TU1208

Training School
Electromagnetic Modelling Techniques for Ground Penetrating Radar
Split, Croatia, 9-12 November 2016

NON-INVASIVE DIAGNOSTIC FOR THE STUDY OF ANCIENT HIPOGEUM OF SAN SALVATORE, SARDINIA, ITALY

Martina Cogoni_Conservator-Restorer of Architectural and Environmental Assets _ Architect.
Henge s.r.l Heritage Engineering Geophysics, Spin-Off of University of Cagliari, Department of Civil and Environmental Engineering and Architecture (DICAAR)
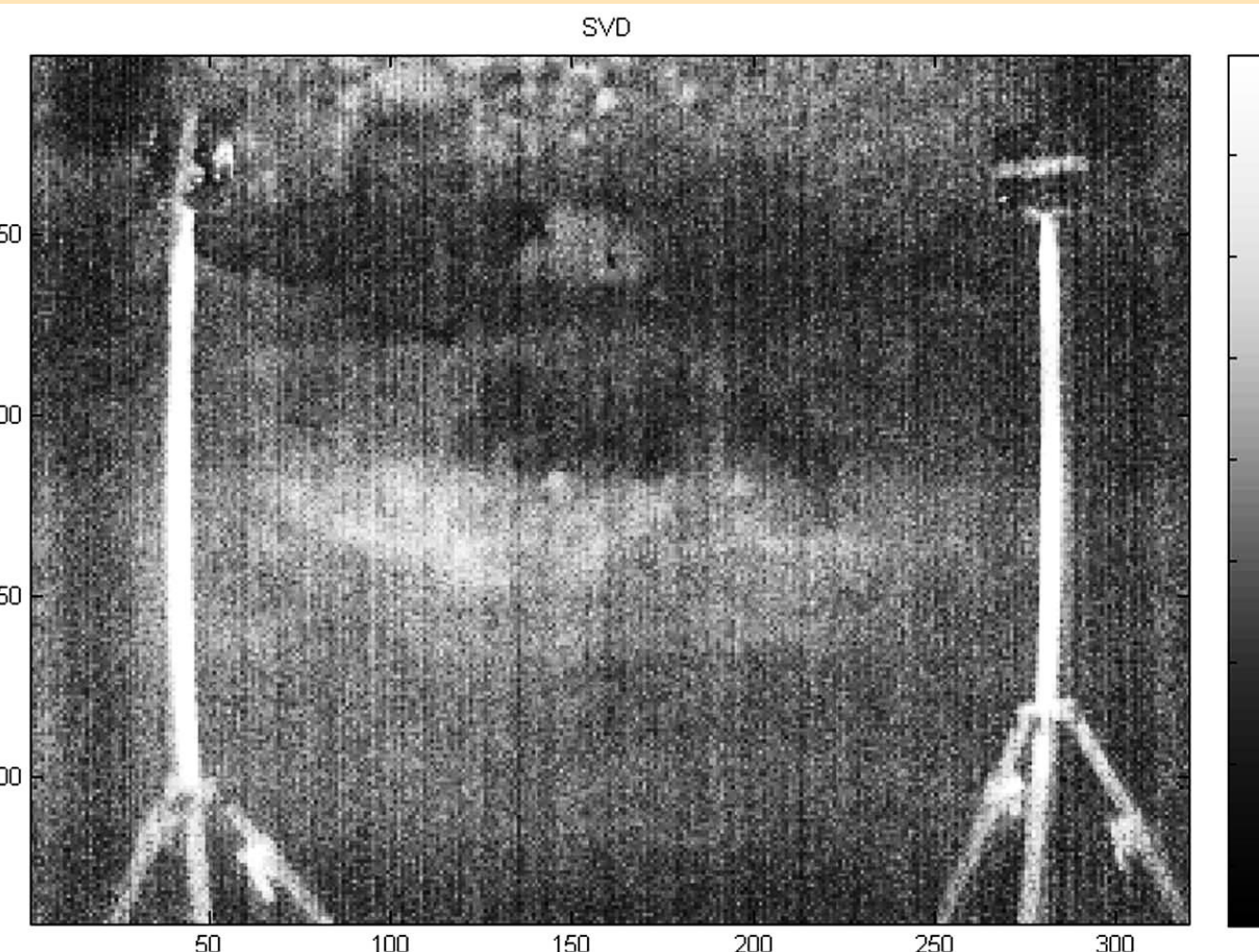Team: G. Ranieri, A. Trogu, F. Loddo, M. Cogoni.
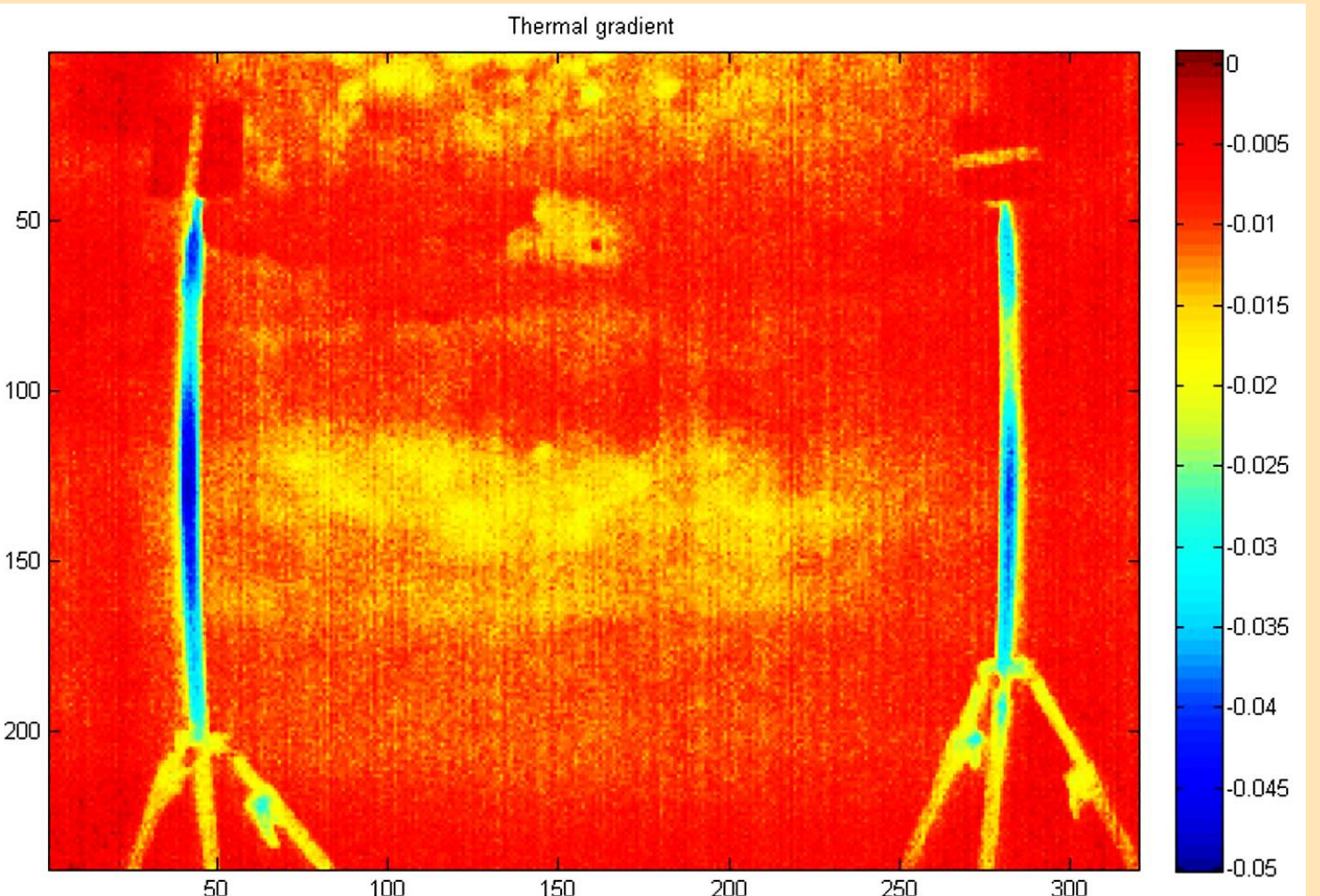
Thermography

