

	Sp. gr.	Vol.	Fixed Carbon	Sulphur	Water	Ash
Anthracite, Mammoth.....	1·617	3·08	86·38	0·50	4·12	5·92
“ “	1·631	4·27	83·81	0·64	3·09	8·18
“ “	1·575	4·38	83·27	0·73	3·42	8·20
Bituminous, Waynesburg.....		38·30	48·97	2·73	1·04	8·97
“ “		34·68	49·59	1·27	1·27	13·19
“ Pittsburg.....		37·74	54·56	1·50	1·73	4·47
“ “		25·20	65·52	2·25	1·27	5·76
“ “		37·22	56·01	0·98	1·04	4·15
“ Freeport Upper.....		29·68	63·77	1·72	0·70	4·13
“ “		25·77	70·22	0·62	0·80	2·59
“ “		23·91	64·53	4·79	0·77	6·00
“ Kittanning Upper.....		39·22	55·69	0·57	2·71	1·81

It is found that the Pittsburg coal affords 0·0011 to 0·1248 per cent of phosphorus, which becomes 0·0018 to 0·2003 in the coke. Other analyses are given in the Geological Reports of Ohio, Kentucky, Indiana, Illinois, etc. It is useless to cite further from them, since the variation is very large in a single bed as it is traced over the country, and the state reports should be referred to for details.

The Arctic coal, of Grinnell Land ($81^{\circ} 43' N.$ and $64^{\circ} 4' W.$), is good caking bituminous coal; it afforded R. J. Moss, on analysis, carbon 75·49, hydrogen 5·60, oxygen and nitrogen 9·89, sulphur 0·52, ash 6·49, water 2·01 = 100 (*Proc. R. Dublin Soc.*, 1878).

The ordinary *impurities* of coal, making up its ash, are silica, a little potash and soda, and sometimes alumina, with often oxide of iron, derived usually from sulphide of iron (pyrite or marcasite), besides, in the less pure kinds, more or less clay or shale. The amount of ash in the selected coal does not ordinarily exceed 10 per cent, but it is sometimes 30 per cent; and rarely it is less than 2 per cent. Thin layers of pyrite are rather common, and occasionally a bed of other ores of iron is intercalated.

Wormley gives the following analyses (besides others) of the ash of two coals, one from the Youghiogheny, in western Pennsylvania, and the second from Pigeon Creek, Jackson County, Ohio: Silica 49·10, 37·40, alumina 38·60, 40·77, sesquioxide of iron 3·68, 9·73, magnesia 0·16, 1·60, lime 4·53, 6·27, potash and soda 1·10, 1·29, phosphoric acid 2·23, 0·51, sulphuric acid 0·07, 1·99, sulphur (combined) 0·14, 0·08, chlorine *trace* = 99·61, 99·64. The fact that there is too much sulphur in the Ohio coals for combination with the iron present is shown in the following table, containing some of his results:—

Sulphur in the coals	0·57	1·18	2·00	0·91	0·86
Iron in the coals.....	0·075	0·742	0·425	0·122	0·052
Sulphur required by the iron...	0·086	0·848	0·486	0·130	0·06

The source of the impurities is in part the vegetation of which the coal was made, which is shown on page 74 to be sometimes large, even as regards silica and alumina, the constituents of a clay, and large also for calcium carbonate and potash.

According to the average composition of Lycopods, the dried plant affords 5 pounds of ash to 100 of the plant, and 40 per cent of this is alumina and silica (27 alumina and 13 silica), and hence these two ingredients make up 2 per cent of the plants. Ferns, with the same amount of ash, afford, as the average, 27 per cent of silica, with no alumina. Equiseta afford, on an average, 20 per cent of ash, and 50 per cent of this may be silica.