Λ_{eff} (t) is a positive effective "cosmological" contribution to the Lagrangian. As we remarked earlier the Λ term in Eqs. (6) and (8) is of the same order of magnitude as Trautman's torsion term.

Also it is interesting to note that by using G_f instead of G, the absurdly high density $c^5/G^2\hbar \simeq 10^{94}$ g. cm.$^{-3}$, at which quantum effects of the gravitational field and of space-time curvature are expected to become important is reduced (scaled down) to $\simeq 10^{17}$ g. cm^{-3}, the same value as quoted above. This enables us to explain the somewhat paradoxical result of our getting a much larger radius R(0) and a much lower density ρ (0) on using the higher coupling constant G_f when one would have expected the reverse to happen, *i.e.*, lower radius and higher densities due to the larger gravitation constant, (and hence stronger collapse). The answer is that for *f*-gravity the quantum effects which avert the singularity and halt the collapse (essentially through the Λ term) become important at much lower densities ($\simeq 10^{17}$ g. cm^{-3}) and hence larger radii of the collapsing matter than in classical GTR when these effects become important only at densities $\simeq 10^{94}$ g. cm^{-3} corresponding to much lower initial radii. For classical GTR with $\Lambda = 0$ and without consideration of quantum effects, the density of the singularity is infinity corresponding to R(0) = 0. That the Λ term can avert total collapse is indicative of a repulsive interaction effect. In fact, in a recent work it has been shown that the theory with Λ is related to massive scalar mesons and spin 2^+ tensor mesons, with the former being more massive. Also, the former seems to have a repulsive shorter-range interaction[18]. A brief account of the work reported here appears in Nature[19].

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KAEMMERERITES FROM CHROMITE DEPOSITS OF BYRAPUR, HASSAN DISTRICT, KARNATAKA STATE

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ABSTRACT

Two physically distinct varieties of chromium chlorites occur in the chromite deposits of Byrapur, which form a part of the Naggehalli schist belt. They differ in their habit, one being flaky and the other lamellar to fibrous. Cr_2O_3 in the flaky chlorite is 3·9% and in the lamellar it is 4%. Based on the spacing d_{007} and intensity d_{002} reflections (Lapham, 1958), the Cr is believed to be in the octahedral coordination in both the varieties and hence identified as kaemmererites.

THE Nuggehalli schist belt of Karnataka State extending over a length of 40 km. (Lat. 12° 58′ 30″–13° 17′ 43″ and Long. 76° 17′ 20″–76° 29′ 30″) and a width of about 1·5 km. is composed of green schists, amphibolites, serpentinites, and lenses of dunite transected by siliceous and carbonate veins. The ultramafic lenses contain rich chromite deposits. In association with these chromite deposits, the occurrence of chromium chlorites has been reported earlier from Hulikere chromite mines near Jambur, Hassan District (Viswanathiah[7], 1951; Varadarajan[6], 1964) and chromite mines of Byrapur, Hassan District (Varadarajan[5], 1957).

The authors during the course of their field work encountered chromium chlorites that were distinct in their habit, flaky and lamellar, associated with the ultramafites of Byrapur chromite mines, Hassan District. The flaky form occurs as lensoidal lumps in carbonate veins or as thin films bordering these veins which transect the chromite ore. The lamellar form is always associated with the carbonate and serpentine veins, where the lamellae are aligned across the direction of the veins. These forms were earlier identified by Vardarajan[5], (1957) as kaemmererite (flaky) and kotschubeite (lamellar), based on their tetrahedral Al content and $Fe/Fe + Mg$ ratio.

X-ray powder data, chemical and differential thermal analysis for the two forms, and their identification based on their crystallochemical characteristics are presented in this paper.

Physical and Optical characteristics.—Chlorites of both flaky and lamellar habits are light to deep purple in colour. The flaky variety is more elastic and could be cleaved into thin flakes, whereas the other variety is lamellar to fibrous and rather brittle. Both are non-pleochroic, show anomalous deep blue to violet interference colours and may appear almost isotropic. They are essentially uniaxial negative, though a few grains evidence biaxial isogyres. The optic axial angle for such grains is about 5°. The intimate association and reaction of carbonate material with the chlorites is clear in thin-section.

