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GPR Survey at the Castle Of Taranto (South- Italy).

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Abstract

The Aragonese Castle is located in the southwesternmost part of the inland corresponding to the acropoli of Taranto during the Magna Grecia period. It is at the top of a calcarenitic body ascribed to the Last Interglacial time (MIS 5). Its building was completed in 1492 but there aren't indications about an official beginning; some architectonic particulars, including the structure of the church inside, seem indicate that the building started during the X/XII century. Calcarenitc ashlars present in the wall have size characteristic of the Magna Grecia/roman time; therefore, it is possible that parts of present fortification were build up the Magna Grecia/roman one or, at least, reworking their parts. The present structure of the castle is result of different phases, not yet well documented, of improving and reutilization occurred during their five century of live.

The channel that separate the past acropolis from the centre of Taranto was cut at the end of XIX century, in occasion of the realisation in this city of the biggest base of Italian fleet; however, old documents indicate that in this area a small valley could limited the acropoli from the outside. Goals of present work are: I - to individuate the original topography of the natural environment; II – to individuate past structures at present covered by new ones or by sediments. The preliminary results are encouraging and pointed out the presence of different structures that could be of archaeological interest.

Keywords - Aragonese Castle, GPR survey

I. GEOLOGICAL, HIDROGEOLOGICAL AND GEOMORPHOLOGICAL SETTING

The area is at the front of the southern Apennines, that is a fold – and – thrust belt developed following the closure of the Mesozoic Tethys Ocean, and the deformation of the Adraiatic passive margin during Tertiary and Quaternary times. The thick basement of carbonatic Mesozoic rocks is partially sealed by Pleistocene foredeep deposits, which represent the infill of the Bradanic Trough. The upper portion of the middle Pleistocene succession consists of marine sands and conglomerates forming several orders of terraces (Bentivenga et al., 2004; Doglioni et al., 1999; Ricchetti, 1967, 1979). The morphology of the area (Fig. 1)

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is characterized by a broad plain, slightly sloping towards the sea, in many places marked by natural and/or man-made channels which form the drainage network. The altitude is between 3 and 4 metres above sea level. The coastal belt is one of the most beautiful of the Ionian gulf because of the existence of humid zones. The area contains two overlapping and hydraulically separate aquifers: the first (superficial) aquifer is formed by the Pleistocene marine Terraced Deposits overlying the Pleistocene clays, holding a phreatic groundwater body. Unfortunately, the quantity of water that can be drawn by this aquifer is not enough to satisfy the water requirement of the surrounding fields, so numerous wells emerge from the deep aquifer; the second (deep) aquifer lies in the Mesozoic limestones, made up of fractured and karstic carbonatic cretaceous rocks, and in the overlying Lower Pleistocene calcarenite. This deep groundwater body floats on a base of sea water from continental invasion, in accordance with the principle of Ghyben-Herzber. In the area where the deep aquifer lies below the subapennine Clays, it contains water under pressure and is therefore of Artesian type.

II. GPR DATA ACQUISITION AND ANALYSIS

The GPR survey was performed, with Sir 3000 georadar system, using a 200 MHz centre frequency antenna. The following acquisition parameters were selected: samples per scan, 512; recording time window, 100 ns; gain function, manual. The quality of the raw data did not require advanced processing techniques. However, an easier interpretation using the GPR-Slice software (*www.gpr-survey.com/*). The following data processing has been performed: (i) amplitude normalization, consisting of the declipping of saturated (and thus clipped) traces by means of a polynomial interpolation procedure; (ii) background removal, whereby the filter is a simple arithmetic process that sums all the amplitudes of reflections that were recorded at the same time along a profile and divides by the number of traces summed the resulting composite digital wave, which is an average of all background noise, is then subtracted from the data set; (iii) Kirchhoff two-dimensional velocity migration,which is a time migration of a two-dimensional profile on the basis of a two-dimensional velocity distribution is performed. The goal of the migration is to trace back the reflection and diffraction energy to their ‘source’. A close examination of the data showed the presence of the numerous reflection hyperbolae from a point source. This allows us to estimate the EM wave velocity propagation ranging from 0.07 m/ns to 0.09 m/ns in the surveyed areas.

