TABLE 2. RECIPROCAL-LATTICE PERIODS FOR STRUCTURE AND BOND ASSEMBLAGE (MORPHOLOGY)

	3-dimensional	2-dimensional			1-dimensional		
	hkl	*h*0*l*	*hk*0	0*kl*	0*k*0	00*l*	*h*00
Structural	a^*, b^*, c^*	$2a^*, c^*$	a^*, b^*	b^*, c^*	$2b^*$	c^*	$2a^*$
Morphological	a^*, b^*, c^*	$2a^*, c^*$	a^*, b^*	b^*, c^* or $b^*, 2c^*$	$4b^*$	c^*	$4a^*$

latter, it is (a, b). As to the yz projection, the period of the bond assemblage could be either (b, c) or $(b, c/2)$. The 1-dimensional conclusions are tentative: the periods of the linear projections on y, z, x, which are $b/2$, c, and $a/2$, for the structure, probably are $b/4$, and c, $a/4$, for the bond assemblage. (Note that, in the yz projection, the projection lines are parallel to the x axis; in the z projection, the projection planes are parallel to xy.) The morphological data of hodgkinsonite are not sufficient to warrant more definite conclusions.

Note added in proof: The structure of hodgkinsonite has now been published by Rentzeperis (*Zeit. Krist.* **119,** 117–138, 1963).

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A CHROME-NICKEL PENNINE FROM SERPENTINITE, JAMBUR CHROMITE MINES, MYSORE STATE, INDIA

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The bluish green variety of chlorite occurring in the form of small veins in the serpentinite mass, adjacent to chromite veins, in the Jambur

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Chromite mines (N. 12°58′45″–12°59′25″: E. 76°28′15″–76°28′37″), Hassan district, Mysore State, India, is found to be a variety of penninite containing both chromium and nickel. The lithology of the Jambur chromite block is characterized by a lensoid serpentinite mass (960 m. ×360 m.) intruding into hornblende amphibolite trending in a NNW–SSE direction. Tabular chromite veins up to 5 m thick (mostly mined out), striking N. 80° E. and dipping N. 10° W. at high angles, occur in a serpentine mass. The veins of the mineral, generally about 1 cm thick, occur around the chromite veins particularly in the footwall of the Sundara Murthy pit. Grains up to 5 mm in diameter lie parallel to the walls of the vein.

Properties

The mineral is micaceous in habit with perfect basal cleavage. In places it is pseudohexagonal in nature. In thin flakes the mineral is pale bluish green but deeper colored in aggregates. The specific gravity is 2.65.

Optical characteristics of the mineral were determined on the universal stage.

The pleochroism is distinct with X = Y = pale bluish green, Z = pale pinkish orange. Extinction is straight. Uniaxial to biaxial; in biaxial grains $2V$ is as large as 12°. The optic sign is positive; optic elongation negative. Z is almost normal to (001); optic plane is (010). Dispersion moderately strong, with r < v. α and β determined by immersion method in sodium light and γ index determined by the method of Fergusson and Peacock (1943) are:

$$\alpha = 1.579,\ \beta = 1.580,\ \gamma = 1.584;\ \pm 0.002.$$
$$\gamma - \alpha = 0.005 \pm 0.002.$$

X-Ray Study

Brindley's investigation of the mineral (pers. comm.) has yielded the following results (Table I).

The results are similar to the data recorded by Lapham (1958, p. 937) for chromian chlorites.

The basal spacing of the mineral is 14.19±0.02 Å. On the basis of the equation $d(001) = 14.55 \times 2.9X$ (Brindley, 1960, p. 270) deducing $X = 0.89$, the estimated tetrahedral ions are $(Si_{3.11}Al_{0.89})$. This falls in the pennine field of Tschermak's classification and also that of Hey (1954, p. 280). The b parameter of the mineral is 9.44 Å.

Brindley (pers. comm.) points out that this value of b (beyond 9.40 Å) is high for chlorite and (if correct) may indicate a considerable percent-

TABLE I. *X*-RAY CRYSTAL DIFFRACTION DATA OF THE Cr-Ni PENNINE

Basal Planes	Intensities	d(Å). (obs.)	d values (obs.)	
001	40	14.0	14.0	
002	85	7.08	14.16	
003	95	4.75	14.25	
004	100	3.562	14.25	
005	34	2.853	14.27	
006	2	2.830	14.28	14.29±0.02
007	10	2.040	14.28	
008	—	—	—	
009	2	1.591	14.32	
00, 10	5	1.431	14.31	

age of iron or similar ions. Brown and Bailey (1963, p. 52) have recorded a *b* value of 9.427 Å for a chromian pennine from Erzincan mines, Turkey, having $Cr_2O_3=9.30$, $FeO=1.40$ and $Fe_2O_3=0.05$ (weight percentages). The mineral investigated here contains $FeO=2.40\%$, $Fe_2O_3=0.50\%$ (Table II).

