X-RAY AND MÖSSBAUER CHARACTERISTICS OF A CUMMINGTONITE FROM YELLOWKNIFE, DISTRICT OF MACKENZIE

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INTRODUCTION

Cummingtonite in the metasedimentary sequence of Archean age about 40 km northeast of Yellowknife was reported by Kretz (1967). The mineral is confined to thin layers that are rich in silica (Kamineni 1973), and also within ellipsoidal concretions. Modal percentages as well as the size of cummingtonite vary considerably from the center to rim of the concretions. At the center, the grains are finer and biotite is absent, whilst at the border the grains are coarser and coexist with biotite. Other minerals that are commonly observed in these rocks are ilmenite, sodic andesine and apatite. Occasionally, garnet, epidote and gedrite, and rarely hornblende are also present.

CHEMICAL COMPOSITION AND X-RAY DIFFRACTION PATTERN

The cummingtonite-bearing rock (No. 286, Kamineni 1973) chosen for the study contains biotite, ilmenite and plagioclase (An$_{36}$), and occurs near the cordierite isograd. On the basis of mineral assemblages, the temperature of formation of cordierite is estimated to be 500°C (Kamineni 1973).

Cummingtonite was separated by the conventional methods of magnetic separation and heavy liquids, and the final product was hand-picked to a purity of 99% or better.

Chemical analysis of cummingtonite was performed by using a combination of techniques: atomic absorption for Fe (total), Mg, Mn, Ca, K, Na; electron microprobe for Si, Al and Ti; and classical methods for FeO and H$_2$O. The chemical analysis is given in Table 1.

The x-ray powder patterns were obtained with Mn-filtered Fe $K\alpha$ radiation, and correction for film shrinkage was applied by means of an internal standard (quartz). The results obtained by using a least square refinement program are given in Table 2. These values compare well with cummingtonite 10Å of Klein (1964).

MÖSSBAUER SPECTRA

Finely ground cummingtonite powder (-400 mesh) was used to obtain the Mössbauer spectra,

TABLE 1. CHEMICAL COMPOSITION OF CUMMINGTONITE

	wt. %		No. of ions on the basis of 24 (O,OH)	
SiO$_2$	54.10	Si	8.035	
TiO$_2$	0.04	Ti	0.004	
Al$_2$O$_3$	0.30	Al	0.052	
Fe$_2$O$_3$	1.66	Fe^{3+}	0.184	
FeO	25.42	Fe^{2+}	3.157	
MnO	0.78	Mn	0.097	6.863
MgO	14.71	Mg	3.256	
CaO	0.58	Ca	0.092	
Na$_2$O	0.11	Na	0.015	
K$_2$O	0.06	K	0.005	
H$_2$O$^+$	1.88	OH	1.901	
H$_2$O$^-$	0.04			
Total	99.68			

TABLE 2. X-RAY DIFFRACTION DATA OF CUMMINGTONITE

hkl	d_{calc}	d_{obs}	I/I_o	hkl	d_{calc}	d_{obs}	I/I_o
020	9.101	9.082	40	351	2.035	2.038	20
110	8.297	8.259	100	370			
11$\bar{1}$	4.820	4.810	5	190	1.994	1.997	5
040	4.550	4.538	35	40$\bar{2}$	1.945	1.965	5
220	4.149	4.145	40	191	1.875	1.877	10
13$\bar{1}$	3.858	3.861	35	460	1.848	1.851	10
131	3.448	3.444	5	371	1.785	1.785	20b
240	3.256	3.253	90	461	1.658	1.658	80
060	3.064	3.060	100	1.11.0	1.629	1.629	80
310	3.033	3.058	5	2.10.1	1.577	1.579	15
221	2.998	2.985	10	600	1.554	1.555	40
151	2.748	2.741	90b	0.12.0	1.517	1.517	70
061	2.620	2.623	40	3.11.0	1.460	1.460	30
202	2.499	2.503	40b	4.10.$\bar{1}$	1.430	1.434	25
350	2.362	2.366	20	512			
080				46$\bar{3}$	1.383	1.381	60
35$\bar{1}$	2.290	2.294	35b	66$\bar{2}$	1.325	1.325	30
42$\bar{1}$	2.240	2.245	40	2.12.$\bar{2}$	1.297	1.296	40
261	2.190	2.190	90	4.12.0	1.271	1.270	30
242							
081	2.090	2.092	10				
202							

