intercorrelated variables the relatively few mutually independent factors, the use of the discriminant function in discerning significant differences in composition between rock types, individual rock masses or tectonic environments. The article is concise and informative, and gives insight into the usefulness of the many statistical techniques open to the geochemist.

One thing lacking in this volume is an introductory or concluding article linking the different areas of geochemistry covered by the six articles. A separate article on the physicochemical and crystal chemical control of element and isotope distribution, and on the chemical significance as compared to the statistical significance of parameter variability would have helped to serve this purpose. Apart from the minor criticisms noted, this volume is highly recommended for those who are interested in the new techniques being developed to tackle petrologic problems.

P. L. Roeder

PROCEEDINGS OF THE NINTH ANNUAL MEETING OF THE MINERALOGICAL ASSOCIATION OF CANADA

The Ninth Annual Meeting of the Mineralogical Association of Canada was held on May 18–19, 1964 in the Royal York Hotel, Toronto, Ontario, in conjunction with the annual meetings of The American Association of Petroleum Geologists, the Society of Economic Paleontologists and Mineralogists, and the Geological Association of Canada.

The general business meeting of the Association was held on Tuesday, May 19 and was chaired by the President, Dr. D. M. Shaw. The Secretary, S. Kaiman, reported that in the election of officers for 1964, 227 ballots were cast and the following slate was elected:

President	D. M. Shaw
Vice-President	W. W. Moorhouse
Secretary	S. Kaiman
Treasurer	H. R. Steacy
Committee Members	J. R. Smith (3 years)
	K. L. Currie (3 years)
	W. E. Hale (2 years)
	A. J. Frueh, Jr. (2 years)
	E. H. G. Cornford (1 year)
	J. P. Girault (1 year)
	D. H. Gorman

Membership as of May 11, 1964 numbered 755, made up of 503 ordinary and associate members, 241 corporate members and 11 student members.

H. R. Steacy, Treasurer, reported a balance of $3,867.99 for the end of the fiscal year 1963. In addition, the Association holds a guaranteed investment with the Royal Trust Company of $3,000.00, bearing interest at 4½% per annum.

The Editor, Dr. L. G. Berry, reported that the total cost of publishing Volume 7 of *The Canadian Mineralogist* had been $21,676.90. Volume 8, Part 1 was in press and it was expected that Part 2 would go to press during the summer. The publication on the Bruderheim meteorite fall by R. E. Folinsbee and associates had been delayed so as to include information on a new fall. This volume would be published as a special memoir and not as a regular issue of The Canadian Mineralogist.

The members present voted in favour of a motion by Dr. A. R. Graham and seconded by Dr. R. B. Ferguson, that abstracts of papers presented at the annual meeting be published in the journal as part of the proceedings of the meeting.

The chairman reported that the 1965 annual meeting of the M.A.C. would be held in Toronto in conjunction with the annual meeting of the Prospectors and Developers Association and that the 1966 meeting would be a joint meeting with the Geological Association of Canada, to be held in Halifax. The chairman also presented a summary of the proceedings of the M.A.C. Executive Meeting which had been held earlier in the day. The Executive Committee had adopted a proposal to establish honorary life memberships and a proposal to provide for prepayment of life membership. The implementation of these proposals would require revisions in the bylaws which would have to be approved by the membership.

The annual dinner of the Association was held on Monday, May 18 in the Hunting Room of the King Edward Hotel. Dr. Gonzales Reyna of the Geological Survey of Mexico was presented with a gift as a memento of the occasion. Mrs. Viola MacMillan won the draw for the door prize which consisted of marble book-ends, the gift of the Royal Ontario Museum. The speaker of the evening was Dr. D. H. Gorman, the retiring president, and the subject of his address was "The Teaching Profession". H. R. Steacy was the genial master-of-ceremonies.

The technical sessions were held on May 18 and 19, 1964. The following are abstracts of the papers presented at the technical sessions.

NEW MINERALOGIC OBSERVATIONS ON STYLOLITE SEAMS

G. C. Amstutz and Won C. Park

University of Heidelberg, Germany, and McMaster University, Hamilton, Ontario

Stylolites in the Fredonia limestone of southern Illinois fluorspar areas and in other typical limestone districts were sampled systematically and the geometric patterns classified into six types.

