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

The Eighth Annual Meeting of the Mineralogical Association of Canada was held jointly with the Sixteenth Annual Meeting of the Geological Association of Canada on June 6–9, 1963, at McGill University, Montreal, Quebec. This joint meeting marked the 100th anniversary of the publication of Logan's "Geology of Canada" and Sir William Logan, the first director of the Geological Survey of Canada, was the topic of an address given by the present director, J. M. Harrison, at the annual banquet of the G.A.C. At the annual dinner of the M.A.C. held on Thursday, June 6, J. E. Hawley was honoured by the presentation of the first copy of Volume 7, Part 3 of *The Canadian Mineralogist*, a special issue dedicated to him. The dinner speaker was J. E. Gill of McGill University who gave an illustrated lecture on his recent trip to Russia, entitled "Observations on Mineralogy in the Soviet Union."

The general business meeting of the Association was held on Friday, June 7, chaired by the President, D. H. Gorman. The Secretary's report showed that in the election of officers for 1963, 211 ballots were cast, giving approval to the following slate:

President	D. H. Gorman
Vice President	D. M. Shaw
Secretary	S. Kaiman
Treasurer	H. R. Steacy
Committee Members	W. E. Hale (3 years)
	A. J. Frueh, Jr. (3 years)
	E. H. G. Cornford (2 years)
	J. P. Girault (2 years)
	S. A. Forman (1 year)
	E. H. Nickel (1 year)
	R. M. Thompson

Membership as of May 13, 1963, numbered 653, made up of 208 corporate members, 432 ordinary and associate members, and 13 student members.

H. R. Steacy, Treasurer, reported a balance of $4,025.96 for the end of the fiscal year 1962 and a balance at June 5, 1963, of $5,329.87. He noted that the M.A.C. holds a guaranteed investment with the Royal Trust Company of $3,000.00 yielding interest at $4\frac{1}{2}\%$ per annum.

The report of the Editor, L. G. Berry, noted that (a) publications are well in hand and Volume 7, Part 5 will go to press during the summer and will include an index for the entire volume (b) action is being taken to publish a special number on the Bruderheim meteorite fall, by R. E. Folinsbee and associates, (c) 335 bound copies and 500 unbound copies of the Sudbury ores issue are still available.

D. M. Shaw reported that in regard to the suggestion for the need for primary standards for mineralogical analyses the Geological Survey of Canada has offered to prepare and make available a limited number of rock standards and that a picrite from Muscox was already in the process of preparation.

The chairman reported that the M.A.C. will meet jointly with the G.A.C. in

Toronto in 1964 and 1965, and in Halifax in 1966 and that his committee on long-range planning proposes that the M.A.C. continue to meet jointly thereafter with the G.A.C.

The technical sessions were held on June 6 and 7, 1963. The following are abstracts of the papers presented at the technical sessions.

AUTOLUMINOGRAPHS IN THE STUDY OF RARE-EARTH MINERALS IN FLUORITE-CELESTITE ROCK, BIRCH ISLAND, B.C.

R. M. Buchanan
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Contact photographs (autoluminographs) have recorded unsuspected subliminal luminescence from rare-earth minerals like bastnaesite and yttrium-bearing fluorite in a non-radioactive rock.

The technique can be used for locating rare-earth minerals in thin sections, polished sections and hand specimens. It will also provide a new, rapid and cheap method for making preliminary examinations of diamond drill cores from rare-earth deposits.

TRANSFORMATION IN MINERALS

B. J. Burley
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An elementary review of classifications of transformations with suggestions for further work. A discussion of the effect on transformations of pressure, and trace element content. The α-β quartz transformation will be discussed in some detail from these points of view.

PYRITE, A NATURAL SEMICONDUCTOR

George Alexander Collins
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Elements of semiconductor theory have been reviewed and applied to the problem of the variability in the electrical properties of pyrite.

The electrical resistivity of six mineral specimens of pyrite was measured as a function of temperature in the range 63° to 770° K. The Hall coefficient in an 8000 oersted magnetic field for the same specimens was measured for the first time as a function of temperature. The number of the electrical charge carriers and the Hall mobilities of the carriers were calculated and tabulated.

