



Division of Mines and Mineral Resources — Report 1991/25

Asbestos at Savage River

by R. S. Bottrill

Abstract

Fibrous minerals at Savage River were sampled in many airborne dust and rock samples and examined by various methods for asbestos. The results indicate that much of the fibrous material is relatively coarse, but some falls within the present working definitions of asbestos, and includes tremolite and antigorite. Most of the fibres are relatively short and squat and probably relatively benign, but the material requires further study.

INTRODUCTION

Fibrous (asbestiform) minerals have been known from Savage River Mines for many years, but previous workers (Bottrill, 1985; Cruickshanks-Boyd, 1985) have found the samples tested to contain coarse fibre, of no significant health risk, rather than the finer true asbestos fibre ($<3 \mu\text{m}$ in diameter: NOHSC, 1988). A recent sample submitted by an anonymous person and stated to be derived from these mines did, however, contain true asbestos fibre. This sample was determined at first to be an amphibole asbestos "of the amosite type (anthophyllite or tremolite)" (Bottrill, 1991a), and later studies confirmed it was in fact tremolite (Bottrill, 1991b, using optics, AAS & XRD; also Rogers and Conaty, 1991, using optics, TEM, EDAX and SAED). Rogers and Conaty (1991) also noted the presence of serpentine (antigorite) fibre but made little comment on this. In September 1991 the Mines Inspection Branch surveyed the site to determine the actual asbestos risk, and sampled rock samples, drill cuttings and airborne dust around the mines and mill.

RESULTS*Bulk samples*

Twenty-three (23) bulk samples from Savage River Mines were checked for quartz and asbestos by optical microscopy and XRD (X-ray diffraction). These samples comprised seven drill cuttings and sixteen rock samples. The sample details and analytical results are shown in Table 1.

The drill cuttings all contain asbestos fibre (probably tremolite or related amphiboles), and three contain minor to trace quartz (less than about 10%). The asbestos fibre is

rare in G401206 but relatively common ($<1\%$) in the other samples. Most of this fibre is relatively short and squat, rarely being greater than $10 \mu\text{m}$ in length, or less than a micrometre in diameter.

Most of the rock samples contain fibrous amphibole (Table 1), but this is rarely fine enough to be classified as asbestos. In thin section the amphiboles vary considerably in colour, from colourless to dark green to blue, reflecting compositional changes. The colourless amphibole is probably tremolite, the green is probably around actinolite or hornblende in composition, and the blue could represent crossite, riebeckite or similar sodic amphiboles. The blue amphiboles indicate potential for crocidolite (fibrous riebeckite), and this requires further investigation. Serpentine is also present in several rock samples, and while the species is uncertain in most cases, some is probably antigorite (from XRD), and some is fibrous or asbestiform. Quartz is present in three rock samples, up to about 15 wt%.

Airborne dust samples

Fifty membrane filters were weighed for total dust and analysed for quartz and asbestos by XRD; the results are shown in Table 2. Amphibole was detected on many of the filters by XRD, indicating a significant potential for asbestos. Quartz is $<0.07 \text{ mg}$ and frequently <0.01 . Some of the weights were negative and these were determined by ashing of the filter at 900°C in platinum crucibles.

Twenty of the filters were checked for fibre by removing some of the dust and placing it in immersion oil on a glass slide. The results of this are shown in Table 2, and indicate that asbestos fibre is ubiquitous in the samples studied, and perhaps comprises up to 5% of some samples. Again, however, most of this fibre is relatively short and squat, rarely being greater than $10 \mu\text{m}$ in length. There is a suggestion of some chrysotile asbestos being present, but this requires confirmation by other techniques.