The following features in these stylolites were investigated in detail: (1) pressure lamellae in carbonates and their mechanical symmetry; (2) oriented quartz prisms along stylolite layers; (3) the diagenetic paragenesis of sphalerite, galena, and pyrite; (4) the residual accumulation of sphalerite along stylolite seams; (5) pyrite along bituminous portions of the seams.

The following conclusions are derived: (a) sphalerite formed before, galena and pyrite during, the stylolite formation; (b) the age of the stylolites in most cases falls within Dapples' second and third period of diagenetic compaction and crystallization; and (c) the diagenetic age of the stylolites and their relation to slumping patterns suggest, together with other sedimentation features, that most of the V-structures in the fluorspar district of southern Illinois are submarine erosion channels, in part triggered by faulting.

X-RAY STUDIES ON NOVA SCOTIA ZEOLITES

F. Aumento
Dalhousie University, Halifax, Nova Scotia

The more common zeolites from the Triassic basalts of Nova Scotia were studied by single crystal photography and diffractometry techniques. These included analcite, apophyllite, chabazite (including the variety "acadialite"), gmelinite, laumontite, mordenite, natrolite, stilbite, thomsonite, and other minerals occurring as intergrowths.

Buerger precession photos were taken and cell parameters calculated directly. These parameters were processed by an IBM 1620 electronic computer to calculate all possible lines and indices which could occur in the respective diffractograms. Results were compared with experimentally obtained diffractograms, and tabulations were made of actual *d* spacings so obtained against tentative indices. Cell parameters were then re-calculated with greater precision from the indexed diffractograms.

A sequence of crystallization, related to the stratigraphy of the basalts, was tentatively formulated from field observations to be as follows: silica acting as a base, with chabazite and gmelinite as the first zeolites, followed by stilbite, heulandite, laumontite, apophyllite, analcite, thomsonite, and finally natrolite (with mesolite intergrowths).

SERANDITE FROM ST. HILAIRE, QUEBEC

Jean Boissonnault and Guy Perrault
École Polytechnique, Montreal, Quebec

Serandite from St. Hilaire, Quebec, has the following chemical composition: SiO_2 47.90, Fe_2O_3 0.08, FeO 0.86, Al_2O_3 1.20, MnO 33.8, CaO 5.56, MgO 0.03, Na_2O 6.40, K_2O 0.00, $H_2O^{-105^0\ C}$ .20, $H_2O^{+105^0C}$ 2.42, Y_2O_3 0.27. Total 98.73%.

X-ray diffraction data show that this mineral is a pectolite-type mineral. The name serandite was originally given by Lacroix to the manganiferous end member of the series $Ca_2NaH(SiO_3)_3-Mn_2NaH(SiO_3)_3$. Serandite from Las Archipelago (Lacroix, 1931) contained 28.99% MnO and 10.42% CaO, whereas serandite from St. Hilaire, Quebec, is closer to the end member with 33.8% MnO and 5.56% CaO.

NATURE AND DISTRIBUTION OF IRON SILICATES IN THE GUNFLINT IRON FORMATION, PORT ARTHUR

S. M. A. Boutcher and W. W. Moorhouse
University of Toronto, Ontario

The iron silicate minerals from more than 70 specimens of the Proterozoic Gunflint Iron Formation, near Port Arthur, Ontario, were identified by *x*-ray powder methods and microscopic techniques. There appears to be a stratigraphic distribution of the mineral species. Chamosite and chlorite characterize the Lower Gunflint, which contains relatively little iron silicate, while the intermediate argillite-tuff member contains an illite-bearing calcareous horizon, along with chamosite, chlorite and talc. The taconitic western facies of the Upper Gunflint is characterized by abundant greenalite and stilpnomelane, the ratio of stilpnomelane appearing to increase in the vicinity of the Logan Sills. By contrast chamosite is the only iron silicate mineral so far identified from the eastern chert-carbonate facies of the Upper Gunflint.

