

## AUXILIARY VENTILATION PLANT AND AIR DISPERSED PARTICULATES: AN EXPERIMENTAL STUDY IN THE STOPES OF AN ITALIAN TALC MINE

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### SUMMARY

The paper refers to the results of an experimental research developed at the most important Italian talc mine of Fontane. A preable series of tests confirmed the substantial absence of asbestos fibres, and the consequent exhaustivity of gravimetric samples to evaluate the particulate content in the atmosphere; on the basis of extended sampling work as performed in an experimental and in other working stopes, a correlation has been identified between the scheme of auxiliary ventilation plant at various flow rates and the dust concentration. It was also possible to show a good efficiency of the exhausting system, as compared with the blowing system, owing to a quicker removal of particles from the workplaces, to a reduction in air dispersed dust up to about 20%, and to the absence of secondary dust production and annoyance of miners. On the basis of research results in the future the exhaust ventilation system will be as much generalized as possible in the mine.

### INTRODUCTION

The Fontane talc mine, located in the Germanasca valley 80km West of the city of Turin, is exploited by Talco e Grafite Val Chisone Co. The mine is one of the most important talc mines in Europe in terms of both the tonnage and the quality of talc produced (about 40000 t/y of pure white talc); for instance specifications of Extra Superiore brand quality are summarized in Figure 1.

The orebody has a typical "rosary" structure—a series of lenses en echelon—which strikes N20 W and dips towards the West at an average slope of 20°–22°.

The lenses can be large, but are extremely irregular, varying in width from a few centimeters up to 5–8 m, exceptionally to 15 m.

The footwall bedrock is a compact augen-gneiss while the hanging wall comprises greenstones and mica schists.

At present the mine is being worked in two different sections: Gianna, on the left side of Germanasca river, and Crosetto, on its right (see Figure 2).

Since 1974 the exploitation method is underhand horizontal slicing with cemented backfill, taking the ore in strips running transversely to or parallel with the orebody, with stopes of up to 8 m<sup>2</sup> cross section (Figure 3).

The primary ventilation at Crosetto section, in an experimental stope of which the described tests were carried out, is based on a fan activated exhaust system, linking the main level (1400 m over sea level with an upper one at 1500 m).

At present blind stopes ventilation, in which faces may reach a distance of more than 120 m far from the main ventilation level, sometimes proved not to be quite satisfactory, in particular with regards to air velocity (Italian mining law requires a mean air velocity of 10 cm/s in the stopes), and comfort conditions.

A common research work has been carried out by Talco e Grafite Val Chisone Co. and Mining Dept. of Technical University of Turin, to both identify a proper technique of dust measurements in the stopes of Fontane mine, and to achieve further improvements in the general environmental conditions.

### DUST SAMPLING TECHNIQUE

A preliminary problem to be solved in order to organize systematic dust concentration surveys in the mine stopes was to identify a correct sampling organization, and suitable apparatus.

A more than two years long campaign, developed with battery powered Dupont P4000 samplers (flow rate 1 dm<sup>3</sup>/min., open holders for 25 mm dia.—0.8 μm pore diameter cellulose filters) has been carried out, and made possible to achieve some preliminary results. First, some mining operations were identified, during which the maximum dust production occurs, in terms of gross air concentration (see Figure 4); furthermore it was confirmed that, in this case too, a proper evaluation of workers exposure may be obtained with personal sampling devices carried by the workers: the risk of unpredictable human behaviours has shown to be very low after two months of testings.

**TALCO E GRAFITE VAL CHISONE S.P.A.**

**TALC: EXTRA SUPERIORE**

Extra Superiore Talc is a hydrous magnesium silicate, platy in structure, which meets all pharmaceutical specifications (Eur. Pharm.) and does not contain asbestos minerals (C.T.F.A. J4-1)

