XII.—*Report on the Chemical Qualities and Analysis of a Combustible Mineral Substance from the Mersey River, Tasmania, forwarded by Mr. A. M'Naughtan, of Hobart Town. By* Professor Penny, *of the Andersonian University, Glasgow.* [*Read* 13*th September,* 1854.]

This mineral consists essentially of a mixture of silicious sand and clay, with a combustible fossil substance, resembling resin. It also contains small quantities of water and iron pyrites, (sulphuret of iron).

One hundred parts gave by analysis the following results:—

Resinous matter	26·64
Sand and clay	69·83
Pyrites	2·16
Water	1·37
	100.

Under the microscope the leading ingredients may be easily recognized and distinguished. The clay and sand, which are nearly colourless, form the basis, and by far the greater bulk, of the mineral, while the resinous matter, which is of a light amber-brown colour, is disseminated through the clay basis in extremely minute particles or flakes.

The resinous matter renders the mineral highly combustible. When heated in the open fire it readily kindles, and burns with a bright voluminous flame, giving off much smoke. The sand and clay are left as a bulky reddish coloured ash.

When distilled in a closed vessel, or retort, at a temperature below a red heat, it yields an oil, a strong acid, and tarry matter, leaving a carbonaceous residuum in the retort. The volatile products are of course derived exclusively from the resinous ingredient. The quantity of mineral received for examination was too small to admit of an extended investigation being made into the exact nature of the liquid products afforded by distillation. Even if there had been sufficient for the purpose, I should not have considered it necessary to incur the expense of pursuing this part of the inquiry, for, although exceedingly interesting in a scientific point of view, it appears to me to be altogether irrelevant to the principal questions submitted for my consideration, viz.,—Whether this mineral can be employed in the manufacture of gas, or be applied to steam purposes, or to any other practical use in the arts?

I have tried its gas-producing powers very carefully. When strongly and quickly heated, in the same way that coal is treated in the manufacture of gas, it affords a notable quantity of gas, which is similar in qualities and powers to that obtained from cannel coal. In consequence, however, of the very large proportion of earthy matter existing in it, the amount of gas that it gives is very small, as compared with the quantity afforded by Scotch and English gas coal. From a careful trial on a limited scale, I estimate that a ton of the mineral will produce about 3000 cubic feet of gas, which is a little more than one-fourth of the quantity yielded by good cannel coal of this country. Lesmahago coal, which is, with the exception of Boghead coal, the most productive cannel coal in Scotland, gives about 11,500 cubic feet of gas per ton, and the Boghead coal nearly 14,000 cubic feet.

The following Table exhibits the results obtained by analyzing this mineral, according to the method generally employed in the analysis of gas coal; and I have added, for the purpose of comparison, a statement of similar results from Lesmahago and Boghead coals:—

Ingredients.	Mineral from Mersey River, Tasmania.	Lesmahago Gas Coal.	Boghead Gas Coal.
Volatile Matters	20·41	55·23	67.11
Coke { Fixed Carbon ...	5·50	36·72	10·52
Coke { Ash	71·20	4·35	21·00
Sulphur	·73	·55	·32
Water	2·16	3·15	1·05
	100	100	100

The results in the above Table are replete with information. The actual quantity of gas that any coal will afford may in general be fairly estimated from the proportion of "volatile matters" that it gives when analyzed according to the foregoing method. The larger the proportion of these matters, (which consists of gases and volatile liquid substances), the greater will be the quantity of gas procurable from the coal by distillation in the usual way. On reference to the Table, it will be at once seen that the amount of these ingredients (volatile matters) in the Van Diemen's Land mineral is comparatively small: and accordingly, as a gas-yielding material, it is very inferior to ordinary cannel coal.