CATIONIC SUBSTITUTIONS IN THE ALUNITE GROUP

GERALD P. BROPHY
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Minerals of the alunite group are designated as $AB_3(SO_4)_2(OH)_6$ with A = Na, K, Pb, NH_4, Ag or H_3O and B = Al (alunite) or Fe^{+++} (jarosite). Synthesis studies of Na-K and Al-Fe substitutions produce a series of solid solutions for which natural counterparts have been found. Synthesis has been successful at temperatures ranging from 78° C. to 180° C. with pressures up to 6 atmospheres. At the lower temperatures, analyses show a univalent cation deficiency and an excess of $+H_2O$, indicating the presence of H_3O^+. DTA curves of hydronium-bearing jarosites show three endothermic reactions at approximately 350° C., 400° C., and 800° C. The 350° C. reaction is broad and represents a loss of hydronium ion. Similar results have been noted for natural, low-temperature jarosites.

Synthesis of alunites and jarosites with variable K-Na ratios shows a marked preference for K^+. The Na-K substitution produces little change on the a_0 dimension, but a pronounced effect upon c_0 is recorded. The opposite effect obtains upon substitution of Fe^{+++} for Al. The preference for Fe^{+++} in the structure is lowered with increased temperature and reduced acidity.

Currently the parameters controlling the incorporation of Ag and Fe in the alunite structure are being investigated.

GEOLOGY OF A PORTION OF THE CONTWOYTO LAKE AREA, NORTHWEST TERRITORIES

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Approximately 24 square miles of Archean(?) igneous and metamorphic rocks have been mapped at a scale of 1 inch equals 1,000 feet in an area centred 5 miles south of the central part of Contwoyto Lake, N.W.T.

The oldest rock unit is apparently a quartz-plagioclase-biotite-K-feldspar paragneiss containing numerous pegmatitic segregations of quartz, plagioclase, K-feldspar, and minor amounts of muscovite, tourmaline, and apatite. A sequence of low- to medium-grade meta-sediments overlies the paragneiss. In the northern part of the area, these rocks are largely quartz-chlorite-muscovite phyllites. As the grade of metamorphism increases southward, biotite, almandite, andalusite, cordierite, and staurolite become common. Approximately 20 beds of quartz-hornblende-almandite amphibolite up to 10 feet in width have been mapped in the schist sequence. The phyllites, schists, and amphibolites are believed to be correlative with the Yellowknife group.

Two biotite granite bodies approximately one mile in diameter intrude the Yellowknife group metasediments. The sediments are also cut by diabase dikes 20–100 feet in width, and a gabbro stock ⅜ mile in diameter.

Pyrrhotite, pyrite, and arsenopyrite are found locally in a few of the amphibolite beds. Gold mineralization is locally present in some of the tightly folded pyrrhotite and arsenopyrite-bearing amphibolites.

LATTICE PARAMETER STUDIES OF SYNTHETIC NEPHELINE SOLID SOLUTIONS AND OTHER TRIDYMITE-TYPE STRUCTURES

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Lattice parameter determinations of pure sodium nephelines, crystallized from gels and glasses at 1,000 Kg/cm^2 water vapour pressure, show that the parameters of this mineral are very variable and that they can not be correlated either with their crystallization temperatures or with the length of the experiments, unlike the parameters of albite (MacKenzie, 1957). In contrast, the lattice parameters of nephelines of composition $Na_3KAl_4Si_4O_{16}$, which more closely approach those of natural nephelines and of pure kalsilites, do not vary with their crystallization temperatures. Investigation of the lattice parameters of nepheline solid solutions in the systems $NaAlSiO_4$—$NaAlSi_3O_8$—H_2O, and $NaAlSiO_4$—$CaAl_2Si_2O_8$—H_2O indicates that the addition of very small amounts of both the $NaAlSi_3O_8$ and $CaAl_2Si_2O_8$ molecules produces an increase in the *c* parameter and also stabilizes both the *a* and *c* parameters of the nepheline solid sloutions. No change in nepheline solid-solution lattice parameters was found in the system $Na_3KAl_4Si_4O_{16}$—$CaAl_2Si_2O_8$—H_2O. These results are discussed in terms of three hypotheses proposed by Smith & Tuttle (1957), and it is concluded that the main factor causing the variability in pure nepheline parameters is the collapse of the framework structure about the small sodium atom, although the substitution of hydroxyl ions for oxygen atoms and variations in the starting materials in these experimental studies may also contribute to these variations.

