DEALING WITH ASBESTOS PRESENCE IN TUNNEL EXCAVATION: THE CASTAGNOLA CASE STUDY AND THE IMPORTANCE OF THE GEOLOGICAL MODEL

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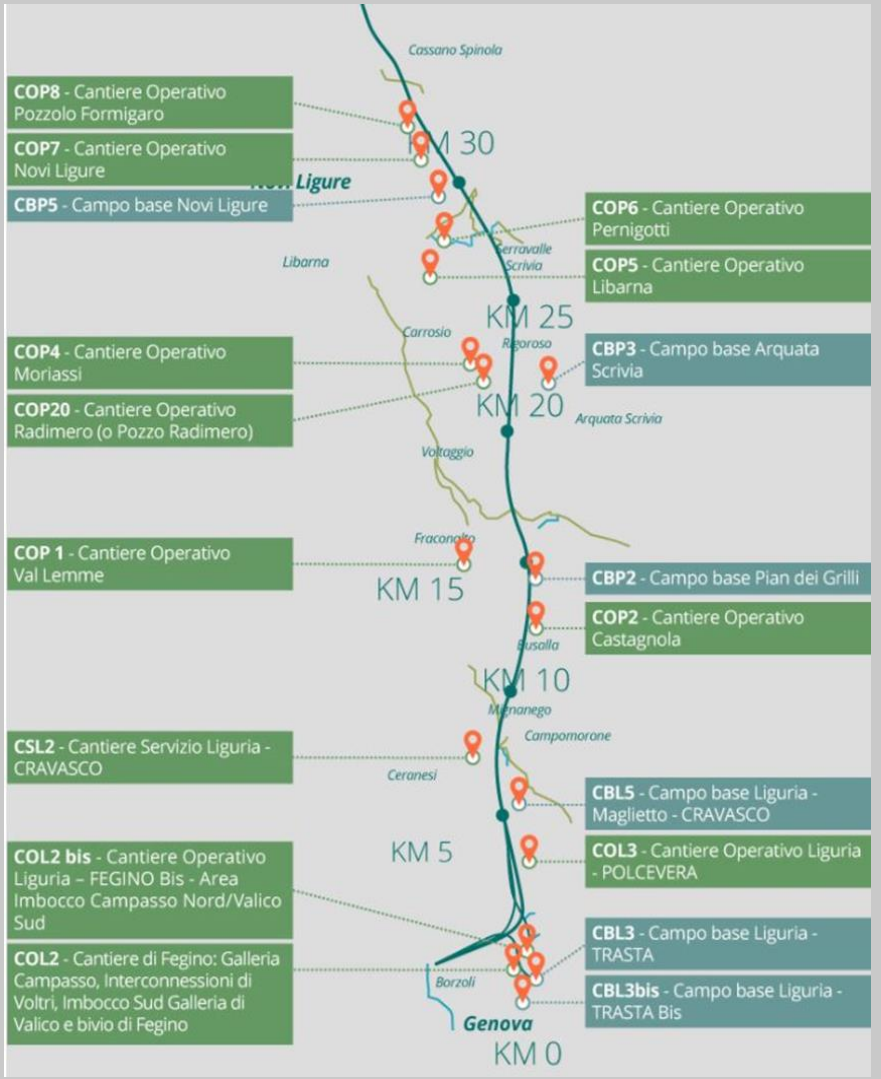
The presence of Naturally Occurring Asbestos (NOA) is one of the greatest danger for environmental and occupational safety of workers involved in excavations and tunnelling of the new high speed-high capacity railway line in Northern Italy, between Genoa and Milan called Terzo Valico.