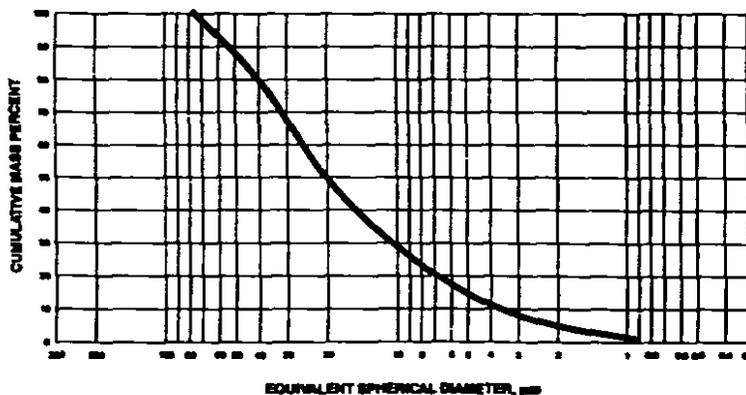
It is suitable for various applications where high purity and extremely platy talc is desired.

**PHYSICAL DATA**

Whiteness (FMY/C - Green Filter) %:	90.5	Oil Absorption (DIN 53199/ASTM D281-31) %:	32
(FMZ/C - Blue Filter) %:	89.5		
Specific Gravity (DIN 53193) g/cm <sup>3</sup> :	2.8	B.E.T. Surface (DIN 66131/66132) m <sup>2</sup> /g:	4
Tapped Density (DIN 53194) kg/dm <sup>3</sup> :	0.79	Abrasivity (AT 1000 - 2 hours) mg:	10
Loose Density (DIN 53468) kg/dm <sup>3</sup> :	0.45	Hardness (Mohs) :	1

**PARTICLE SIZE DISTRIBUTION**

< μm	:	%
75	:	99.3
45	:	83.6
20	:	49.8
10	:	30.5
5	:	15.3
2	:	7.4
1	:	3.5



**CHEMICAL DATA**

SiO <sub>2</sub>	%: 60.1	L.O.I. (1050°C)	%: 5.3
MgO	%: 31.8	pH (DIN 53200 - 10% slurry)	: 9.3
Al <sub>2</sub> O <sub>3</sub>	%: 1.5	Moisture (DIN 53198 - 105°C)	%: 0.2
Fe <sub>2</sub> O <sub>3</sub>	%: 0.9	Water Solubility (DIN 53197)	%: 0.1
CaO	%: 0.4	Acid Solubles (DIN 55920)	%: 2.3

Figure 1. Specifications of Extra Superiore brand quality.