THE CRYSTAL STRUCTURE OF DAWSONITE, $NaAl(CO_3)(OH)_2$

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Using Weissenberg and precession techniques on a single crystal of dawsonite obtained from a recent excavation on the McGill campus, the following crystallographic data were determined:

Orthorhombic, $a = 6.77$ Å, $b = 10.40$ Å, $c = 5.58$ Å, $V = 392.9$ Å^3, $D_m = 2.44$, $Z = 4$, $D_x = 2.43$

Space group: *Imcm* or *I2cm*

These data confirm those determined by Lauro (1941) on Albanian material.

First by using the special positions of the centro-symmetric space group (*Imcm*), and by taking account of the strong birefringence to orient the carbonate groups, and then from the interpretation of the Patterson projections a trial structure with the following parameters was proposed:

4 Na in 4(*c*): 1/4, 3/4, 1/4
4 Al in 4(*b*): 0, 1/2, 0
4 C in 4(*e*): 0, *y*, 1/4 with $y = 0.217$
4 O in 4(*e*): 0, *y*, 1/4 with $y = 0.094$
8 O in 8(*h*): 0, *y*, *z* with $y = 0.280$; $z = 0.052$
8 OH in 8(*i*): *x*, *y*, 1/4 with $x = 0.180$; $y = 0.530$

This yields an *R* factor of .45 for the (*hk*0) reflections. This value is considered low enough to warrant refining this trial structure.

LAURO, C. (1941) *R.C. Accad. Ital.* **3**, 146–150

SOME MINERALS FROM THE OKA ALKALINE COMPLEX, OKA, QUEBEC

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The carbonate rocks of the Oka complex contain abnormally high amounts of Zr, Nb, Ce, La, Nd, Sr, Ba, P, Mn, Ti, Na, K, F, S, and Cr, and give rise to an impressive array of unusual and rare minerals. Some seventy minerals have been so far identified from the alkaline rocks and carbonatite at Oka.

As in most alkaline complexes the paucity of silica is reflected in the low silica type of minerals they contain, by the presence of oxide minerals of iron, titanium, phosphorus, and niobium, and undersaturated silicate rocks. Substitution of elements in some of the minerals is inferred from their chemical composition, and probably accounts for their anomalous optical properties. The constituent minerals of the silicate rocks are commonly characterized by high alkali, alumina, manganese, and low silica content, with in some cases unusually high substitution of alumina for silicon. In the oxide minerals niobium commonly substitutes for titanium. Analyses of the following minerals are presented: titanaugite, sodian augite, hornblende, lamprobolite, green biotite, brown biotite, chrysolite, monticellite, melilite, melanite, nepheline and calcic nepheline, wollastonite, magnetite, and partial analyses of zirconium garnet, hauynite, and apatite.

MILLERITE AT STRATHCONA MINE, SUDBURY DISTRICT

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Millerite occurs in relative abundance with chalcopyrite, pentlandite, violarite, and sparse pyrite in discontinuous stringers and disseminations along fractures and joints in leucocratic and amphibolitic footwall gneisses near the norite contact more than 3,000 feet below the present surface. Some roughly equidimensional masses up to 8–10 centimeters in size show splendent crystal faces and excellent cleavages barred by polysynthetic twinning. Gangue minerals include sodic and potassic feldspar, quartz, amphibole, epidote, garnet, and biotite. Partial chemical analysis on handpicked cleavage fragments of millerite gave 62.0% Ni, 0.04% Cu, 0.33% Co, and 1.44% Fe. The x-ray powder diffraction pattern gave $a_0 = 9.622 \pm 0.006$ Å and $c_0 = 3.150 \pm 0.005$ Å. Primary origin by crystallization from a hot sulphur-rich iron-poor fluid is proposed from the environmental evidence available.

X-RAY SPECTROGRAPHIC ANALYSIS OF MINUTE MINERAL SAMPLES

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X-ray spectrographic analysis is applied to the analysis of one milligram aliquots of mineral samples. Investigation of the sulpho-salt family of minerals indicated a need for non-destructive analysis of minute quantities of mineral samples usually available for study. Thus the *x*-ray spectrograph method offered a likely possibility.

The apparatus used in the spectrographic analysis consisted of a Norelco generator, a vacuum sample container (in which the sample is inverted), and circuit panel equipped with a scintillation counter and pulse height analyzer.