The A5 profile (Fig. 2) has been acquired in the lectures room using the 200MHz antenna. The analysis of the raw data pointed out: a low penetration of the electromagnetic signal “60ns” (about 2.7m in depth with the average electromagnetic wave velocity of 0.09m/ns); the presence of an interface, labelled I, located to

1.6m in depth. Such interface could represent the bedrock; the presence of numerous anomalies with characteristic hyperbolic shape that, from ESE toward WNW, are denominated: S) located along the abscissas 3m, 8m, 10m, 13m, 22m, 27m, 29m, 34m, 38m, 42m, 47m respectively and 0.2m in depth; such anomalies are due to the probable presence of hydraulic network; G) located at the abscissas 1-5m and 1.6m in depth; such anomaly could be related to the presence of a structure of archaeological interest; H) located at the abscissas 34-40m and 1.6m in depth; such anomaly could be related to the probable presence of a man made structure (cistern?).

The profile A6 (Fig. 3) has been acquired in the courtyard using the 200MHz antenna .The analysis of the raw data pointed out: a good penetration of the electromagnetic signal "100ns" (about 4.5m) in depth with the average electromagnetic wave velocity of 0.09m/ns); the presence of an interface, denominated "saturated zone", located 4.5m in depth. Such interface could represent the zone of transition with greater presence of water (groundwater); the presence of numerous anomalies with characteristic hyperbolic shape that, from WSW toward ENE, are denominated: S) located along the abscissas 10m, 21m, 33m at 0.4m in depth; such anomalies are due to the probable presence of hydraulic network; K) located along the abscissas 2-6m at 0.8m in depth; such anomaly could be related to the probable presence of a man made structures; R) located along the abscissas 36-41m at 0.8m in depth; such anomaly could be related to the probable presence of a zone strongly rehandled and therefore to man made structures subsequently filled with discard materials.

The profile A7 (Fig. 4) has been acquired in the courtyard using the 200MHz antenna. The analysis of the raw data pointed out: a good penetration of the electromagnetic signal "100ns" (about 4.5m in depth with the average electromagnetic wave velocity of 0.09m/ns); the presence of an interface, denominated "saturated zone", visible at 4.5m in depth. Such interface confirm the zone of transition with greater presence of water; the presence of numerous anomalies with characteristic hyperbolic shape that, from SSE toward NNW, are denominated: S) located along the abscissa 36m at 0.4m in depth; such anomaly is due to the probable presence of hydraulic network; R) located along the abscissas 0-7m, 10-22m, 27-31 respectively and to the depth of 0.6m; such anomalies could be related to the probable presence of a zone strongly rehandled and therefore to man made structures subsequently filled with discard materials.

The A1 profile (Fig. 5) has been acquired on the vertical wall with the use of the 500MHz antenna. The analysis of the raw data pointed out: a good penetration of the electromagnetic signal 70ns (about 3.15m in depth with the average electromagnetic wave velocity of 0.09m/ns); the presence of numerous anomalies with characteristic hyperbolic shape that, from west to east direction, are denominated: A) located between the abscissas 8-11m and depth between 0.60 and 2.4m; B) located between the abscissas 16-28m and depth between 0.60 and 2.4m; C) located between the abscissas 33-38m and depth between 0.60 and 2.4m.

The dimensions of such anomalies make to think about the probable presence of void zones or man made structures. The great amplitudes of electromagnetic signal could make to think about the probable presence of small voids.

The profile A8 (Fig. 6) has been acquired in the courtyard, on the steps, using the 200MHz antenna. The analysis of the raw data pointed out: a good penetration of the electromagnetic signal “120ns” (about 5.4m in depth with the average electromagnetic wave velocity of 0.09m/ns); the presence of numerous anomalies with characteristic hyperbolic shape that, from SSW toward NNE, are denominated: S) located along the abscissa 19m; such anomaly is due to the presence of a gutter set in surface; M) located along the abscissas 4-9m at 2.4m in depth; such anomaly could be related to the probable presence of a man made structure; N) located along the abscissas 12-16m at 2.4m in depth; such anomaly could be related to the probable presence of a man made structure;

L) located at the abscissas 18-21m at 2.4 and 4.5m in depth; such anomaly could be related to the probable presence of a cavity.

III. CONCLUSIONS

The GPR survey carried out in the Aragonese Castle have had as objective the investigation on the presence of man made structures of archaeological interest.

The individualization, in the radar sections, of different anomalies of hyperbolic shape, pointed out the presence of probable man made structures that could also have archaeological interest.

Some of them could be due to the presence of cavity, such as the anomalies denominated L, N; others are due to the presence of hydraulic network, such as the anomalies denominated S. The presence of anomalies of hyperbolic shape has made a rapids and accurate analysis of the electromagnetic wave velocity that results to be 0.09m/ns.