Instrumental Technique.—Both the samples were carefully purified using bromoform suitably diluted with benzene in order to remove the associated carbonate and other impurities. The sample was further checked and hand picked under binocular microscope. An X-ray powder diffractogram was taken using Shimadzu XRD Unit with CuKα radiation. The 2 θ scanning rate was 1° per minute. Quartz was mixed as internal standard. Chemical analysis was carried out using spectrophotometric method of Riley[4] (1958). Chromium was determined volumetrically by the method of Mall[3] (1964). The D.T.A. was carried out on non-recording type of unit, manually programmed with an automatic transformer to give a heating rate of 10°–12° C per minute. The differential temperature was read on the deflecting galvanometer and the temperature measured with vernier potentiometer. 0·5 gm of powder ground with agate pestle and mortar for about an hour was taken in a stainless steel sample holder. Sintered alumina powder was used as reference material.

Classification.—The chemical analysis and structural formulae are calculated for these two chlorites on the basis of 18 oxygen atoms Table I. CaO and TiO_2

TABLE I

Chemical analysis and structural formulae (Hydrous basis 18 Oxygen Atoms) for Flaky (A) Lamellar (B) Kaemmererites of Byrapur

Oxides		A	B
SiO_2	..	32·47	31·66
Al_2O_3	..	10·57	10·94
Cr_2O_3	..	3·90	4·00
Fe_2O_3	..	0·18	0·37
FeO	..	0·84	0·84
MnO	..	0·21	0·26
MgO	..	37·91	38·16
CaO	..	1·41	1·28
TiO_2	..	0·26	0·33
H_2O^+	..	10·72	11·38
H_2O^-	..	0·78	0·48
TOTAL	..	99·25	99·70

(A) $(Si_{3\cdot023}\ Al_{0\cdot977})\ (Mg_{5\cdot26}\ Al_{0\cdot184}\ Fe^{+3}{}_{0\cdot012}\ Fe^{+2}{}_{0\cdot065}\ Cr^{+3}{}_{0\cdot286}\ Mn_{0\cdot016})\ O_8\ (OH)_{6\cdot662}$.

$(Si\ Al)_4\ (Mg\ Al\ Fe^{+3}\ Fe^{+2}\ Cr\ Mn)_{5\cdot823}\ O_8\ (OH)_{6\cdot662}$

(B) $(Si_{3\cdot105}\ Al_{0\cdot895})\ (Mg_{5\cdot576}\ Al_{0\cdot370}\ Fe^{+3}{}_{0\cdot027}\ Fe^{+2}{}_{0\cdot069}\ Cr_{0\cdot31}\ Mn_{0\cdot021})\ O_8\ (OH)_{7\cdot442}$.

$(Si\ Al)_4\ (Mg\ Al\ Fe^{+3}\ Fe^{+2}\ Cr\ Mn)_{6\cdot373}\ O_8\ (OH)_{7\cdot44}$.

Analyst B. Puttaraj.

are suspected to be due to impurities and omitted in the calculation of structural formulae. The Al was first assigned to tetrahedral site assuming complete tetrahedral occupancy and the remainder Al was assigned to octahedral site. Both the chlorites are relatively rich in Mg and Si. They are poor in Al and Fe content and are similar to the chlorites associated with Alpine chromites and ultramafites (Lapham, personal communication). The Cr_2O_3 in flaky and lamellar forms is 3·9 and 4% respectively. The presence of CaO in the analysis and relatively higher magnesium content is attributed to the intimately interleaved magnesite and calcite, which could not be completely got rid off. There is an apparent charge imbalance with the defficiency of hydroxyl molecules, particularly in the flaky chlorite.