Standardization was achieved by analysis of 100 milligram aliquots of selected mineral samples using the fusion technique. The samples were fused in 40:1 ratio of potassium pyrosulphate and the intensity ratios of the elements compared with those obtained from artificial standards to give the atomic ratios. Working curves were then prepared from finely ground 1 milligram aliquots of the analyzed pure minerals.

LITHIUM METASOMATISM AROUND PEGMATITES

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A widespread exogenetic effect accompanying the crystallization of lithium pegmatites is the introduction of small amounts of lithium into the wall rocks. Lithium is not found in altered wall rock around pegmatites that do not contain independent lithium minerals. This metasomatic lithium is housed in a number of different minerals, especially muscovite, biotite, tourmaline, and holmquistite. Lithium-bearing hedenbergite and hornblende each have been reported from a single deposit. Likewise, lepidolite and zinnwaldite have each been reported once, but proof of their identities has not been given. Thus it may be affirmed that the major pegmatitic species (spodumene, lepidolite, petalite, amblygonite, Fe-Mn-Li phosphates) are not formed exogenetically.

Mineralogically, two types of lithium metasomatism are known. (1) The lithium is restricted to combinations of muscovite, biotite (usually also contains Li, Rb, Cs) and tourmaline. This type occurs typically in micaceous schists or gneisses around zoned or structurally complex pegmatites that contain lepidolite, amblygonite, Fe-Mn-Li phosphates, ± spodumene. (2) The lithium occurs chiefly in holmquistite (±a narrow Li-biotite zone closer to the pegmatite). This is developed invariably in hornblendic wall rocks around unzoned, poorly zoned (Kings Mtn. type), or zoned pegmatites that contain early-crystallized spodumene, usually as the sole lithium species, or with petalite, rarely with lepidolite.

The number of holmquistite occurrences is now known to be ten, with a new discovery at Bernic Lake.

NORMAL AND REVERSE PLEOCHROISM IN BIOTITE

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Normal biotite has the absorption formula $Y > Z \gg X$ with Y reddish brown, Z greenish brown and X pale brown. Rarely biotite is pleochroic with absorption $X \gg Y > Z$. Blue River, B.C. biotite is of the second ("reverse") type with pleochroic colours X deep red brown and Z' pale yellow. Brown phlogopite from Old Chelsea, P.Q. also shows reverse pleochroism with X deep orange brown and Z' almost colourless. The effect is caused by a broad transmission maximum for light vibrating parallel to the mica sheet and a narrower transmission maximum for light vibrating across the sheet. Green phlogopite from Old Chelsea shows less marked reverse pleochroism. With thick sheets transmission maximum Y is at 6200 Å and Z at 5800 Å. No absorption maxima were noted in any of these varieties. Chemical data suggest the reverse pleochroism may be associated with ferric iron in tetrahedral sites.

CRITICAL ANALYSIS OF THE GLADSTONE-DALE RULE AND ITS CONSTANTS

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The Gladstone-Dale rule, which is an empirical attempt to relate chemical composition, refractive indices, and density, was applied to minerals by Larsen in 1934. In 1956, Jaffe offered some corrections and additions to Larsen's original constants.

While applying the Gladstone-Dale relationship to some tellurites and selenites this writer found that Larsen's constants for TeO_2 and SeO_2 required revision. Furthermore, the value of these constants, as well as those for many other oxide components, varied widely, depending on the particular compounds used to calculate them.

Values of k for various oxide components are given here, using Larsen's form of the Gladstone-Dale equation:

$$\frac{n-1}{d} = k_1\frac{p_1}{100} + k_2\frac{p_2}{100} + \ldots k_n\frac{p_n}{100}.$$

In this equation, n is the average index of refraction, d is the density, k is the specific refractive energy for a particular oxide component, and p is the weight percentage of the component.

Oxide	Larsen's k	k—This Study Aver.	Range	No. of Compounds
Cs_2O	.124	.120	.116–.122	3
CaO	.225	.225	.213–.239	7
CoO	.184	.182	.167–.206	4
CuO	.191	.182	.173–.201	8
ZnO	.153	.160	.139–.179	4
BaO	.127	.128	.123–.132	6
PbO	.137	.144	.125–.169	7
SeO_2	.147	.196	——	1
TeO_2	.200	.193	.181–.206	4

Users of the Gladstone-Dale relationship should realize that wide differences between calculated and observed refractive indices and densities may be caused by the variation in k values.