A large number of membranes were also used for asbestos sampling, and twenty of these were submitted for fibre counting (Table 3). Although we lack the recommended equipment (NOHSC, 1988) and training, our results agree well with those of the Government Analyst (Appendix 1). The determined fibre concentrations vary from <0.01 to

0.05 fibres/mL, below the TLV for amphibole asbestos minerals of 0.1 (NHMRC, 1983). Three of the membranes were examined under the electron microscope, and this confirmed the typical sizes and shapes of fibres (typically about 1-3 µm × 5-10 µm, Figures 1 and 2).

SUMMARY

The results of this study indicate that a large amount of fibrous amphibole is present at Savage River Mines, and some serpentine fibres are also present. Much of the amphibole is probably tremolite, but a large compositional range is present in the rocks of the area (Turner and Bottrill, in prep.), and probably includes riebeckite (potentially crocidolite).

The material is variable in grain size, shape and fibrosity, but a significant percentage of the dust falls within the asbestos size range, as defined by the NOHSC (1988). It should be noted, however, that most of this asbestiform fibre is relatively short compared to most asbestos minerals, and as such is likely to pose a considerably lower health hazard. Stanton and Layard (1978) note that the greatest risk is with particles >8 µm long and <0.25 µm wide, whilst the average asbestos particle in this study is probably about 2 × 6 micrometres.

Cruickshanks-Boyd (1985) considers that most of the amphibole and tremolite "fibres" at Savage River Mines are cleavage fragments rather than true fibres, and the asbestos definitions are overly restrictive. This is probably true, but we must work within the present guidelines, and under these definitions asbestos is present at Savage River. More work will be needed on this material for adequate characterisation of its nature and potential hazard.

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[23 December 1991]

Table 1

Results of petrographic and XRD analyses of bulk samples, Savage River Mines

Reg. No.	Field No.	Rock type	Quartz	Amphib.	Serpent.	Chl	Mag	Talc	Fsp	Others
G402101	C1	Drill cuttings		3,F		4	4	3		Py
G402102	C2	Drill cuttings		3,F		4	4	2		Py
G402103	C3	Drill cuttings		3,F		4	4	2		Py
G402104	5 CLD 22	Drill cuttings		4,F		4	2	2	2	Mica
G402105	6 CLD	Drill cuttings		3,F		4	4	2		
G402106	1NDED	Drill cuttings	3	1,F		4	2	2	2	
G402107	2NDDE	Drill cuttings	3	1,F		4	2		3	Dol, Cal
G402108	South Lens	Chl-mag schist			3,F	4	4	2		Py
G402109	Central D	Tr schist		4,F		2	2	3		
G402110	1CL22-60W	Bt schist		3,F		4	1		3	Mica, Py, Tur
G402111	2CL22-110W	Chl-tr schist		4,F		4	2			Py
G402112	3CL22-180W	Tlc-tr schist		3,F		4	2			Py
G402113	7CL22	Amphibolite		4,F		4		2	2	Py
G402114	1SLW (W-SL)	Magnetite ore				3	4			Py
G402115	2SLW	Chl-amphibolite		3,F		4	3			Py
G402116	3SLW	Ep-amphibolite		4,F		3	1		4	Dol, Ep, Py
G402117	4SLW	?mixture		3,F	2,F	4	2			Mica, Py
G402118	5ASLW	Amphibolite	3	4,F		3	3	2	3	Mica, Py
G402119	6SLW	Amphibolite		4,F		4	2			Mica, Py, Ep
G402120	5BSLW	Serpentinite			4		3	3		Py, Dol
G402121	3NDE	Chl-fsp schist	3			4			4	Cal, mica, py
G402122	4NDE	Ep-amphibolite	3	3,F		4	1		3	Ep, Cal, Py, mica
G402123	5CLD	Srp-breccia		3,F	4	3	3	3		Calcite, Tur

1: Present: 1%	Mag: magnetite	Ep: epidote
2: trace: ~1-5%	Chl: chlorite	Tr: tremolite
3: minor: ~5-20%	Tlc: talc	Cal: calcite
4: major: >~20%	Py: pyrite	Dol: dolomite
Blank: not detected	Fsp: feldspar	Srp: serpentinite
F: fibres present	Bt: biotite	Tur: tourmaline