Figure 2: Thermographyc data acquisition. Thermographyc camera-on the left; electrical infrared heater-in the middle; reflecting targets-on the right.

Figure 3: Portion of ancient wall analyzed by thermographyc data acquisition. Yellow-brown area is a past unknown restoration.

Figure 4: Thermogram obtained after SVD processing. Both processing methodologies of thermic thomography show the presences of detachment-brighter parts of thermic images between plaster and masonry, which are not evident watching the wall.

**Figure 5**: Thermogram obtained after NTG processing.

Multispectral Analysis

Figure 6: Multispectral data acquisition. Multispectral modified camera in the middle; two halogen lamps symmetrically positioned on the left and on the right.

Figure 7: Visible spectrum image taken by a common digital camera, of some wall drawings. Brighter area is a past unknown cleaning/restoration. It shows what is visible to naked eye.
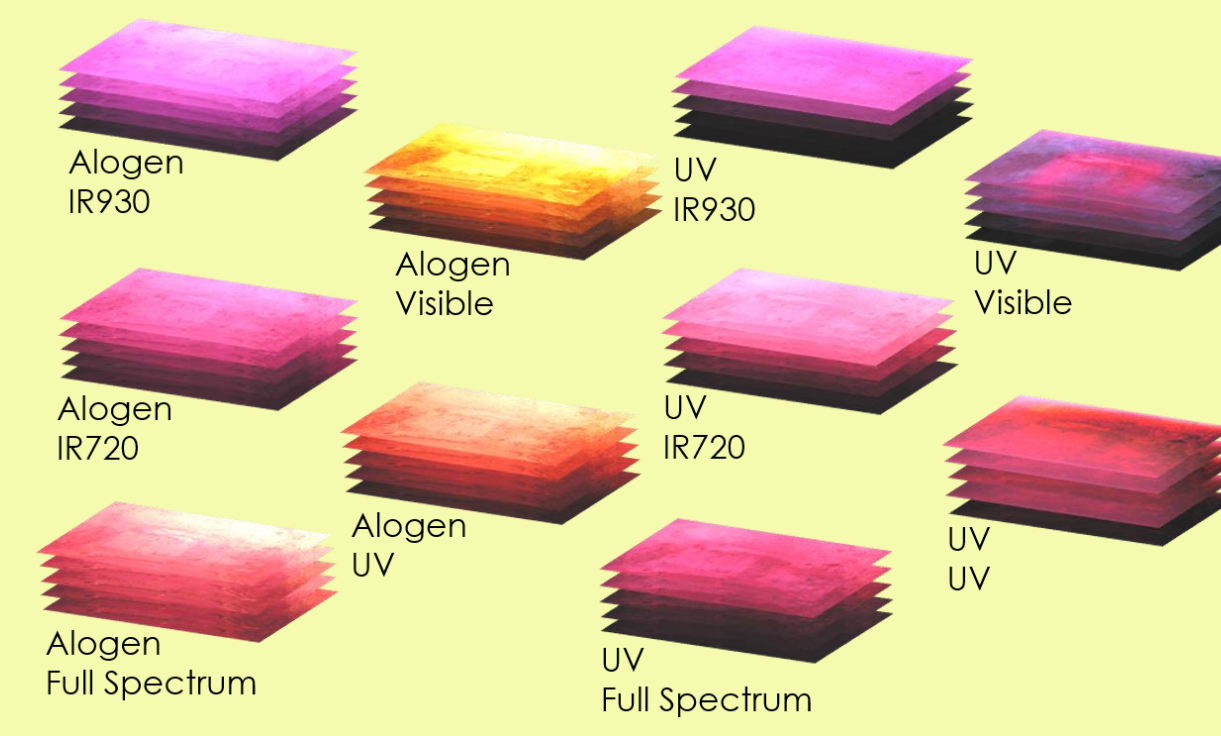
Figure 8: Multispectral stacked images. For each kind of light source all multispectral stacked data were acquired at different camera exposition by using different filters on camera lens.

Figure 9: 1°step of data processing. Converting from 8 bit to 16 bit and from RGB to BW each group of multispectral stacked images and then merging them in order to obtain only one resulting 16 bit BW multispectral image from each group.

Multichannel GPR Survey

Figure 14: Multichannel GPR

Figure 15: San Salvatore's village with the identification of investigated area.

Figure 1: Layout of the eighteenth century rural church superimposed on the hypogeum; (A A') longitudinal section and (B-B') cross section (Cogoni, M., 2014/2015). Archaeological findings inside and outside the hypogeum (Donati et al., 1992) and one of the most prominent and peculiar archaeological sites of the Sinis area, the near Mont'e Prama necropolis (Ranieri et al., 2015) prove that the hypogeum could date back to the Nuragic civilization.

Figure 10: NIR image (up to 830 nm) resulting from the preliminary processing. After first step of data processing, the image shows more details of ancient drawings which results more readable.

Figure 11: Historic image of wall drawing, cropped from Levi's book, 1949.

