PROCEEDINGS OF THE THIRTIETH ANNUAL MEETING OF THE MINERALOGICAL SOCIETY OF AMERICA AT EL PASO, TEXAS

C. S. HURLBUT, JR., *Secretary*

The thirtieth annual meeting of the Society, which was held on November 10–12, 1949 in El Paso, Texas, was attended by 134 members and fellows. Scientific sessions were held in the morning and afternoon of November 10th and the morning of November 12th, at which thirty-five papers were presented. Five additional papers were presented in the afternoon of November 11th at a well-attended Symposium on *Disorder in Minerals.*

The annual luncheon of the Society on November 11th was attended by 87 fellows, members and guests. Following the luncheon, Norman L. Bowen introduced the recipient of the Roebling Medal, Herbert E. Merwin of the Geophysical Laboratory, Washington, D. C. Dr. Merwin is the ninth recipient of the medal. Preceding the Symposium on *Disorder in Minerals*, the retiring President, John W. Gruner, addressed the Society on *An Attempt to Arrange Silicates in the Order of Their Free Energies.*

The Council at its meetings on November 9 and 10, 1949, in addition to transacting routine business of the Society, passed unanimously two motions that should be of interest to the general membership. The first was the new award of the Mineralogical Society of America for an outstanding contribution to mineralogy by a person of not more than thirty-five years of age. The specifications for this award were printed in the January-February 1950 issue of *The American Mineralogist.* The second was the election of

Charles Palache, Honorary President of the
Mineralogical Society of America.

Although the Constitution of the Society provides for election by the Council of honorary officers, Dr. Palache, Professor Emeritus of Mineralogy at Harvard University, is the second to be elected an honorary officer. The first Honorary President was Edward S. Dana, who served in that capacity from 1925 until his death in 1935. Dr. Palache was a charter fellow of the Society and served as its second President in 1921. He was the first recipient of the Roebling Medal, which was awarded to him in 1937.

At its meeting in 1948 the Council felt that the Constitution of the Society should be completely revised and brought up to date. Accordingly, a committee with Joseph Murdoch as Chairman was appointed by President Gruner to scrutinize the Constitution and bring before the Council at its next meeting any recommendations. The report of this committee was discussed at length, and several changes were accepted by the Council. The complete Constitution, incorporating these changes, will be printed in the July-August 1950 issue of *The American Mineralogist*, and the general membership at the next election will be asked to accept or reject these changes.

On the following pages are given the reports of the officers for the year ending October 31, 1949, as read before the Council at its meetings on November 9 and 10, 1949.

REPORT OF THE SECRETARY

To the Council of The Mineralogical Society of America:

ELECTION OF OFFICERS AND FELLOWS

Four hundred and thirty-one ballots were cast in the election of officers: 284 by members and 147 by fellows of the Society. The officers elected are:
President: George Tunell, University of California at Los Angeles, California.

Vice-President: Ralph E. Grim, Illinois Geological Survey, Urbana, Illinois.
Secretary: C. S. Hurlbut, Jr., Harvard University, Cambridge, Massachusetts.
Treasurer: Earl Ingerson, U. S. Geological Survey, Washington, D. C.
Editor: Walter F. Hunt, University of Michigan, Ann Arbor, Michigan.
Councilor (1950–53): E. F. Osborn, Pennsylvania State College, State College, Pennsylvania.

According to the provisions of the Constitution, the following have been elected to fellowship:

