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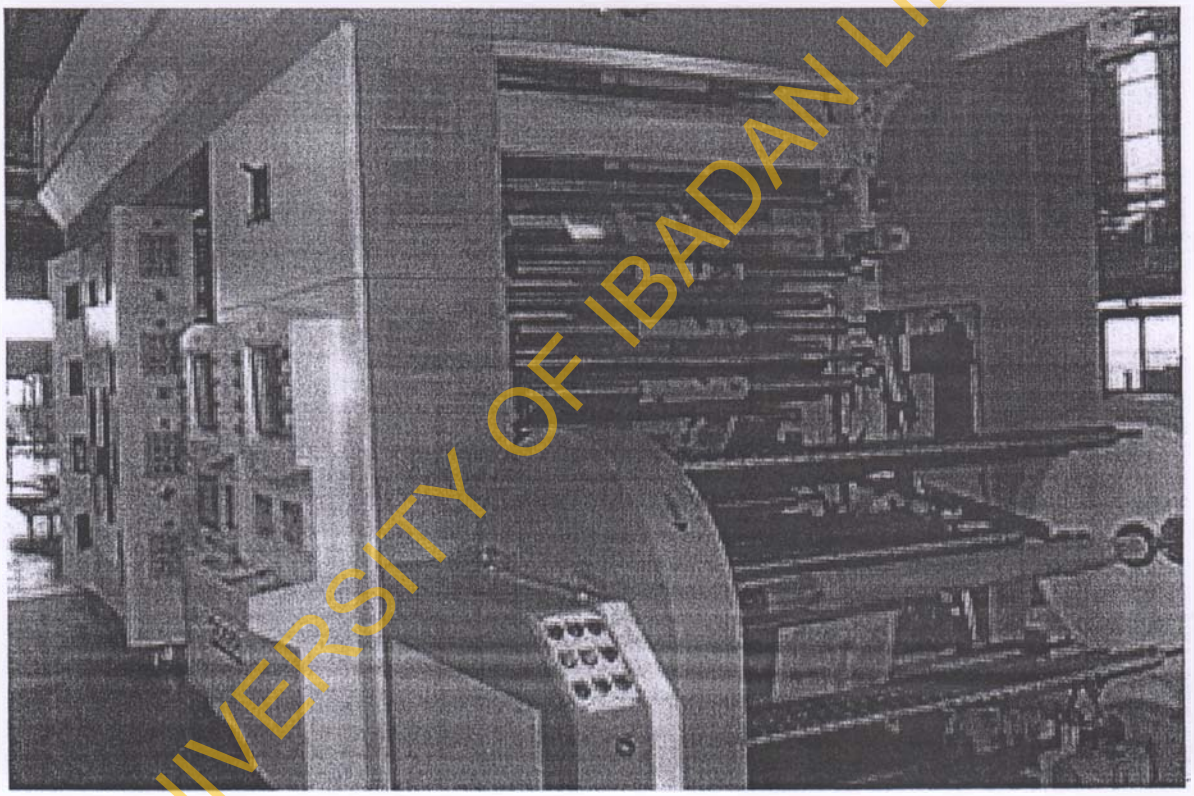
REPORT ON

MINERALOGICAL INVESTIGATION OF CORROSION PRODUCTS IN PROCESSING MACHINES



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RESEARCH AND DEVELOPMENT (R&D) DEPARTMENT

REPORT ON

MINERALOGICAL INVESTIGATION OF CORROSION PRODUCTS IN PROCESSING MACHINES

DEPARTMENT OF GEOLOGY
UNIVERSITY OF IBADAN

AUGUST, 1997

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MINERALOGICAL INVESTIGATION OF CORROSION PRODUCTS IN PROCESSING MACHINES

INTRODUCTION

Extracted samples of unknown corrosion products obtained from the NSPMC processing machines, were provided for the identification of their mineralogical compositions. In view of the disaggregated state and small quantity of each of the 3 specimens, it was obvious as requested, that the X-ray diffraction analysis would be the most effective and efficient technique for the study.

This is due to the fact that every crystalline substance has its perculiar atomic or molecular structure which diffracts X-rays in a diagnostic style. Consequently, the individual constituents of a mixture can be recognized by isolating their patterns.