Further investigations, possibly of detail, you/they could help to understand better the complexity of the structure of the subsoil of the castle.

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FIGURES

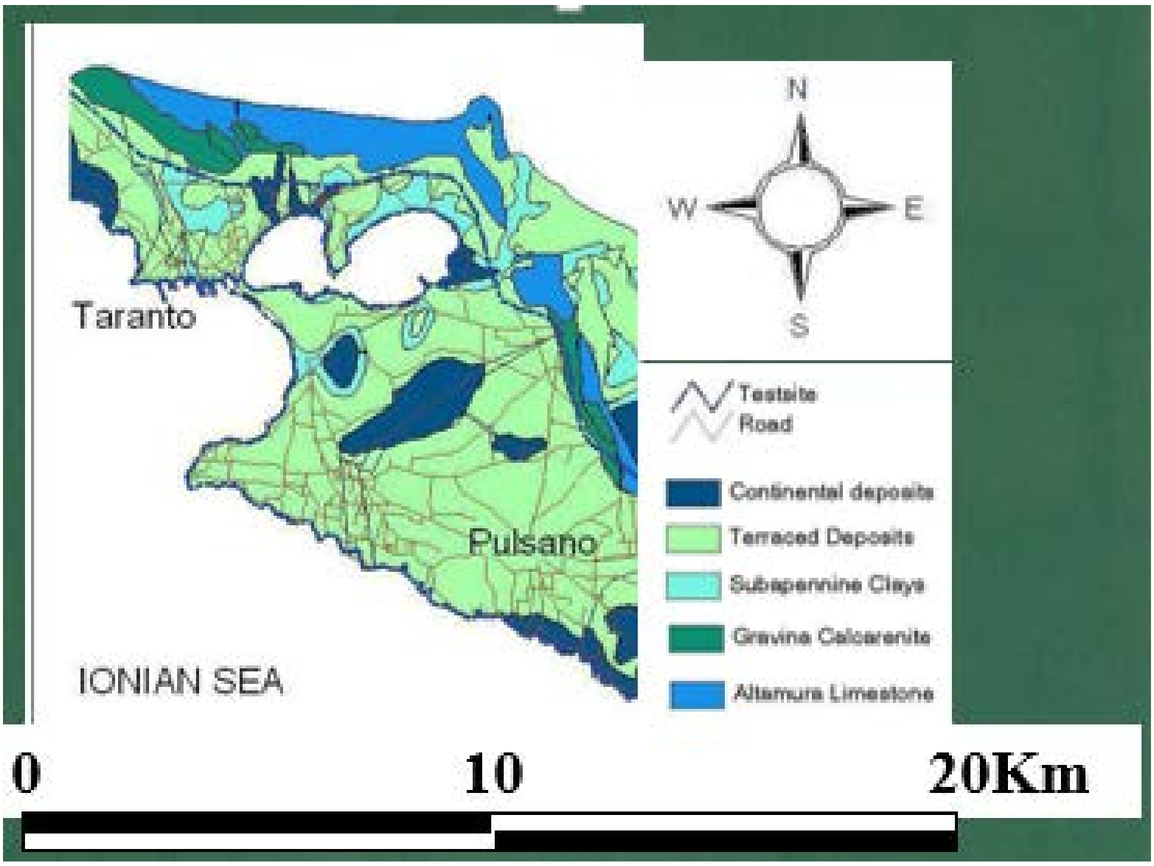

Figure 1. The geological map of Taranto

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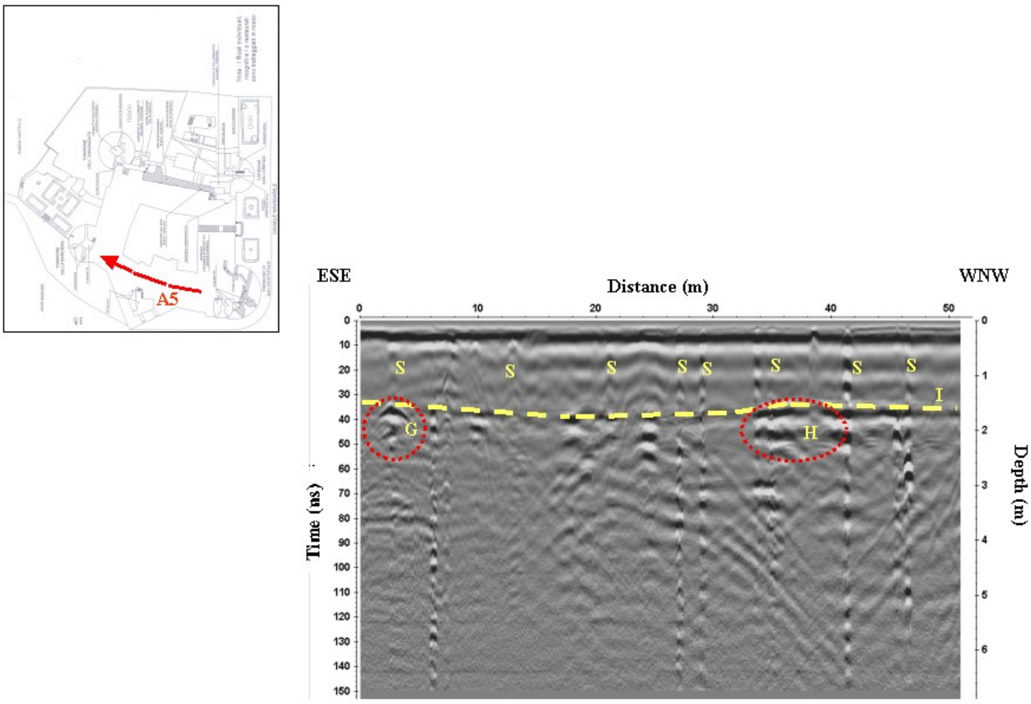

