

B₂O₃ was made following Hillebrand and Lundell (1955, p. 755). Considerable difficulty was experienced in determining FeO as the mineral could not be completely decomposed. As the procedure described by Hey (1941, p. 117) was also ineffective, total iron was determined and recalculated as FeO.

The distribution of ions in the structure of the analysed kornerupine following McKie, 1965, p. 350, is (Na, Mn, Fe, Ti)_{0.511}^[8,6] (Mg, Al)_{4.014}^[6] Al₅^[6,4] (Al, Si)₄^[4] (Si, B)₁^[4] (O, OH)₂₂.

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An occurrence of wüstite

THE occurrence of wüstite or ferrous oxide in nature has not been definitely proved though there have been reports (Brun, 1924; Foshag, 1926; Yudin, 1956). A natural occurrence of ferrous oxide identified by X-ray diffraction pattern is reported in this note.

On examining the heavy fraction of a natural coke obtained from Pathardih colliery, Jharia coalfield, Bihar, India, under a binocular microscope, a few grains were found to be magnetic. Some of them were black in colour and others were brownish. Both were examined by the X-ray powder method using Fe-K α radiation and the 57.3 mm diameter camera. The brownish grains were found to contain magnetite, hematite, akaganéite¹ (β -FeOOH), and goethite. The spacings obtained from a black magnetic grain are given in table I.

It is seen that in addition to magnetite and hematite, both of which give a continuous line pattern, there is another phase giving rise to the

¹ β -FeOOH (akaganéite) was reported by the author from the heavy mineral fraction of a natural coke obtained from a borehole (K. C. Chandy, 1961, *Indian Minerals*, vol. 40, p. 197). The one reported here is the second occurrence of this mineral in a natural coke from a different locality.

TABLE I. X-ray diffraction spacings observed from black magnetic grain and their analysis

1 Grain		2 Magnetite		3 Hematite		4 Wüstite		5 Spotty lines
<i>d</i>	<i>I</i>	<i>d</i>	<i>I</i>	<i>d</i>	<i>I</i>	<i>d</i>	<i>I</i>	<i>d</i>
4.86 Å	vw	4.85 Å	10					
3.66	vw			3.67 Å	35			
2.96	m	2.97	30					
2.79	vvwi							
2.69	m			2.69	100			
2.53	vs	2.532	100	2.514	75			
2.47	m, sp					2.475 Å	50	2.47 Å
2.20	vvw			2.204	25			
2.16	w							
2.14	s, sp					2.145	100	2.14
2.10	m	2.100	20					
1.839	vw			1.838	30			
1.716	vvw	1.714	15					
1.689	w			1.692	45			
1.615	m	1.617	25					
1.529	vvw							
1.518	m, sp					1.515	65	1.518
1.484	s	1.485	35	1.484	20			
1.450	w			1.452	25			
1.293	w, sp					1.292	25	1.293
1.279	w	1.280	10					
1.239	vw, sp					1.237	25	1.239
1.210	vvwi	1.212	4					
1.121	vvwi	1.122	4					
1.093	m	1.093	15					
1.073	w, sp					1.072	10	1.073
0.984	m, sp					0.983	7	0.984

1. Spacings observed in X-ray diffraction pattern of black magnetic grain.

2, 3, 4. Standard spacings (H. P. Rooksby, 1961, *The X-ray identification and crystal structures of clay minerals*, ed. G. Brown, pp. 386-387).

5. The spotty lines of column 1.

i, ill-defined; sp, spotty.

distinct group of spotty lines. The set of lines, the association with magnetite and hematite, and the cell size (cubic, a 4.29 Å) show that the mineral responsible for this pattern is wüstite (a 4.29 Å for artificial FeO, Dana, 1955). It is distinguished from cuprite Cu_2O by the absence of any indication of its 110 line at 3.02 Å and the cell size (cuprite a 4.25 Å, Dana, 1955). The number of such grains however was too small for detailed work to be undertaken.

Faint continuous lines at 2.16 Å and 1.529 Å show that fine grained wüstite with a higher cell-size is also present.

Many minerals such as siderite (= chalybite) and ferriferrous chlorites give rise to ferrous oxide on heating. At high temperatures this will be immediately oxidized to hematite if free access to air is permitted. The case of siderite requires special consideration as it is a constituent of coals and the 2.79 Å line may well be due to residual siderite. On heating siderite in vacuum at 550° C, both FeO and Fe₃O₄ have been reported to form (Bernal, Dasgupta, and Mackay, 1959), the latter from FeO itself by disproportionation. The same process may give rise to hematite and wüstite with differing cell size.

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Thermal transformation of β -ferric oxyhydroxide

AKAGANÉITE, β -FeOOH, has been shown to be tetragonal^{1,2} unlike the other two monohydrates of Fe₂O₃, goethite and lepidocrocite, which are orthorhombic. The author reported³ a natural occurrence of β -FeOOH and in the course of an investigation on artificial preparations, it was found that it becomes orthorhombic on heating before the final transformation to hematite, which is the final product of heating all the three polymorphic forms.

β -FeOOH prepared by hydrolysing ferric chloride solution at 80° C, repeated washing, and drying at 90° C, was heated to different temperatures and durations. Changes in the X-ray patterns recorded with a 57.3 mm diameter powder camera using Fe-K α radiation were observed.