Grenville orogeny or any of the Morin series rocks, all of which give ages in excess of 850 million years. Ellsworth (1932) has recorded the only age from the Grenville subprovince comparable with that found for the Chatham-Grenville intrusive. He determined the age of a pegmatite in Cardiff township, Ontario, by the U/Pb ratio to be 627 million years. However, other pegmatities in the same region all have much older ages and it is possible that this single determination is in error.

The age of the Chatham-Grenville intrusive is therefore unique amongst the ages of igneous rocks so far recorded from the Grenville subprovince. Other intrusives that may be of the same age have been mentioned by Osborne (1934, p. 63). They include the Rigaud stock (LeRoy, 1901), the syenite from Boischatel township near Rouyn (Gunning, 1927) and the syenite at the Beattie Gold Mine in Duparquet township (O'Neill, 1932).

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A NICKEL HYDROXIDE MINERAL FROM ROCK CREEK BRITISH COLUMBIA

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A nickel hydroxide mineral associated with annabergite and garnierite was found by the second author while investigating the oxidation of nickel minerals in the serpentinized bodies in the Rock Creek area of British Columbia. Rock Greek is in the Similkameen District of British Columbia some 15 miles southwest of Greenwood.

The general geology of the Rock Creek area has been described by Daly (1912), Cairnes (1937), and more recently by Little (1957). For the purposes of this paper we need only mention the fact that the Rock Creek area contains several Mesozoic ultrabasic intrusions, now mainly serpentinites. These bodies intrude Late Palaeozoic to Jurassic sediments and volcanics and are cut by Mesozoic granodiorite and related rocks of the Nelson intrusives.

The best samples of nickel hydroxide were found in a large dolomite-quartz-serpentine boulder in Rock Creek about 600 feet west of the point where the main highway crosses Rock Creek. This boulder presumably came from the large dyke-like mass of serpentinized ultrabasic rock in the deep gorge of Rock Creek about 4 miles west of the main highway. A similar body was seen along the Kettle River about a mile north of Rock Creek, and other dykes and sills of serpentinized rock are reported to occur in the general area.

The serpentinized bodies are presumably highly altered dunites or pyroxenites. They are rather massive greenish-black rocks with a marked development of serpentine, talc, and in some cases small amounts of garnierite. Dolomitization and silicification is common in some of the bodies.

DESCRIPTION OF THE NICKEL HYDROXIDE

The nickel hydroxide occurs in a dolomite-quartz-serpentine rock whose surfaces and fractures are coated with green garnierite and white to pale green annabergite. Portions of the garnierite appear to be altering to a pulverulent yellow cryptocrystalline mineral which has been identified as a nickel hydroxide.

The yellow powder is readily visible in hand specimens, but the coatings are so thin, and in most cases so intimately associated with brown iron oxide and garnierite, that it is difficult to obtain sufficient material for analytical purposes. Small amounts of the pure powder, placed on a glass slide and examined with a petrographic microscope, were found to be pale yellow aggregates of cryptocrystalline material which show no reaction in water. Treatment with 1:1 HCl gave no effervescence, but the mineral particles were slightly reduced in size, considerably bleached, and the surrounding acid turned noticeably yellow. These crude tests suggested that the mineral was unlikely to be a normal carbonate or sulphate. A small amount of the yellow powder was then picked from hand specimens under the binocular microscope. Qualitative x-ray spectrographic analysis indicated the presence of major nickel and traces of iron, and a spectrophotometric analysis by J. G. Sen Gupta on 0.162 mg. gave 38.7 per cent NiO. A second sample, similarly picked and examined by qualitative optical spectrography, gave the following results: major, Ni; minor, none; trace to faint trace, Si, Mg, Cu, Fe, Ca. Spectrographic analysis of the associated garnierite gave major Si, Ni; minor Mg, Fe; trace Cu, Co, Ca. The above data, when complemented by the *x*-ray powder diffraction pattern, indicate that the Rock Creek mineral is a nickel hydroxide of the type described below.

TABLE 1. *X*-RAY POWDER DATA FOR HIGHER NICKEL HYDROXIDES (filtered copper radiation and 57 mm. diameter cameras). Data for synthetic material taken from Glemser & Einerhand (1950*b*)

Synthetic Ni Hydroxides					British Columbia Mineral			
$4Ni(OH)_2.NiOOH$		$3NiOOH.NiOOH$			$a = 3.07$ Å, $c = 22.74$			
I (est.)	*d* (meas.)	*I* (est.)	*d* (meas.)	*hkl*	*I* (est.)	*d* (meas.)	*d* (calc.)	*hkl*
vs	7.7Å	vs	6.90Å	003	10	7.59Å	7.58	003
s	3.85	s	3.30	006	6	3.79	3.79	006
w	2.63	w	2.42	101	1/2	2.77		
s	2.56	s	2.37	012	6	2.585	2.589	012
		vw	2.19	104	1/2	2.41	2.41	104
s	2.31	s	2.09	015	5	2.296	2.296	015
vw	2.09	w	1.88	107	1/2	2.06	2.06	107
s	2.03	s	1.77	018	4	1.946	1.942	018
w	1.75	w	1.57	10.10	1	1.73	1.73	10.10
w	1.66	w	1.47	01.11	1	1.64	1.63	01.11
s	1.53	m-s	1.41	110	3	1.536	1.535	110
s	1.50	m-s	1.37	113	3	1.507	1.505	113
		w	1.32	10.13	1/2	1.47	1.46	10.13
w	1.42	w	1.30	116	1	1.426	1.423	116
					1/2	1.39	1.39	01.14
		w	1.21	202	1	1.32	1.32	202
w	1.32			119			1.31	119
					1/2	1.29	1.29	024
w	1.28	w	1.17	205	1/2	1.28	1.28	205
					1/2	1.26	1.25	10.16
					1/2	1.21	1.20	208

