Critical reappraisal of Balangero chrysotile and mesothelioma risk

Edward B. Ilgren[1], Frederick D. Pooley[2], Yumi M Kumiya[3] and John A. Hoskins[4]

ABSTRACT

BACKGROUND: Balangero, 40 km northwest of Torino in the Piedmonte Region, was home to the largest and most active chrysotile mine in Europe operating from 1916 - 1990 and employed over 300 men at any one time. The chrysotile was thought to be pure. Despite this some claim it has been responsible for causing numerous mesotheliomas. This report refutes this claim on the grounds that it is not pure but potentially contaminated by tremolite asbestos. In addition there are numerous alternate sources of naturally occurring and commercially available amphibole asbestos in the region.

METHODS: Geological studies illustrate the presence of naturally occurring tremolite and various analyses have shown naturally occurring and commercially used amphibole by its presence in animal and human tissue. The diagnostic criteria used to study pleural disease in the Balangero cohort were examined on a case by case basis.

RESULTS: Several authors have searched available registries for post-mortem information and listed possible mesothelioma cases. Cross matching these searches has been attempted and the strength of their diagnoses examined.

CONCLUSIONS: There is good evidence that crocidolite, amosite and tremolite are responsible for the alleged mesothelioma cases at Balangero. Myriad sources of naturally occurring and commercial amphibole asbestos exist in the region to account for the alleged cases. Regrettably, necessary information is incomplete and insufficient for the cohort which calls the diagnostic accuracy of the cases into question. The problem is further compounded by confusion surrounding job titles and raises the question if any of the cases actually occurred in 'miners' per se.

Key words: chrysotile, Balangero, Piedmonte, Casale Monferato, mesothelioma

(1) Formerly Faculty of Biological Sciences, Oxford University. Oxford, UK

(2) Research Professor Pathology Department Medical Microscopy Science Laboratory, Cardiff University, Cardiff

(3) Formerly Bryn Mawr College, Pennsylvania, USA

(4) Consultant Toxicologist, Haslemere, Surrey, UK

CORRESPONDING AUTHOR: *Edward B Ilgren, Formerly Faculty of Biological Sciences, Oxford University. Oxford, UK. e-mail: dredilgren@aol.com*

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INTRODUCTION

Balangero is ca. 40 km northwest of Torino in the Piedmonte Region of Italy. It was home to the largest and most active chrysotile mine in Europe operating from 1916 - 1990 and employed over 300 men at any one time. The chrysotile was thought to be pure. Despite its presumed purity, some claim it has been responsible for causing numerous mesotheliomas. This report refutes the claims that Balangero chrysotile is able to produce mesothelioma on the grounds that it is not pure but potentially contaminated by tremolite asbestos; because the diagnosis of most of the allegedly attributable cases has not been proven; also numerous alternate sources of naturally occurring and commercially available amphibole asbestos, and possibly other fibrous silicates can explain the allegedly attributable mesothelioma cases.

QUESTIONS OF PURITY - TREMOLITE:

Geological Evidence

The Balangero chrysotile mine is situated in a serpentinite satellite body of the Lanzo Massif (Piedmont, Italy), the largest ultramafic body of the Western Alps [1]. Various areas within the Lanzo massif are conducive to the formation of tremolite asbestos as shown through direct sampling of rock, air and lung tissue. Fornero et al. [2] noted that the region is very rich in serpentine rocks, many of them outcropping, and some that have been exploited in the past during the quarrying of asbestos. "In areas such as Piedmont, everyone is exposed to low doses of airborne asbestos …The asbestos species commonly found in natural sources (i.e. rocks) is asbestos tremolite and asbestos actinolite" [3]. Many have noted this and in consequence parts of the Susa Valley are contaminated with tremolite. Many local talc mines [4] found near Balangero are contaminated with tremolite asbestos. One, 'Brunetta' was thought to be the source of the tremolite asbestos found by Pooley in the lungs of a Balangero worker with mesothelioma "The presence of tremolite in soil in the Susa and Chisone Valleys (Western Alps) is a plausible explanation for the most western mesothelioma clusters…." [5].

Analytical Evidence

Direct analysis of Balangero chrysotile has shown the presence of tremolite. For example, Butler [6] found tremolite in one of four Balangero samples he studied using TEM – XRD.