TABLE II. CHEMICAL ANALYSIS AND THE NUMBER OF CATIONS IN THE UNIT CELL OF THE Cr-Ni PENNINE

Oxides	Wt. %	Mol. Prop.	Oxygen atoms	Hydrous basis 18 Oxygen atoms Tschermak (1891)	Anhydrous basis 14 Oxygen atoms Hey (1954)	
SiO_2	32.99	.5498	1.0996	3.14	3.14	
Al_2O_3	14.12	.1382	.4146	1.58	1.58	0.86
Cr_2O_3	1.56	.0160	.0480	0.18	0.18	0.72
Fe_2O_3	0.50	.0030	.0090	0.03	0.03	
FeO	2.40	.0330	.0330	0.19	0.19	
MnO	0.18	.0028	.0028	0.02	0.02	0.21
MgO	32.98	.8247	.8247	4.72	4.72	
CaO	0.50	.0090	.0090	0.05	0.05	
Na_2O	0.07	.0011	.0011	0.01	0.01	
K_2O	0.05	.004	.0004	0.005	0.005	
H_2O^+	12.66	.7033	.7033	8.02	—	
H_2O^-	0.86					
TiO_2	0.17	.0024	.0048	0.014	0.014	
NiO	0.38	.0048	.0048	0.03	0.03	
P_2O_5	0.07	.0005	.0025	0.006	0.006	
Total	99.49			18.015	9.995	

Analyst: S. Varadarajan.

Chemical Composition

A pure sample of the mineral, devoid of any inclusions, was analyzed according to the methods of Shapiro and Brannock (1956) using G−1 and W−1 as standards (U.S. Bureau of Standards). The chemical composition and the number of cations calculated for the unit cell (hydrous basis 18 oxygen atoms; anhydrous basis 14 oxygen atoms) are given in Table II.

The structural formula for the mineral is:

$$Na_{.01}Ca_{.05}(Mg_{4.72}Al_{.72}Cr_{.18}Fe^{2}_{.21}Fe^{3}_{.03}Ni_{.03})(Si_{3.14}Al_{.86})O_{10}(OH)_{8.02}$$

or

$$Na_{.01}Ca_{.05}(Mg, Al, Cr, Fe^{2}, Fe^{3}, Ni)_{5.9}(Si, Al)_4O_{10}(OH)_{8.02}.$$

It is to be noted that the mineral contains 1.56% Cr_2O_3, and 0.38% NiO. The number of tetrahedral ions calculated from the chemical analysis is $Si_{3.14}$ and $Al_{0.86}$. These correspond very well with those estimated by Brindley on *x*-ray data. Further, the proportion of Si:Al = 1.99:1 is within the range of pennine (Niggli, p. 96).

Discussion and Classification

The mineral investigated is a normal chlorite (Nelson and Roy, 1958, p. 707) with a basal spacing of 14.29±0.02 Å. It is a pennine with Si = 3.14 and Si:Al = 1.99:1; with 1.56% Cr_2O_3 it is a chromian pennine (Hey, 1954, p. 280; Lapham, 1958, p. 953).

But the refractive indices of the mineral are low for the percentage of Cr_2O_3 that it contains (Lapham, 1958, p. 940) and also for the atomic percentage (calculated for 10 cations) of 7.6 for

$$\frac{Fe + Mn + Cr}{Fe + Mn + Cr + Mg}$$

(Albee, 1962 p. 865). The presence of nickel introduces discrepancies and tends to lower the refractive index as is clear from the varieties of chromium chlorites, with and without nickel, investigated by Lapham (1958, p. 940), given in Table III.

Table III

Variety	Wt. % Cr_2O_3	Wt. % NiO	Refractive Indices			$\gamma-\alpha$
			α	β	γ	
No. 2 Lapham	1.14	—	1.577	1.578	1.581	.004
No. 23 Lapham	2.90	0.47	1.568	1.569	1.573	.005
No. 25 Lapham	3.08	0.10	1.573	1.574	1.578	.005
Mineral investigated	1.56	0.38	1.579	1.580	1.584	.005

It is clear from Table III that the refractive indices of the mineral are higher than would be expected for the percentage of Cr_2O_3 and NiO that it contains. But the chromian chlorite series, with varying proportions of NiO, has not yet been investigated sufficiently to justify any generalizations in this respect.

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ON THE OCCURRENCE OF ASBESTOS IN CHAMOLI, U.P., INDIA

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Introduction

Asbestos (Bowles, 1959) mineralization was noted in Kandhara (30° 26′ 10″:79° 5′ 0″) and Jalai villages (30° 27′ 20″:79° 5′ 0″) on the left bank of Mandakini river in the Garhwal Himalaya (Narain, 1954). During 1960–61 Dalela was associated with the prospecting party (Prakash,