Intrinsic pyrite at 293° K. will have a resistivity of 1.8×10^3 ohm. cm. An energy gap for the intrinsic pyrite was calculated as 0.81 eV from the slope of the resistivity curve as a function of 1/T. The activation energy of holes was calculated as approximately 0.27 eV.

THE DISTRIBUTION OF MINOR ELEMENTS WITHIN A SINGLE APATITE CRYSTAL

E. F. CRUFT

McMaster University, Hamilton, Ontario

An apatite crystal, approximately 12 cm. in diameter, from the Grenville of Quebec, was grid sampled on a cut basal section by taking 102 small cores, each 1 cm. × 0.34 cm. The individual core samples were spectrographically analysed in triplicate for Ce, Y, La, Si, Fe and Mn. Variance analysis of the results showed the content of these elements to be markedly inhomogeneous in the crystal. Contoured diagrams showing the element distributions within the crystal have been prepared and correlation coefficients calculated for each combination of element pairs. The data is discussed in terms of its geochemical significance, and possible crystal growth mechanisms are presented.

THE GEOLOGY OF THE NEW QUEBEC CRATER

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Geological Survey of Canada, Ottawa, Ontario

The exposed rocks in the region of the Crater are acid Precambrian gneisses cut by several series of basic dykes, and by two granitoid plutons. Rocks in the Crater rim show strong alteration to epidote and sericite, with development of spectacular crystals of the former. The generally northerly trend of the structure is disturbed in the region of the crater so that structural elements are radial to the crater over an area of seven square miles. Patterns of recent fracturing indicate recent slow updoming of the rim. It is concluded that the crater is the result of magmatic intrusion followed by catastrophic failure of the roof. No evidence of meteorite impact was found, and it is considered that the structural and petrographic data refute this hypothesis.

THE INFLUENCE OF WEATHERING ON THE QUALITY OF BEEKMANTOWN DOLOMITE AS CONCRETE AGGREGATE

L. M. M. DOLAR-MANTUANI

Hydro-Electric Power Commission of Ontario, Toronto, Ontario

The Beekmantown dolomite investigated in detail in connection with the studies of aggregate for the St. Lawrence Development, proved to be an excellent material for use as concrete aggregate. However, near-surface strata and some gravel from various pits in the St. Lawrence Lowland might be weathered to a degree to cause popouts in concrete when occurring close to the surface of the structures. Comparison of fresh and weathered material based on extensive petrographic examinations and on standard acceptance tests, is made.

VARIATIONS OF POTASSIUM FELDSPAR "TRICLINICITIES" WITH K, Na AND Ca CONTENTS IN SOME PLUTONIC AND METAMORPHIC ROCKS

R. B. Ferguson, G. D. Pollock, L. T. Trembath, J. M. Hodgkinson, and Norma Tweedy Bristol

University of Manitoba, Winnipeg, Manitoba

The "triclinicities" of the K feldspars, and the K, Na and Ca rock contents have been determined for several dozen rock specimens from massive granites, granite gneisses and paragneisses from the Thompson-Moak Lake and Duval Lake Areas of Manitoba and from the Dogtooth Lake Area of Ontario. Most of the specimens fall into one of three categories:

(1) The massive granites and some of the granite gneisses show a regular variation of K feldspar triclinicities with the ratio K: (K + Na + Ca), and with the ratio Na:(Na + Ca). The relationship between triclinicities and the ratio K:(K + Na + Ca) is close to that predicted from crystal-structural considerations by Ferguson (*Can. Mineral.* 6, 415–436, 1960).

(2) The paragneisses from Duval Lake show no regular variation of triclinicities with K:(K+Na+Ca), but they do show a regular variation of triclinicities with Na:(Na+Ca).

(3) The paragneisses and some of the granite gneisses from Thompson-Moak Lake which have so far been analysed for only K and Na, show a regular variation of triclinicities with K:(K+Na) but this variation is much different from the corresponding variation given under (1).

Pending further experimental work, the K feldspars in (1) are tentatively interpreted as low-temperature forms in which the triclinicities have been determined by the ratio of K:(K+Na+Ca) in the rock, and those in (2) and (3) as intermediate-temperature forms in which the triclinicities have been determined by variations in metamorphic conditions.