The opera is part of a European connection plan



THE "CASTAGNOLA" CASE STUDY

THE OPERA IS INSERTED IN A GEOLOGICAL AREA WITH SEVERAL CRITICISM AND SUDDEN LITHOLOGIES' CHANGES

The opera interests a geologically complex area with a high probability of crossing ophiolitic formations

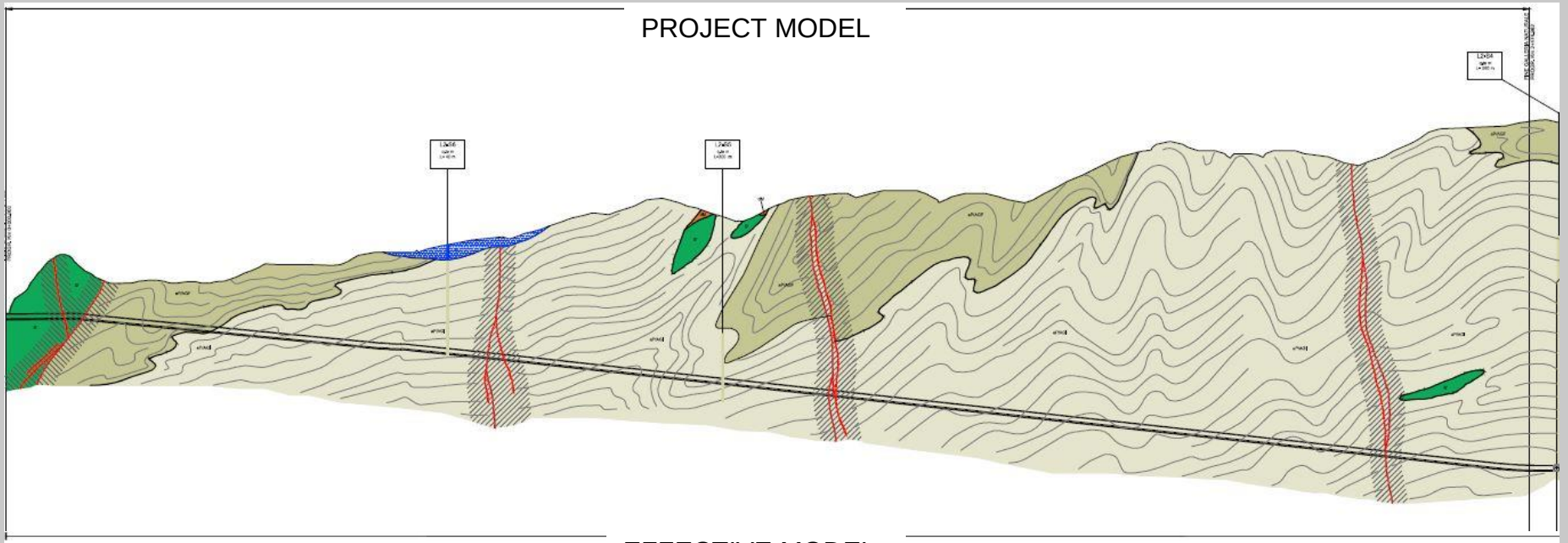
The "Castagnola" tunnel (2475 meters long) is located in the south piedmont area near Fraconalto. This area, situated at the southeastern termination of the western Alps, represents the transition from the Alps to the Apennines domains (Capponi et al., 2008); this transition area it's formed by metamorphic ophiolites units derived from the Jurassic Ligurian – Piedmont ocean, involved in the alpine orogenic events (Capponi et al., 2009).

The section across the "Castagnola" tunnel is interested by the Figogna Unit which is elongated in a north-south direction and strictly related to Sestri-Voltaggio Zone, characterized by greenish - reddish rocks metabasalt and recent grey shales in the upper part of the area.

