3D GEOLOGICAL MODELLING APPLICATION IN A CONTAMINATED SITE.

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INTRODUCTION

The environmental characterization is the first and foremost important phase of drainage interventions of polluted sites. Its aim is to define the conceptual model of the site which provides information about the migration and the propagation of the contamination in various soils. Besides, it defines an action plan for the following phases.The geological investigation activities that we propose here are aimed at re-building and modeling (in 3-D) the geological bodies that host contaminated sites. These are carried out as part of a larger project which has as its final goal the testing of new models. The geological modeling in 3D represents an effective means in order to overcome the limits of the bi-dimensional cartographic representation. Specifically, in this representation, only part of the collected and coded data is represented in the map or in its framed sections, determining a loss of information. The applied methodology provides a useful tool for the integrated management of multi-z and multi-scale as well as for the use of existing databases (D'Ambrogi, 2009). Moreover, 3D geological modeling constitutes a tool for synthetic data analyses and geological knowledge that favours the understanding of the geological reality; it further ensures that a more complete analysis of geological phenomena can be carried out. In our case, the 3-D modeling has rendered a more efficient representation of the geological structures of the contaminated sites under investigation, that is the RSU dump situated in municipality of Baronissi (southern Italy). Tridimensional geological modeling software, as the one used in this study, is able to deal with large sets of geological data in relation to surface and substratum. It allows the user for visualization and interaction with data, with the purpose to analyse precise and complete relations among data. The resultant 3D model allows for controlling data coherence and for verifying the spatial relations of the unit. For the site under examination, the database collected data deriving from geognostic (carotage and stratigraphy) and geophysics investigations (electric tomography, geo-electric investigation).

The developed methodology includes several steps to process data depending on their type (Figure 1). A first phase for the recovery and re-cataloguing of the data of the area, further selecting those that are useful for the 3D geological model. A second phase that is the processing of the data in order to realize the dataset, in which data are geo-referenced and digitalized, through open source software called Qgis. The GRASS open source software is a powerful instrument in various research fields in natural science (Neteler, 2012).

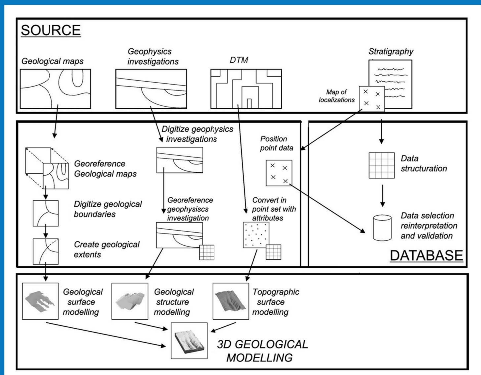

Figure 1 – Organigram of metholodology developed.

DEVELOPED METHODOLOGY

Interpretative information like geological maps and cross-sections are often available as well. Geological maps are static representations of outcropping rocks at the ground surface drawn from observations that are interpreted following the regional geological framework prevailing at the time of their realization. These plane data are used to synthesize and transmit the geological information but do not involve a complete representation of the subsurface geology. To overcome this limitation, cross-sections are sometimes added to deal with the third dimension and give a more detailed interpretation of the subsurface structure. Documents available today obviously do not integrate knowledge and data acquired after their publication. However, unless they are totally obsolete, they can be used to constrain a 3D reconstruction of the subsurface geology.Some steps are automated to speed up data processing and allow easier and model updates. Other steps like data reinterpretation or validation require user interaction. Data pre-processing includes collecting, structuring and reinterpreting data. The data collection step relies mainly on prior knowledge of available sources and on bibliographic research. Then, punctual and plane data are processed separately. As older information usually exists only in a nondigital or unstructured format, it must be structured, encoded or digitized and then positioned in a reference spatial coordinate system. Finally, a reinterpretation of descriptions in a consistent geological interpretation framework has to be done. In applications such as environmental follow-up, land-use planning, hazard mitigation or resource management the reference coordinate system is usually a projected coordinate system like a national grid. A DTM may be used to model the topographic surface and assign new elevations to all data. In case this is done, special attention must be given to areas where the relief was modified (embankments, slag heaps, etc.). To store punctual data descriptions in a database, they must be structured, encoded and their coordinates must be converted into a reference projection system. Maps and cross-sections are digitized and managed as point, line or polygon objects in a GIS. Geological boundaries are digitized from geological maps and corrected where necessary using newer information.