$a=9.525\pm 0.003$
$b=18.202\pm 0.004$
$c=5.313\pm 0.003$ Å
$\beta=101.83\pm 0.40°$

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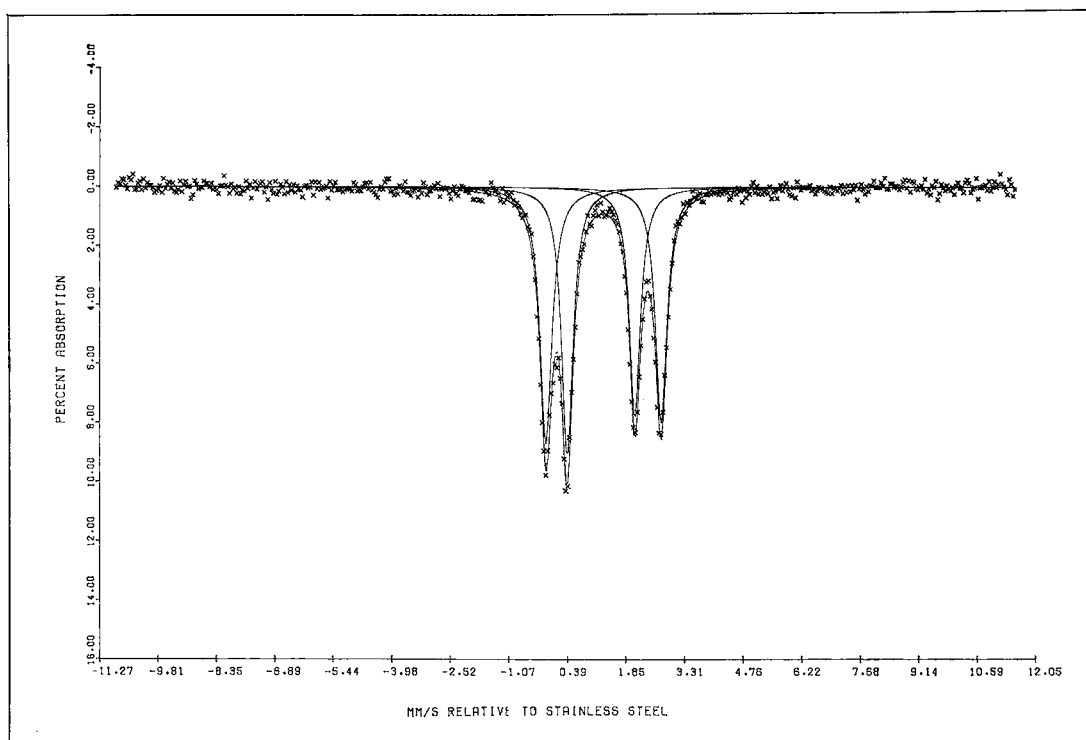
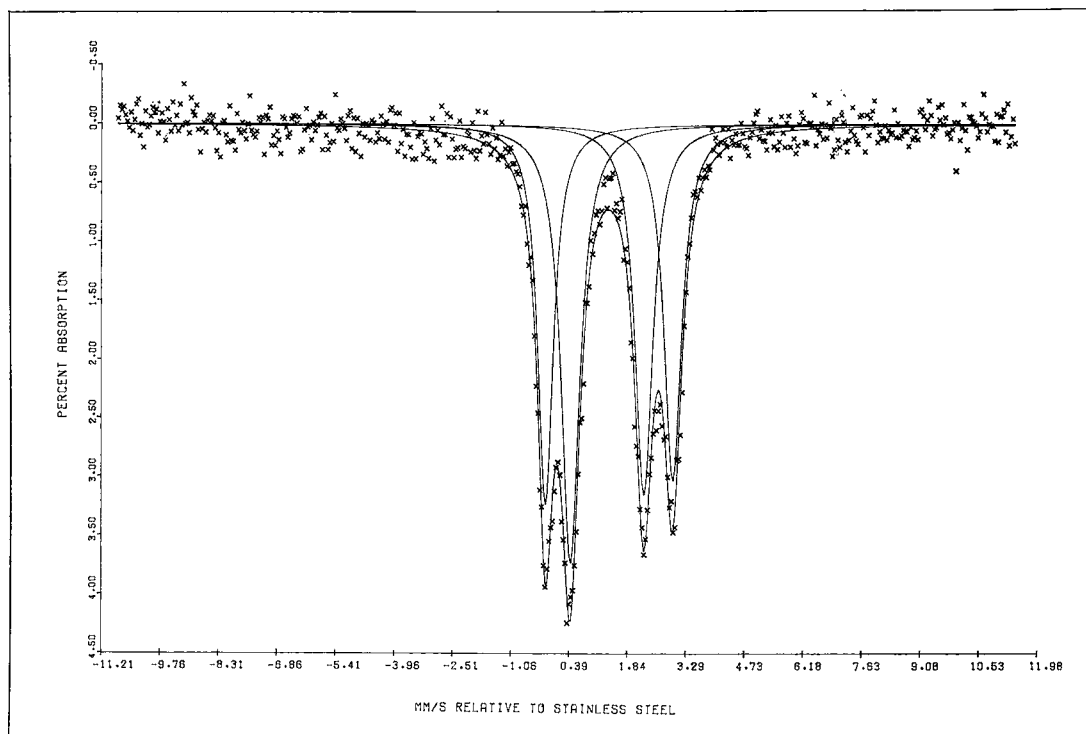FIG. 1. Mössbauer spectra of the cummingtonite at 298°K.