FURTHER EVIDENCE FOR THE EXISTENCE OF CARBONATE MAGMAS

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The problems of carbonatite genesis and emplacement have always hinged on the supposed impossibility of a carbonate liquid existing at petrologically reasonable temperatures and pressures. As a result of phase equilibrium studies reported over the past two years there are now few objections on the grounds of physical chemistry to the existence of such liquids (carbonate-rich liquids exist down to at least 450° C. and probably lower), and sodium-calcium carbonate lavas are now known in nature. However, in all experimental work of this type few instances have been reported where natural rock textures have been produced artificially. Such a correspondence has been produced in studies of carbonate systems at elevated temperatures and pressures. In all the carbonate systems studied so far, solid carbonate that is in equilibrium with carbonate liquid forms spherical single crystals. On quenching, a porphyritic texture is produced. A natural carbonatite from Southern Rhodesia presents an analogous texture in hand specimen and it is concluded that it represents a quenched liquid that carried carbonate crystals in suspension at the time of its emplacement. Similar textures have been found recently in several other carbonatites.

PERICLINE TWINNING AND DEFORMATION IN FELDSPARS

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Unlike the common composition planes for most twin laws the rhombic section in the triclinic feldspars is not parallel to a crystallographic plane of low energy, because the planes of atoms parallel to the rhombic section are relatively densely spaced and sparsely populated.

It is suggested that at the time and local stress conditions at which pericline twinning developed the elastic displacements among atoms in the feldspar structure were such that what now corresponds to the rhombic section was parallel to a relatively widely spaced crystallographic plane with small Miller Indices. This condition can be demonstrated by distorting a flexible bonding model of triclinic feldspar in such a manner (preferably by shearing in a certain direction parallel to (001) as to produce a relatively wide spacing in a direction normal to what is now the rhombic section. To simulate more closely the actual manner in which an essentially open framework of SiO_4^{4+} groups is likely to deform it would, in the suggested demonstration, be necessary to ensure that the deformation of the structure framework be taken up entirely by the relative rotation and mutual reorientation of the coordination tetrahedra, and not by the distortion of individual tetrahedra themselves.

PHLOGOPITE FROM THE SOUTHERN GATINEAU REGION, QUEBEC

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Phlogopite from about 100 mica-apatite occurrences was often found to be twinned according to a variant of the mica law in which the twin plane was the composition plane. $2M$ phlogopites could be distinguished from $1M$ phlogopites by dispersion and pleochroism. The two-layer phlogopites were most common in marble and calc-silicate rocks whereas one-layer phlogopites usually occurred in gneisses.

A STUDY OF NATURAL AND SYNTHETIC BASIC ZINC CARBONATES

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Corrosion of metallic zinc in distilled water at room temperature resulted in the formation of a basic zinc carbonate having the composition $Zn_5(OH)_8CO_3.H_2O$. With the addition of $Cu(OH)_2$ to the solution, $Zn_5(OH)_6(CO_3)_2.2H_2O$ was precipitated. Formation of $Zn_5(OH)_6(CO_3)_2.H_2O$ was accomplished by saturating a ZnO–H_2O slurry with CO_2, by corrosion of metallic zinc in warm agitated water, and by corrosion in an oven at 55° C. D.T. and T.G. analyses of this compound are compared to those of hydrozincite and the relationship of the synthetic precipitates to natural zinc carbonates is discussed.

MOLYBDOMENITE FROM THE RANWICK MINE MONTREAL RIVER HARBOUR, ONTARIO

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Molybdomenite, the rare lead selenite previously known only from Cerro de Cacheuta, Argentina, and Trogtal, Germany, has been found as an alteration of clausthalite at the Ranwick Uranium Mine. It occurs as small (up to 1 mm), colourless, blade-like crystals, and as pale yellow rounded aggregates of fine radiating fibres. Crystals have one very good cleavage and a second, poorer cleavage. Molydbomenite is monoclinic. The space group is $P2_1$ or $P2_1/m$, $a = 6.86$ Å, $b = 5.48$ Å, $c = 4.50$ Å, $\beta = 112° 45'$. The strongest lines in the x-ray powder pattern are: 2.741 (10), 3.31 (9), 3.16 (8), 3.40 (7), 4.13 (6), and 2.071 (5).