Figure 12: 2° step of data processing, applied to both historic and 1°step processed multispectral image: Image special wavelet decomposition, regional field deletion, levels merging, histogram enhancing, contrast and bright calibration, curve levels adjustments.
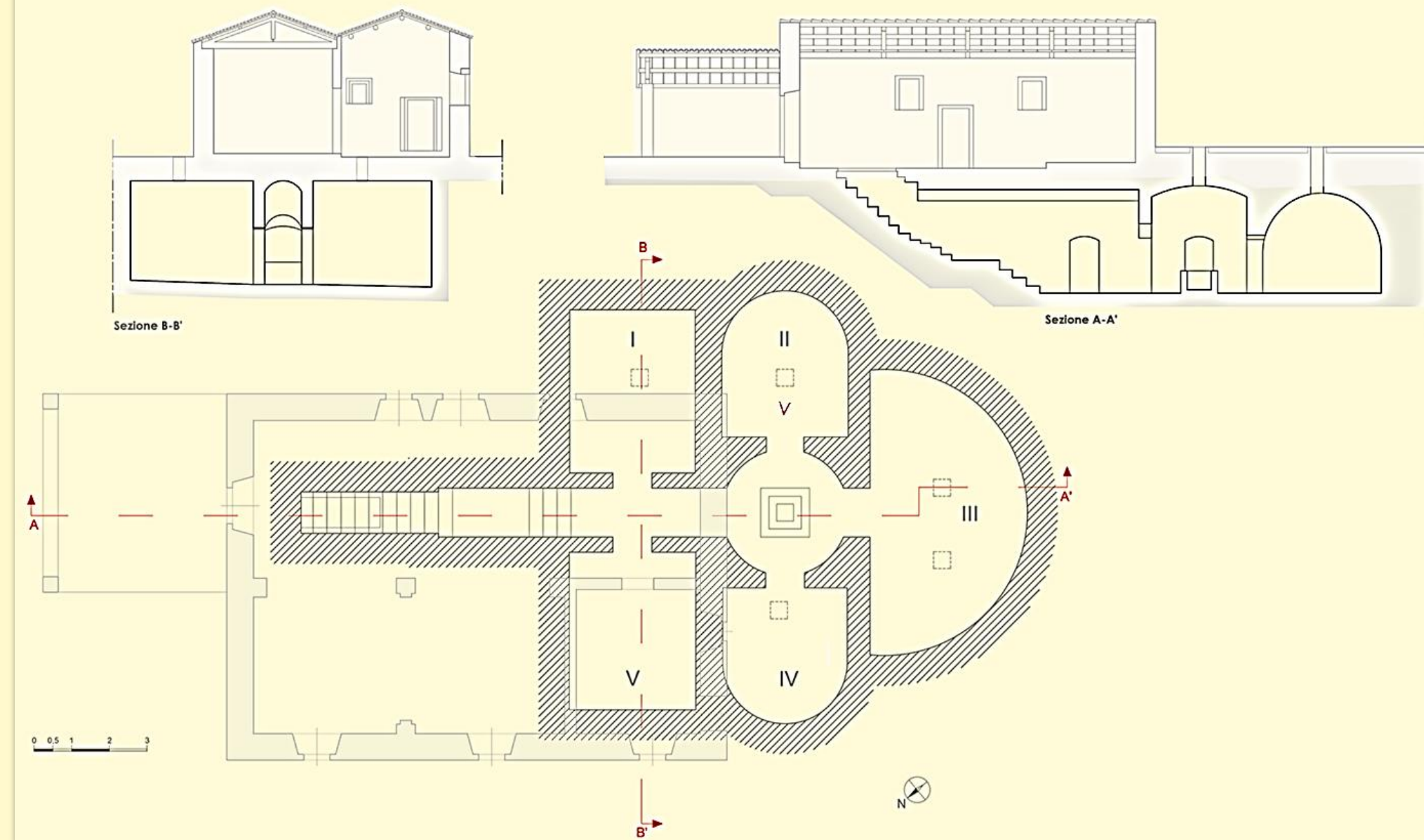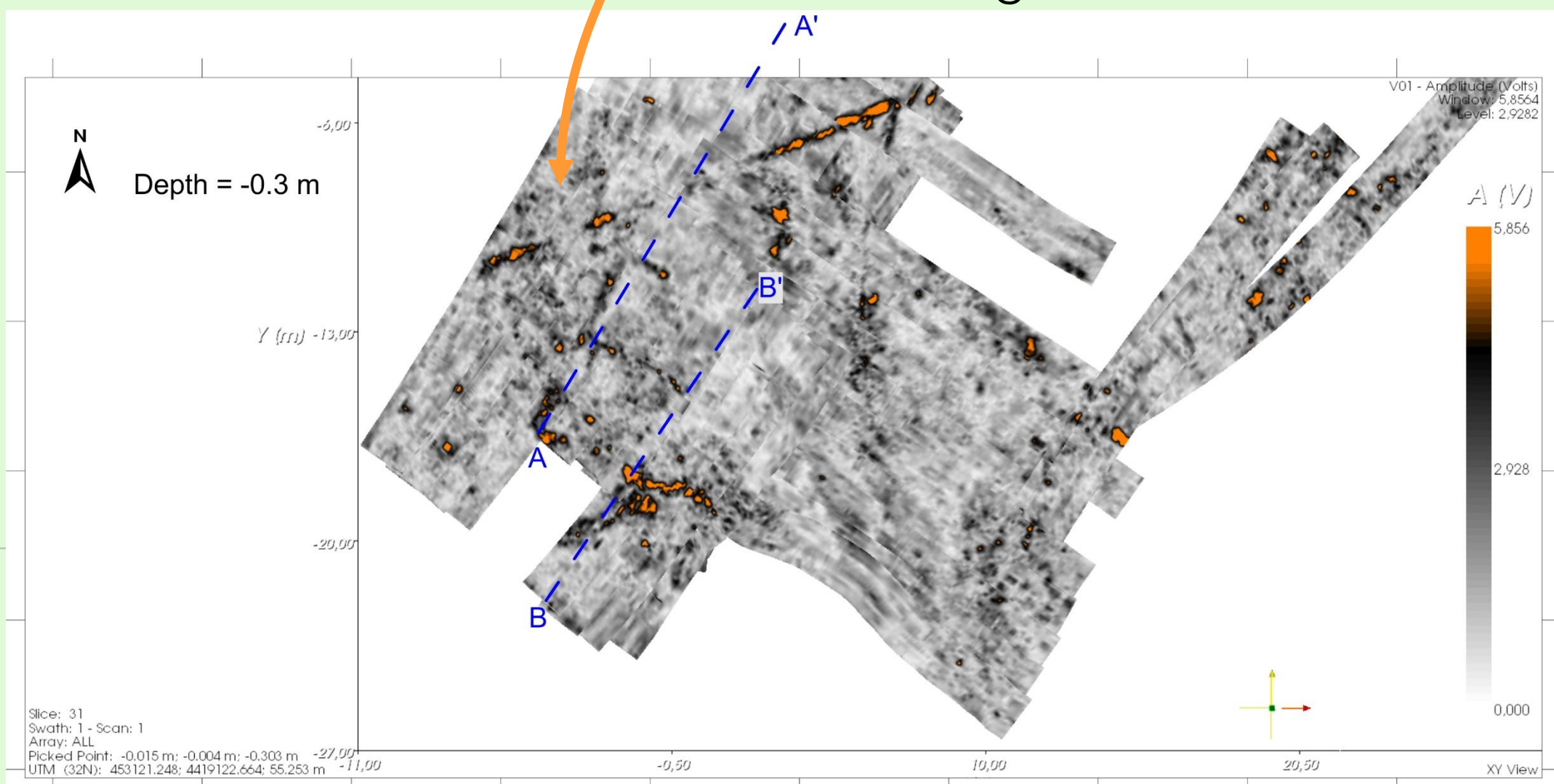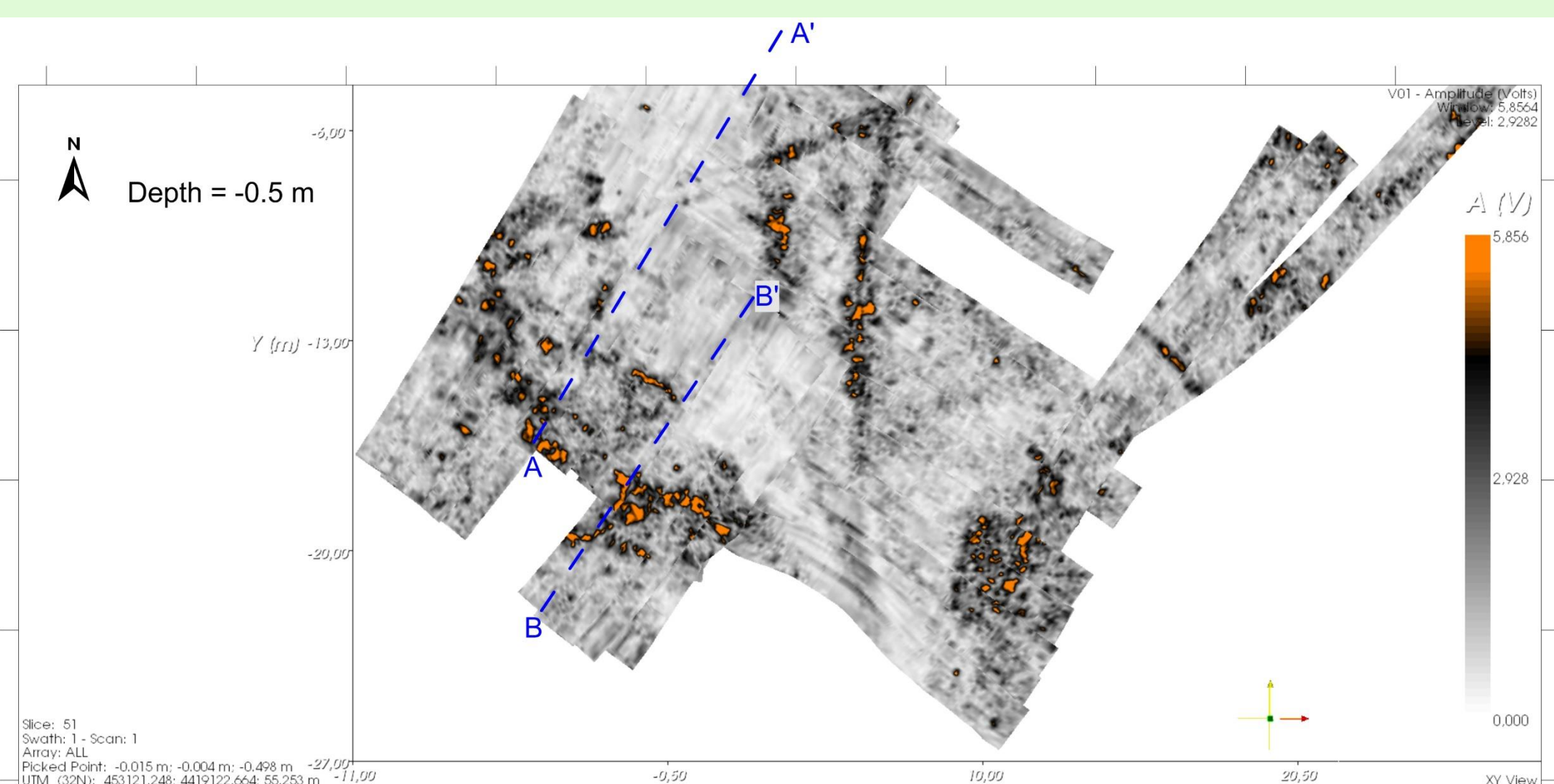