FIG. 2. Mössbauer spectra of the cummingtonite at 77°K.

both at room and liquid nitrogen temperatures. Co^{57} source in copper was used. The data obtained were fitted by a least square iterative procedure to a given number of Lorentzian curves (Figs. 1 and 2) by a computer.

As has been noted by Ghose & Hafner (1968) and Buckley & Wilkins (1971) respectively, for metamorphic and volcanic cummingtonites, small differences in spectra at room (298°K) and liquid nitrogen (77°K) temperatures are observed.

The Mössbauer parameters obtained from the computer output are shown in Table 3. Following the procedure of Bancroft *et al.* (1967), the inner two peaks have been assigned to ferrous iron in the M_4 position, and the outer peaks to ferrous iron in M_1, M_2, M_3 positions. The proportions of iron in M_4 and M_1, M_2, M_3 are calculated (room temperature) from the relation used by Bancroft *et al.* (1967), $A_4/A_{1,2,3} = 0.9\ n_4/n_{1,2,3}$ where A is the peak area, n is the number of ferrous atoms and the subscripts refer to atomic positions. On this basis, the value

obtained for ferrous iron is 1.61 in M_4 and 1.51 in M_1, M_2, M_3.

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Manuscript received June 1973.

TABLE 3. MÖSSBAUER PARAMETERS OF CUMMINGTONITE

T°K	peak	width	area	doublet	isomer shift	quadrupole shift
298	1	0.40	0.37	1 & 4	1.27	2.87
	2	0.37	0.36			
	3	0.36	0.30	2 & 3	1.21	1.67
	4	0.38	0.32			
77	1	0.52	0.36	1 & 4	1.38	3.16
	2	0.62	0.50			
	3	0.59	0.41	2 & 3	1.33	1.82
	4	0.58	0.39			

ON THE REPORTED URANITE, URANOCHRE AND URANOCITE OF THE SEYMOUR IRON MINE, MADOC TOWNSHIP, ONTARIO.

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Recent reports on uranium occurrences near Madoc, Ontario (Boyle & Steacy 1973; Grasty & Charbonneau 1973; Steacy *et al.* 1973) may renew interest in earlier accounts of other occurrences in the area. The purpose of this note is to correct an erroneous report of a secondary uranium mineral at the old Seymour iron mine, lot 11, concession V, Madoc township. The occurrence was first noted in Logan (1863) and reference has been made to it periodically since then.

In his description of the Seymour deposit, Logan (p. 675) notes that "yellow uranite occurs in small quantities in the fissures (in the ore)", and again, in the chapter on mineral species, prepared by T. Sterry Hunt, Logan (p. 504) records under uranium that "uran-ochre, in the form of a sulphur-yellow crystalline crust, has been observed lining fissures in the magnetic iron ore of Madoc". Hoffmann (1886) refers to the mineral as uraconite. Two magnetite-rich specimens from the Seymour mine, carrying