Charles Findlay Davidson, Geological Survey of Great Britain, London, England.
Gordon Leslie Davis, Geophysical Laboratory, Carnegie Institution, Washington, D. C.
Frank Ebbutt, Howe Sound Company, Toronto, Canada.
Austin Burton Edwards, University of Melbourne, Australia.
Albert E. J. Engel, California Institute of Technology, Pasadena, California.
George M. Furnival, Department of Mines and Natural Resources, Winnipeg, Manitoba.
Gonzalez-Bonorino, Felix, Direccion de Minas y Geologia, Buenos Aires, Argentina.
Wilfrid K. Gummer, Aluminum Laboratories Limited, Arvida, Quebec, Canada.
Maurice Hall Haycock, Bureau of Mines, Ottawa, Canada.
Elbridge Churchill Jacobs, University of Vermont, Burlington, Vermont.
Howard W. Jaffe, U. S. Bureau of Mines, College Park, Maryland.
Mackenzie L. Keith, Geophysical Laboratory, Carnegie Institution, Washington, D. C.
Paul D. Krynine, Pennsylvania State College, State College, Pennsylvania.
Kathleen Lonsdale, University College, London, England.
Charles E. Michener, The International Nickel Company of Canada, Ltd., Copper Cliff, Ontario, Canada.
Arie Poldervaart, Geological Survey, Bechuanaland Protectorate, South Africa.
A. Williams Postel, U. S. Geological Survey, Washington, D. C.
Rex Tregilgas Prider, University of Western Australia, Nedlands, Western Australia.
Thure Georg Sahama, University of Helsinki, Finland.
Ernest B. Sandell, University of Minnesota, Minneapolis, Minnesota.
Frederick Stewart Turneaure, University of Michigan, Ann Arbor, Michigan.
Francis J. Turner, University of California, Berkeley, California.
Samuel Zerfoss, Naval Research Laboratory, Washington, D. C.

CHANGES IN THE BY-LAWS

On the recent ballot, fellows and members were asked to vote on the following proposed change in Article II, Section 4 of the By-Laws:

From

A single prepayment of one hundred dollars ($100) shall be accepted as commutation for life for either fellows or members. In the case of fellows who are also fellows of the Geological Society of America, a single prepayment of fifty dollars ($50) shall be accepted as commutation for life.

To

A single prepayment of an amount equaling twenty times the annual dues of a fellow of the Society shall be accepted as commutation for life for either fellows or members.

This change was approved by a vote of 372 in the affirmative with 35 in the negative.