CERIUM MINERALS FROM THE MARATHON AREA, ONTARIO

JOSEPH A. MANDARINO AND WALTER M. TOVELL

Royal Ontario Museum, Toronto, Ontario

Parisite and bastnäsite have been found in syenite pegmatites near Marathon. The parisite replaces long (up to 20 mm.) crystals of bastnäsite. In most cases, only a thin core of bastnäsite remains, surrounded by numerous small parisite crystals. The parisite is pink to red. It is optically uniaxial positive; $\omega = 1.676$ and $\epsilon = 1.770$. The strongest lines in the x-ray powder pattern are: 3.58 (10), 2.850 (10), 2.066 (9), 4.71 (8), 1.964 (8), 1.891 (8), and 1.671 (7). The bastnäsite is black and is opaque except for the very finest fragments. The strongest lines in the x-ray powder pattern are: 3.56 (10), 2.875 (10), 4.90 (6), 2.067 (5), 2.023 (3), and 1.903 (3).

STATISTICAL STUDIES ON SCAPOLITES

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Major and trace element data presented by Shaw (1960) have been studied utilizing the multivariate statistical techniques of factor analysis and linear regression. Factor studies reveal the existence of the marialite-meionite solid solution, and suggest the existence of a second, MgO-H_2O, major element factor. Factor analysis reveals the existence of (a) Be, Ga, Li (b) B, Rb (c) Mn, Pb factors. Multiple regression studies indicate that both major element factors influence the refractive indices of scapolites.

HORNFELSES FROM THE ST. CYR RANGE, YUKON

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Intrusion of a granitic stock into a series of limestones, argillites, and calcareous argillites has developed a variety of cordierite hornfelses, andalusite hornfelses, vesuvianite-diopside hornfelses, garnetites, and scapolite-bearings chists. Shearing preceded and followed metamorphism, producing unusual textures in the abundant cordierite-bearing phases. Detailed mapping of a part of the contact zone revealed unusual structural relationships which are briefly described.

NICKEL MINERALIZATION AT TILT COVE, NEWFOUNDLAND

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Narrow veins containing nickel minerals occur in an operating copper mine at Tilt Cove, Newfoundland. The minerals include niccolite and Ni-Fe arsenides, associated with coarse millerite. The mineralogy of the showing has been described by E. Sampson.

The mineral assemblages of the nickel-bearing veins will be re-examined on the basis of the recent work by Yund and others on the Ni-As-S system. The mineralogy and geological environment of the Tilt Cove nickel showing will be compared with those of a somewhat similar deposit at Montmagny, Quebec, and some conclusions will be drawn about the conditions of formation of such deposits.

DETERMINATION OF THE HEAVY ATOM CONTENT IN CHLORITE BY MEANS OF THE *X*-RAY DIFFRACTOMETER

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An investigation was made to establish whether the approximate iron content in chlorite can be determined by means of the *x*-ray diffractometer. Twenty-eight chemically analyzed chlorites whose compositions range from those of the iron-rich varieties to those of the magnesium-rich varieties were studied. The results show that the intensities of *x*-rays diffracted from even-ordered basal planes of chlorite are proportional to the number of heavy atoms (Fe + Mn + Cr) in the octahedral layers of the mineral. A ratio of these intensities, expressed by the term $(I002 + I004)/I003$, was selected as a variable factor representing the intensity, and its relationship to the number of atoms in the octahedral layers of chlorite was derived.

RAPID DETERMINATION OF TRACE AMOUNTS OF SELENIUM IN ROCKS

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The classical method of determining very minor amounts of selenium in rocks and soils utilized a tedious distillation technique with hydrobromic acid in an all-glass apparatus.

A rapid method using 3, 3′-diaminobenzidine has been used successfully on Cretaceous rocks where the selenium content is on the order of 1–100 p.p.m. Diphenylpiazselenol is formed which can be quantitatively extracted by toluene. Absorbance at 420 μ is then measured. Ferric iron and other associated metal ions have been adequately masked by EDTA. No special separations are needed to remove other elements.

