in the interpretation results. To solve or alleviate this problem, different solutions have been suggested in which the integration of two or more geophysical methods can be considered as a solution to obtain a more reliable and accurate interpretation. The aim of this research work is to compare, and then, integrate the results of electrical resistivity tomography (ERT) and ground penetrating radar (GPR) methods for detection of a shallow subsurface target in a case study. As a result, the capabilities and weaknesses of each of the ERT and GPR methods are practically investigated in this case study, and then, it is shown that a more reliable and accurate interpretation of the results is obtained from integrating the results of these two geophysical methods.
In this research, a water qanat has been selected as a suitable shallow subsurface target for investigation by these two geophysical methods. To detect the water qanat, located in an area northeast of Iran, ERT and GPR surveys have been carried out in the area. Then, two-dimensional (2-D) and three-dimensional (3-D) modeling of the acquired geophysical data has been made and modeling results have been interpreted. The results clearly indicates higher resolution of the GPR method in comparison with the ERT method so that the water qanat cannot be recognized from the ERT profiling results while the GPR sections clearly indicate the water qanat in the subsurface. However, ERT method, compared to GPR method, has higher depth of penetration so that GPR method cannot depict the water qanat in deeper subsurface parts. In general, the results of both methods are mainly in good agreement with each other. For instance, increasing the grain sizes of the subsurface sediments causes an increase in depth of penetration of GPR method and an increase in resistivity values of corresponding subsurface parts in ERT profiles, and vice versa. Furthermore, an intensive increase of resistivity in a subsurface zone that is evident in the 3-D resistivity modeling section has been interpreted as a subsurface small cavity. This cavity is indicated in the corresponding GPR section by the ringing phenomenon which normally occurs due to the existence of cavities in the subsurface. Both the ERT and GPR data modeling results have qualitatively indicated grain sizes of the sediments and the water leakage from the water qanat to its surroundings although the ERT method has demonstrated its superiority over the GPR method in this regard. Finally the findings of this research work indicate that integration of both ERT and GPR data results enhances the accuracy and reliability of detection of shallow subsurface targets such as the water qanat, cavities and coarse- or fine-grained sediments.