SAMPLE PREPARATION AND ANALYSES

Powered samples were prepared for mineralogical analyses using a X-ray diffractometer. Each was run through the instrument set to produce diffraction chart at a scanning rate of 2°/min./cm, with Ni-filtered Cu-K alpha radiation.

Data obtained from the diffractograms were then interpreted by comparison with standard patterns of the appropriate minerals. Quantitative estimates of the identified constituents were computed by employing the area-method of the peaks.

MINERALOGICAL COMPOSITIONS

X-ray diffraction curves of the 3 samples are depicted in Figs.1 to 3, and the corresponding compositional characteristics are outlined in Tables 1 to 3.

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The relevant illustrations and tabulations clearly show that all the specimens contain jarosite (ca.60%), as the dominant component, while lepidocrosite (ca. 17%) is next in abundance. Conspicous intensities are reflected by jarosite at 2θ values of 17.0, 17.2, and 28.5°. Distinctive lepidocrosite peaks are indicated at 2θ values of 14.2, and 38.3°. Cronstedtite (ca. 9%) which is a fairly essential constituents of the samples, portrays detective reflection at 25.6° 2θ value.

As presented in Table 1, sample 1 bears subordinate amounts of halotrichite, melanterite and copiapite. Table 2 demonstrates that the accessory components of sample 2 comprise graphite, halotrichite, melanterite, goethite, hematite and copiapite. On the other hand, the minor constituents of sample 3 are diaspore, graphite, melanterite, halotrichite and copiapite (Table 3).

DISCUSSION AND CONCLUSIONS

Deductions emanating from X-ray diffraction diagrams have revealed the mineralogical attributes of the study samples. The charts particularly illustrate the dominance of jarosite, and the essential quantity of lepidocrosite in the 3 specimens. Some other Fe-rich minerals occur in varying, but lesser proportions.

Chemical formulae indicate that the constituents are mostly hydrated oxyhydroxides and hydrosulfates. Therefore, they are mainly products of alteration by oxidation, hydrolysis and hydration of steel or ferroalloy machineries or items. It is also remarkable that some of the minerals including the most important, are sulfate-bearing. These components inferably have incorporated substantially the acid- or sulfur-based additives or pigments of the operations. The non-

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ferroalloy metals, notably K, (Na?), Si and Al could have also been sourced or introduced notably from the water system, as expected in the Lagos environment. However, the detection of carbon as graphite in samples 2 and 3, likely represents acquisition from soot or combustion exhaust.

On the whole, geochemical analyses of samples may provide further clues on compositional characterization and discrimination. Besides, such data would be valuable in assessing environmental implications, corrosion rates and treatment or remedial options. Similarly, it is pertinent to note that larger quantities of samples are desirable for sensitive analytical work, as to enable replicate determinations and reproducibility estimations.

ACKNOWLEDGEMENTS

Immense thanks is extended to the NSPMC, particularly the Research and Development AGM, for this unique opportunity of initiating meaningful collaborative linkage. It is highly envisaged that this would be duly sustained.

22/8/97

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Table 1: Mineralogical Properties of Sample 1 (M4 Cylinder Extract)

Mineral	Chemical Formula	Quantity (%)
Jarosite	$KFe_3(SO_4)_2(OH)_6$	60
Lepidocrosite	γ-FeO(OH)	18
Cronstedtite	$(Fe_2^{2+}Fe^{3+})(Si\,Fe^{3+})O_5(OH)_4$	8
Halotrichite	$Fe^{2+}Al_2(SO_4)_4.22H_2O$	6
Melanterite	$FeSO_4.7H_2O$	6
Copiapite	$Fe^{2+}Fe_4^{3+}(SO_4)_6(OH)_220H_2O$	2

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Table 2: Mineralogical Properties of Samples 2 (M8 Cylinder Extract)

Mineral	Chemical Formula	Quantity (%)
Jarosite	$KFe_3(SO_4)_2(OH)_6$	58
Lepidocrosite	γ-FeO(OH)	18
Cronstedtite	$(Fe_2^{2+}Fe^{3+})(SiFe^{3+})O_5(OH)_4$	9
Graphite	C	4
Halotrichite	$Fe^{2+}Al_2(SO_4)_4.22H_2O$	3
Melanterite	$FeSO_4.7H_2O$	3
Goethite	α-FeO(OH)	2
Hematite	α-Fe_2O_3	2
Copiapite	$Fe^{2+}Fe_4^{3+}(SO_4)_6(OH)_2.20H_2O$	1