Additional studies of air and lung show tremolite. Short and long term air sampling in the Lanzo and Susa Valleys detected long tremolite and actinolite fibres using SEM – EDS. Lung burden studies of cows grazing in both Lanzo and Susa valleys also showed elevated concentrations of tremolite/actinolite asbestos [2,7]. Similarly, human lung samples from those residing either in or near Balangero in the Lanzo Valley and others living in the Susa valley nearby also contained tremolite/actinolite asbestos fibres [2,7]. Urine samples from individuals residing in Susa valley also contained tremolite [2,7]. Mirabelli et al. [8] cite Fornero's animal lung burden work to support the alleged role of Balangero chrysotile in producing an environmental mesothelioma risk but fail to mention Fornero's finding of natural and commercial amphibole asbestos in many of the samples taken.

Pooley [9] demonstrated elevated tremolite concentrations in lung tissue from three Balangero workers (21% of fibres > 5 µm long: Table 42 in [9]) and nine control subjects (Table 1). The workers died of asbestosis, lung cancer and mesothelioma; the controls from non-asbestos related causes.

Naturally occurring tremolite is not surprising. The geology is conducive to its formation. Why has its presence not been noted before? Sampling error is certainly one explanation as very few samples have been analyzed, the sample sizes have generally been small, and the analytical methods (XRD) may not have been sufficient to detect it. None, aside from Butler [6], ever tested samples using acid digestion and TEM-XRD. The considerable mining area and heterogeneity in the ore body created difficulties in obtaining representative samples over the nearly 75 years of its operation.

Relatively small percentages of tremolite can be biologically important representing substantial airborne fibre concentrations [10]. Therefore, the very high dust levels produced during mining [11-13], may have contained very high concentrations of tremolite.

TABLE 1

RESULTS OBTAINED FROM THE ANALYSIS OF LUNG PARENCHYMAL TISSUE FROM CASES OF INDIVIDUALS EMPLOYED AT THE BALENGERO CHRYSOTILE MINE AND CONTROLS FROM LOCAL RESIDENTS LISTING FIBRE CONCENTRATIONS AND FIBRE TYPES OBSERVED

CASES	FIBRE CONCENTRATIONS X 10^6 PER GRAM DRY LUNG TISSUE					
SAMPLE NO	CHRYSOTILE FIBRES	CROCIDOLITE FIBRES	AMOSITE FIBRES	TREMOLITE FIBRES	TOTAL ASBESTOS FIBRES	NON ASBESTOS FIBRES
1	531.6	36.4	23.5	5.4	598.6	2.4
2	205.7	4.6	0.7	4.4	230.3	14.9
3	175.4	131.3	31.8	0.96	362.9	23.84
Arithmetic Mean	304.0	57.4	19.3	3.6	397.9	13.6
Geometric Mean	267.6	28.0	8.1	2.8	368.1	1.5
CONTROLS	FIBRE CONCENTRATIONS X 10^6 PER GRAM DRY LUNG TISSUE					
SAMPLE NO	CHRYSOTILE FIBRES	CROCIDOLITE FIBRES	AMOSITE FIBRES	TREMOLITE FIBRES	TOTAL ASBESTOS FIBRES	NON ASBESTOS FIBRES
1	52.4	1.06	0.1	2.9	64.6	8.24
2	20.1	1.78	0	0.1	46.75	24.87
3	45.3	0.1	1.2	6.5	75.7	22.6
4	98.4	0.37	0.37	0.67	119.24	19.43
5	133.9	0.1	0.67	0.96	137.1	1.47
6	47.7	0.6	0.87	0.9	51.6	1.53
7	49.9	0.1	0.14	0.59	59.7	9.07
8	139.4	1.47	1.7	9.5	157.8	5.73
9	86.9	1.5	0	0.8	95	5.8
Arithmetic Mean	74.9	0.8	0.6	2.5	89.7	11.0
Geometric Mean	64.0	0.4	0.2	1.2	82.3	6.4

BALANGERO CHRYSOTILE COHORT - DIAGNOSTIC ISSUES:

Piolatto et al. [14] reported the first two mesotheliomas in the Balangero cohort. The first case (1975) was diagnosed cytologically; the other (1977) histologically. Neither used immunohistochemistry (IHC). Calisti [12] reported a third mesothelioma in the Balangero cohort whilst Browne (1992 pers commun.) said that as of 1992 there were at most four mesotheliomas reported at Balangero, "one in a manager, but they were suspect given the doubtful nature of the occupational histories".