SYNTHESIS AND CRYSTALLOGRAPHY

Syntheses and an *x*-ray study of the higher nickel hydroxides were carried out by Glemser & Einerhand (1950a, 1950b). The two hydroxides relevant to the present study are, in Glemser & Einerhand's notation, blue-black nickel (II, III)-hydroxide with the composition $NiO_{1.22-1.07}.xH_2O$, and secondly, a nickel (III)-hydroxide γ-NiOOH corresponding to $Ni_2O_3.xH_2O$. The blue-black hydroxide is prepared by anodic oxidation of a nickel sulphate solution, whereas the second compound is formed by melting nickel with either sodium peroxide or potassium peroxide and subsequent hydrolysis of the melted mass with water.

Although the B.C. mineral is yellow rather than dark in colour, its chemical and x-ray powder diffraction data are in harmony with the identification of the material as a nickel hydroxide intermediate between the two above mentioned synthetic compounds. All three materials give x-ray patterns mutually agreeing with regard to the arrangement and intensity of their lines. They differ, however, in the size of their unit cells, with the blue-black nickel hydroxide having the largest and the other synthetic product having the smallest.

Both artificial compounds are non-stoichiometric. The blue-black hydroxide has a composition near $NiO_{1.1}.1.5H_2O$, whereas the second compound approximates $Ni_2O_{3.1}.2.5H_2O$. From structural considerations their respective ideal formulas are $4Ni(OH)_2.NiOOH$ and $3NiOOH.NiOOH$. The respective hexagonal cell dimensions are $a = 3.07$ Å, $c = 23.2$, and $a = 2.82$ Å, $c = 20.65$. From indexing of the x-ray powder diffraction pattern (Table 1), the B.C. mineral has approximate cell dimensions of $a = 3.07$ Å, $c = 22.74$. The parameters thus place the mineral between $4Ni(OH)_2.NiOOH$ and $3NiOOH.NiOOH$, though much closer to the former.

In $4Ni(OH)_2.NiOOH$ the structure is of a layered type with $1/4NiOOH$ located in a disordered manner between laminae of $1Ni(OH)_2$. Lack of stoichiometry is attributed to a variable content of NiOOH. The only difference in the compound $3NiOOH.NiOOH$ is that the $Ni(OH)_2$ laminae have been oxidized to NiOOH laminae and the rhombohedral cell contents become $NiOOH. 1/3NiOOH$. Although the cell dimensions of this compound are somewhat variable, the magnitude of a is characteristically 2.8 Å. We may therefore focus our attention on $4Ni(OH)_2.NiOOH$ and the B.C. mineral as they both have $a = 3.07$ Å. In the artificial material the c dimension expands with increasing oxygen content. We may thus attribute the slightly smaller c-dimension obtained for the B.C. mineral as being due to a relatively low content of the interlayered NiOOH.

CONCLUSIONS

We conclude that the yellow cryptocrystalline mineral from Rock Creek, B.C. is a non-stoichiometric nickel hydroxide corresponding to the artificial compound with an ideal formula $4Ni(OH)_2.NiOOH$, hexagonal cell dimensions $a = 3.07$ Å, $c = 23.2$; rhombohedral dimensions $a = 7.93$ Å, $\alpha = 22°19'$, $V = 63.18$, $Z = \frac{1}{4}$ S.G. (calc.) 2.96.

The nickel hydroxide probably originated as one of the products of hydrolysis of nickel-bearing solutions that derived their metal either from the silicates of the serpentinite or from the secondary nickel minerals, annabergite and garnierite.

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CATAPLEIITE FROM ST. HILAIRE MOUNTAIN, QUEBEC

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Catapleiite, a rare hydrous sodium-zirconium-silicate has been found as a result of recent studies of the mineralogy of a quarry in nepheline-sodalite-syenite at St. Hilaire.

The catapleiite occurs both in irregular pegmatitic veins and in a vug which was found during quarry operations in the syenite that forms most of the eastern half of this Monteregian intrusive which lies twenty miles due east of Montreal.

In the pegmatitic veins, the translucent catapleiite is a tan colour with a pearly luster and is found as plates up to 7 cm. in width and 9 mm. in thickness, enclosed for the most part in analcite and penetrated only by aegirine. These plates result from parallel growth of the catapleiite. Crystal faces exhibiting the pseudo-hexagonal habit of the mineral are well developed around the margins of the plates. Although catapleiite crystallizes originally in the hexagonal system, on cooling it inverts to monoclinic symmetry at temperatures ranging from 8 degrees to 230 degrees, (Bøggild, 1953, p. 252). Aegirine, albite, astrophyllite, rhodochrosite, sphalerite, analcite and calcite are found with the catapleiite.

The catapleiite found in the vug occurred as individual, transparent, hexagonal crystals, either colourless or with a faint bluish tint, and averaging 2 mm. across. It is associated here with aegirine, sphalerite, pyrite, natrolite and calcite. Two larger parallel growths of catapleiite were also obtained from this same vug. On one of these, the faint blue tint of the thin edge of the crystal becomes a light tan colour as the crystal thickens.

In both occurrences, i.e. in the pegmatitic veins, and the vug, the crystals are tabular parallel to the base and are usually bounded by the faces of two dipyramids. However, less frequently, prism faces are also observed.