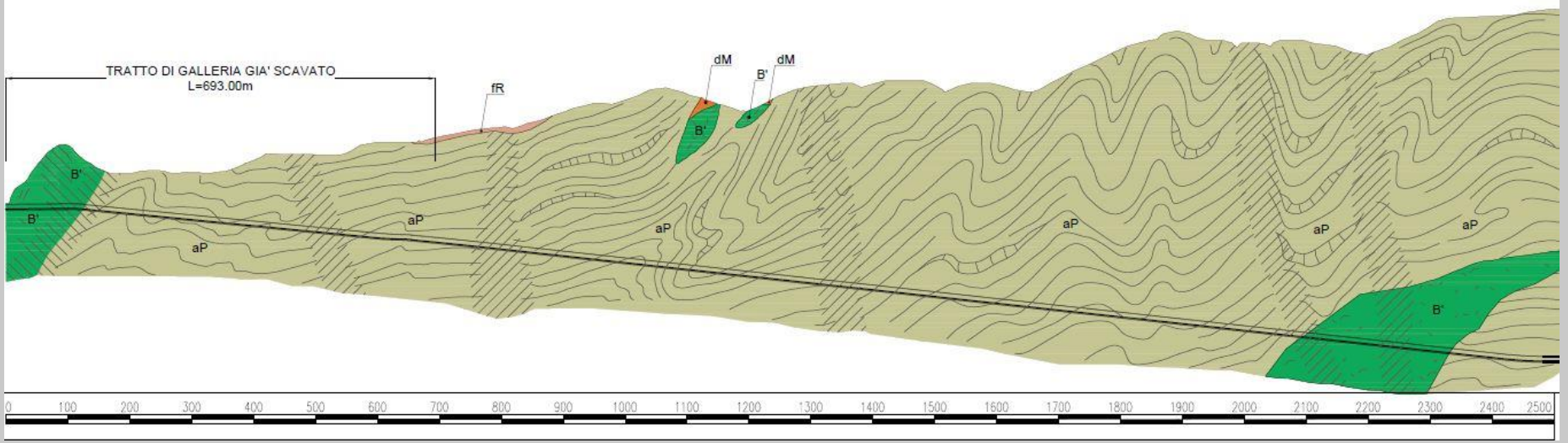
GEOLOGICAL MODEL

- Unexpectedly from the geological project model, elaborated thanks to geological sections and different investigations, metabasalts have been crossed since January (2017) until November (2017),from pk 2+113,6 to pk 2+349.

PROJECT MODEL



EFFECTIVE MODEL



FIRST PHASE

IN A PRELIMINARY PHASE (ABOUT 30 EXCAVATION CYCLES), PRECAUTIONS WERE TAKEN IN ORDER TO PREVENT THE DISPERSION OF AIRBORNE FIBERS

1/5 Wetting system applied to the excavator hammer

2/5 Fog cannons for the excavated rocks

3/5 Water portal for all vehicles entering and leaving the tunnel

4/5 DPI dispositive for all workers inside the tunnel

5/5 In addition, continuous monitoring of the airborne and a set of rock samples were applied, for a total of 262 airborne samples (159 near the excavation front and 103 about 150-200 meters far from it) and 17 massive samples (every 2-3 meters), in order to evaluate the behaviour of the fibers released in the air and to compare the concentration in the excavated material and in the airborne samples

