

this line to inter-molecular oscillations of polymerised groups of molecules in the solid. In a note⁶ to *Current Science*, I have shown that this frequency-shift agrees approximately with the Lindemann frequency as well as with the Pauling rotational frequency of solid CO₂. I was thus led to conclude that the new line observed by Sirkar arises from coherent rotational oscillations of molecules in the crystal lattice. This point of view has been fully supported by later theoretical and experimental researches on the subject by several authors.

In the present note, the following frequencies, duly corrected for low temperatures, are adopted for the calculation of specific heat of carbon dioxide: 668, 1,336 and 2,350 cm.⁻¹ for internal frequencies and 63 cm.⁻¹ for rotational frequency and 122, 61.5 and 32 cm.⁻¹ for the first, second and third order lattice translational frequencies. The specific heat, C_v at any temperature T° K. is represented by the relation,

$$C_v = 1/3E \left(\frac{958}{T} \right) + 1/3E \left(\frac{1915}{T} \right) + 2/3E \left(\frac{2370}{T} \right) + 8/3 \cdot 1/3E \left(\frac{93}{T} \right) + 3/4 \cdot E \left(\frac{180}{T} \right) + \frac{7}{4 \times 8} E \left(\frac{90}{T} \right) + \frac{7}{4 \cdot 8 \cdot 8} E \left(\frac{45}{T} \right).$$

TABLE I

T°K	C _v Raman Theory	C _p Observ.	C _v Observ.	C _p B & Z
15	0.52	.54	.54	.52
20	1.286	1.23	1.23	1.16
30	3.067	3.08	3.08	2.95
40	4.624	4.69	4.65	4.70
50	5.824	6.10	5.88	6.11
60	6.715	7.18	6.82	7.17
70	7.437	7.97	7.48	7.98
80	7.866	8.58	7.77	8.61
90	8.237	9.11	8.29	9.12
100	8.541	9.53	8.53	9.54

The experimental value of C_v is computed from the data for C_p and the melting point of CO₂. The values of temperature, C_v (calculated), C_p (observed) and C_v (observed) are given in columns 1 to 4 of Table I. Column 5 gives the values of C_p calculated by Brucksch and Ziegler⁷ on the basis of the theoretical views of Andrews and Lord for comparison. The excellent agreement between the experimental values of specific heat and those calculated according to Raman's theory shows that the latter is applicable to molecular compounds as well.

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September 6, 1943.

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1. Symposium of papers on thermal energy of crystalline solids, *Proc. Ind. Acad. Sci.*, (A), 1941, **14**, 459-506.
2. Raman, C. V., *Ibid.*, 1941, **14**, 459. 3. Fermi and Rasetti, *Zeit. f. Physik*, 1931, **71**, 689. 4. Venkateswaran, C. S., *Proc. Ind. Acad. Sci.*, A, 1941 **14**, 506.
5. Sirkar and Gupta, *Curr. Sci.*, 1937, **6**, 21. 6. Venkateswarn, C. S., *Ibid.*, 1938, **6**, 378. 7. Brucksch and Ziegler, see *Joun. Chem. Physic*, 1942.

ABSORPTION SPECTRA OF ORTHO-DICHLOROBENZENE

A CAREFUL study of the ultra-violet absorption spectra of *o*-dichlorobenzene has been made using a very simple method of developing the absorption bands. A hydrogen discharge tube was used as the ultra-violet source and the vapour was contained in a tube 20 cm. long and 2.5 cm. in diameter with plane quartz windows at both ends. Twelve absorption bands have been obtained at the optimum condition corresponding to 14 mm. mercury pressure and a temperature of 24° C.