Table 2

Summary data for membrane filters, Savage River Mines (inspirable dust)

Reg. No.	Location	Site	Total Weight	Quartz	Amphibole	~% fibre
D0718	Drill 45R1	North pit	0.69	0.01		2
D0719	PH1 Shovel	Central Deposit	0.56	0.01		1
D0720	PH3 Shovel	North pit	0.42	0.03		ne
D0721	Drill 40R1	North pit	2.03	0.05	Y	5
D0722	Truck S4	Central Deposit	0.74	0.01		ne
D0723	Crusher Cab	Crusher	0.28	<		ne
D0724	PH1 Shovel	Central Deposit	0.45	<		ne
D0725	Truck 49	Central Deposit	0.38	<		ne
D0726	Truck 35	Central Deposit	0.52	<		ne
D0727	Outside cab	Crusher	0.48	<		ne
D0728	Truck 49	Central Deposit	0.41	0.01		ne
D0729	PH1 Shovel	Central Deposit	0.37	0.01		1
D0730	Crusher Cab	Crusher	0.83	0.02	Y	1
D0731	FE Loader	South Lens	0.55	0.02		ne
D0732	Truck 33	Central Deposit	0.46	0.01		ne
D0733	PH1 Shovel	Central Deposit	0.43	<		ne
D0734	PH4 Shovel	North pit	0.64	<		<1
D0735		Maintenance shop	0.26	<		ne
D0736	Truck 44	Central Deposit	0.32	0.02		1
D0737	PH1 Shovel	Central Deposit	0.43	0.02	Y	3
D0738	Drill 45R1	North pit	0.25	<		ne
D0739	Truck 37	South Lens	0.42	0.02		ne
D0740	PH1 Shovel	Central Deposit	0.31	<		ne
D0741	Drill 45R2	South Lens	4.92	0.01	Y	2
D0742	Outside cab	Crusher	0.87	<	Y	<1
D0743	Drill 45R1	North pit	0.63	<		ne
D0744	Centre ground floor	Maintenance shop	0.40	<		ne
D0745	Outside cab	Crusher	0.55	<		ne
D0746	Drill 45R2	South Lens	7.75	<	Y	3
D0747	Truck 49	Central Deposit	0.32	<		ne
D0748	PH1 Shovel	Central Deposit	0.61	<		ne
D0749	Crusher Cab	Crusher	3.44	<		ne
D0750	Outside cab	Crusher	3.10	0.01	Y	ne
D0915	Floor 2 centre rail	Mill				3
D0916	Floor 1 2nd feed	Mill				ne
D0917	Floor 1 1st feed	Mill				1
D1029	PH1 Shovel	Central Deposit	?<0.1	<	Y	ne
D1030	Truck 43	Central Deposit	0.17	<	Y	ne
D1031	Floor 2 middle rail	Mill	0.38	<		ne
D1032	Drill 45R2	South Lens	47.79	too loose	Y	ne
D1033	PH3 Shovel	North pit	0.68	0.01		ne
D1035	Drill 45R2, deck	South Lens	1.23	<	Y	1
D1036	Drill 45R2, cab	South Lens	0.46	0.02	Y	<1
D1037	PH3 Shovel	North pit	0.53	0.07		ne
D1038	Drill 40 R4 cab	Central Deposit	0.36	0.02	Y	1
D1039	Floor 1 centre	Mill	0.29	0.02	Y	2
D1040	Drill 40R4 outside	Central Deposit	0.80	<		1
D1041	Outside cab	Crusher	0.09	0.04		ne
D1042	Outside cab	Crusher	0.25	0.04		ne
D1043	Drill 40R1 cab	North pit	3.83	0.02	Y	5
D1044	Outside cab	Crusher	0.83	0.01	Y	ne
D1045	Drill 40 R4 cab	Central Deposit	1.15	0.01	Y	ne
D1046	Truck 42	Central Deposit	0.71	0.01	Y	1
D1047	Floor 1 exit, centre ball mill	Mill	0.45	<	Y	ne
D1048	Floor 1 entry, centre ball mill	Mill	0.26	0.01		ne