Figure 2. GPR time slices A5 profile

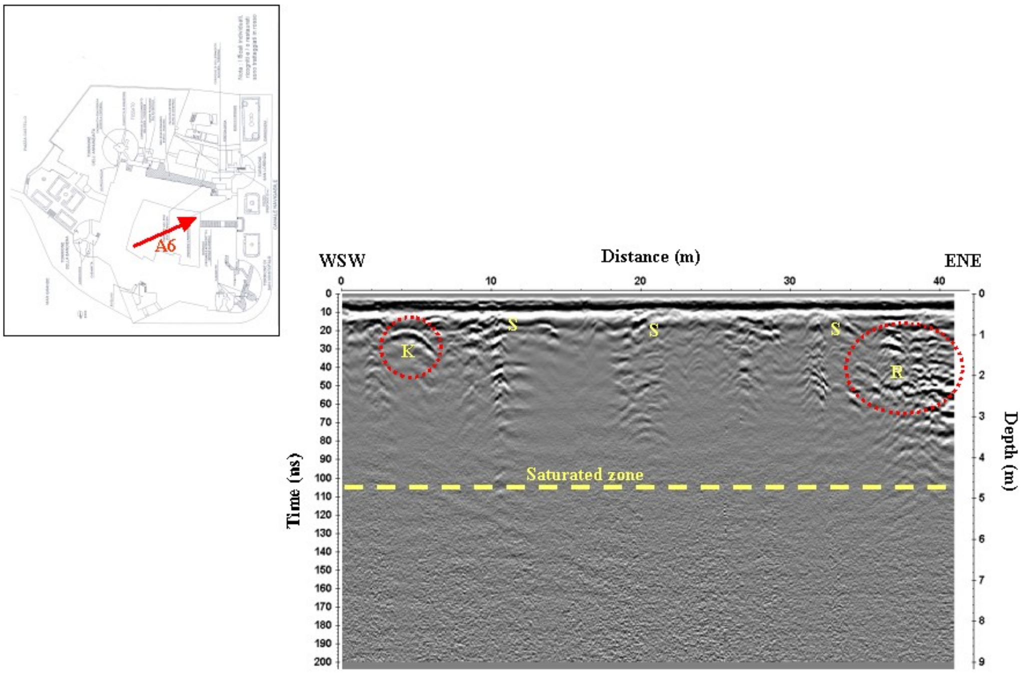

Figure 3. GPR time slices A6 profile

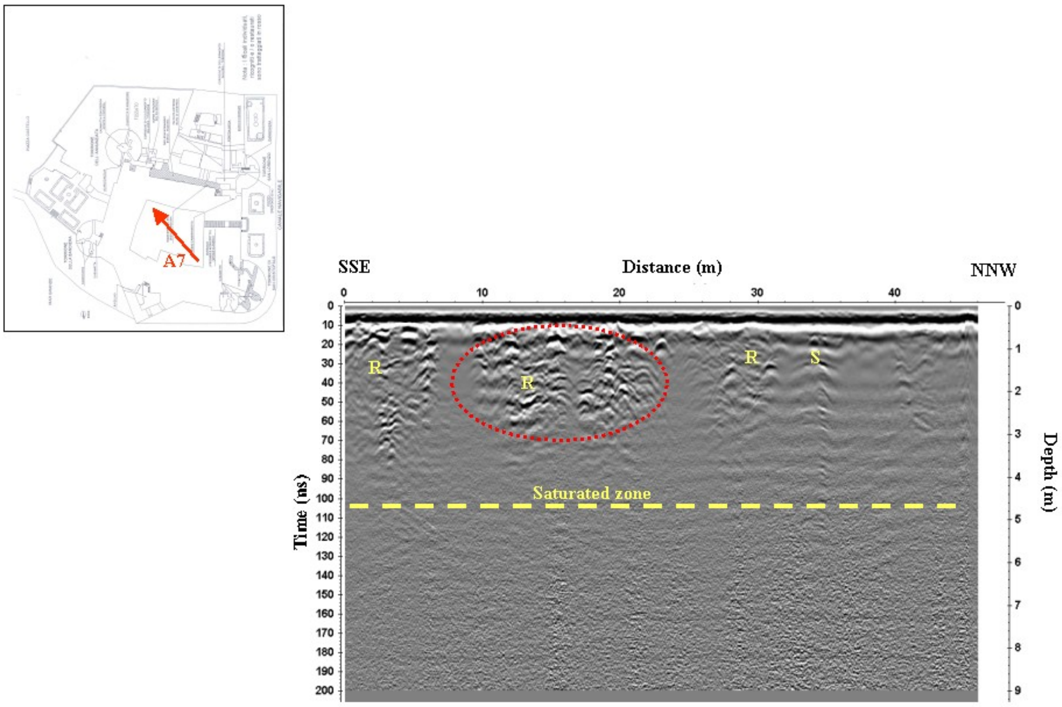

Figure 4. GPR time slices A7 profile.