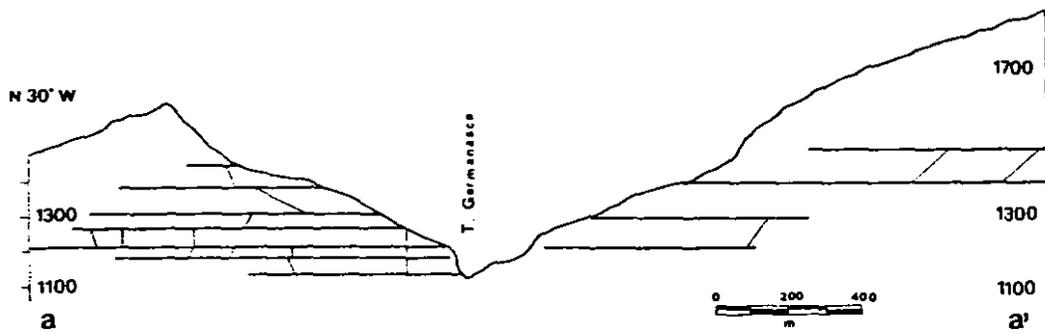
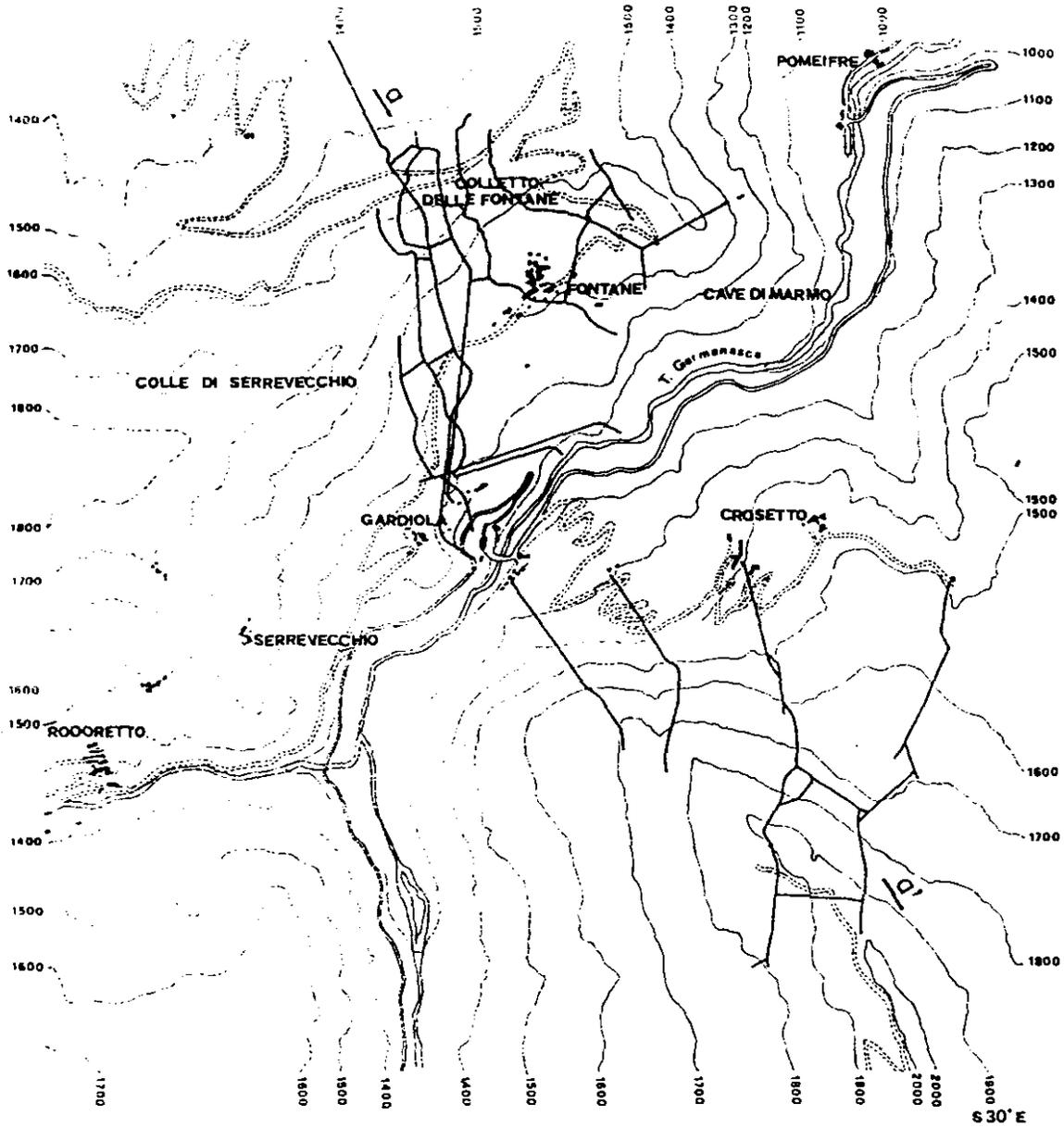


Figure 2. The Fontane talc mine, plan and section, showing the main underground levels.

At last a systematic microscope analysis on more than 200 samples from production stopes, carried out with phase contrast illumination (500x magnification), confirmed a respirable particle content of crystalline silica less than 1% (in mass).

X.R.D. analysis of samples proved the absence of asbestos minerals. Some fibrous shaped elements—from platy talc breakage—were sometimes identified, well less than 1% in number of respirable dust particles.

Owing to the shape of talc particles in respirable dust collectable in Fontane mine stopes, it has been necessary to verify the actual effectiveness of separating devices for this particular application.

In situ and laboratory tests (in a specially designed apparatus, see Figure 5) were carried on, to collect information on the performances of two different size-selectors, also in comparison with open holder samplings. The flow rates have been adjusted according to separators Constructor data, and 1 dm<sup>3</sup>/min respectively.