More recently, the studies of the incidence of mesothelioma in Balangero chrysotile 'workers' (see below) have been conducted by two groups in Torino. One, situated largely at the Institute for Occupational Medicine (IOM) the other at the University of Turin in collaboration with the Institute for Pharmacological Research, 'Mario Negri', (MN) who investigated the health of the Balangero workers based upon analyses of death certificates found through searching company records. Since the IOM had very limited access to hospital records and pathology material first hand diagnostic confirmation was generally not possible. Pira et al. [15] said: "The use of death certificates instead of cancer registries in occupational cohorts investigating cancer risk has inherent limitations due to the inadequacy of available information". Apparently, on rare occasions Pira et al. [15] could identify cases of mesothelioma using means other than death certificate since they said "One case of pleural mesothelioma was identified in the cohort but lung cancer as a cause of death was reported in the death certificate. Since the diagnosis of mesothelioma is still complex, this is not surprising". The methods used to identify the

mesothelioma case were not discussed.

Another group, the Unit of Cancer Epidemiology, (CPO) relied principally upon the Registry of Malignant Mesotheliomas (RMM) [8,11,16]. This only covered information from 1980 onwards but cases among mine employees could be identified in some instances in the hospital records and other Registry materials.

The most recent updates of the Balangero chrysotile workers were done by Pira et al. [15] at the IOM-MN and by Mirabelli et al. [8] at the RMM. Pira et al [15] compared their results 'on pleural and peritoneal cancer to those reported in another analysis conducted in the same area, based on the Piedmonte registry of malignant mesotheliomas´. Pira et al [15] 'found 4 deaths from pleural and 1 from peritoneal cancer as compared to 6 deaths from pleural mesothelioma during the same period in the registry based study'. They concluded that 'despite the 'different sources of data (death certificate versus registry information) the results for pleural cancer are in substantial agreement'.

Despite the efforts to compare the findings of the IOM and the RMM, the individual cases have never been matched. Prof La Vecchia, Dr Negri and Dr Pelucchi have provided the available underlying detail on the six cases reported by Pira et al. [15] to compare with the nine 'occupational' cases reported by Mirabelli et al. [8]. Full analysis of the complex cross-matching is given in the supplemental data to this paper.

Sylvestri et al. [11] also assessed the incidence of mesothelioma in the cohort, 'on the basis of a search of the literature and of the files of the Mesothelioma Registry of Piedmont'. They said 'Three additional cases of malignant mesothelioma of the pleura were found with past exposure in the mine, and no evidence of other occupations entailing exposure to asbestos'. Also, 'Lifelong work-history was known for two with no evidence of other occupations entailing exposure to asbestos. Case 1 was a technical clerk (the study was limited to blue-collar workers) who died after the end of follow-up. Case 2 worked in the Balangero mine from 1936 to 1944. Case 3 was included in the study by Piolatto et al. but died after the end of follow-up.' Therefore, case 1 can be dismissed. Case 3 appears to be one of the cases reported by Piolatto shown in Table 2 (supplemental data) . Case 2, on the basis of the dates of hire and separation, may be the same as that reported by Calisti et al [12]

Since histology with IHC is the currently recognized standard for the diagnosis of mesothelioma, no more than two of the cases reported to date have used the technique and so are potentially confirmed. However, the exact panel of IHC markers used, the adequacy of negative and positive controls, and the staining patterns and intensities for those stains are not known and so confirmation is not definite.

There is the further question that none of the cases are specifically called 'miners'. For example, Mirabelli et al. [8] claims to have found a 'cluster of 14 mesothelioma cases among workers who were *active in the mine*' but only list 9 such cases in Table 1 of their report and none are called 'miners'. Confusion on the point also concerns the workers studied by the IOM and MN. Rubino et al. [13] said 'the work force has numbered about 300 men. At present some 350 men are employed in the mine and its associated milling, crushing, screening and bagging plant'. Their cohort consisted of 952 male workers with at least 30 days employment between 1 Jan 1930 and 31 Dec 1945. Their cohort data are not broken down into those who worked at the mine and/or the mill/plant as opposed to those who only worked at the mine versus those who only worked at the 'mill/plant'. Enigmatically, Rubino et al. [13] said "almost all workers had changed their job during their working life at the *factory*", and Piolatto et al. [14] said their study is an 'update of cancer mortality among chrysotile asbestos *miners*' but 'the cohort comprised men who had worked for at least one year at the *factory* between 1946 and 1987'. What is meant by 'factory' is not explained. Similarly, Pira et al. [15] said they 'obtained employment data from personnel records at the factory and ascertained vital status and causes of death through population registers and copies of death certificates from municipal registration offices.' So it looks like the IOM – MN has been studying 'factory workers' rather than 'miners'. The term 'plant' engenders further confusion. Specific data for millers are also not provided though reference is frequently made to work in the mill.