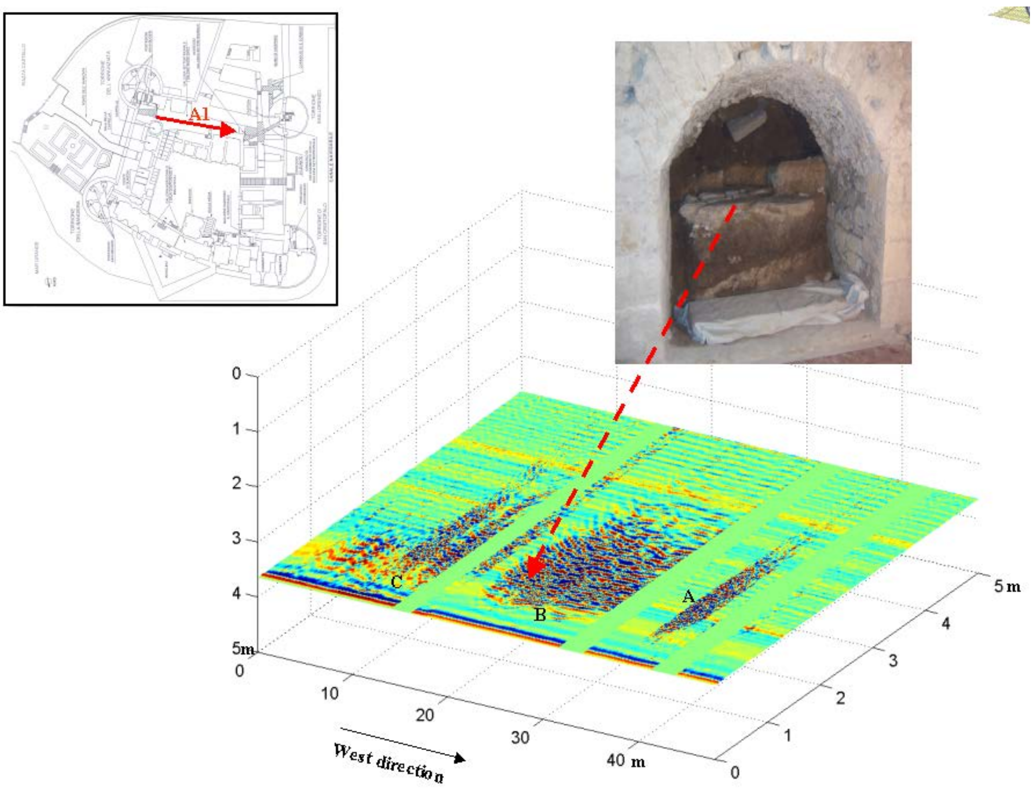

Figure 5. GPR A1 profile

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