The results of the above mentioned tests are summarized in Table I. The 10mm nylon cyclone separator confirmed its high efficiency with reference to Respirable Particulate definitions, however it has been possible to observe a remarkably greater (but with extremely dispersed data) content of respirable particles in the "not respirable" deposit. Sometimes, moreover, in long duration samplings in stopes with high humidity degree, particle agglomeration and partial obstructions were to be feared.

Consequently, it appeared at the moment preferable to select, as the most suitable for dust sampling in Fontane mine stopes, the stainless steel shell cyclone separator, in spite of some lower separation efficiency, considered that this over-estimation may help technical improvements of the environmental conditions.

The analysis of the collected samples may properly be based on the mass determination criterium, according to International Standards, provided that the crystalline silica content and mineralogical nature of fibrous elements are periodical-ly verified.

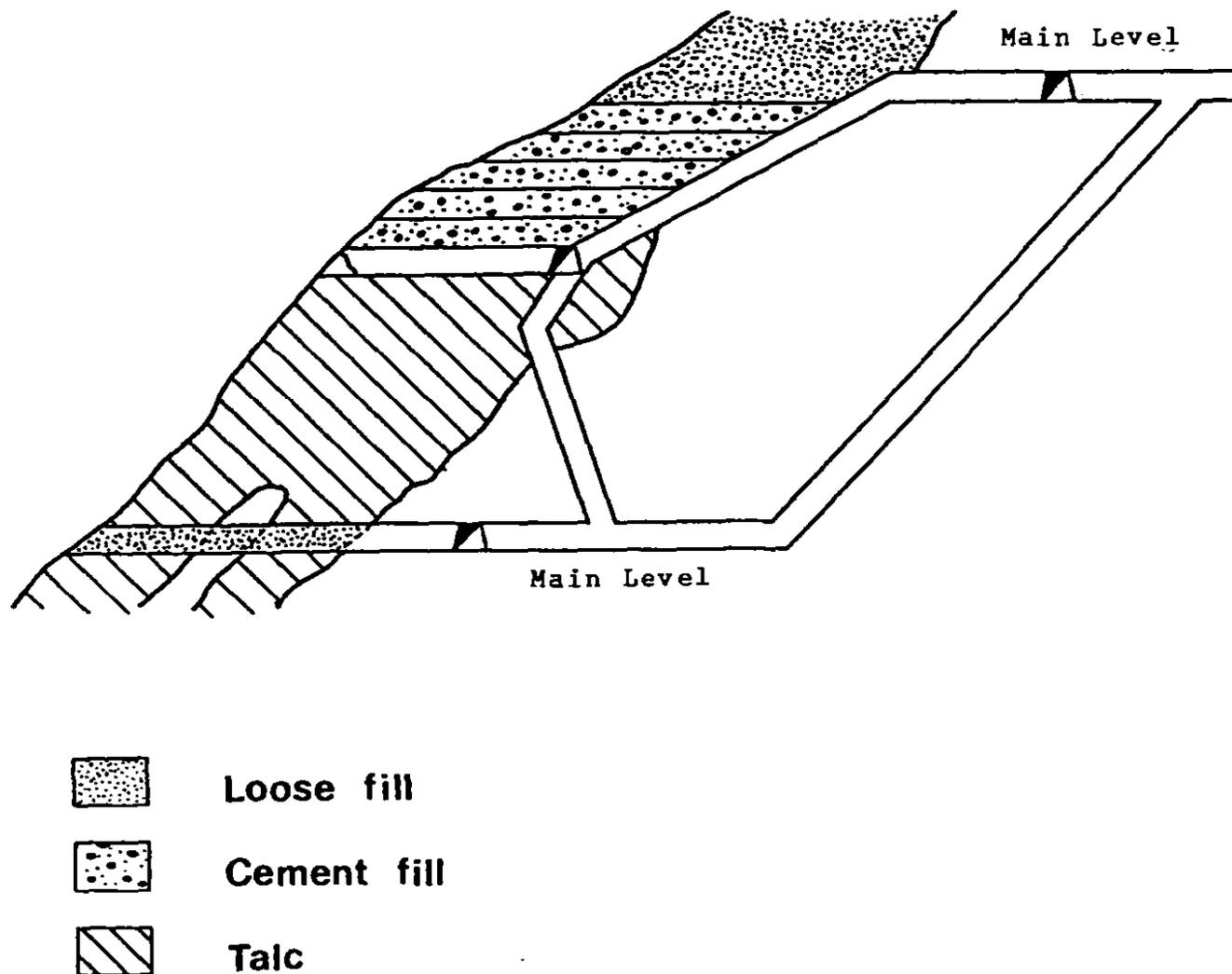


Figure 3. The mining technique employed: underhand method with cement fill.