The coke from it is utterly worthless. It consists almost entirely of clay and sand, and a very small quantity only of combustible matter, or "fixed carbon." The following Table shows the per-centage amount of coke afforded by this mineral and by the coals previously referred to, and also the proportion of "fixed carbon" and ash in each coke:—

	Coke from	Fixed Carbon in Coke.	Ash in Coke.
	per cent.	*per cent.*	*per cent.*
Tasmanian Mineral.........	76·70	7·17	92·83
Lesmahago Gas Coal	41·07	89·50	10·50
Boghead Gas Coal	31·52	33·38	66·62

In estimating the value of coal for the manufacture of gas, the quality of the coke which is used as fuel in the distillation of the coal, and also sold for other purposes, is an important item of consideration. The heat-producing powers of coke, when used as fuel, depend exclusively on the "fixed carbon," or charcoal, it contains, and accordingly its economic value is directly proportioned to the amount of this ingredient. In the coke from Lesmahago coal, there is a large per-centage of "fixed carbon," and it is therefore very valuable as fuel. Boghead coke, on the contrary, is very deficient in this respect, and almost valueless. The product from the present mineral is little else, as already mentioned, than clay and sand, (nearly 93 per cent.), and scarcely entitled therefore to the name of coke.

I made a careful analysis of the ash which this mineral gives when completely burned, with a view to ascertain whether it could be applied to any useful purpose. The following statement gives the results obtained from one hundred parts :—

Sand and silica	85·50
Alumina	10·71
Oxide of iron	1·29
Lime, magnesia, &c.	2·50
	100.

From these results it is evident that this ash consists of little else than sand, and is obviously of no value whatever.

With regard to the nature of the combustible matter in this mineral, I may mention that it is essentially different from coal. In its chemical composition, as well as in some of its leading qualities, it is more analogous to resinous matter than any other known substance, though I must add that in many particulars it presents some striking peculiarities. Generally speaking, resins are more or less soluble in alcohol, ether, naphtha, and oil of turpentine; but this mineral is very little acted upon by these solvents. It gives a small quantity of soluble matter to ether and oil of turpentine. It also partially dissolves in potash. It cannot be considered as a "bitumen," as all true bitumens dissolve to a greater or less extent in naphtha and oil of turpentine, which, even after protracted boiling, have very little action on the present substance. I find also that the combustible portion of this mineral contains a large amount of oxygen, whereas in ordinary bitumen there is comparatively a very small proportion of this elementary substance. The following statement contains the results of an elementary analysis of the combustible matter of the mineral, and also that of coal and of resin :—

	Mersey Mineral.	Resin.	Coal Lesmahago	Coal Boghead.
Carbon	61·62	72·0	80·45	81·16
Hydrogen	9·78	9·3	6·89	11·25
Oxygen and Nitrogen	28·60	18·7	12·66	7·59
	100	100	100	100

In conclusion, therefore, I have merely to repeat that this mineral consists of clay and sand, highly impregnated with a combustible substance analogous to resin, on the presence of which all its peculiar as well as useful properties entirely depend. The principal use to which it is capable of being applied is in the manufacture of gas for illumination. It is, however, very inferior in this respect to gas coal, both as regards the quantity and the quality of the gas it will give. Unless, indeed, it can be procured very cheaply and abundantly, I am clearly of opinion that it can scarcely be worked with advantage even for this purpose. In its natural state it cannot be used as fuel, in consequence of the considerable amount of clay it contains ; and hence it is not available for steam purposes. Its coke also for the same reason is perfectly worthless. The gas from it will require to be carefully and extensively purified, in order to remove the injurious products afforded by the sulphur existing in it; and the large amount of "oxygen" it contains will have the effect of making the gas very thin, or, in other words, of diminishing its illuminating powers. The only other application of it I can suggest is for the manufacture of oil, similar to the oil obtained from rosin and coal, called rosin oil and paraffin. These oils, now so extensively employed in this country in preparing grease for machinery and for railway carriages, are made by cautiously distilling rosin and coal at a heat below that at which they yield gas. I am not prepared to state whether it could be economically applied to this purpose, as it would be necessary to make an experiment on a large scale before a trustworthy opinion could be formed. It is, however, in my opinion well worth the trial in the country where this mineral is found. I would also recommend a diligent search for richer specimens of the mineral, and perhaps the resinous substance could be found in a state of greater purity.