PYROCHLORE FROM OKA, PROVINCE OF QUEBEC, CANADA

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Five varieties of pyrochlore have been identified at Oka.

1. A metamict variety containing uranium and thorium; bright red colour, fine-grained, associated with ijolitic rocks. $a_0 = 10.43 \pm 0.05$ Å.
2. A cerian variety; chocolate-brown, coarse-grained, euhedral (octahedra and dodecahedra), associated soda pyroxene marble. $G = 4.38$, $a_0 = 10.393 \pm .001$ Å.
3. A thorian variety; brownish red, in calcite-forsterite rock. $a_0 = 10.428 \pm .005$ Å.
4. A zirconian variety; reddish brown to black, occurrence in carbonatite. $a_0 = 10.395 \pm .001$ Å.
5. A high Nb_2O_5 variety contains 65.8% Nb_2O_5. It is beige in colour and occurs in calcite rock. $a_0 = 10.4195 \pm 0.0005$ Å.

MINERALOGY OF THE MOUNT PLEASANT TIN DEPOSIT IN NEW BRUNSWICK

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The Mount Pleasant tin deposit in New Brunswick is mineralogically complex and contains a wide variety of minerals. The tin-bearing minerals are cassiterite and stannite. Cassiterite is the chief tin mineral, and it occurs in altered wall rock, fluorite, and sulphide veins. The cassiterite in the altered wall rock and sulphide veins is present as small grains, whereas that in fluorite is present as relatively large grains. Stannite was found as irregular grains, veinlets, and minute inclusions in sphalerite.

Sphalerite is the most abundant ore mineral. It is black and contains minute exsolution bodies of chalcopyrite and stannite. Analyses of sphalerite concentrates give Fe 8.2–14.3%, Cu 1.3–5.5%, Sn 0.15–0.40%, In 0.03–0.30%, Cd 0.12–0.19%, and Mn 0.06–0.08%.

Sphalerite geothermometry indicates that the depositional temperatures of the sphalerite fall between 335° C. and 700° C., and arsenopyrite geothermometry gives depositional temperature up to 500° C.

INTRUSIVE CARBONATE IN THE ICE RIVER COMPLEX, BRITISH COLUMBIA

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The Ice River valley is situated in Yoho National Park in the westerly ranges of the southern Rocky Mountains, British Columbia. The region is the site of a nepheline syenite-ijolite-jacupirangite complex which is intruded into Cambro-Ordovician sediments and is dated (potassium-argon method with biotite) as Devonian in age.

Associated with the ijolite-jacupirangite differentiates is a mass of brown-weathering carbonate (dominantly ankeritic carbonate with calcite and iron oxide) at least 2 miles long and 900 feet across. This mass was originally described as a "stoped block or roof pendant" but recent field observation indicates that the carbonate is intrusive. Two traverses are described.

The carbonate is succeeded by an intensely fractured and brecciated ferruginous zone, which merges into carbonatized aegirine-feldspar gneisses or fenites which in turn merge into and alternate with ijolite or the aegirine-feldspar pegmatite dykes that cut the ijolite. Augen of unaltered to partly altered pegmatite occur commonly in the fenite. Pods and lenses of carbonate (similar in composition to that of the main mass and as much as 500 feet from it) are associated with the fenite.

A 10-foot xenolith of aegirine-feldspar pegmatite occurs in the main mass of carbonate. Toward the periphery of the zenolith the pegmatite merges into fenite, then fenite with carbonate and finally carbonate.

The carbonate mass may be termed carbonatite.

HIGH-PRESSURE STUDIES IN THE SYSTEM $MgO—SiO_2$ AND THE CONSTITUTION OF THE UPPER MANTLE

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The compositions $MgO \cdot SiO_2$ (enstatite) and $2MgO \cdot SiO_2$ (forsterite) were studied over the pressure range 20 to 130 kilobars at temperatures between 500° and 1,200° C. This pressure range corresponds with depths of about 75–400 km. which include part of the 200–900-km. seismic discontinuity zone in the upper mantle.