Samples	I endothermic	II endothermic	exothermic
Flaky (A)	710° C	770° C	837° C
Lamellar (B)	702° C	817° C	846° C

Figure I gives the D.T.A. plot of the two Byrapur chlorites. The peak temperatures are given below:

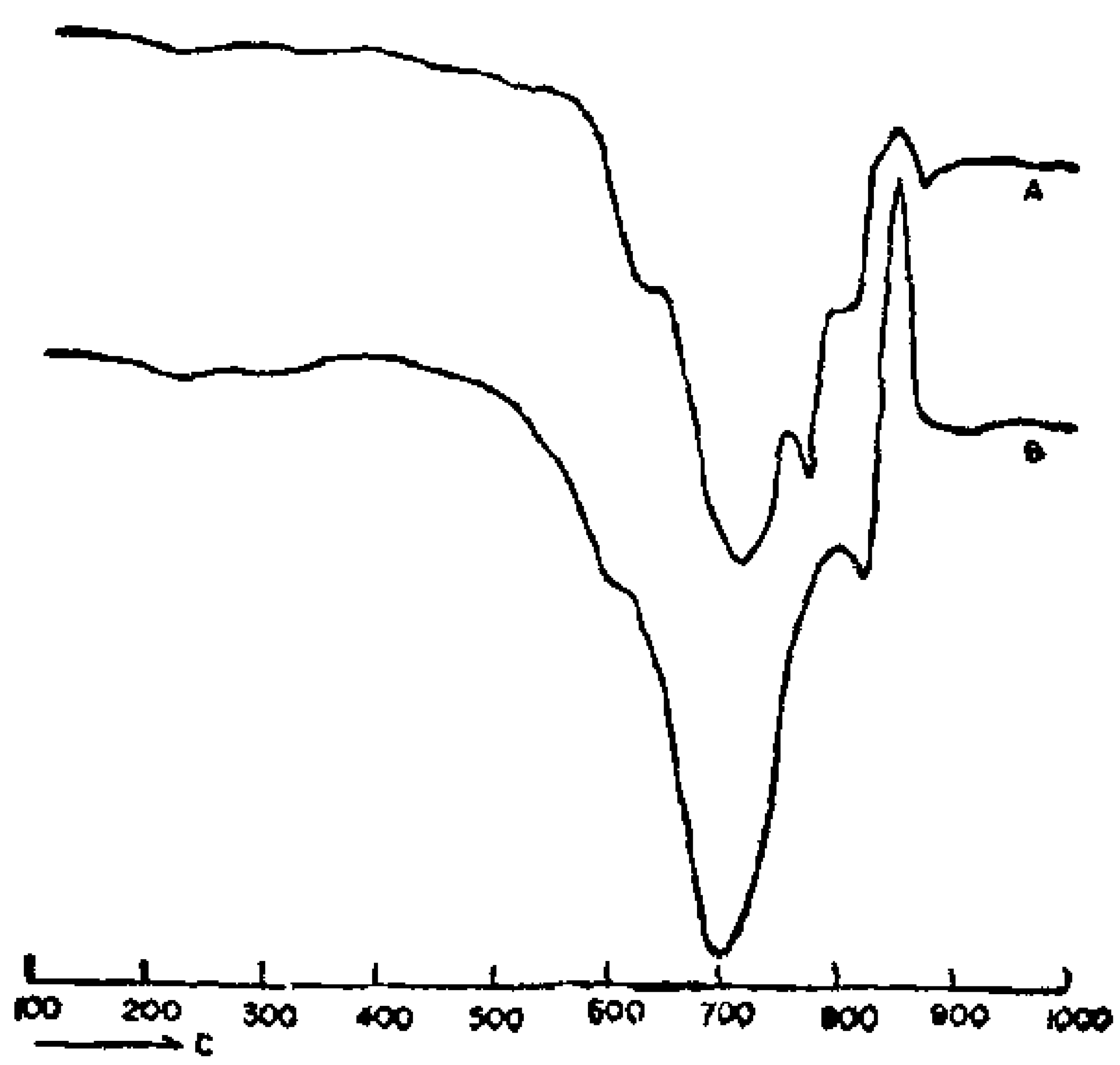

FIG. 1. D.T.A. of flaky (A) and lamellar (B) kaemmererites.

The first two endothermic peaks, corresponding to the expulsion of water from brucite and talc layers respectively, are better resolved in the flaky variety than in the lamellar one. The exothermic decomposition reaction in the lamellar is sharper and more vigorous than in the flaky chlorite. The temperature of decomposition is shown to decrease with increasing chromium content (Lapham[2], 1958). On the other hand in the Byrapur chlorites with an increase of 0·1% of Cr_2O_3 (sample B) the decomposition temperature at about 850° C has increased by 9° and the second endothermic reaction at about 800° C representing destruction of talc layer, by 47° C.