MEMBERSHIP STATISTICS

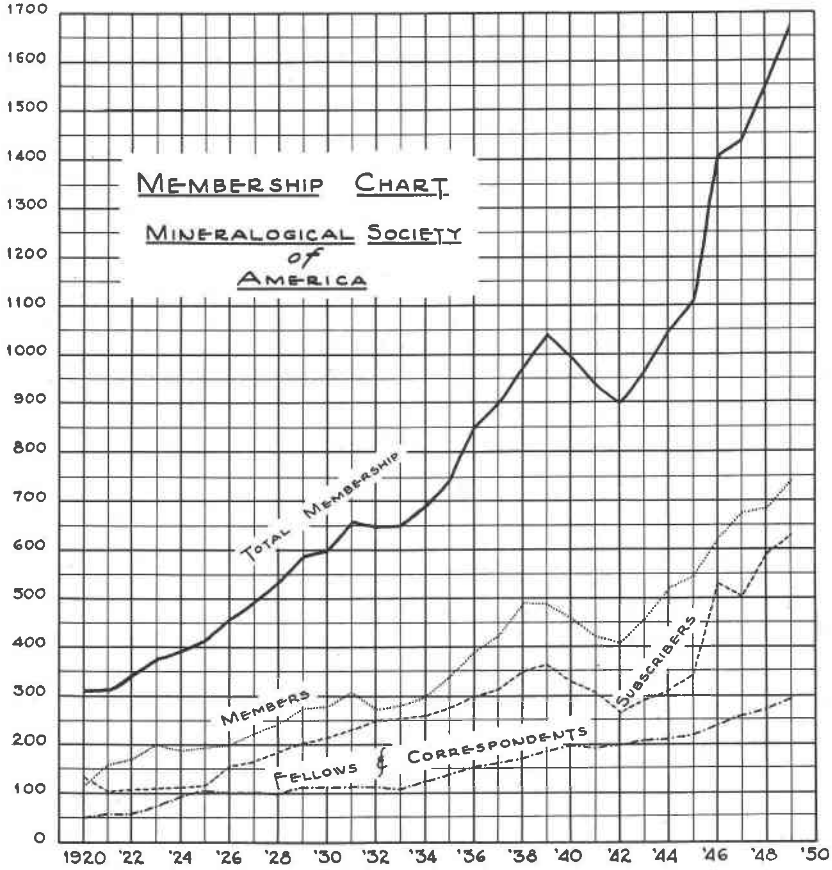
November 1, 1949

	1948	1949	*Gain*	*Loss*
Correspondents	5	5	0	0
Fellows	270	290	23	3
Members	686	746	182	122
Subscribers	592	630	91	53
	1553	1671	296	178

The above figures show a net gain of 20 fellows, 60 members and 38 subscribers. Considering the four groups together, there is a total gain of 118. The present total of members and subscribers is 1,671, which represents an increase of almost 8% since 1948.

The Society lost through death two fellows: F. N. Ashcroft, of London, England, and E. L. Bruce, of Kingston, Ontario, Canada.

Respectfully submitted,
C. S. HURLBUT, JR., *Secretary*



REPORT OF THE EDITOR FOR 1949

To the Council of the Mineralogical Society of America:

In presenting the annual editorial report at this time, the same general policy will be followed as that pursued a year ago. With five issues published and distributed and only one still in press, sufficient data are now available to give a general survey of the year's activity. By the time the Editor's report appears in print (March-April issue) the missing data will be available and be incorporated, so that the then complete report can be compared on the same basis as the summaries given for last year and those of previous years.

From the standpoint of scholarly productivity I think the critical readers will agree that the Journal for 1949 has moved forward and has not merely marked time. From present indications the current volume will reach, or possibly exceed the 900 page mark, a substantial increase in size (approximately 100 pages) over that of a year ago. If this goal is realized it would represent the largest volume in the history of the Society with the single exception of the volume of 1937 that included the unusually large special Palache number.

In the main the policy of former years has been followed. Several excessively long manuscripts have been returned to authors for condensation and in several instances for reduction in the number of cuts originally submitted. This policy seems necessary not only to reduce as far as possible printing costs but also to speed up the production line by printing the largest number of manuscripts in the available space.

Unusually long manuscripts do impose at times special problems as they act as "road blocks" to rapid service by replacing several shorter articles. Also in some cases they represent highly specialized phases on the outer fringe of mineralogy or crystallography. In addition some are highly mathematical in character. In those cases I believe it can be truthfully stated that they are read in toto by very few readers, most of whom are quite content to merely glance at the abstract.

The question of how to reduce costs and expedite production is one not restricted to our Journal. The larger parent organization, the Geological Society of America with its large and efficient editorial staff and liberal financial resources, is facing the same problem. Permit me to quote one short paragraph from the Report of the Committee of Publications as recorded in the Interim Proceedings—Part 3, (Sept., 1949) page 32.

"The Committee also felt that economies could be effected at the source, and urged greater care in composition of papers by prospective authors. They recommended that the rising costs be impressed on Fellows, Members, and authors generally, and that authors be urged to condense all papers to a minimum. They further recommend that, in the editorial and publication procedure, short papers be given priority in publication procedure." This idea of giving shorter papers priority seems a splendid suggestion and one that I think we could follow with profit.

This year's volume included one colored folded insert of an article illustrating line and band spectra observed with a Bunsen spectroscope. It was felt that this article could be adequately illustrated only by employment of color. An innovation this year, sanctioned by the Council, which appears to have met with the hearty approval of our readers, was devoting the May-June number exclusively to *Contributions to Canadian Mineralogy*. In that issue the guest Editor, Dr. M. A. Peacock, assembled 15 interesting papers and assumed full responsibility in seeing these contributions through the press. I should like to express my appreciation to Professor Peacock for this timely and valuable assistance. Also recognition and gratitude is here expressed for the generous and continued assistance from the Geological Society of America in the form of financial support toward defraying a substantial portion of the ordinary publication costs and likewise for aid in reproducing and printing the colored insert.