(Signed) FREDERICK PENNY,
Professor of Chemistry.

TABLE showing the Proportions per Cent. of Volatile Matters, Fixed Carbon, Ash, Sulphur, and Water, of Various Cannel Coals, analyzed by Dr. PENNY, with the Quantities of Fixed Carbon and Ash in the Coke of each.

CANNEL OR PARROT COALS.	COAL.						COKE.		
	Sp. Gr.	Volatile Matters.	Fixed Carbon.	Ash.	Sulphur.	Water.	Total Amount of Coke in Coal.	Carbon in Coke.	Ash in Coke.
		per cent.	*per cent.*	*per cent.*	*per cent.*	*per cent.*	*per cent.*	*per cent.*	*per cent.*
1. Rochsoles (1851)	1·448	53·7	4.9	37·4	1·6	1·	42·3	11·58	88·42
2. Hardie's 1852	1·420	34·	4.	58·4	*	3·5	62·4	6·44	93·56
3. Boghead, *Brown* (1851)	1·160	71·06	7.10	26·2	·24	·4	28·3	25·09	74·91
4. Boghead, *Black* (1851)	1·2185	62·7	9.25	26·5	·35	1·2	35·75	25·88	74·12
5. Torbanehill (1853)	1·1892	67·11	10.52	21·	·32	1·05	31·52	33·38	66·62
6. Boghead, (1849)	1·1550	71·3	11.3	16·8	(·34)·	·6	28·1	40·22	59·78
7. Bathville	1·201	64·35	12.6	22·2	·25	·60	34·80	36·21	63·79
8. Stan, (Ayrshire)	1·4647	52·08	14.77	32·	*	1·15	46·77	31·52	68·48
9. Methill	1·3002	49·23	17.57	29·7	*	3·50	47·27	37·17	62·83
10. Capeldrae	1·3603	45·73	19.97	31·5	*	2·80	51·47	38·80	61·20
11. Wemyss	1·1831	58·52	25.28	14·25	*	1·95	39·53	63·95	36·05
12. Balbardie (1852)	1·420	38·96	29.66	28·	·38	3·0	57·66	48·56	51·44
13. Hillhead (Kilmarnock)	{1·602 / 1.320}	36·65	32·34	27·4	·61	3·	59·74	54·14	45·86
14. Brymbo	*	32·10	36·4	29·4	*	2·1	65·80	55·32	44·68
15. Lesmahago (Auchinheath)	1·1990	56·23	36·7	4·3	·55	3·15	41·	89·50	10·50
16. Bartonshill	1·280	48·	39·6	10·	2·	2·4	49·6	79·84	20·16
17. Bartonshill	1·350	38·	37·9	18·7	2·2	3·2	56·6	66·96	33·04
18. Stevenson (Ayrshire)	1·3850	40·21	40·14	19·35	*	·3	59·49	67·64	32·36
19. Lesmahago (Southfield)	1·228	49·34	40·97	6·34	1·35	2·	47·31	86·60	13·40
20. Knightswood	1·234	44·77	41·13	11·05	*	3·05	52·18	78·83	21·17
21. Cairnbroe	1·247	42·83	42·67	8·50	*	6·	51·17	83·39	26·61
22. Skaterigg	1·252	49·32	44·83	2·50	*	3·35	47·33	94·42	5·58
23. Cowdenhill	1·299	46·0	45·	5·	·50	3·50	50·	90·	10·
24. Breadisholme	1·335	39·	48·5	8·1	·4	4·	56·6	85·69	14·31
25. Ruchill	1·223	45·73	49·27	2·5	*	2·5	51·77	95·17	4·83
26. Kelvinside	1·231	40.17	53·42	1·9	·21	4·3	55·32	96·57	3·43

* Not Estimated.