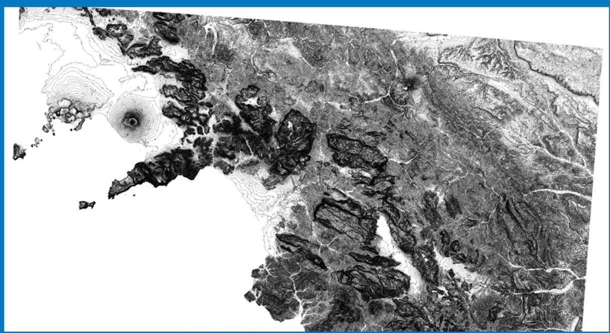

Figure 2 - Contour lines generated from DTM

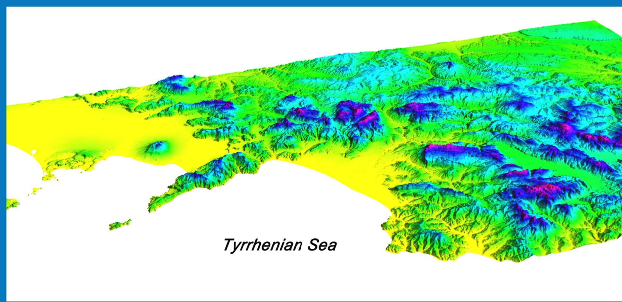

Figure 3 - 3D view of the DTM

CONTEXT

The Apennine chain exposed in the Salerno area is formed by a stack of tectonic units originating from the deformation of basinal domains (Sicilide and Lagonegro Units) and carbonate platform domains (Apennine Carbonate Platform and Apulian Platform. The southern Apennine is the segment of the circum-Mediterranean orogenic system between the central Apennine to the North and the Calabria-Peloritani arc to the South, bounded by the Ortona-Roccamonfina and the Sangineto tectonic lines respectively. It consists in a salient north-east verging thrust and fold belt, interposed between the back-arc Tyrrhenian basin to the West and the undeformed Apulian-Adriatic foreland to the East. This area, corresponding to much of Picentini, dominated by tall and steep carbonate mountains, sometimes exceeding 1,500 m, it contains not only a complete stratigraphy of the Mesozoic from a Triassic shallow sea, with significant changes in facies but also one of the main evidences of tectonic compression. The structural setting of the Tyrrhenian margin is strongly characterized by extensional structures that overlap the structuring contractional the Apennines reached during compression Miocene and lower Pliocene. In the studied extensional structures are represented by high-angle normal faults that low-angle normal faults. The cartographic analysis and kinematic conducted within the project CARG (sheet 467 "Salerno") made it possible to recognize the different low-angle normal faults as segments of a single system of extensional detachment (Southern Picentini Detachment System), of regional significance, characterized by dipping into E / SE, an average of less than 30 ° inclination and direction of tectonic transport towards ESE. According to the reconstruction carried out, such a detachment would develop from the late Pliocene and mainly during the Early Pleistocene (Casciello et al, 2006).

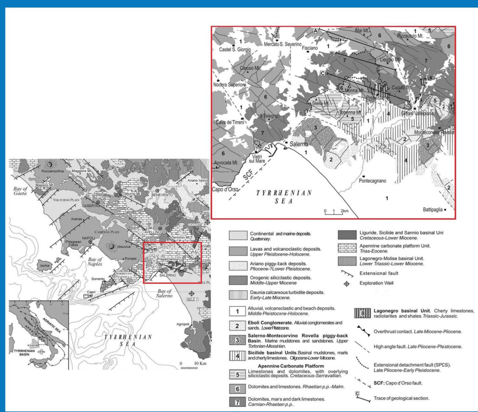

Figure 4 - Geological sketch map of Tyrrhenian margin of the Campania region and the semplified geological map of the Salerno. (Casciello et al, 2006)

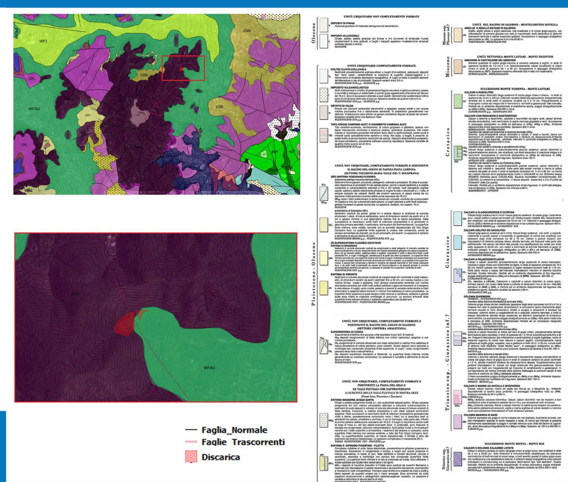

Figure 5 - Georeference and digitize of Geological map

CONCLUSION

The 3D model of the contaminated site based in Baronissi highlighted that the waste body is laying on an eluvian-colluvian blanket of increasing thickness towards the valley. Moreover such blanket leans in the southern edge of a nearly vertical fault. Therefore the site is contained in asymetric tectonic depression of dolomite and dolomitic limestone of significant thickness.
This re-construction has allowed for the understanding of the direct contamination within the blanket as well as along the fault and the subordinate fractures connected to dolomite rock.

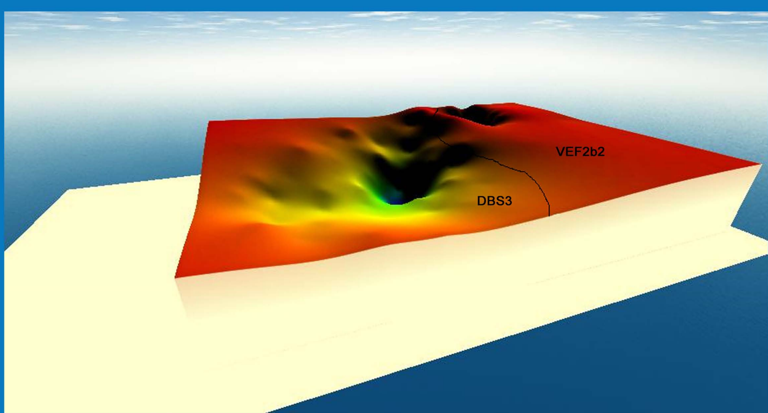

Figure 6 - 3D view of the bodies of landfill

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