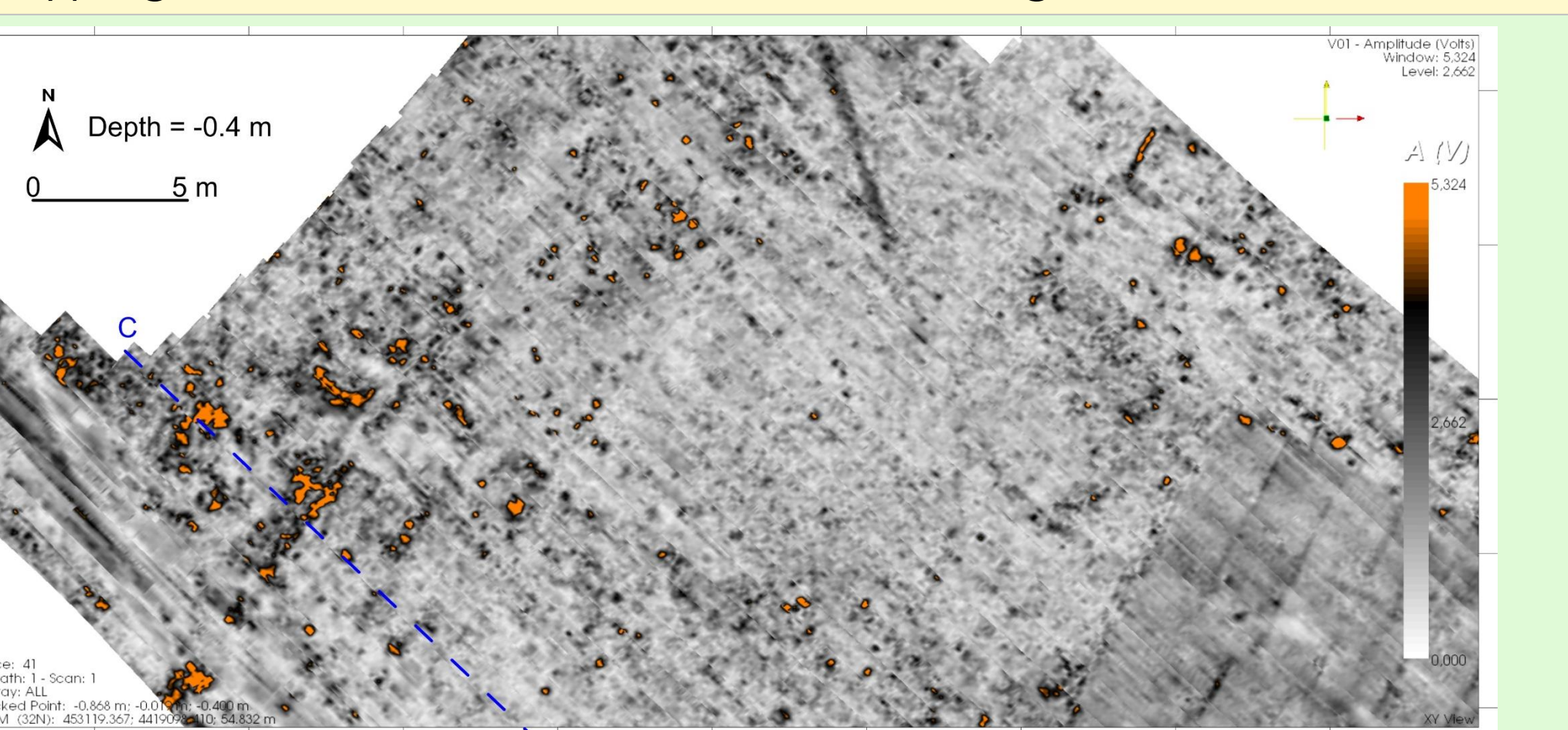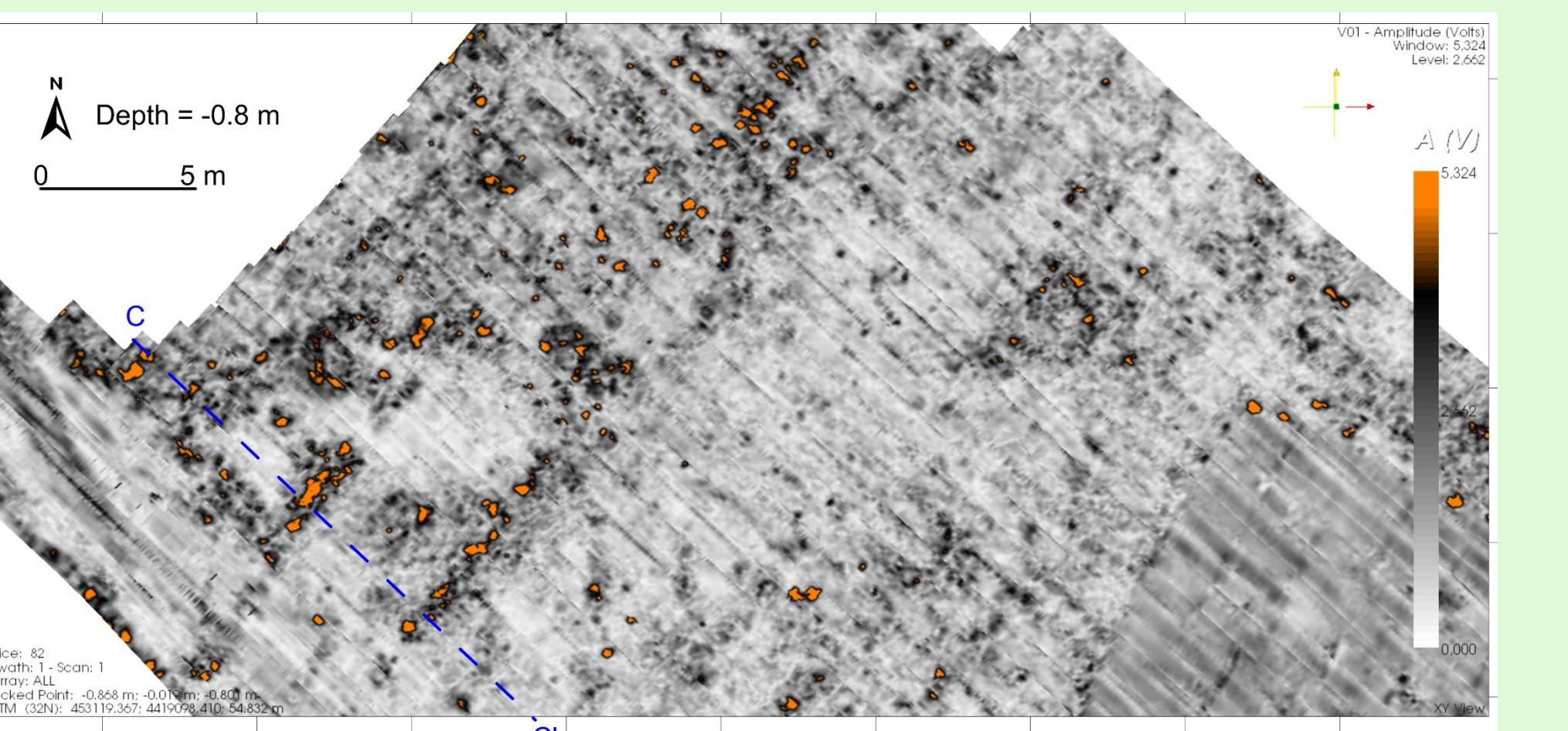
Figure 16: Time slice of south-eastern plot of land of the San Salvatore village at a depth of -0,3 m. Linear and quadrangular anomalies probably referred to a roman or medieval structure of the village. A-A': location of A-A' radargram. B-B': location of B-B' radargram.

