Amosite Asbestos.

(Read 27th January, 1930.)

By G. J. V. Clarence, B.Sc.

Introduction.

Dr. Reinecke, your President, has asked me to make a few notes on amosite asbestos to be presented at this meeting, and in doing so has imposed on me a rigid time limit of twenty minutes. I will, therefore, endeavour to interest you for this brief space with a few of the salient points pertaining to this remarkable mineral.

History.

The first mention of white amphibole asbestos is found in the annual report of the Geological Survey of the Transvaal in 1907, as occurring on the farms Penge No. 780 and Streatham No. 1083, about 80 miles north of Lydenburg, in the Eastern Transvaal.

Production only commenced about 1915, as many difficulties had to be overcome before manufacturers could be induced to try this new form of fibre.

In 1915 the total output of asbestos from the Transvaal was only 55 tons, whereas in 1928 the output amounted to 18,522 tons, of which 6,435 tons was amosite. The amosite figure should be exceeded in 1929, and probably doubled in 1930.

The name amosite was first suggested by Dr. Hall in 1918, and is derived from the initial letters A M O S A of the pioneer producing company—The Asbestos Mines of South Africa.

Distribution.

Up to the present time amosite—white amphibole asbestos—has not been discovered in any other part of the world except in the North-Eastern Transvaal—between Pietersburg and Lydenburg, the western limit being at Chuniespoort, and the eastern at Penge, near the junction of the Steelpoort and Olifants Rivers, a total distance along the strike of about 60 miles. The width of the banded ironstone formation in which the amosite occurs varies from three to six miles.

Mineralogy.

Composition.—The following three analyses of amosite are taken from Hall's Memoir:—

1. Third grade brownish asbestos from Penge.
2. Second quality asbestos from Streatham.
3. First grade white asbestos from 4th Level, Penge Mine.

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ANALYSES BY PROFESSOR HAHN.

	1	2	3
SiO_2	49·72	49·10	50·24
Al_2O_3	5·72	–	–
Fe_2O_3	–	–	7·80
FeO	37·00	43·86	32·00
MgO	3·77	6·14	3·96
CaO	1·65	0·46	Trace
Na_2O	–	–	2·12
Water (Const.)	–	–	–
Moisture	2·29	–	–
Ignition	–	–	3·00
Total	100·15	99·56	99·12

It is thus essentially an amphibole or ferro magnesian silicate with or without a small quantity of soda.

PHYSICAL PROPERTIES.

Tensile Strength.—This is fair to good, though generally inferior to that of crocidolite and chrysotile.

Flexibility.—Good and equal to that of chrysotile.

Fineness of Fibre.—This varies from harsh to superfine, but is usually inferior to chrysotile.

Incombustibility.—Approaches that of chrysotile and is superior to that of crocidolite.

Length of Fibre.—This varies from 1/16th inch to over 12 inches in exceptional cases. While some varieties of amosite are distinguished by the exceptional average length of the fibre, there are others which occur at different geological horizons which vary from a pencil line to about $1\frac{1}{2}$ inches and average probably $\frac{3}{8}$ inch to $\frac{1}{2}$ inch.

Resistance to Acids and Alkalis.—In this respect amosite is distinctly superior to chrysotile and equal to crocidolite.

Resistance to Sea Water.—Equal to crocidolite and superior to chrysotile.

Elasticity.—Good.

Heat Insulating Value.—Good.

Electrical Insulating Value.—Fair to good.

Colour.—Pale green, grey and white. After fiberising these colours usually change to either dirty white or pure white.

In his work "Non-metallic Minerals," Ladoo gives the following comparative tabulation of the properties of the three varieties of asbestos:—

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PROPERTY.	CHRYSOTILE.	CROCIDOLITE.	AMOSITE.
Fibre length (usual maximum	1½–2in.	1½–3in.	7in.
Tensile strength	High	Higher than Chrysotile	Good
Fineness of fibre	Very fine	Fine	Fine
Resistance to heat ..	Good, but becomes brittle	Poor; fuses to a glass	Good, but becomes brittle
Resistance to acids, alkalis and sea-water ..	Poor	Good	Good
Electrical Insulating Value	Fair to good	Good	Good
Heat Insulating Value ..	Good	Good for moderate heat	Good
Spinnability	Excellent	Fair	Good

GEOLOGY.

Occurrence.—The amosite occurs in cross fibre veins on three or more horizons interbedded in banded ironstone formation about 200 ft. above the base of the Pretoria Series, which is underlain by dolomite of the Dolomite Series. A very persistent intrusive basic sill, from 30 to 50 ft. in width, occurs below the main asbestos horizon, and between it and the dolomite contact.