Therefore, taking the strictest view of the data presented in the literature to date by the IOM and the RMM, including the recently obtained unpublished data from MN, no more

than two cases alleged to be mesothelioma would begin to meet present day diagnostic standards. However, neither case can be said to be, with a high degree of certainty, a Balangero asbestos miner.

BALANGERO CHRYSOTILE COHORT - SOURCES OF ALTERNATE CAUSATION

General Considerations

Piedmont was home to many asbestos industries [17]. The region around and in Turin and Balangero historically housed an extensive asbestos industry with many former asbestos factories and plants. In consequence, amphiboles were the 'common urban environmental pollutant in Turin' [12]. Amphiboles first arrived from South Africa at the factory at Basse di Dora ('Capiamianto') in Torino which made 'all kinds of white, blue, and amosite asbestos articles and specialised in white and blue asbestos textiles [18]. Other factories in the area also used South African blue (crocidolite) asbestos and amosite [19]. All crude asbestos for Italy was initially delivered to Genoa and some men from the Piedmont would commute to work from the mines and plants to the port to work in shipyards and steel mills [18,20]. Piedmont was home to the greater part of the Italian asbestos industry [21,22]

The extensive use of amphibole asbestos is reflected in the significantly elevated incidence of mesothelioma in Turin and the surrounding province and has been demographically demonstrated for this region [20,22] with respect to the location of the main asbestos industries and the residences of mesothelioma cases. Clusters of pleural cancers in different parts of the Province were also found in other 'high-risk areas due to a wide range of asbestos manufacturers (mainly textile [23], and the production of brakes and clutches) and industrial use of asbestos products [20]. A population based case control study of two industrialized areas close to the City of Torino also demonstrated large numbers of mesotheliomas in relation to the many industrial activities found in the area [24]. The spatial mortality studies also found a circular cluster around Turin that reached the Lanzo Valley where Balangero is situated [20].

Sources in the mine and the mill

Pooley [9] identified significantly elevated concentrations of crocidolite in the lungs of three workers and four out of nine control subjects living in the vicinity of the mine (see above) (Table 1). In addition to the tremolite/actinolite noted above cow and human lung tissue from the Lanza valley also contained amosite whilst those from Susa had both amosite and crocidolite. Air sampling found long crocidolite fibres in both Lanza and Susa valleys.

The numerous sources of commercial amphibole asbestos exposure in and around Balangero explain the lung burden findings. Production had increased during the post-war reconstruction period and technological improvements in the mid-1950s were mainly in mining methods and only marginally in dust control. During the sixties production in the mill increased to between 100,000 and 150,000 tonnes per year. [16].

Some 'mine' workers also worked outside Balangero with possible exposure to other types of asbestos [17], in railway coach construction, in an iron foundry and in a motor vehicle assembly plant. Further alternate exposures in the mine may have come from the use of crocidolite asbestos cement from Casale. Crocidolite was also apparently used in the Balangero mine for 'short' periods in small amounts for material testing and preparing mixtures [15], and in different parts of the Balangero mine and mill for 'longer' periods for various purposes. Crocidolite was also at times added to the Balangero chrysotile ore; [25]. Crocidolite and amosite were transferred to the mine by Balangero subcontractors from different asbestos firms. Amphibole asbestos cement coverings in the new part of the Balangero mill" [12] were said to contain crocidolite from Casale. Crocidolite and amosite were also transferred to Balangero in jute bags [11]. These are known to create a significant mesothelioma risk (e.g. see [26])

Other exposure to airborne asbestos can result from buildings constructed on serpentinitic rocks which may contain manufactured materials containing asbestos.

Occupations at Risk of Mesothelioma in the Piedmonte

Many job titles and occupations have

been reported to be at risk of mesothelioma in the Piedmonte [20,22,24,27-29]. Most of these comport well with the 'alternate exposures' noted in most of Mirabelli et al's [17] cases said to be attributable to Balangero chrysotile exposure. Rubino et al [22] identified 22 trades at risk. Ronco et al. [24] identified several industries as well as trades at risk. Nesti et al. [29] found, on the basis of the Registry analysis, high risk categories to include bricklayers, plumbers, carpenters, electricians and others. Mirabelli et al. [28] also noted that 'Other industries producing asbestos-containing materials, such as asbestos textiles, linings for brakes and clutches, and asbestos cardboard and packing, were mainly located in Piedmont'. Mauhle et al. [20] found cases in the textile sector, cement and a foundry) synthetic-fibre textile plants, and local railway carriage construction.