With reference to the material now on hand and tentative commitments for 1950, mention might be made of the following:

(1) Presidential Address and 27 abstracts of papers given at the fourth annual spring meeting of the Crystallographic Society of America, held at Ann Arbor, Michigan, April 7–9, 1949.

(2) About 30 papers on general mineralogical subjects now on file, not including those in press to appear in the November-December issue.

(3) Contributions to Canadian Mineralogy will again very likely constitute a complete single issue and the May-June number may be used for this purpose.

(4) Arrangements are being made at Harvard for a special number and the September-October issue has tentatively been set aside for such an issue.

From this outline, even at this early date, it would seem that 1950 will be a very busy year. The size of the Journal will unquestionably equal and very likely exceed the current volume of 900 printed pages. Much depends upon the size of the special number as to the size of the volume for next year. Indications are, however, that no depression is in sight.

During the past year there has been no extremely heavy back log of accumulated manuscripts. The expansion in size of the individual issues thus far has been able to take care of the papers submitted. Ordinarily, the time interval between reception and appearance of

Table 1. Distribution of Subject Matter in Volume 34

Subjects	*Articles*	*Pages*	*Per Cent of Total*
Leading articles*			
Descriptive mineralogy	10		
Chemical mineralogy	22		
Structural crystallography	15		
Geometrical crystallography	6		
Petrography	3		
Optical crystallography	2		
Mineralography	1		
Memorials	5		
Miscellaneous	9		
	73	754	84
Shorter articles	25	54	16
Notes and news	20	9	
Proceedings of Societies	5	65	
Book reviews	10	11	
New mineral names	20	5	
Total entries	153	898	100
Illustrations	221		
Index, Title page, Table of contents		18	
Grand total		916	

* Leading articles average 10.3 printed pages each.

the printed article has been from six to eight months. In some few instances the delay has been slightly longer. This time interval may seem long to some authors who frequently ask for an early appearance, but to those who have had experience with other scientific publications the delay does not seem unreasonable for present conditions.

The current volume will contain 73 leading articles and 25 of a shorter character, totaling 98 published manuscripts for the year (last year it was 55 and 18, totalling 73). Twenty-eight contributions were received from contributors residing outside of the States, 21 of which were received from Canada. These contributions were received from 109 contributors associated with 52 different Universities, research bureaus, and technical laboratories.

Nine new mineral species were described in detail for the first time: frondelite, laubmannite, retgersite, rockbridgeite, scorzalite, sengierite, souzalite, torreyite and wolfeite.

The accompanying table 1 summarizes in detail the distribution of subject matter in volume 34.

Respectfully submitted
WALTER F. HUNT, *Editor*

(Treasurer's report on next page.)

REPORT OF THE TREASURER FOR 1949

To the Council of the Mineralogical Society of America:

Your Treasurer submits herewith his report for the fiscal year beginning November 1, 1948, and ending October 31, 1949.

RECEIPTS

Cash on hand, November 1, 1948	$ 2,579.23
Dues and subscriptions	7,307.86
Sale of back numbers	1,237.83
Authors' charges on reprints	798.17
Income from endowment	3,761.85
Final payment of principal of Trenton Mortgage Co. stock	156.22
Geological Society of America aid in printing the Journal	6,328.75
Advertising	429.73
Sale of 20-volume Index	9.00
Sale of Index to volumes 21–30	124.19
Sale of securities	5,175.00
Securities called	1,050.00
	$28,957.83

DISBURSEMENTS

Printing and distribution of the Journal (six issues)	$11,544.48
Printing and distribution of reprints	1,438.02
To the Editor, Secretary, and Treasurer	1,250.00
Postage and express	350.53
Clerical and secretarial assistance	514.25
Office equipment	150.55
Printing and stationery	268.79
Programs and abstracts (1948)	254.27
Roebling Medals (1948 and 1949)	279.15
New securities purchased	9,067.78
Commission on securities	74.14
Federal taxes on securities	8.50
Dividend and interest adjustments	30.86
Safety deposit box	7.80
Telegrams	4.02
Committee expenses	2.80
Society luncheon	7.10
Exchange charges on checks	1.50
Refunds	21.45
Travel expenses of officers to Annual Meeting	55.80
Back numbers of the Journal purchased	24.50
	$25,356.29
Cash balance, October 31, 1949	3,601.54
	$28,957.83