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Table 3: Mineralogical Properties of Samples 3 (Steel Flake of Intaglco Cylinder)

Mineral	Chemical Formula	Quantity (%)
Jarosite	$KFe_3(SO_4)_2(OH)_6$	60
Lepidocrosite	γ -FeO(OH)	15
Cronstedtite	$(Fe_2^{2+}Fe^{3+})(SiFe^{3+})O_5(OH)_4$	9
Diaspore	AlO(OH)	5
Graphite	C	5
Melanterite	$FeSO_4.7H_2O$	3
Halotrichite	$Fe^{2+}Al_2(SO_4)_4.22H_2O$	2
Copiapite	$Fe^{2+}Fe^{3+}(SO_4)_6(OH)_2.20H_2O$	1

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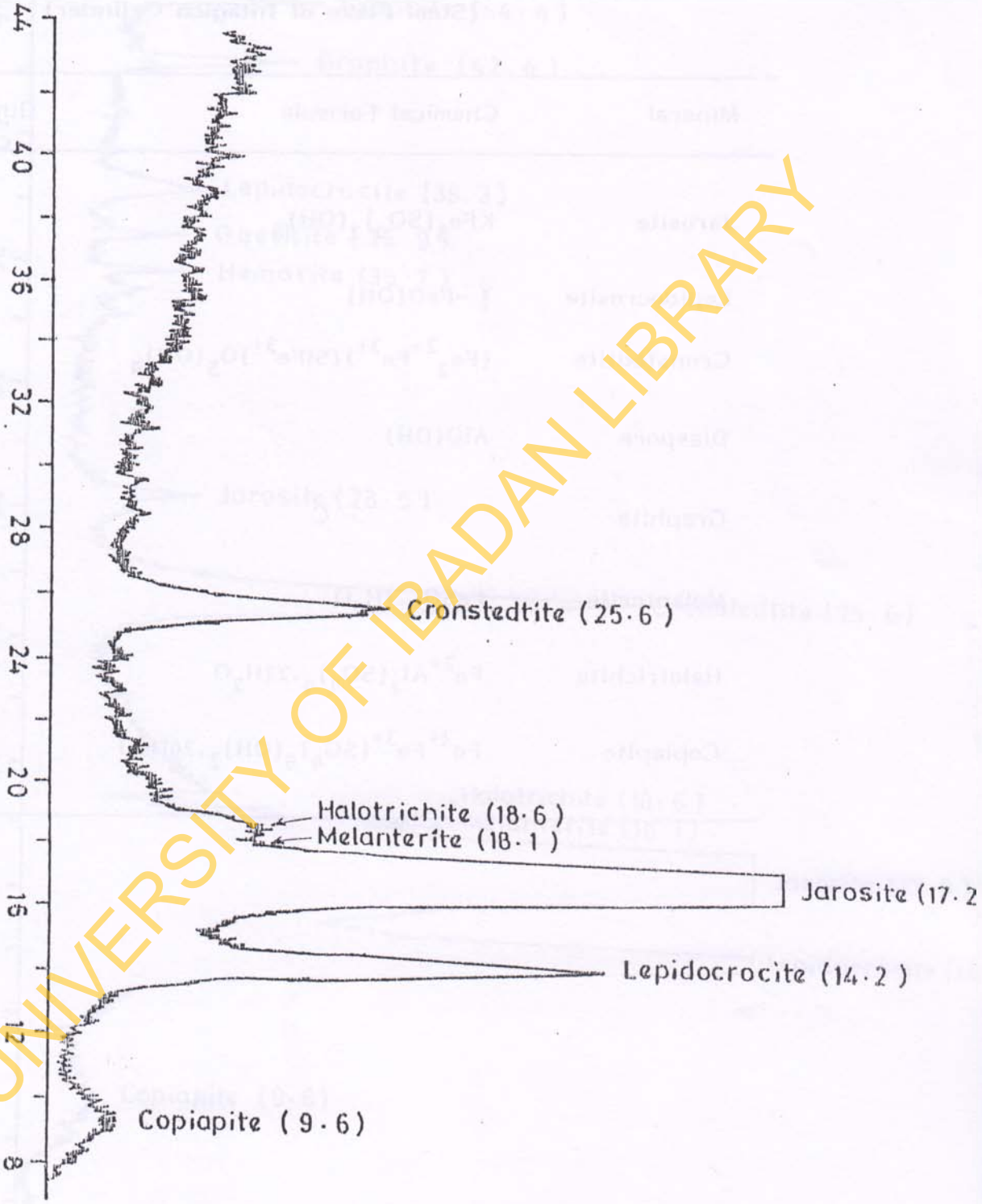