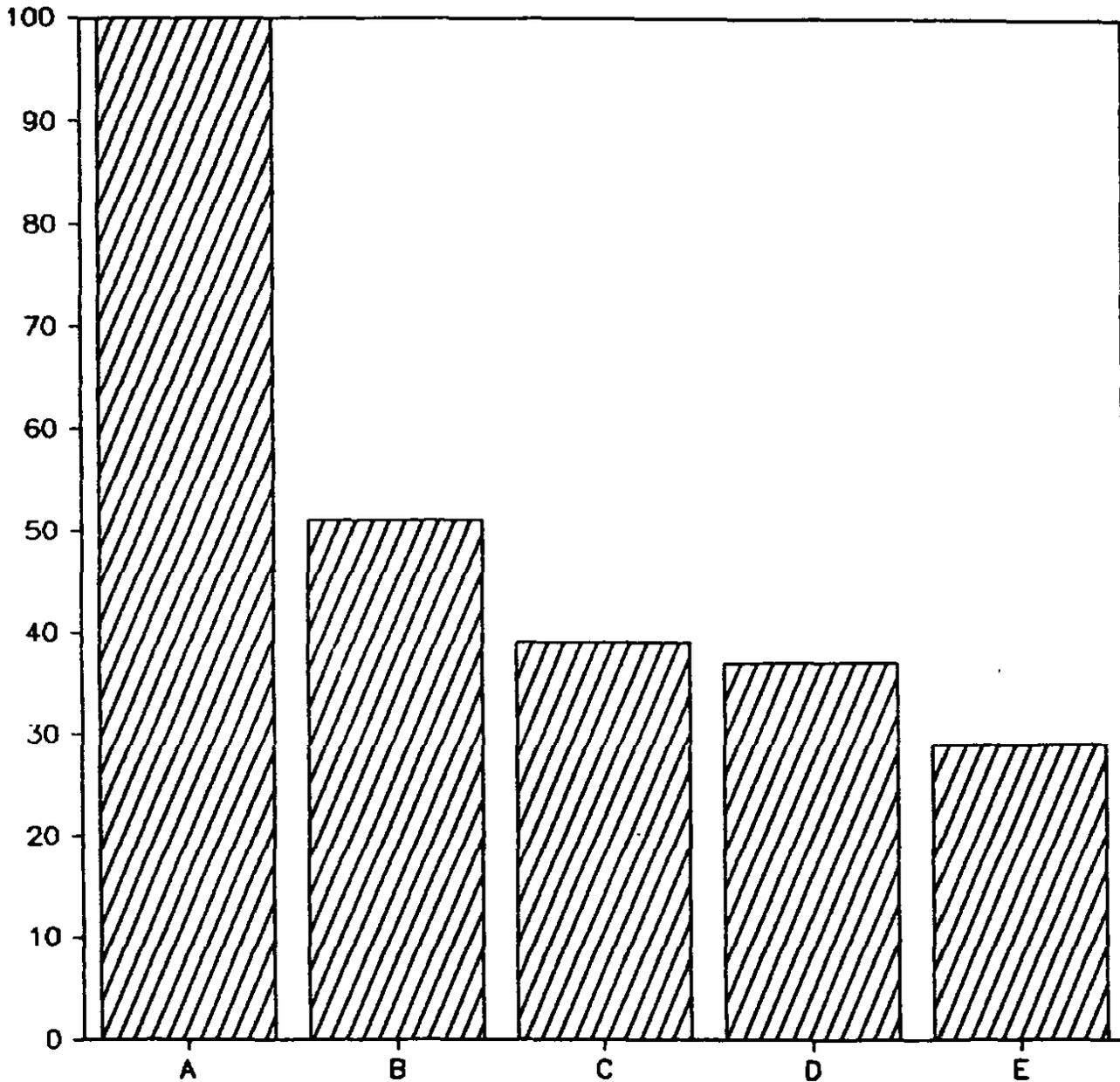


Figure 4. Comparative dust level, compared to case A:  
 A—breaking with hammerpick; B—loading with compressed air shovel (on rail);  
 C—loading and hauling with rubber tyred electrohydraulic equipment; D—face  
 and roof cleaning; E—others (maximum).

### BLOWING AND EXHAUSTING AUXILIARY VENTILATION

In order to verify the possibilities of improving the environmental conditions in the mine stopes, an experimental stope of 4 m<sup>2</sup> cross section (Crosetto, n.7, Figure 6), in which the face was at a distance of about 40 m from the main ventilation level, has been equipped with a centrifugal fan (7.5 kW) and a flexible tubing (300 mm dia.) in rubberized nylon with metal springs.

The tubing was set in such a way that it was possible to attach

it to the inlet or to the outlet of the fan.

The face end of the ventilation duct was set at a distance of 5 m from the face.

A series of tests has been carried on at various flow rates, obtained by properly positioning the regulation metal brattice of the fan, both in exhausting and in blowing configuration.

Dust concentration, air mean velocity and microclimate parameters at the face were recorded, and W.B.G.T. comfort index calculated for each plant regulation. Moreover explosive

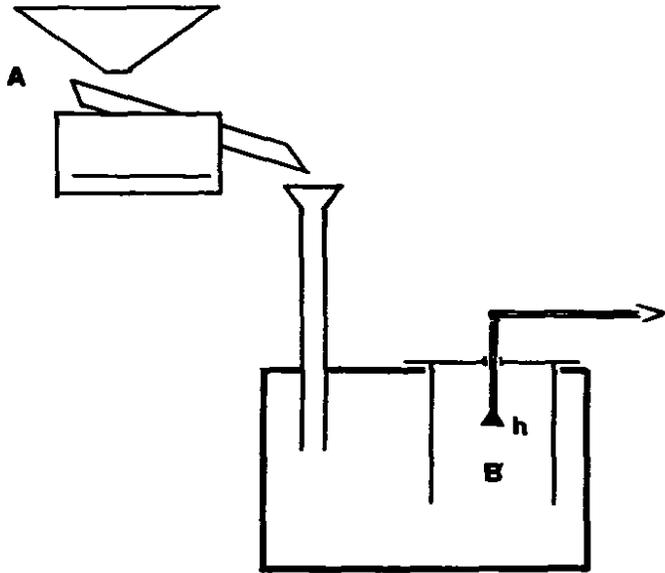


Figure 5. Layout of the apparatus used in laboratory tests (schematic): A—hopper and vibrating feeder; B—sampling room; h—sampling holders.

fumes concentration (NO<sub>x</sub> and CO) were systematically measured (with Drager test equipment) 15 minutes before the restarting of work (two hours after the blast).

For each test also dust concentration in the access way to the stope was measured, at a distance of about 20 m from the face.

Table II summarizes the most significant results of the above mentioned tests. As to thermal and humidity conditions it was observed that, in the period of testing, the mean temperatures resulted of 7–10°C and 10–14°C respectively in the main level and at the face, and the relative humidity in both sites was near to 100%; W.B.G.T. values at the face ranged from 10 to 14°C.

On the basis of the achieved results it must be observed in particular that dust concentration and comfort conditions at the face appear clearly not acceptable with the maximum flow rate in blowing plant configuration, due to the excessive air velocity.

Taken for granted that noxious fumes concentration is not a problem in any case, it may be assumed that satisfying environmental conditions at the face can be achieved both with a blowing scheme as in case 2, and with an exhausting scheme as in case 1.