Figure 17: Time slice of south-eastern plot of land of the San Salvatore village at a depth of -0,5m. Circular anomalies probably referred to nuragic structures of the village.

Figure 18: A-A' radargram.

Figure 19: B-B' radargram.

Figure 20: Time slice of south-western plot of land of the San Salvatore village at a depth of - 0,4m. There are some circular and linear anomalies. C-C': location of C-C' radargram.
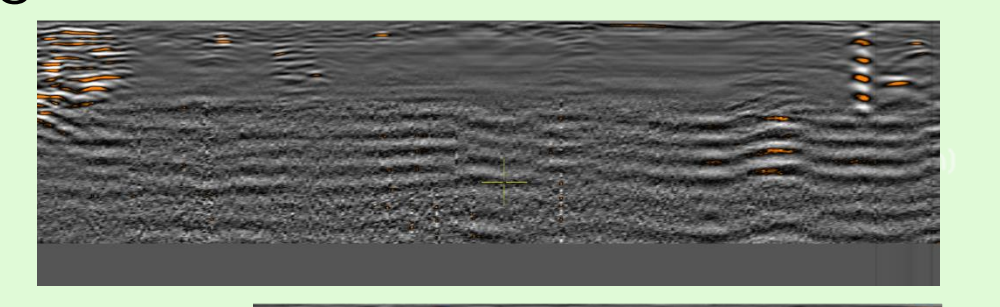
Figure 21: Time slice of south-western plot of land of the San Salvatore village at a depth of -0,8m. Circular and linear anomalies are clearer because of the depth.
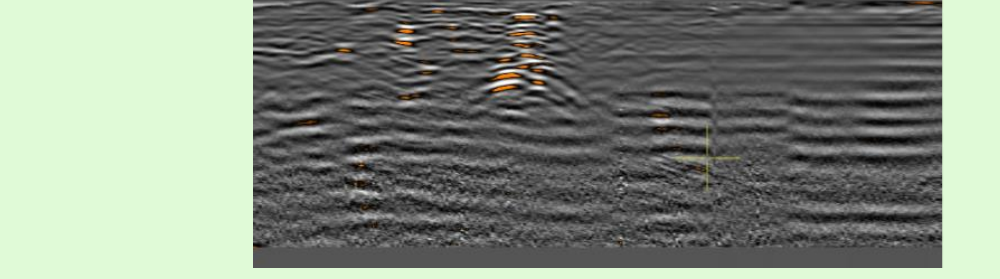
Figure 22: B-B' radargram

Figure 13: 3° step: superimposed enhanced historical information (red), on enhanced multispectral information, NIR channel (blue). Red signal refers to drawing parts which were visible in the past and are invisible nowadays; red+blue signals refer to drawing parts which were visible in the past and are still visible; blue signal refers to drawing parts which were invisible in the past but are visible through the multispectral analysis. If the shapes of blue signal concerns to the drawings iconography they are part of ancient decorations, otherwise we can deduce they are results of modern vandalistic actions.
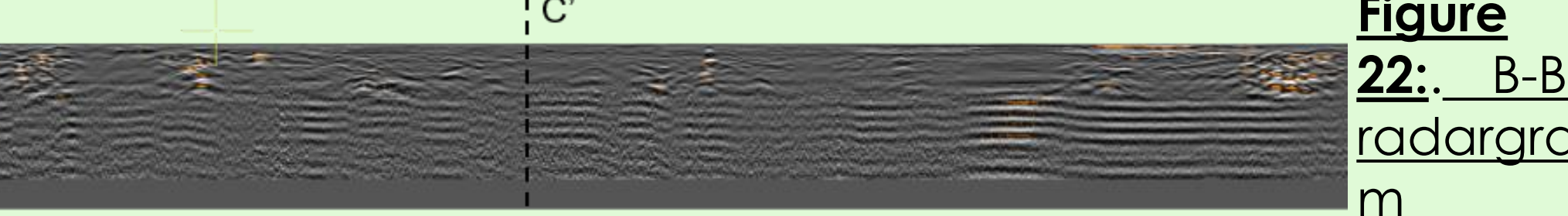
References
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