Fig. 1 : Diffractogram for sample 1

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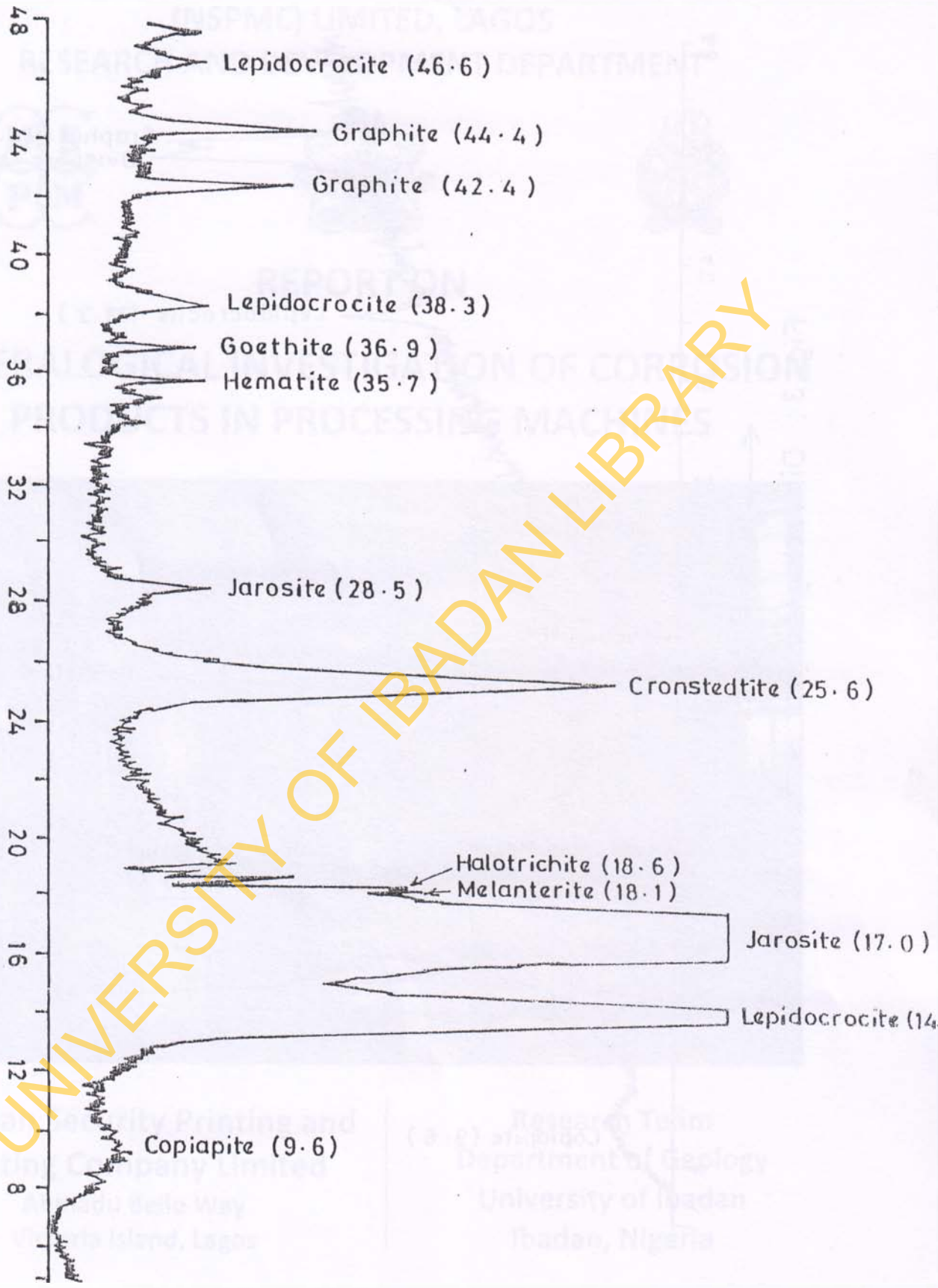