PERFORMED ANALYSIS

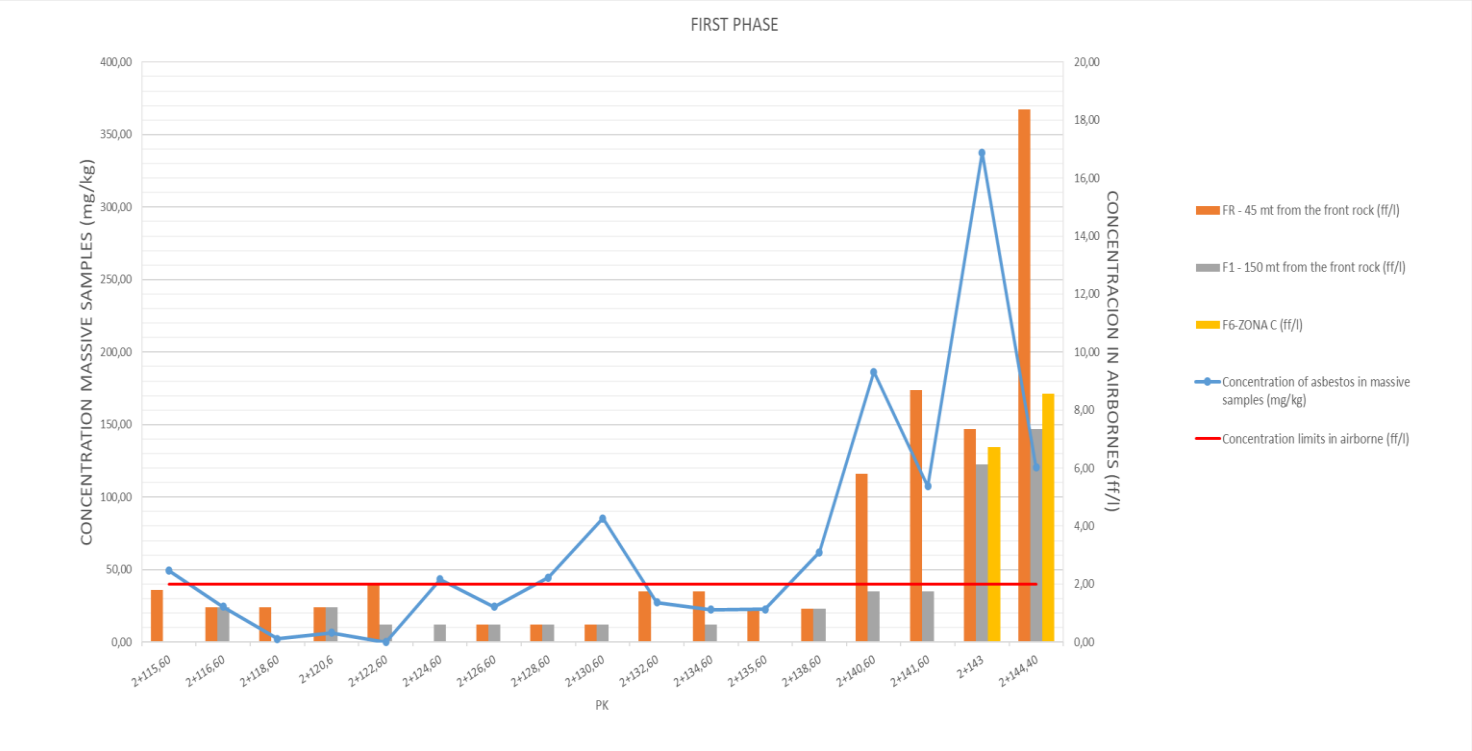
During both phases we collected a huge number of data, both airborne and massive. The airborne were analyzed using the SEM-EDS analytical method, instead, the massive samples were analyzed with PCOM and/or SEM-EDS methods.

	Massive samples	Airborne in work environment (inside tunnel)	Airborne in life environment (outside tunnel)
First phase	17	357	87

The results of the analysis carried out on the rock samples, showed a very low NOA concentrations compared to the limit of 1000 mg/kg set by the Italian legislation.

Nevertheless, the concentration of asbestos in the airborne dispersions analyzed was very high.

The graph shows the immediate increase of the concentration of airborne fibers against a relative low content in the massive sample



SECOND PHASE

AT THE END OF MARCH, THE EXCAVATIONS WERE INTERRUPTED DUE TO AIRBORNE VALUES >10 FF/L AT THE FRONT AND >2 FF/L IN THE MOST DISTANT AREAS, EVEN IF THE CONCENTRATIONS OF ASBESTOS IN THE EXCAVATED ROCKS WERE WELL BELOW THE LAW LIMIT OF 1000 mg/Kg (D. LGS. 52/2016)

1/5

Following the Cravasco case study described by Gaggero et al., 2017; precautions were implemented by dividing the tunnel into 3 zones A-B-C (contaminated - decontamination - decontaminated), separated from each other by automatic sliding doors.