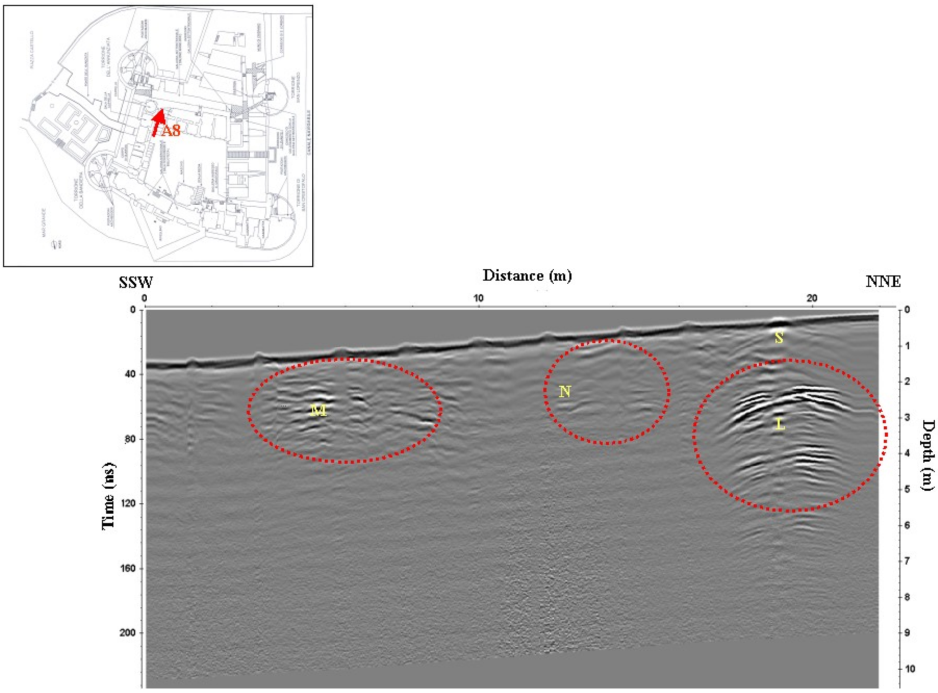

Figure 6. GPR A8 profile

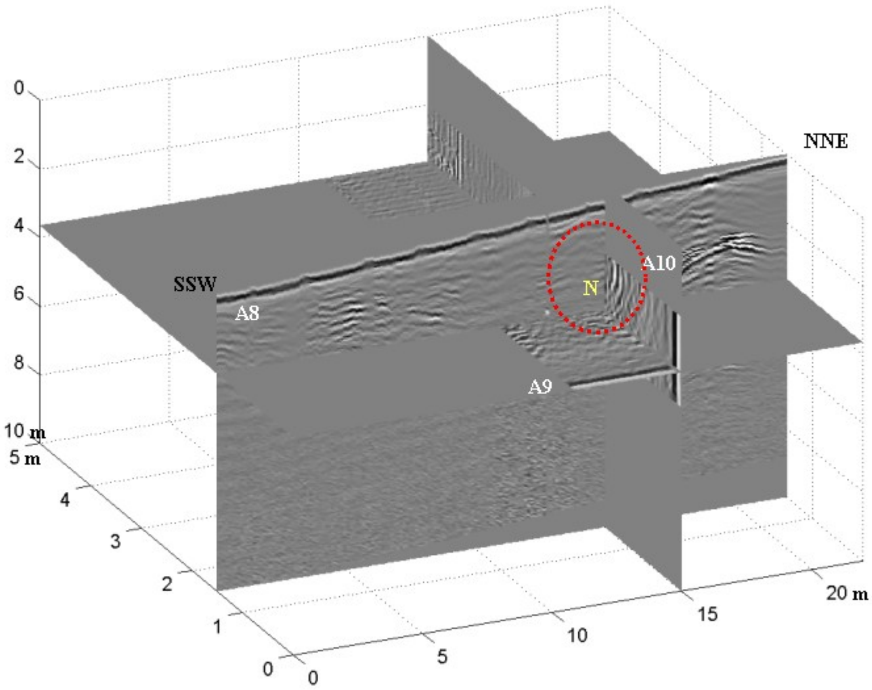

Figure 7. GPR pseudo 3D visualization