Case Specific Alternate Sources of Exposure Outside the Mine and the Mill

Mirabelli et al [8] believe Balangero chrysotile also significantly contributed to the production of mesothelioma found in 13 other people exposed to Balangero chrysotile outside of the workforce. They considered 17 cases in four exposure categories, marked with a superscript 'a' (in their table legends) to denote 'possible exposure to other types of asbestos'.

"Cases of malignant mesothelioma among workers employed by sub-contractors at the Balangero mining site" (5 Cases) (Mirabelli et al [17], their Table 1B): Of the five "cases of malignant mesothelioma among workers employed by sub-contractors at the Balangero mining site", one is marked 'a' as having possible exposure to other types of asbestos. Three others worked in facilities and/or had job titles at potential high risk for mesothelioma. Case 10 was also probably exposed to crocidolite transported to and used in the construction of the asbestos mill. Therefore, four of the five cases had significant potential sources of alternate exposure.

"Cases of malignant mesothelioma in workers never employed at the Balangero mining site, but occupationally exposed to chrysotile from the mine" (3 Cases) (Mirabelli et al, [17], their Table 2)]: All three cases "of malignant mesothelioma in workers never employed at the Balangero mining site, but occupationally exposed to chrysotile from the mine", are marked with an 'a'. Mirabelli et al [17] said 'cases 15 and 17 may also have been exposed to fibrous tremolite" at a mill outside the mining site not owned by Amiantifera treating Balangero ore. Case 16 likewise since he analysed ore from the Balangero mine and built/managed pilot plants for ore exploitation. These could have used crocidolite in their construction. All 3 cases had significant sources of alternate exposure.

"Cases of malignant mesothelioma due to household/environmental exposure" (5 cases) (Mirabelli et al. [17], their Table 3): Of the five "cases of malignant mesothelioma due to household or environmental exposure", four of the five merely lived in 'proximity of the mine site'. However, numerous other sources of commercial amphibole asbestos exposure were present in the area immediately around Balangero. (Details in the supplemental data.)

"Cases of malignant mesothelioma among persons exposed to mine tailings used outside mine" (5 Cases). (Mirabelli et al. [17], their Table 4): Of the five 'cases of malignant mesothelioma among persons exposed to mine tailings used outside mine', three are marked with an 'a'. Using asbestos contaminated jute bags by Case 23 was not discounted as a potential cause in their series [17]. "Besides chrysotile asbestos of different fibre length, the mill produced by-products of different specific weight and crushed stone (gravel shingles) to be used as ballast" [11]. Exposure to mine tailings used as ballast may have involved tremolite exposure when it was from other mining areas outside Balangero and processed at the Balangero mill [17]. In all, at least three of the five cases claimed to be due to Balangero chrysotile had potential amphibole exposures.

Conclusion

Fourteen of the 17 mesothelioma cases reported by Mirabelli et al. [17] attributed to Balangero chrysotile worked in occupations at high risk for mesothelioma from potential amphibole asbestos exposure.

Eternit Casale Monferato Asbestos Cement Plant

Balangero is an open pit strip mine ca 25 miles north-west of Turin. Winter snow and the rainy season would prevent the miners from working in the mine for several months a year. A substantial amount of moonlight work was therefore done in other nearby facilities. There were myriad opportunities for exposure to amphibole asbestos in these facilities. One of the most important of these sources of potential alternate exposure was the Eternit Asbestos Cement plant in the town of Casale Monferrato one of the largest asbestos cement pipe factories in the world. It operated more or less contemporaneously (1906 - 1986) with the Balangero mine site (1915 – 1990) being relatively near the mining area itself. Since the Casale asbestos cement factory was an important source of crocidolite and amosite exposure, and Balangero and Casale were both owned by Eternit, an exchange of workers could have taken place between these two facilities when Balangero ceased mining. Whilst the company records at Casale do not list many Balangero workers, they would not have recorded relatively brief e.g. 3 to 4 week, work periods particularly for workers in the pipe section. Casale produced the 'famous 'Italit' brand of asbestos cement shingles, sheathing and pipes' and became the first to manufacture asbestos cement for water mains. The water main division of their business expanded within a very short time a little more than 20 years after it began in 1907, to 'unbelievable proportions', resulting in branches and agents in practically every European country, India and other parts of the world. It became in turn the second largest distributor of asbestos cement roofing'. [30].