Fig. 2: Diffractogram for sample 2

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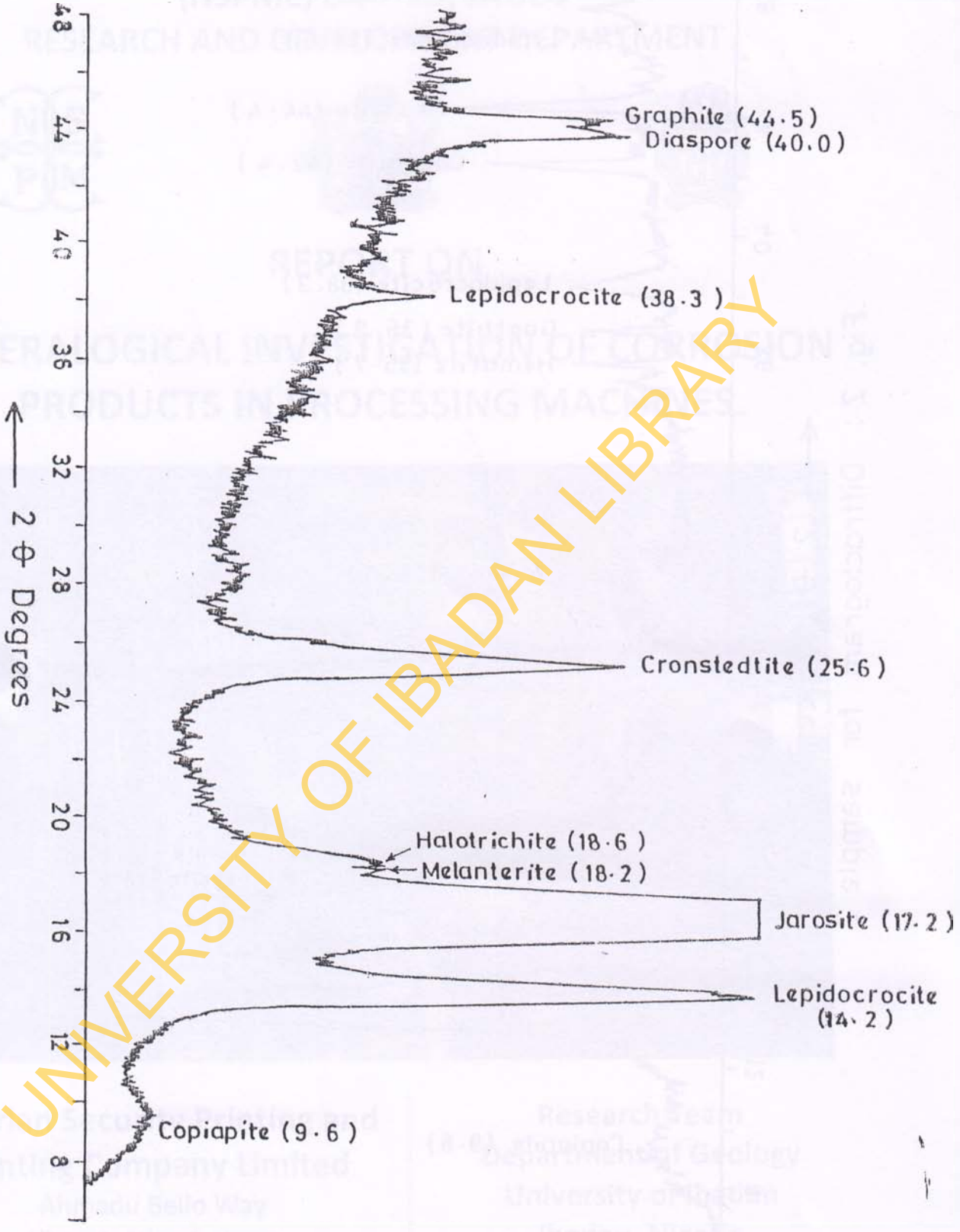

Fig. 3: Diffractogram for sample 3

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