The following are the wavelengths and wave-numbers of the band heads:—

No. of bands	λ in Å° (in air)	ν per cm. ⁻¹ (in vacuum)
1	2,799.1	35,716.5
2	2,794.2	35,779.1
3	2,774.1	36,038.4
4	2,767.3	36,126.9
5	2,762.6	36,187.1
6	2,757.5	36,254.0
7	2,751.6	36,293.5
8	2,713.3	36,844.5
9	2,708.2	36,913.9
10	2,684.9	37,234.2
11	2,680.0	37,302.3
12	2,596.1	38,507.8

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AN ORTHOPYROXENE FROM DODKANYA, MYSORE

An orthopyroxene occurs in large grains, sometimes 1 cm. in length, in a norite of the gneissic complex of Dodkanya bordering the Ultra-basic intrusives of the area. Mr. B. Rama Rao, Director of Geology, Mysore Geological Department, has had this mineral analysed in connection with his memoir on "Charnockites", which he is now writing. The analysis is herein reproduced with his kind permission.

The orthopyroxene is striated on the (100) and pyramidal faces, and, under crossed nicols, shows, occasionally, minute lamellæ, crossing the prismatic cleavages on pyramidal faces. The lamellæ are localised in certain areas of the same plate. The mineral plates show strain shadows. When tilted on the Universal Stage, the lamellæ on the pyramidal faces disappear towards (010) and (001) faces, but become sharp on the (100) face with alternating dark and bright bands. They give an extinction angle of ± 6° on pyramidal faces, which are cut near (010—100) zone, and ± 3° on the same faces, when tilted to the (100) position. The very minute lamellæ are, therefore, slightly variable in chemical composition. The mineral contains plenty of inclusions of plagioclase, which develop radial pressure cracks in the orthopyroxene host; and

a brownish-green amphibole, typical of the charnockites, develops at the contact of the gneiss with the host.

The crystal is set in Fig. 1, following the Pseudo-tetragonal rule applicable to crystal-setting in the Orthorhombic system, whereby angle $a m < b m$.

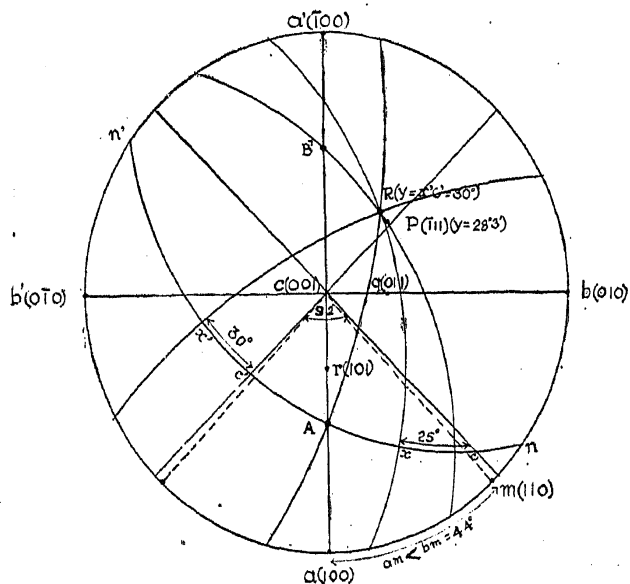


FIG. 1

The obtuse cleavage angle is 92° , and the optic plane bisects this angle; therefore XZ is // to (010) . The optic axial angle was measured directly on the Federov's stage, on a (100) section of a grain not showing the lamellae, by the method of sharp extinction in the 45° position. The optic axial angle is $73^\circ 58'$. The mineral is negative in optic sign and positive in elongation. $X = a$, $Y = b$ and $Z = c$; $Bx_{ac} = X$ and is $\perp r$ to (100) . The mineral is intensely pleochroic with $X =$ clear red, $Y =$ pale yellow, and $Z =$ clear green. The refractive indices are $\alpha = 1.684$, $\beta = 1.690$ and $\gamma = 1.694$. $\gamma - \alpha = .010$. The optical characters of

this mineral are between those recorded for hypersthene, from Lauterbach and Labrador.¹

	Lauterbach	Orthopyroxene Dodkanya	Labrador
% FeO + MnO	10.6	10.5	14.8
2V over Z	95° (2V over X = 5°)	$104^\circ 2'$ (2V over X = $73^\circ 58'$)	—
Ng	—	1.694	1.705
Nm	1.685	1.690	1.702
Np	—	1.684	1.692
Ng - Np	—	0.010	0.013