X-ray powder data for the two Byrapur chlorites was obtained with quartz as internal standard, (Table II). The associated carbonate material was identified with powder photographs and is mainly composed of magnesite and a minor amount of calcite.

Lapham[2] (1958) suggested a new classification for chromium chlorites based on the crystallo-chemical characteristics which appear with the introduction of chromium in the structure. Chromium according to him, could occupy a tetrahedral site replacing silica-alumina, or an octahedral site

TABLE II

Powder data of flaky (A) and lamellar (B) Kaemmererites of Byrapur along with the spacings of internal standard quartz.

A		B		Quartz XPDF 5–490	
d Å	I/I_0	*d* Å	I/I_0	*d* Å	I/I_0
14·255	25	14·325	29	..	..
7·179	100	7·181	100	..	..
4·783	59	4·770	67	..	..
4·260	21	4·265	20	4·26	35
*3·978	16	..	..	..	..
3·590	94	3·583	98	..	..
3·336	45	3·348	38	3·343	100
2·870	23	2·867	24	..	..
2·548	13	2·549	16	..	..
*2·495	12	2·509	15	..	..
2·449	14	2·451	15	2·458	12
2·399	13	2·386	12	..	..
2·281	10	2·281	12	2·282	12
2·239	9	2·239	10	2·237	6
2·127	9	2·105	14	2·128	9
2·050	12	2·049	13	..	..
2·014	11	2·014	14	..	..
..	..	..	..	1·980	6
..	..	*1·940	10	..	..
..	..	1·895	9	..	..
1·818	11	1·820	11	1·817	17
1·800	9	..	..	1·801	< 1
..	..	1·703	11	..	..
1·670	9	1·673	10	1·672	7
..	..	1·629	9	1·659	3
..	..	1·578	12	1·608	< 1
1·541	13	1·542	15	1·541	15
..	..	1·507	9	..	..
..	..	1·490	8	..	..
1·430	11	1·435	11	1·453	< 1
..	..	1·406	12	1·418	< 1
1·382	9	1·383	9	1·382	7
1·375	9	1·375	10	1·375	11
..	..	..	..	1·372	9
..	..	1·299	8	1·288	3
..	..	1·230	8	1·256	4
1·199	9	1·196	10	1·199	5
1·181	8	1·182	9	*Plus* ten lines to 1·0346	

* Impurities.

replacing magnesium-iron, this distinction being measurable only when the chromium exceeds 2%. Accordingly chlorite with chromium in the tetrahedral site may be classified as kotschubeite and those in the octahedral site as kaemmererites. An earlier definition distinguished these two varieties by Si/Al ratio (Hey[1], 1954) in which case kotschubeite resembles clinochlore and kaemmererite resembles penninite. Lapham retained these terms for chlorites with chromium less than 2% and