Orthoenstatite is the high-pressure high-temperature polymorph, and clinoenstatite is the high-pressure low-temperature polymorph. The equilibrium boundary for the orthoenstatite-clinoenstatite transition intersects the temperature axis at 540° C.; at 100 kb the equilibrium temperature is 870° C. At 115 kb and 600° C. clinoenstatite breaks down to forsterite plus stishovite. Forsterite is stable to at least 130 kb.

The experimental results: (1) support Birch's (1952) hypothesis that the inhomogeneous region in the upper mantle is due to pressure-dependent phase transformations; (2) confirm Ringwood's predictions that (a) enstatite breaks down to forsterite plus stishovite at about 120 kb, and (b) higher pressures are required for the forsterite-spinel inversion; (3) explain, when coupled with the results of Bowen & Tuttle (1949) on the system $MgO—SiO_2—H_2O$, the absence of clinoenstatite in terrestrial rocks and its occurrence in meteorites; and (4) explain the experimental results of Turner, Heard, & Griggs (1960) which show that orthoenstatite may be transformed to clinoenstatite by deformation; the latter exemplifies the Becke concept of shear-induced diaphthoresis.

TEST OF THE DISCRIMINANT FUNCTION IN THE AMPHIBOLITE PROBLEM

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Amphibolites from Chandos Township, Peterborough County, Ontario, were classified by field criteria as ortho-amphibolite, para-amphibolite, or of uncertain origin. Following analysis for major and 8 trace elements, discriminant functions were calculated for the ortho and para groups, and used to classify rocks in the uncertain category.

Using analyses of Ti, Al, Fe^{+3}, Fe^{+2}, Mn, Mg, Ca, P, CO_2 in 11 rocks in each group, the discriminant function gives a probability of misclassification of 5.4%.

Analyses of Cr, V, Ni, Co, Sc, Sr, Ba, Zr on 20 rocks in each group gave a discriminant function with 5.7% probability of misclassification.

Ti, Fe^{+2}, Mn, P, Co, and Sc are the most effective elements for discrimination.

It is unlikely that this approach will have universal applications, regardless of the geological setting of an amphibolite, but the method is promising.

NATIONAL MINERAL COLLECTION

H. R. Steacy
Curator, Systematic Reference Series, Geological Survey of Canada, Ottawa

The National Mineral Collection was established in 1961 and consists of two parts, namely: a Systematic Reference Series and a Display Series, with a single catalogue. The Geological Survey of Canada is responsible for the Systematic Reference Series, for the maintenance of the main catalogue, and for research on the Collection. The National Museum of Canada is responsible for the Display Series and for the public display of minerals and related exhibits. Built upon collections of the Geological Survey of Canada, the National Collection has shown steady growth since its establishment and emphasis is being placed on Canadian material. The Collection is proposed as a central repository for type material described by Canadian mineralogists. The Reference Series is a working collection that is available to qualified scientists in all fields of research.

IDENTIFICATION OF CLINOPHYROXENES BY *X*-RAY DIFFRACTION AND OPTICAL METHODS

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The composition of common clinopyroxenes may be defined by measurement of the optical properties $2V_z$ and β. The mole-per cent composition thus obtained differs from that obtained by chemical analysis and for some varieties there is no reliable correlation between the optical properties and the chemical composition. For a diopside from Oka Complex, Quebec, the optical properties ($2V_z = 56^\circ$, $\beta = 1.685 \pm .001$) gave 48.1:41.9:10:0 for the Ca:Mg:Fe ratio, using the best curves available (Hess 1949), and the chemical analysis revealed the ratio 49.4:45.4:5.2.

We have applied optical properties to the determination of Ca:Mg:Fe ratio in various clinopyroxenes and we have observed the following degree of error by referring the composition determined by optical properties with that determined by chemical analysis

1. Diopsides-hedenbergites (mean value of error for 17 specimens) Mg:8.2 Fe:5.8 Ca:4.8
2. Augites (mean value of error for 7 specimens) Mg:3.6 Fe:4.5 Ca:3.6
3. Ferro-augites (mean value of error for 7 specimens) Mg:6.0 Fe:6.1 Ca:3.4

It may be possible to obtain a better definition of that composition by exact intensity measurements of *x*-ray powder diagrams. Several measures on a group of six clinopyroxenes reveal this possibility.