The Casale facility is a major risk factor for mesothelioma in the Piedmonte. This results from its vast scale and extensive use of crocidolite and amosite. The Casale Plant has been said to have an 'overwhelming' influence on the epidemiological situation of the Piedmonte and causative of large numbers mesotheliomas [17]. Mauhle et al. [20] in their study of the spatial map of pleural cancers of the Piedmonte said: 'The most striking mortality excess appears for both men and women in the area around Casale Monferrato (their Fig. 2). The clusters stretch south, in the surroundings of Alessandria, where occupational exposure to asbestos was mainly due to the chemical industry. For men, the cluster is more elongated and, without solution of continuity, reaches areas where it was common for workers to commute to and from Genoa to work in shipyards and steel mills. A similar picture characterized pleural cancer in women"

BALANGERO CHRYSOTILE COHORT - ASCERTAINMENT BIAS

Different methods of ascertainment may have created bias.

Variation in cohort starting dates

Rubino et al. [13] included men who started work in 1930. Piolatto et al [14] appear to only include those who started working in 1946. Pira et al [15] included those who 'started working between 1930 and 1975' but said, somewhat confusingly 'their follow up began in 1946'. Calisti [12] said workers "working in Balangero from 1939 to 1944 were not included in the cohort of Balangero miners and millers studied by Rubino et al [13] and by Piolatto et al [14]. Case 3 was included in the study by Piolatto et al. but died after the end of follow-up.' [12]

Variation in Cohort Inclusion Criteria - Minimum work duration

Rubino et al. [13] included all men who worked at least one month. Piolatto et al. [14] excluded those who worked less than one year. This clearly affected outcome. Pira et al. [15] noted this and said exclusion caused one case of pleural mesothelioma to be missed as he was engaged for a 'short period (<1 year).' Still, there appears to be overall 'agreement' in the number of alleged cases. This would seem to indicate that between the IOM and the RMM most if not all mesotheliomas have been identified regardless of the variation in minimal work duration.

Historical Recall Bias

Reliance on second hand interviews created recall bias and much opportunity to miss many

other important sources of exposure due to "retrospective interview of closest relatives" [11]. Rubino [22] also said "The conclusion thus seems warranted that the data regarding an unequivocal or probable exposure in the mesothelioma group should be considered conservative". Further difficulties with the accurate assessment of alternate exposures results from the apparent inability to classify workers as miners, 'millers' or 'combinations'. This goes to the fact that Rubino et al [13] said "almost all workers had changed their job during their working life at the factory". That means all of the Balangero workers could be susceptible to the same types of alternate exposures cited above in the mill not withstanding exposures potentially incurred in the town and the surrounding municipalities.

Other exposure information on the working and environmental conditions in the Balangero mine was taken from legal proceedings. One must therefore question the thoroughness of this source of data [11] (citing the Pretura di Torino 1996) [15]. Further confounding could arise from reliance on 'ad hoc' examination of the files from the Mesothelioma Registry of Piedmont and of the compensations in cases of asbestosis [11].

BALANGERO CHRYSOTILE COHORT - BALANGEROITE

The role of balangeroite as yet another alternate cause of the mesotheliomas found at Balangero is unclear. In a recent study, Turci et al. [31] said "Considering the profound differences between the structure of balangeroite and amphiboles, previous results and observations on the poor ecopersistence of balangeroite, and the present data, we conclude that balangeroite traces may contribute to the overall toxicity of the airborne fibres in Balangero, but may not be compared to tremolite nor considered the sole responsible for the excess of mesothelioma found in Balangero". It would therefore appear to be more likely than not that balangeroite is a not a major contributor to mesothelioma risk but the data are still insufficient to categorically exclude a causal role for this fibre.

CONCLUSIONS

All the evidence suggests that crocidolite, amosite and tremolite are responsible for the alleged mesothelioma cases at Balangero. Mirabelli et al [8] admit their 'assessment' was based on 'incomplete data'. They regard the association between Balangero chrysotile and mesothelioma only as 'possible'. They "had no access to the individual records of the cohort members alive in 1987" and "Information on exposure (was only) available for 50% of all cases in the RMM". Myriad sources of naturally occurring and commercial amphibole asbestos exist to account for the alleged Balangero cases. The diagnostic accuracy of the cases can also be questioned and confusion surrounding job titles raises the question if any of the cases actually ever occurred in 'miners' per se.

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