

1. Research activity

The research project aims to provide predictions of the Naturally Occurring Asbestos (NOA) occurrence and hazard from geological and minero-petrographic investigation of NOA-bearing rocks.

To perform an accurate NOA hazard assessment, the following information must be acquired: the extent and geological characteristics of NOA-bearing rock outcrops, the minero-petrographic characteristics of NOA-bearing rocks, the type and the crystallo-chemical and morphological properties of NOA minerals and the amount of fibers that could be released into the environment following disturbance of NOA-bearing rocks. In particular, the NOA minerals I will focus on are two non-regulated fibrous minerals: antigorite and glaucophane.

To obtain the geological and minero-petrographic data it is first necessary to study the selected natural areas from a geological point of view and to sample the NOA-bearing rocks.

Once the field investigations are completed and the samples collected, to proceed with the project a series of laboratory analyses are required. In detail, the minero-petrographic characterization will take place with the aid of optical microscopy combined with micro-Raman spectroscopy (essential for serpentines discrimination) and Scanning Electron Microscopy/Energy Dispersive X-ray Spectroscopy (SEM/EDS) chemical analyses for a correct definition of the mineralogical constituents of the rock. The chemical and structural analysis of mineral fibers will be performed by SEM/EDS, Mossbauer spectroscopy, Transmission Electron Microscopy (TEM) and X-ray diffraction on powders (Rietveld method). Furthermore, the quantification of the NOA content in the study samples will be performed by SEM-EDS quantitative analysis of milled samples.

Once these elements are known, a new approach has been chosen to proceed with the NOA hazard assessment. This approach was recently developed to support the executive design of “Gronda di Genova” highway bypass: it consists in the definition of rock classes with similar litho-structural characters, NOA content and NOA mineralogical properties (‘NOA petrofacies’). NOA petrofacies were proposed as an innovative tool to evaluate the NOA distribution and concentration in complex geological settings (Botta et al., 2019).

In this research project, the NOA petrofacies predictive tool will be tested in different geological contexts and validated through the study of the relationships between fibrous minerals properties and the minero-petrographic and geological characteristics of the host rocks.

The project, through the correlation between NOA petrofacies and crystallo-chemical properties of NOA, will provide knowledge bases for a better evaluation of the environmental hazard related to the occurrence of NOA, allowing the implementation of mitigation strategies for the population and the workers involved in soil/rock disturbing activities.

Furthermore, crystallo-chemical data produced during the PhD could be useful to the elaboration of chemical reactivity previsional models to evaluate the effective toxicity of the studied fibrous minerals.

2. Research products

ARTICLES

- 1) **Botta S.**, Barale L., Piana F., Avataneo C., Marcelli I., Compagnoni R., Cossio R., Turci F. & Tallone S. (2019). *Petrofacies for the prediction of NOA content in rocks: application to the “Gronda di Genova” tunneling project*. Bulletin of Engineering Geology and the Environment. 79, 185-204 (2020).
- 2) Groppo C., Ferrando S., Gilio M., **Botta S.**, Nosenzo F., Balestro G., Festa A. & Rolfo F. (2019). *What’s in the sandwich? New P-T constrains for the (U)HP nappe stack of southern Dora-Maira Massif (western Alps)*. European Journal of Mineralogy. 31, 665-683.
- 3) Marcelli I., Barale L., Piana F., Tallone S., **Botta S.**, Irace A., Mosca P., Compagnoni R. & Turci F. (2019). *Geodatabase per la progettazione di infrastrutture civili: problem solving amianto (“Gronda di Genova”)*. Atti XXIII Conferenza Nazionale Asita 2019 “Conferenza Nazionale di Geomatica e Informazione Territoriale”, 709-716, ISBN 978-88-941232-5-8.
- 4) Marcelli I., Barale L., Piana F., Tallone S., **Botta S.**, Brunamonte F., Irace A., Mosca P., Compagnoni R. & Turci F. (2020). *Geological mapping for executive design of civil infrastructures: integration of GIS and AutoCAD informative systems for “Gronda di Genova” highway tunnel*. Rendiconti Online della Società Geologica Italiana.
- 5) Turci F., Avataneo C., **Botta S.**, Marcelli I., Barale L., Tomatis M., Cossio R., Tallone S., Piana F., & Compagnoni R. (2020). *New tools for the Evaluation of Asbestos-Related Risk during Excavation in an NOA-Rich Geological Setting*. Environmental and Engineering Geoscience. 26(1), 113-120.
- 6) Barale L., Piana F., Compagnoni R., Tallone S., Avataneo C., **Botta S.**, Marcelli I., Irace A., Mosca P., Cossio R. & Turci F. (2020). *Geological Model for Naturally Occurring Asbestos Content Prediction in the Rock Excavation of a Long Tunnel (Gronda di Genova Project, NW Italy)*. Environmental and Engineering Geoscience. 26 (1), 107-112.
- 7) Piana F., Avataneo C., Barale L., **Botta S.**, Compagnoni R., Cossio R., Fidelibus C., Tallone S. & Turci F. (in press). *Direct and indirect assessment of the amount of naturally occurring asbestos ore deposits in fractured rocks*. Boletín Geológico y Minero.