Strike and Dip.—The general dip of the bedding varies from a southerly to south-westerly direction as one travels from east to west at a dip varying from 15 to 40 degrees, while the general strike is roughly east to west.

The geology of the Pietersburg amosite fields may best be studied from Sheet No. 13 (Olifants River) of the Geological Survey of the Transvaal, mapped by A. L. Hall in 1907-1908.

Although some slight inaccuracies occur in the mapping of the boundaries of the banded ironstone and dolomite contacts, nevertheless the author has been greatly helped in his many professional visits of inspection in this area by this primary geological survey.

In the Malips Drift area, the three main horizons which have been opened up in mining and prospecting may thus be briefly described:—

1. *Upper Horizon.*—Usual channel width 8 in. to 12 in., consisting of three or four bands, usually from 2 in. to 4 in. in width. Percentage over channel width, 90 per cent.

2. *Middle Horizon.*—About half way between the upper and lower horizon. Usual channel width 3½ to 4 ft., consisting of numerous scattered bands from ⅛ in. to 2 in. width. Percentage fibre over channel width, 7 per cent.

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3. *Lower Horizon.*—About 200 ft. true thickness below the middle horizon. Usual channel width 4 ft., consisting of numerous closely aggregated bands of fibre from $\frac{1}{8}$ in. to $1\frac{1}{2}$ in. in width. Percentage fibre over channel width, 17 per cent.

Quality of Fibre.—Generally speaking, an improvement in quality is met with as work proceeds away from the zone of surface oxidisation.

Quantity of Fibre Available.—The extensive prospecting and development work done on many of the properties has proved conclusively that the various horizons are persistent for miles on the strike and to great depths on the dip, in some cases amounting to over a thousand feet.

An estimate of the total fully developed (*i.e.*, ready for stoping) tonnage of fibre on one property examined by the author amounted to 10,000 tons, while the partially developed fibre amounted to a further 60,000 tons.

It may safely be said that very large tonnages of fibre await recovery from this district in the future.

Structure.

The banded ironstone formation has been subjected to very intensive pressure, which has caused folding and contortion of the beds containing the asbestos on an extensive scale. Synclines and anticlines succeed one another with amazing rapidity, causing frequent duplication of outcrops. The effect of this contortion is to increase the quantity of fibre very greatly in any given area.

In many cases within a stoping width of three to four feet the channel width of fibre has been triplicated, due to intensive pressure, and it is notable that usually where the contortion is greatest the quality of the fibre is excellent.

Very few faults occur in the banded ironstones, as, owing to their plastic nature, they usually bend rather than break.

Genesis.

A. L. Hall, in his Memoir No. 12, "Asbestos in the Union of South Africa," discusses the origin of amphibole asbestos at great length, and anyone requiring further information is referred to this source.

Mining Methods.

Owing to the occurrence of the fibre horizons in highly dissected mountainous country, the greater part of the Pietersburg field lends itself to cheap mining by means of adits driven into the hillsides. Adits have the double advantage of not requiring either hoisting or pumping machinery, as both the ore and water are removed from the workings by gravity, thus reducing to a minimum both the capital expenditure required for equipment and the working costs of production.

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Where the channel widths are narrow, the fibre will probably be mined by resuing, as this method requires a minimum of timbering and produces very little waste rock to be treated in the mill.

Where the widths are wide and the fibre percentage low, the most probable method of support in the stopes will be by means of pillars and timber cribs filled with waste rock.

Milling.

A suitable mill flow sheet is as follows:—

1. Ore from mine.
2. Drying plant.
3. Mill bins.
4. Coarse crusher of the jaw type or coarse rolls.
5. Sorting belt.
6. Fine crusher, generally rolls.
7. Disintegrator or fiberiser.
8. Shaking screens with vacuum suction.
9. Cyclone collectors.
10. Grading machine.
11. Bagging floor.
12. Market.

Principal Uses.

The "Mineral Industry" for 1928 states that the chief use of *spinning fibre* is for making brakeband linings and clutch facings, other important uses being for fireproof theatre curtains and fireproof suits and gloves. Combined with rubber, it is also very largely used for making steam or other high temperature packings.

The principal uses of *non-spinning* fibre are for building material both for outside and inside use combined with cement in the form of shingles, tiles and corrugated sheets, and boards for ceilings, floors and walls. Other uses are for pipe coverings, paper and millboards, boiler coverings and mixed with bitumen as a fireproof roof paint. Another important use is for gaskets enclosed in thin copper sheeting and used for cylinder heads and other packings in the motor car industry.

Asbestos is used largely in industry as heat, cold and sound insulation material, and in chemical engineering and acid filters and wherever a fireproof material is required.