<: <0.01 mg;

Y: amphibole present;

ne: not examined

Table 3

Summary data for fibre counts on membrane filters, Savage River Mines

Reg. No.	Location	~No. fibres/filter	Flow rate (L/min)	Sampling time (min)	Fibres/mL	Counter
D0903	Outside crusher		1059	375	<0.01	GA
D0905	Mill, N side	7119	1023	480	0.02	RSB
D0913	Crusher Cab	10861	1004	350	0.03	RSB
D0914	PH Shovel 1	872	885	310	<0.01	RSB
D0920	PH Shovel 3		1066	305	Overloaded	GA
D0924	Drill 45R2 deck		1111	335	Overloaded	GA
D0926	Drill 45R2	11708	1165	335	0.03	GA
D0931	Drill 40R4	5865	1029	285	0.02	GA
D0932	Drill 40R4		1049	285	Overloaded	GA
D1005	Drill 40R1		1051	320	Overloaded	GA
D1009	Crusher cab	11900	1189	305	0.03	RSB
D1015	PH Shovel 1		1184	300	<0.01	GA
D1019	PH Shovel 1	18176	1262	300	0.05	RSB
D1024	Drill 45R1	13504	1023	330	0.04	GA
D1026	PH Shovel 4		1165	355	<0.01	GA

RSB: R. Bottrill

GA: Government Analyst laboratories

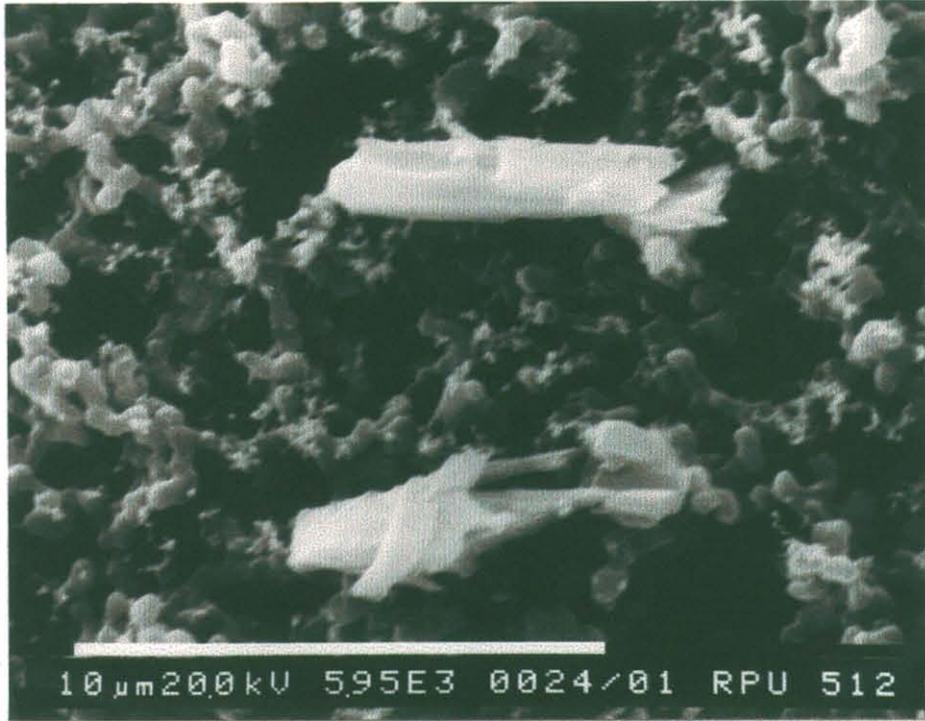


Figure 1

SEM photograph of asbestos fibres on a Millipore membrane filter, Savage River Mines. Magnification: 5950x, scale bar = 10 µm.