- 8) Barale L., **Botta S.**, Piana F., Tallone S., Fidelibus C., Avataneo C., Turci F., Compagnoni R., Cossio R. & Alberto W. (2020). *Estimation of natural asbestos content in rocks by fracture network modeling and petrographic characterization*. Engineering Geology. DOI: 10.1016/j.enggeo.2020.105566

ABSTRACTS

- 1) **Botta S.**, Groppo C., Ferrando S., Frezzotti M.L. & Rolfo F. (2014). *Petrographic study of xenoliths from deep crustal levels of northern Karakorum (Shaksgam Valley, Xinjiang, China)*. Rendiconti Online Società Geologica Italiana, 31 (1), 459 [87° Congresso della Società Geologica Italiana e 90° Congresso della Società Italiana di Mineralogia e Petrologia, September 10-12, 2014, Milano, Italy – Poster Presentation].
- 2) **Botta S.**, Groppo C., Rolfo F. & Ferrando S. (2014). *Petrographic study of the xenoliths hosted within lamprophyric dykes from the Shaksgam Valley (Xinjiang, China)*. Journal of Himalayan Earth Sciences, Abstract Volume, 14-16 (eds.: Montomoli C. et al.) [29th Himalaya-Karakoram-Tibet Workshop, September 2-4, 2014, Lucca, Italy – Poster Presentation].
- 3) **Botta S.**, Compagnoni R., Cossio R., Piana F., Barale L., Marcelli I., Tallone S., Boerio V., Cipolli F. & Polattini S. (2018). *Serpentinites of the Sestri-Voltaggio, Palmaro-Caffarella and Voltri Units. Surface and drill core data from the “Gronda di Genova” highway by-pass*. Congresso congiunto SGI-SIMP, Catania, 12-14 Settembre 2018.
- 4) Marcelli I., Barale L., Piana F., Tallone S., **Botta S.**, Compagnoni R., Boerio V., Cipolli F. & Polattini S. (2018). *Integration of GIS and AutoCAD informative systems for the execution of the “Gronda di Genova” highway tunnel*. Congresso congiunto SGI-SIMP, Catania, 12-14 Settembre 2018.
- 5) Barale L., Piana F., Compagnoni R., Tallone S., Avataneo C., **Botta S.**, Cossio R., Marcelli I., Mosca P. & Turci F. (2018). *Geological model for NOA content prediction in the rock excavation of a long tunnel*. XIII IAEG Congress, San Francisco (USA), 17-21 Settembre 2018.
- 6) Piana F., Barale L., Compagnoni R., Tallone S., Avataneo C., **Botta S.**, Cossio R., Marcelli I., Mosca P. & Turci F. (2018). *Overview of the geotectonic history of the Western Alps which special attention to the NOA-bearing rocks (meta-ophiolites)*. XIII IAEG Congress, San Francisco (USA), 17-21 Settembre 2018.
- 7) Turci F., Avataneo C., **Botta S.**, Marcelli I., Barale L., Tomatis M., Cossio R., Tallone S., Piana F. & Compagnoni R. (2018). *New tools for the evaluation of asbestos-related risks during excavation in NOA-rich geological setting*. XIII IAEG Congress, San Francisco (USA), 17-21 Settembre 2018.
- 8) Avataneo C., **Botta S.**, Marcelli I., Barale L., Tomatis M., Tallone S., Piana F., Compagnoni R. & Turci F. (2018). *Road tunneling and surface excavation in asbestos-rich geological setting: new tools and analytical procedures for the evaluation of asbestos-related risk*. XXII Meeting of the International Mineralogical Association Melbourne (Australia), 13-17 Agosto 2018.
- 9) Barale L., Piana F., Compagnoni R., Tallone S., Avataneo C., **Botta S.**, Cossio R., Marcelli I., Mosca P. & Turci F. (2019). *NOA content prediction in the rock excavation of a highway tunnel system (“Gronda di Genova”, NW Italy)*. European Geosciences Union General Assembly 2019, Vienna (Austria), 7-12 Aprile 2019.
- 10) Marcelli I., Barale L., Piana F., Tallone S., **Botta S.**, Irace A., Mosca P., Compagnoni R. & Turci F. (2019). *Geological mapping for executive design of civil infrastructures: integration of GIS and AutoCAD informative systems for “Gronda di Genova” highway tunnel*. XIV Convegno Nazionale GIT, Melfi (Pz), 17-19 giugno 2019.

- 11) **Botta S.**, Avataneo C., Barale L., Compagnoni R., Cossio R., Marcelli I., Piana F., Tallone S. & Turci F. (2019). *Petrofacies for the prediction of NOA content in rocks: application to the "Gronda di Genova" tunneling project*. Congresso SIMP-SGI-SOGEI, Parma, 16-19 Settembre 2019.
- 12) **Botta S.**, Avataneo C., Barale L., Compagnoni R., Cossio R., Marcelli I., Piana F., Tallone S. & Turci F. (2020). *Naturally Occurring Asbestos (NOA) in meta-ophiolites along the "Gronda di Genova" Highway Tunnels - An approach to estimate asbestos content in rocks*. Abstracts Volume - Winter meeting of the Working Group on the Mediterranean Ophiolites. 31 January 2020 - Torino (Italy).