Contribution ID: **772** Type: **Oral Presentation**

A multiscale approach for the characterization of bio-chemo-mechanical processes in contaminated marine sediments

Thursday, 3 June 2021 11:45 (15 minutes)

The research has been stimulated by the emblematic case of the Mar Piccolo, in the city of Taranto (South of Italy). It is a heavily polluted marine basin but, at the same time, it hosts unique natural ecosystem and several protected species. The need of tuning customized and efficient remediation strategies stirred a cutting-edge multidisciplinary investigation campaign and an advanced integration of data among geologists, geophysicists, biologists, chemists, hydrogeologists, geochemists, mineralogists, geotechnical engineers and environmental technologists. They jointly designed sampling procedures, devices, sediment handling procedures, in order to ensure their compliance with the relevant standards for the different scientific fields. Thereafter, the whole team ended up with the definition of an advanced conceptual site model that included such holistic site characterisation to originally support decision makers in the risk management of the site.
The multidisciplinary investigation has produced a huge database, allowing for a new insight into the processes occurring in natural marine sediments including anthropic and natural contaminants (Cotecchia et al., 2020). In particular, the geotechnical characterisation of the clayey sediments has shown that their physical and mechanical properties do not appear to vary solely with the mineralogical composition of the soil skeleton and the depositional loading history (Sollecito et al., 2019; Vitone et al., 2020). This finding has inspired a multiscale testing on sediments, which entails understanding the extent to which either anthropogenic or natural factors trigger bio-chemo-mechanical processes that affect the geotechnical properties of marine sediments and may make the design of remedial measures particularly challenging.
Indeed, according to the Gouy-Chapman diffusive double layer model (Gouy, 1910; Chapman, 1913), the thickness of the diffusive double layer (DDL) in clay microstructure decreases when either the electrolyte concentration or the cation valence increases and the dielectric constant decreases, as in the case of pore water including high concentrations of salts, metal ions and organic pollutants. These conditions favour flocculation and prompt significant variations in soil properties (index properties and mechanical parameter values) with respect to those exhibited by the clay including pure water. However, differently from the literature contributions dealing with spiking tests on monomineralic fine soils artificially contaminated in laboratory until fully saturated, contaminated marine sediments in natural deposits are usually formed by a pool of minerals (e.g. illite, smectite, kaolinite) and contain anthropogenic compounds (heavy metals ions and organic pollutants) that, although exceeding the environmental law thresholds, are often in diluted concentrations. Furthermore, they include several sources of natural contaminants (salinity, organic matter, diatoms, fossils) which may activate bio-geo-chemical processes.
In the case of this site, while the prime suspect for unconventional behaviour was the chemo-mechanical coupling between soil skeleton and contaminants, the innovative interpretation of thermogravimetry tests on samples of marine sediments, associated to other micro-scale tests (scanning electric microscopy and mercury intrusion porosimmetry) and chemical tests, provided evidences that the biogeochemical degradation of organic matter and the presence of microfossils and diatoms is likely to affect significantly the micro to macro behaviour of contaminated marine sediments.

Time Block Preference

Time Block A (09:00-12:00 CET)

References

Chapman D. L. (1913). A contribution to the theory of electrocapillarity. Philosophical Magazine, 25, 475–481.

Cotecchia F., Vitone C., Sollecito F. et al. (2021) A geo-chemo-mechanical study of a highly polluted marine system (Taranto, Italy) for the enhancement of the conceptual site model. Scientific Reports. DOI 10.1038/s41598-021-82879-w

Gouy G. (1910). Electric charge on the surface of an electrolyte. Journal of Physics, 4, No. 9, 457–468.

Sollecito F., Cotecchia F., Mali M., Miccoli D., Vitone C. (2019). Geo-chemo-mechanical characterization of a polluted marine basin. E3S Web of Conferences 92, 18001.

Vitone C., Sollecito F., Todaro F., Corbelli V. (2020). Contaminated marine sites: geotechnical issues bridging the gap between characterisation and remedial strategies. Rivista Italiana di Geotecnica, RIG 4:41-62, 10.19199/2020.4.0557-1405.041.

Acceptance of Terms and Conditions

Click here to agree

Newsletter

Student Poster Award

Primary authors: Prof. VITONE, Claudia (Politecnico di Bari); Dr SOLLECITO, Francesca (Politecnico di bari); Prof. COTECCHIA, Federica (Politecnico di Bari); Prof. PUZRIN, Alexander (ETH Zurich); Dr PLÖTZE, Michael (ETH Zurich); Dr PETTI, Rossella (Politecnico di Bari)

Presenter: Dr PETTI, Rossella (Politecnico di Bari)

Session Classification: MS18

Track Classification: (MS18) Innovative Methods for Characterization, Monitoring, and In-Situ Remediation of Contaminated Soils and Aquifers