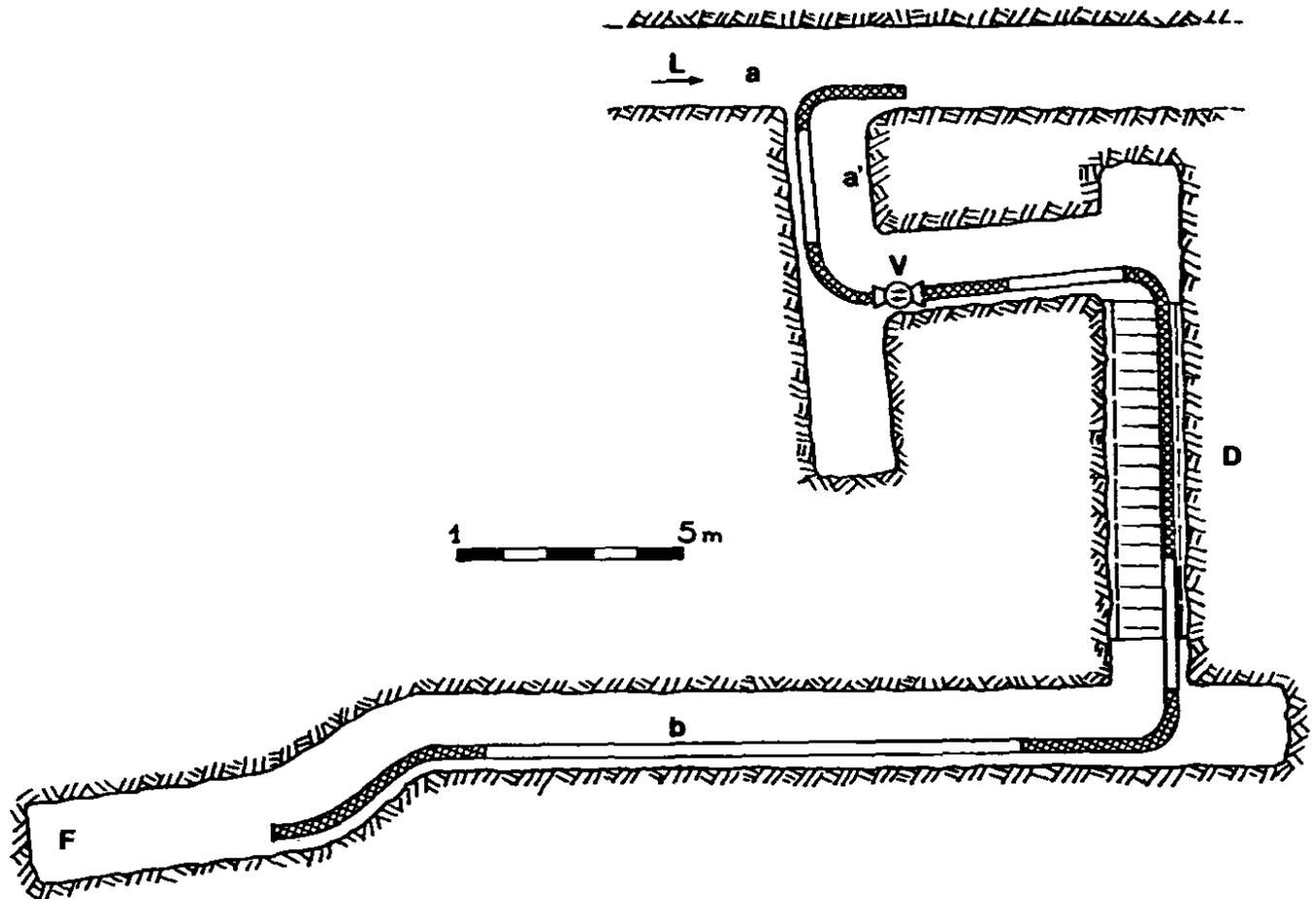


Figure 6. Diagram of stope n.7, Crosetto, where the tests were carried out: L—main level; F—stope face; D—slope; a, a', b, F—sites of measures.