An important recent development is in the use of non-spinning asbestos for moulded brake linings for internal expanding brakes of automobiles, as these are rapidly displacing the woven brake linings which require the highest grade spinning fibre for their manufacture. These moulded brake linings afford a splendid opportunity for the use of amosite as a cheap substitute for the higher price spinning grades of chrysotile which are being so largely used for woven brake linings at the present time.

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A still more recent use for asbestos is as a sound proof wall-coating or stucco in auditoriums, music halls, etc. It is found that the acoustic properties of halls treated in this way are greatly improved. The absorption of sound by asbestos coated walls is from 25 to 33 per cent. greater than ordinary plaster walls and echo is entirely eliminated when the hall is correctly designed and coated with this asbestos plaster.

Yet another important use for asbestos is in the manufacture of asbestos cement piping, which is used for flue and exhaust stacks for carrying liquids or gases at pressures varying from 40 to 225 lbs. per sq. in. It is suitable for delivery of hot or cold water, brine and various chemical liquids and solutions under pressure.

These pipes can be cut, tapped or threaded with the same tools and in the same manner as iron pipe. Its weight for the same carrying capacity is from 50 per cent. to 65 per cent. less than cast iron pipe. It is not subject to rust or corrosion from acids or electrolysis.

One of the principal uses of amosite to-day is as an adulterant to be mixed with chrysotile in the manufacture of building and insulating material.

Asbestos, in ratio of 15 per cent., combined with 85 per cent. magnesia, is the basis of the large magnesia covering industry in the United States and in Europe.

The superiority of amosite and crocidolite over chrysotile in their capacity to withstand sea water has been so well demonstrated that their exclusive use has been enforced in the German Navy, and the principal use in Great Britain to-day of these two varieties is for use in the British Navy and Mercantile Marine.

A 10,000 ton cruiser uses from 90 to 100 tons of asbestos, while a 34,000 ton aircraft carrier requires 1,400 tons of asbestos in its make up. Asbestos composition switch boards have completely displaced slate and marble in the Navy and Mercantile Marine.

The Navy is obtaining its new high speeds in light cruisers and other craft only because it can use asbestos high pressure steam packings. The Navy, besides switch boards and packings, uses quite large quantities of fibrous paints, roofing cements, asbestos floor coverings, asbestos shingles, pipe coverings, mill boards and high temperature cements and asbestos brake linings; in fact, the Navy is becoming asbestosized almost completely.

New uses for asbestos are being constantly found, and it is almost impossible to do more than mention the more important uses as has been done above.

MARKETING.

Amosite is sold entirely by sample in lots of from five tons upwards, usually f.o.r. or f.o.b. the nearest railhead or shipping port.

Sales in lots of from 5 to 30 tons of Transvaal amosite have been effected during the current year at prices varying from £17 to £59 per

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ton, and a fair average price may be taken at £25 per ton under present market conditions.

A recent trial order of 10 tons of run-of-mine amosite from one of the Malips Drift mines is at present in transit to America, where it has been sold to a firm who are prepared to take large quantities per month provided this shipment is in every way equal to the samples on which the order was placed.

Production.

The following figures have been taken from "Mineral Industry" for 1928:—

Country.	Variety.	Short Tons.	Per cent.
United States	Chrysotile, Amphibole	2,239	0·6
Canada	Chrysotile	273,033	70·5
Rhodesia	Chrysotile	39,960	10·3
Union of South Africa ...	Chrysotile, Crocidolite, Amosite	23,584	6·1
Cyprus	Chrysotile	16,287	4·2
Italy	Chrysotile	5,000	1·3
Russia	Chrysotile	27,000	7·0
		387,103	100

The sales of asbestos from the Union of South Africa in 1928, according to the report of the Government Mining Engineer, were:—

		Short Tons.
Amosite	Transvaal	6,748
Chrysotile	do.	12,162
Blue	do.	66
Blue	Cape ...	5,077
Total		24,053

Conclusion.

The late Dr. P. Wagner, writing in 1917, in the *Journal of Industries,* page 267, referred to the Pietersburg asbestos fields as giving every assurance of becoming one of the most important asbestos producing areas in the world.

Dr. A. L. Hall, in his Memoir No. 12, page 130, published in 1918, states: "Though more information is wanted as to the behaviour of amosite when tested under the conditions prevailing in manufacture, the experience so far available justifies the hope of a great future for

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this new asbestos variety (amosite).'' A footnote to this stated that samples of amosite submitted to technical tests by the Imperial Institute showed that this asbestos could be spun into yarn and woven into cloth which could be used for any purposes such as working of asbestos mattresses.

I am in entire agreement with both Drs. Wagner and Hall that the Pietersburg amosite fields are destined to become a great factor in world asbestos production. I firmly believe that South Africa, including Rhodesia, will one day outstrip Canada as the world's greatest producer of asbestos.

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