(100) and (010) sections give straight extinction, but others give oblique extinction with a maximum extinction angle of 31° . The section giving an extinction angle of 31° does not show any lamellae. To test if this section was not cut parallel to a pyramid of the orthopyroxene, the grain was mounted on the universal stage, and the emergence of optic axis B' was located giving the co-ordinates $a'_{E-W} = 20^\circ 50'$ and $a'_{N-S} = 29'$ for the pole R. The pole R of the hypothetical pyramid and its trace are projected in Fig. 1. By the Biot-Fresnel Law, the cleavage angles on this hypothetical pyramid are the arcs x' , c' and xc , which read 30° and 25° respectively. The extinction angle of 30° , thus deduced by the graphical method, is in close agreement with the observed angle 31° . For comparison is reproduced the calculated angle $28^\circ 3'$ for the unit pyramid $P(\bar{1}11)$ of the hypersthene of Halagur.² The high extinction angles of the orthopyroxene under study, are therefore, the extinction angles, theoretically possible on pyramids of orthorhombic crystals.³

The chemical composition of the mineral is herein set down, alongside the chemical composition of orthopyroxenes of the Bushveldt type, studied by H. H. Hess and A. H. Phillips.⁴ Analysis of a hypersthene from the Charnockites of Uganda is also included.

	I	III	IV	Orthopyroxene Dodkanya	Hypersthene Uganda	Metasilicate molecules: Orthopyroxene Dodkanya
SiO ₂	53.61	53.60	54.63	52.66	55.15	
Al ₂ O ₃	1.67	3.51	2.39	1.28	6.50	MgSiO ₃ — 66.40
Fe ₂ O ₃	1.48	0.79	1.71	5.47	2.10	
FeO	6.70	11.38	7.07	9.36	17.68	FeSiO ₃ — 17.29
MgO	33.15	25.34	30.30	26.58	16.62	
CaO	2.32	4.19	2.20	3.30	1.58	CaSiO ₃ — 6.84
Na ₂ O	0.04	0.25	0.45	0.84	—	
K ₂ O	0.06	0.03	0.11	0.18	—	Na ₂ SiO ₃ — 1.59
H ₂ O	0.54	0.27	0.52	0.19	—	
H ₂ O	0.08	0.04	—	0.32	—	MnSiO ₃ — 1.70
TiO ₂	0.09	0.29	0.36	tr	0.03	
P ₂ O ₅	tr	—	0.12	nil	—	AlAlO ₃ — 1.28
Cr ₂ O ₃	0.38	—	—	—	—	
MnO	0.16	0.19	0.14	0.89	0.34	FeFeO ₃ — 5.47
	100.16	99.88	100.00	100.73	100.00	100.57

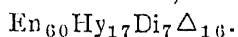
I, III, IV copied from the *American Mineralogist*, 1938, 23, 453, H. H. Hess and A. H. Phillips.

Orthopyroxene, Dodkanya.—Analyst, B. Sadasiva Raju, Chemist, Mysore Geological Department.

Hypersthene, Uganda.—A. W. Groves, *Q.J.G.S.*, 1935, 71, 156.

The chemical analysis of the Dodkanya orthopyroxene does not accord with that of the Charnockite type, but is in fair agreement with the analysis of the Bushveldt type, except for the high content of ferric iron, which accounts for the intense pleochroism of the Mysore mineral. The presence of alumina and alkalis in the analyses of orthopyroxenes is pointed out by Hess and Phillips to be characteristic of orthopyroxenes of the Bushveldt type. It may be remarked that the ratio of soda to potash, and of both to lime, are ratios, fairly constant in the rock analyses of the Charnockites of India. Hess and Phillips ascribe the CaO content to the presence of the Diopsidic molecule as lamellar intergrowths in the orthopyroxene host; they also hold that some of the low extinction angles are due to this intergrowth.

Calculating the chemical analysis in terms of metasilicate molecules, and expressing the mineral in terms of its minals, the mineral of Dodkanya has the formula,



Winchell⁵ has proposed the restriction of the term Bronzite to an FeO tenor of 5-14 per cent. or of FeSiO₃ tenor of 9.2-25.72 per cent. The mineral under study is, therefore, a Bronzite of the Enstenite series, but it has not the typical inclusions of Bronzite.