Table I  
 Mean Size Distribution (Number of Particles) as Measured  
 in the Samples Collected with Different Apparatus:  
 A—Open Holder; B—Stainless Steel Cylindrical Shell Cyclone;  
 C—10 mm Nylon Cyclone

	particle size ( $\mu\text{m}$ )	A (2)	B (3)	C (3)
<b>Laboratory tests (1)</b>	< 5	80.1	88.1	90.1
	5 - 10	17.4	13.0	9.7
	10 - 20	2.2	0.8	0.2
	> 20	0.3	----	----
	Dmax(4)	25	20	15
<b>In-stope tests</b>	< 5	93.5	97.1	98.1
	5 - 10	4.2	2.4	1.9
	10 - 20	1.8	0.4	----
	> 20	0.5	0.1	----
	Dmax(4)	60	30	15

- (1) Performed on commercial product (0-80  $\mu\text{m}$ )  
 (2) Flow rate 1 dm<sup>3</sup>/min.  
 (3) Flow rate according to Constructor data.  
 (4) Exceptional.

Table II  
Results of the Tests Carried on at Crosetto n.7 Experimental Stope

	flow rate m <sup>3</sup> /s	mean air velocity (stope) m/s	max air velocity (stope) m/s (*)	t <sub>max</sub> -t <sub>min</sub> in stope °C	t <sub>max</sub> (st)- -t(lev) °C	t <sub>m</sub> (st.acc.) -t(lev) °C	respirable dust conc. (**) mg/m <sup>3</sup>
<b>exhausting system</b>							
case 1	0.44	0.12	0.19	1	3	0	0.45
case 2	0.38	0.10	0.12	0	3	0	1.15
case 3	0.35	0.09	0.09	0	3	0	2.10
<b>blowing system</b>							
case 1	0.57	0.15	0.33	2	3	3	2.30
case 2	0.45	0.12	0.15	3	3	3	0.50
case 3	0.36	0.09	0.09	3	3	3	2.05

\* Italian mining law ref. > 0.10 m/s

\*\* samples collected during breaking with hammerpick.

The exhausting system—in the above mentioned conditions—has proved to be more efficient in particular with regards to comfort conditions in stopes where the temperature is remarkably warmer than in the ventilation level: annoying localized temperature variations are avoided both at the face and at the beginning of the stope access way from the main level.

Moreover, a lowering of dust concentration along the stope access way (about 20%) has been observed at equal air velocities in the different ventilation systems, even if in any case the absolute values were far from suggested T.L.V. for talc dusts.

On the basis of the previous considerations the use of the exhaust ventilation system will in future be generalized in the stopes with important differences between stope and main stream air temperature, while blowing system can be maintained (for economic and technical reasons, such as lower

costs of tubing and installation) where this problem does not arise.

A research work has been undertaken to design a diffusive tubing outlet to be suggested for blowing system, to avoid a discomfortable localized air stream at the face.

### CONCLUSIONS

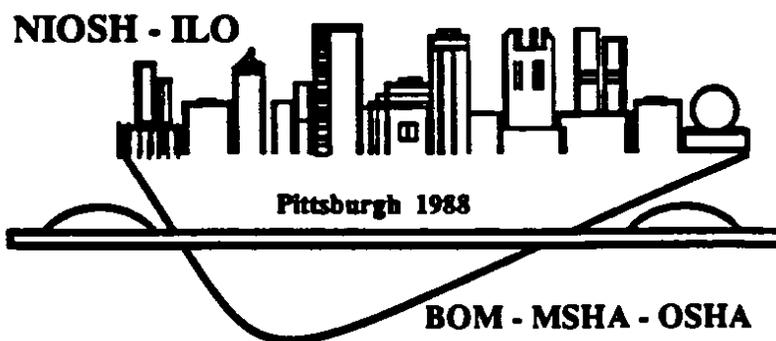
A proper dust sampling technique has been tested, specially fitted for Fontane talc mine.

The results of tests on auxiliary ventilation systems made possible to identify the main plant features that may give good environmental conditions and stressed that, in particular where an important difference between face and level air flow temperature arises, the exhausting ventilation system must be preferred.

Research work is now being carried on to achieve further improvements.

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