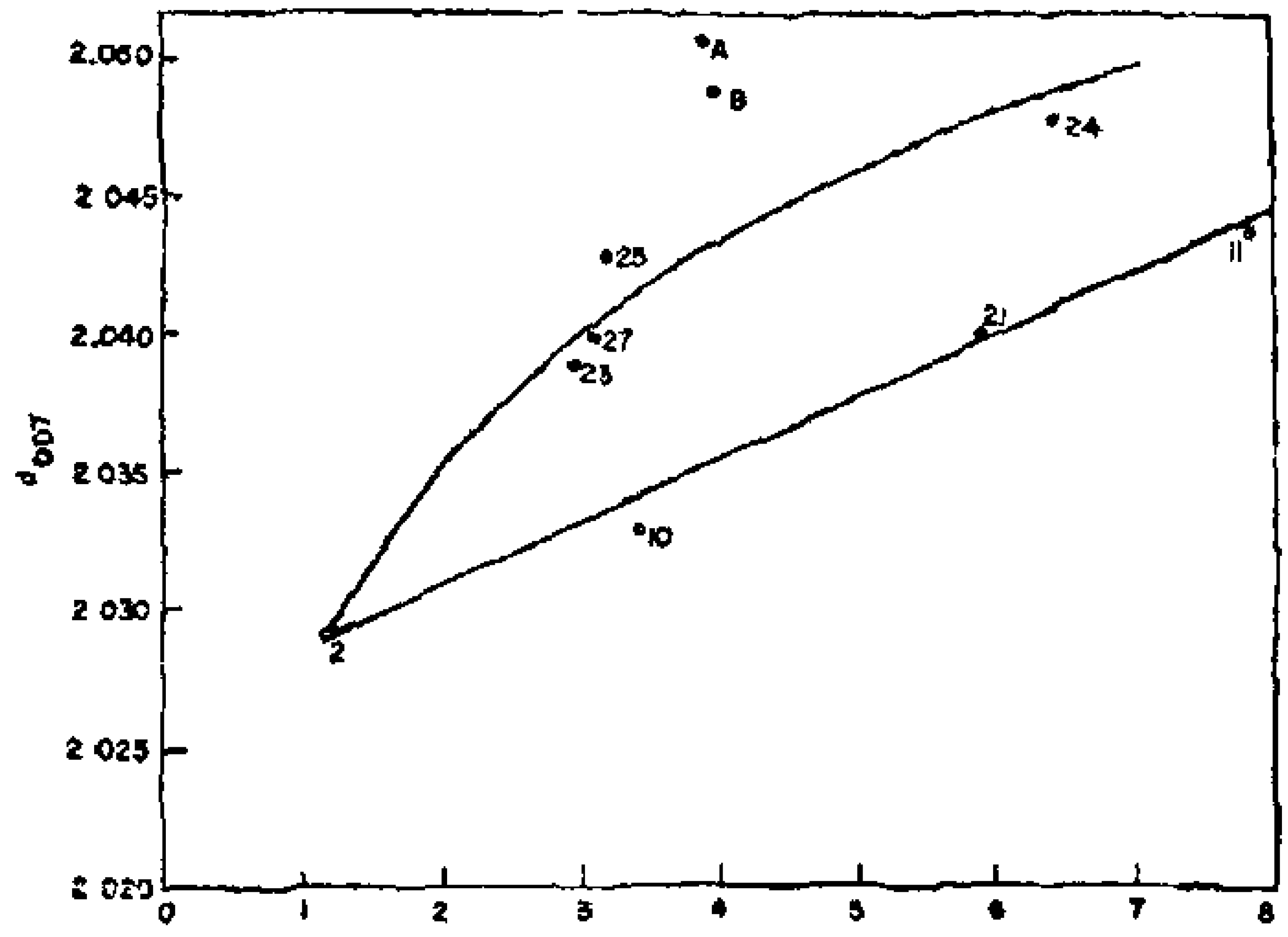

FIG. 2. Variation of chromic oxide content with (007) spacing. The upper curve represents octahedral chromium and the lower curve tetrahedral chromium (after Lapham, 1958).