COMPOSITION OF THE CANADIAN PRECAMBRIAN SHIELD—A PROGRESS REPORT

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Estimation of element abundances in any region of the earth's crust constitutes a problem in sampling and analysis. In the case of the Canadian precambrian shield information is required concerning variability in composition of a given rock type in different provinces and of different ages, and variability in proportion of different rock types from area to area. Such data will permit quantitative speculation concerning evolution of the crust and geochemical provinces, provided that the sampling models are designed to provide confidence estimates.

Current work is concentrating on testing procedures and making preliminary estimates for areas in Baffin Island, Ungava and north-western Ontario.

A STUDY OF POLYTYPISM IN SILICON CARBIDE

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An x-ray study of 195 single crystals of silicon carbide was carried out using transmission Laue photography to determine polytype distribution. The crystals were all grown in a controlled atmosphere using high purity silicon and graphite, at temperatures of 2400–2600° C. Using the method of Mitchell (*Amer. Min.* **38**, 60, 1953) we had great success in identifying polytypes, even where as many as 4 individuals were syntactically related. The most abundant polytypes found were 6*H* and 15*R*, one or both being present in almost every crystal. One interesting feature was the scarcity of 4*H* forms. Another was the abundance of giant polytypes, found in 26 crystals. No significant correlation could be found between crystal colour and polytype composition. Five new polytypes were identified—72*H*, 408*H*, 213*R*, 240*R* and 1080*R*.

OLIVINE REGRESSION STUDIES—I. MULTIPLE REGRESSIONS OF OPTICAL PROPERTIES ON NUMBERS OF CATIONS PER UNIT CELL CONTAINING 16 OXYGEN ANIONS

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Trial regressions of refractive indices, optic angle, and the cosine of the optic angle on certain chemical constituents in olivines and monticellites give satisfactory agreement between predicted and observed values of the dependent variables, the predictions generally being well within the ordinary error of a microscopic determination.

Seventy-two analyses of olivines and monticellites were recast as metals per 16 oxygen atoms, to give the chemical variables defined in the table below. Si and Mg (x_1 and x_5) are considered dependent upon the others for reasons of valency balance and space available in the unit cell; combinations of (I) all the remaining x's, (II) all but Ti, (III) all but Fe″′, (IV) all but Al, and (V) all but Ti, Fe″′, and Al, were tried.

Combination II appears to give the best fit for various simple end-members (as forsterite, etc.) whose properties appear to have been rather well determined, and this

combination also gives statistical criteria such as the Coefficient of Multiple Determination and the *F*-ratio, that are at least as favourable as similar criteria for any other combination.

The regression equations may be represented by $y_p = b_{0p} + b_{ip}x_i$, where the subscript p identifies the physical property (n_X, n_Y, n_Z, $2V_X$, or cosine of $2V_Z$, respectively for $p = 1, 2, \ldots, 5$), the subscript i identifies the chemical element ($i = 0$ signifies the constant term), b is a regression coefficient, and x is the number of atoms per 16 oxygens. The meanings of these are clear from the following table giving coefficients b_{ip}.:

REGRESSION COEFFICIENTS b_{ip} FOR COMBINATION II, USING Al, Fe$''$, Mn, Ca

p / i constituent	1 $y_1 = n_X$	2 $y_2 = n_Y$	3 $y_3 = n_Z$	4 $y_4 = 2V_X$	5 $y_5 = \cos(2V_Z)$
0 x_0 = 1(const.)	1.63848	1.64899	1.66756	97.96	+0.96200
1 x_1 = Si	(Si considered dependent upon other constituents as explained)				
2 x_2 = Al	−0.02475	−0.01857	−0.01926	−8.98	−0.13594
3 x_3 = Fe$'''$	+0.05757	+0.05798	+0.05804	−10.16	−0.14695
4 x_4 = Ti	(Ti omitted from consideration for its empirical non-significance)				
5 x_5 = Mg	(Mg considered dependent upon other constituents as explained)				
6 x_6 = Fe$''$	+0.02331	+0.02740	+0.02618	−6.49	−0.10290
7 x_7 = Mn	+0.01622	+0.01872	+0.01817	−4.21	−0.06761
8 x_8 = Ca	−0.00177	−0.00176	−0.00424	−4.80	−0.07887