2/5

A new system of exhaust ventilation and a dedusting equipment were installed to extract air as close as possible to the rock front and to purify it with an absolute filter system

3/5

Implementation of DPI

4/5

DPI dispositive for all workers inside the tunnel

5/5

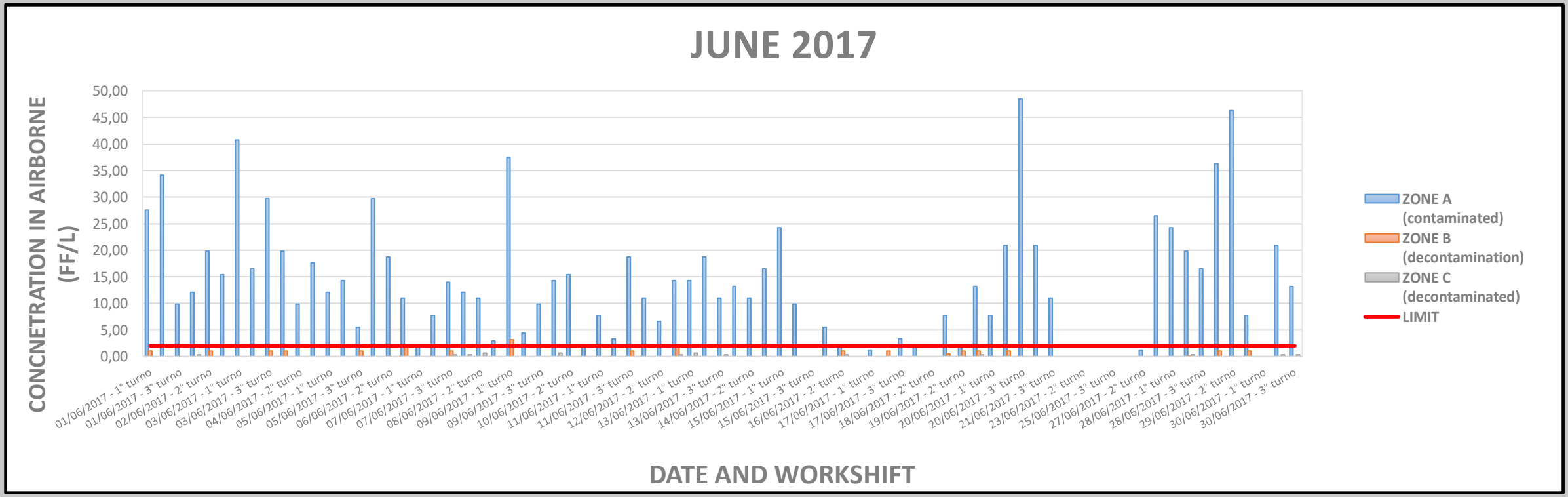
Airborne monitoring was implemented identifying 8 significant air sampling stations:

- 3 stations inside tunnels (zone A, zone B, zone C);
- 2 stations inside cab’s vehicles (dumper and drilling excavator);
- 2 stations inside decontamination unit in zone B (black and white unit);
- 1 station in random position in zone C for other operations.

PERFORMED ANALYSIS

In the following graph the month of June is reported as an example of the effectiveness of the engineering system. After the implementation of the new safety and technical measures it is evident that the release of fibers is confined almost exclusively to the contaminated “A” area of the tunnel

	Massive samples	Airborne samples in work environment (inside tunnel)	Airborne samples in life environment (outside tunnel)
Second phase	72	1525	587



CONCLUSIONS

The importance of the predictive geological model is crucial. The predicted scenario could change suddenly due to the complex geological area in which the opera is built. The experience of “Cravasco” tunneling was extremely important in this case and without the engineering system previously used the excavation phase would have stopped for a lot of months.

This occasion was fundamental for another test of the engineering system used during the Cravasco experience. All the adopted proceedings comprising the new system of exhaust ventilation, the division of the tunnel in different areas and the continuous monitoring of the released fibers have proven to be effective again to deal with the asbestos emergency

In the Cravasco experience the concentration of asbestos in the excavated rock were constantly higher than the law limit of 1000 mg/Kg. In the “Castagnola “ area the concentration of NOA was always under this threshold. Despite this, airborne analyzes have proved to be extremely sensitive to the concentration of asbestos fibers in the air. It is still unthinkable to predict the content of asbestos in the rock material starting from the concentration of airborne dispersed fibers ff/l