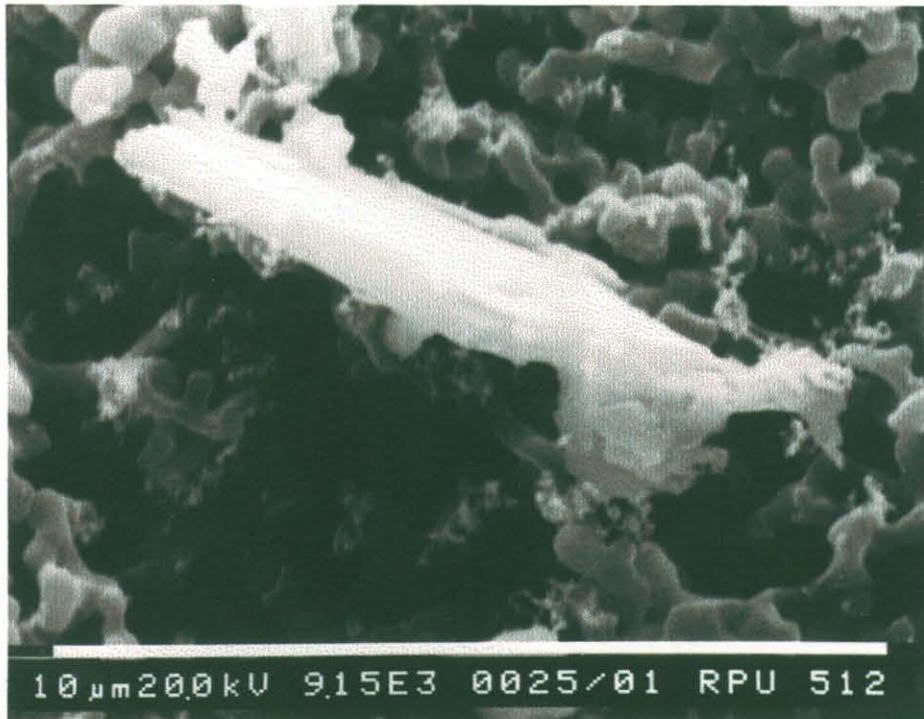


Figure 2

SEM photograph of an asbestos fibre on a Millipore membrane filter, Savage River Mines. Magnification: 9150x, scale bar = 10 µm.



Appendix 1

Fibre counting results — Government Analyst Laboratories

CERTIFICATE OF ANALYSIS

Registration Number : 912408

Material : 11 ASBESTOS FILTERS

Received: 31-10-91 per MR CURTAIN

Your ref: ATT: M.E. CURTAIN Your Ref: MEC51.91:LD

Test Method: Filters examined in accordance with 1988 NOHSC
Guidance note on the Membrane Filter Method.

SAMPLES EX: DEPARTMENT OF RESOURCES & ENERGY

MICROSCOPIST: NIRINDA RICE

ASBESTOS DUST CONCENTRATIONS

FILTER No.	SAMPLE LOCATION	FLOW RATE (mL/min)	SAMPLING TIME (mins)	FIBRE CONCENTRATION	
				(fibres/fields)	(fibres/mL)
⊙ 5	BLANK	1051	320	-	-
15		1184	300	8.5/100	lt. 0.01
24		1023	330	24/100	0.04
* 26		1165	355	6/100	lt. 0.01
85				1/100	
# 103		1059	375	5/100	lt. 0.01
⊙ 120		1066	305	-	-
⊙ 124		1111	335	-	-
126		1165	335	24/100	0.03
131		1029	285	11/100	0.02
⊙ 132		1049	285	-	-

lt. = less than

⊙ = Extremely high dust content made counting impossible.

* = High Dust concentration made this result doubtful.

= A high concentration of larger particles outside of the effective filter area, would lead to the conclusion that an air leak was present during the sampling period.