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August 14, 1943.

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1. Winchell, A. N., *Elements of Optical Mineralogy*, 1933, 2, 217. 2. Naidu, P. R. J., *Curr. Sci.*, 1943, 12, No. 5, 158. 3. Johannsen, A., *Petrography*, 1937, 3, 213. 4. *American Mineralogist*, 1938, 23, 453. 5. Alling, H. L., *Interpretative Petrology of the Igneous Rocks*, 1936, p. 85.

A NOTE ON THE COAGULATION STUDIES OF THE LATEX OF *CRYPTOSTEGIA GRANDIFLORA* R. Br. AS A WAR-TIME SOURCE OF VEGETABLE RUBBER

IN a previous communication¹ describing the Chemical and Technological investigations on *Cryptostegia grandiflora*, a method of coagulating cryptostegia latex with water was reported. This method consists in mixing 20 volumes of distilled water, 15-16 volumes of tap water or 6-8 volumes of hot water, to latex whereby it gets coagulated yielding a white coagulum of rubber which can be sheeted and a clear straw coloured or red serum.

When the pH value shifts towards the alkalinity side, coagulation takes place. Continuation of the investigations showed that although this method has the advantage that it does not require acids or other chemicals, it has the disadvantage that on the large scale it involves the use of large quantities of water and bigger coagulating tanks. It was, therefore, considered necessary to devise a still simpler and more advantageous method of coagulation. Investigations were carried out

with a large number of substances such as calcium and sodium chlorides, sodium, potassium, calcium and ammonium hydroxides and carbonates, alcohol, acetic acid and formaldehyde and eventually the following method has been found to answer the purpose in view. The following tentative conclusions can be drawn:—

1. Latex can be coagulated by diluting it with water (1/100 part that of latex) of an alkalinity which would bring the final pH value to the vicinity of 7.7.

2. The per cent. dry rubber obtained does not vary much with coagulants.

3. Three volumes of a solution of lime water saturated at 31° C. (approximately N/25.5) are required to bring about coagulation, while of N/10 NaOH, N-NaOH, 10 N-NaOH, only 1, 1/10 and 1/100 volumes respectively are required.

4. The quality of rubber in every case is satisfactory and the coagulum can be sheeted.

Description of the Method.—Take latex (20 c.c.) in a beaker, add 10 N-NaOH (0.2 c.c.). The solution turns dirty pink. On warming to 80-90° C. it separates into a clear blood red to brownish red serum and a white coagulum of rubber. The coagulum is sheeted and after washing it with water till it is free of alkalinity, it is dried at 90-95° C. in an air oven.

The details will appear elsewhere.

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¹ *Journal, Board of Scientific and Industrial Research*, July 1943, 1, No. 4, 365-57.

THE BERBERINE CONTENT OF *COSCIINIUM FENESTRATUM* (COLEBR.)

WE are glad to confirm the observation of Varier and Pillai¹ that berberine is the predominant alkaloidal constituent of *Coscinium fenestratum* by putting on record a brief note of an examination of Ceylon material carried out in 1939.

Air-dried stems (moisture 6.8 per cent., ash 2.6 per cent.) were exhausted with 95 per cent. alcohol in a Soxhlet apparatus, which removed 9.2 per cent. of material. From the alcoholic extract berberine is readily precipitated as the acid sulphate by addition of a slight excess of sulphuric acid (the yield of crude salt 4.1 per cent.).

The combined filtrates after separating and washing the berberine acid sulphate with alcohol, were evaporated and taken up in water and ether; the latter solvent removed resinous matter (4.1 per cent.). The aqueous solution after thorough ether extraction was made alkaline with caustic soda and again extracted with ether which removed 0.67 per cent. of crude alkaloids. After treatment with carbon dioxide, the aqueous liquor yielded to ether a further 0.2 per cent. of crude phenolic alkaloids.

We should not, therefore, go as far as Varier and Pillai in stating that berberine is the only