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APPLICATION OF MÖSSBAUER SPECTROSCOPY TO IRON-57 IN BAUXITE RECOVERY PROCESS

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Résumé.- Des bauxites ferrières de la Jamaïque, ainsi que le résidu rouge résultant du procédé d'extraction de l'alumine par la méthode de Bayer, ont été analysés par spectrométrie Mössbauer et résonance paramagnétique électronique (RPE). Il n'apparaît pas de différence entre les oxydes de fer avant et après le traitement alcalin. La haute teneur en alumine des résidus rouges provient probablement d'une substitution des oxydes de fer par Al^{3+} .

Abstract.- Mössbauer spectroscopic and electron paramagnetic resonance measurements were made on ferruginous bauxite from Jamaica, and on the corresponding red mud residue remaining after alkaline hydrolysis treatment to extract alumina (Bayer Process). The Mössbauer parameters showed no discernable differences in the iron oxide morphologies before and after alkaline treatment. The high alumina content of the red mud residue may be explained by a substitution of trivalent aluminum in the iron oxides.

Chemical analysis of Jamaican bauxite occurring in the principal producing areas of Kirkvine, Ewarton and Alpart showed 48.5 %, 48.8 % and 47.49 % alumina respectively, and the corresponding iron oxide (Fe_2O_3) content is 18.1 %, 19.1 % and 19.4 % (Table I). Similar ores are subjected to the alkaline extraction Bayer process to recover alumina. Red mud residues are a troublesome waste product.

Analyses of the residues show a surprisingly high alumina content of 13.2 % in the Kirkvine red mud, 17.1 % in the Ewarton and 16.0 % in the Alpart residues (Table I), and this can be viewed as a serious loss of resource.

Iron oxide, the second major component in these bauxites and a principal component of red mud (Table I) can be investigated effectively by Mössbauer /1, 2, 3/ and electron paramagnetic resonance.

Table I : Typical compositions of bauxite and corresponding red mud

	Al_2O_3	Fe_2O_3	SiO_2	LOI	P_2O_5	TiO_2	CaO	Na_2O
Bauxite:								
Kirkvine	48.5	18.1	0.59	28.20	0.33	2.7	..	..
Ewarton	48.8	19.1	1.84	27.10	0.28	2.5	..	..
Alpart	47.5	19.4	2.70	25.50	0.49	2.6	0.7	..
Red Mud:								
Kirkvine	13.2	48.8	1.83	..	..	7.4	9.6	..
Ewarton	17.1	48.8	4.70	..	..	6.0	7.4	..
Alpart	16.0	42.6	5.90	12.53	1.00	5.9	10.3	3.6

Kirkvine - gibbsite + hematite (typical plateau bauxite)

Ewarton - gibbsite + hematite + some boehmite

Alpart - gibbsite + goethite (+hematite) + boehmite (typical graben type)

Table II : Mössbauer parameters of bauxite and red muds

Sample	300 K (room temperature)							77 K (liquid nitrogen)								
	Central Doublet			Magnetic Phase				Magnetic Phase I				Magnetic Phase II				
	IS.* mm/s	ΔE_Q mm/s	Rel. Area	IS. mm/s	ΔE_Q	H.*** Internal	Rel. Area	IS. mm/s	ΔE_Q	H.int.	Rel. Area	IS. mm/s	ΔE_Q	H.int.	Rel. Area	
Bauxites	.34	.49	52.6	0.370	0.180	494.2	47.4	.443	.215	517	29.4	.537	.027	470.7	70.6	
Red Mud (residue)	A	.35	.46	17.9	0.372	0.233	495.8	15.8	.456	.162	515	32.3	.433	.147	458.9	67.7
	B	.34	.50	22.5	0.191	0.215	492.4	37.1	.438	.185	513	39.7	.392	.163	458.9	60.3
	C	.34	.50	34.5	0.198	0.200	491.4	32.6	.439	.188	513	30.8	.368	.482	452.4	69.2

* IS. = Isomer Shift relative to Iron

** ΔE_Q = Quadrupole splitting

*** H. = Internal magnetic field

The Mössbauer parameters of the bauxites are very similar and that of three representative muds show some variations when measured at 300 K and 77 K (Table II). At 300 K, each spectra exhibited a prominent central doublet and a magnetic phase of approximately 490 kilogauss. This internal field, which increases to about 515 kilogauss at 77 K, has been assigned to hematite of fine particle size and/or substitution of diamagnetic trivalent Al in the α -Fe₂O₃. This reduces the usual field strength of hematite from 515 to 490 kilogauss at room temperature (300 K). The paramagnetic central doublet, which results in a second magnetic phase at 77 K of around 460 kilogauss, has been attributed to superparamagnetism as a result of fine particles of goethite, or substitution of aluminum in goethite.

Electron paramagnetic resonance measurements were made on the same samples of bauxite and red muds at 77 K. The spectrum of each sample indicated a principal component with a g factor of 4.25 and a line width at half maximum (HWHM) of 50 gauss. In addition, there is an upper field component with a g factor of 2.01 (HWHM = 1000 gauss) in the bauxite but not in the red muds. It is replaced by a lower field component with a g factor of 2.94 (HWHM = 1000 gauss). This can be explained by a dissolution of an iron phase in the bauxite, and the production or concentration of another iron phase, which may or may not be aluminous in the red mud residues.

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