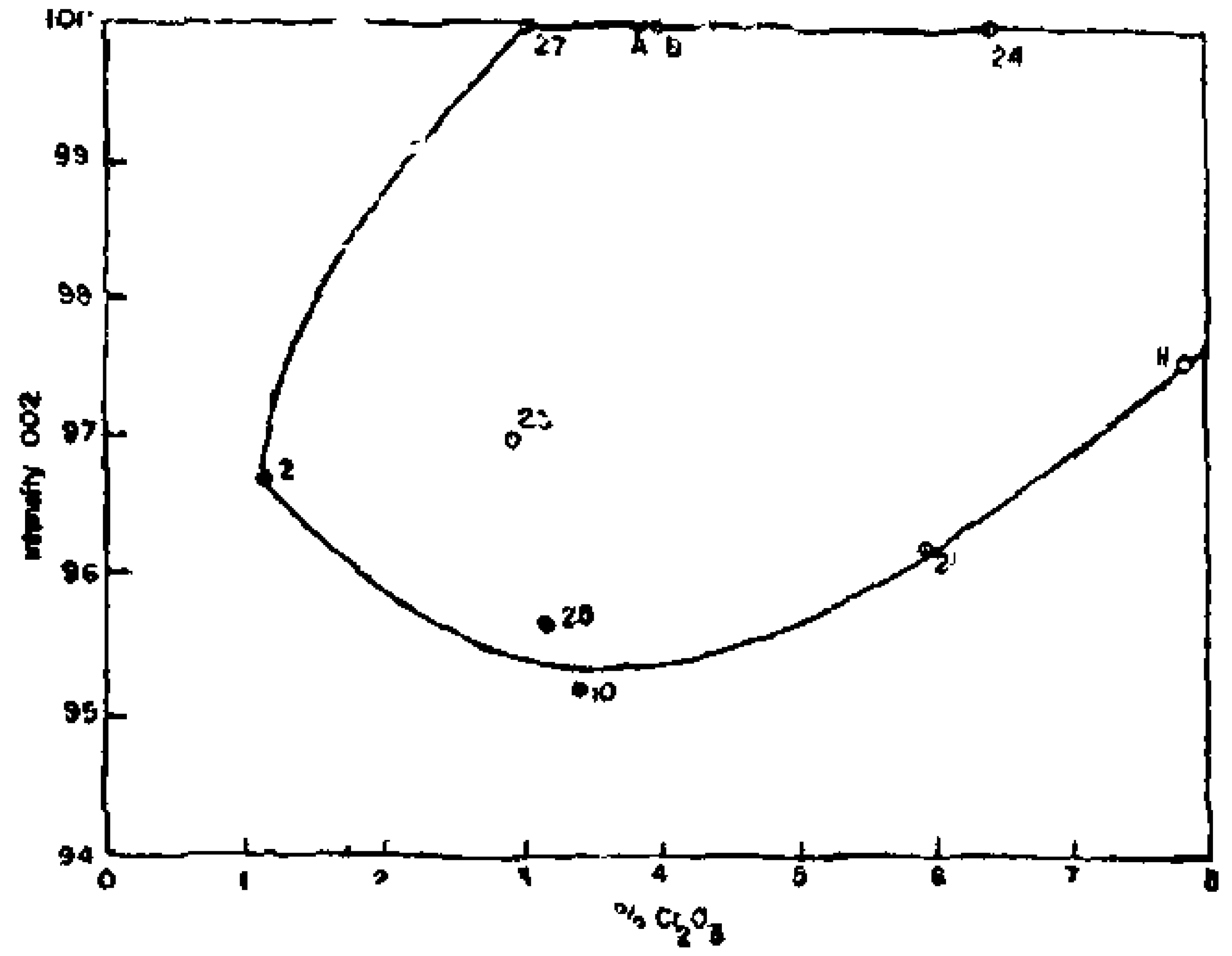

FIG. 3. Variation in chromic oxide content with (002) intensity. The upper curve represents octahedral chromium and the lower curve tetrahedral chromium (after Lapham, 1958).

suggested the use of names peninite and clinochlore by prefixing the term 'chromium'.

The plot of Cr_2O_3 against d_{007} and Cr_2O_3 against intensity of 002 reflections for Byrapur chlorites on the diagrams of Lapham (Figs. 2 and 3) indicate that chromium in both the flaky and lamellar chlorites is in the octahedral position. The presence of more than 2% chromium and its occupancy in the octahedral sites warrants the classification of both the flaky and lamellar chlorites of Byrapur as kaemmererites.

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DEVELOPMENT OF CULTURED PEARLS IN INDIA

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THE technology of production of spherical cultured pearls was first developed in Japan in 1907[1]. In Australia, the first experimental production of cultured pearls was reported in 1957[2]. In India, experiments to produce cultured pearls commenced in 1933 but, despite prolonged efforts, were not successful[3]. The present author, in an earlier communication, described the pearl culture technology of Japan and indicated the prospects of producing cultured pearls in the Indian pearl oyster *Pinctada fucata*[4]. Experiments on pearl culture were initiated at the Pearl Culture Laboratory of the Central Marine Fisheries Research Institute at Veppalodai (near Tuticorin) in December 1972. The successful development of the technology, for the first time in India, is described here.

EXPERIMENTAL PROCEDURE

A pearl oyster farm was established in the Gulf of Mannar, about 1·5 km off Veppalodai. Modern method of raft culture was employed for rearing the oysters which were collected from the pearl banks off Tuticorin. The pearl oysters, after they have grown in the farm for a few months, were brought to the laboratory for surgical operation. A total of 150 oysters was operated in the first series of experiments during May-August 1973. The oysters ranged 53·7–69·0 mm along their dorso-ventral axis and 25·5–51·5 g in weight.