The endowment funds of the Society as of October 31, 1949, consist of the following securities:

Bonds

6M Atlantic Coast Line, 4½.	$5,257.50	
5M New York Central, 5	4,300.00	
5M Southern Railway, 5	5,743.75	
4M Cleveland Union Terminal, 5	4,055.00	
4C Great Northern, 5½	400.00	
		$19,756.25

Preferred Stocks

200 shares, Southern California Edison, 4.88	$5,250.00	
100 shares, Union Pacific, 4	4,570.25	
60 shares, Jones and Laughlin, A, 5	4,987.50	
55 shares, United States Steel, 7	6,946.20	
50 shares, Virginia Electric & Power Co., 5	5,942.50	
24 shares, Public Service Electric & Gas Co.	728.40	
10 shares, Consolidated Edison, 5	1,066.64	
		$29,491.49

Common Stocks

240 shares, Potomac Electric Power Co.	$3,175.00	
60 shares, United Fruit Co.	3,067.50	
50 shares, Chesapeake and Ohio Railway	2,368.75	
50 shares, Pennsylvania Railroad	1,468.75	
41 shares, American Telephone and Telegraph	5,599.32	
40 shares, Kroger Co.	1,990.00	
28 shares, Standard Oil of New Jersey	1,444.84	
1 share, New York, Chicago & St. Louis Railroad	37.00	
		$19,151.16
		$68,398.90

Respectfully submitted,
EARL INGERSON, *Treasurer*

DANA FUND

Disbursements are made to needy mineralogists in war areas and to needy families of deceased mineralogists in war areas.

Receipts

Available balance, November 1, 1948	$372.42
Interest	8.42
	$380.84

Disbursements

Disbursed	$ 40.00
Available balance, November 1, 1949	340.84
	$380.84

Respectfully submitted,
Earl Ingerson, *Treasurer*

REPORT OF THE AUDITING COMMITTEE

To the President of the Mineralogical Society of America:

The Auditing Committee has examined and verified the accounts of the Treasurer of the Mineralogical Society of America for the fiscal year beginning November 1, 1948, and ending October 31, 1949. The securities listed in the Treasurer's report, with all future coupons on the coupon bonds attached, are in the safety deposit box at the West End Branch of the Washington Loan and Trust Company in Washington, D. C.

Respectfully submitted,
Felix Chayes
John C. Rabbitt
George Switzer, *Chairman*

ABSTRACTS OF PAPERS PRESENTED AT THE THIRTIETH ANNUAL MEETING OF THE MINERALOGICAL SOCIETY OF AMERICA, EL PASO, TEXAS, NOVEMBER 10–12, 1949

THE LEUCOXENE PROBLEM*

VICTOR T. ALLEN
Saint Louis University, St. Louis, Missouri

The author's interest in leucoxene began in 1934 during a study of the diaspore clays of Missouri. From 1939–46 leucoxene was observed in bauxite and high-alumina clays. *X*-ray patterns were made by P. F. Kerr, W. F. Bradley, J. W. Gruner, and J. M. Axelrod, and electron micrographs were contributed by the U. S. Bureau of Standards. The laboratories of the U. S. Geological Survey and the Illinois State Geological Survey made chemical analyses of new leucoxene samples that formed in the following ways: as a coating on ilmenite from Norway, as a clay derived from lavas from Hawaii, as a clay at Andersonville, Ga., as a pocket-filling clay at Roseland, Va. Hydrotitanite from Arkansas and xanthitane from North Carolina were also analyzed. These analyses served as controls for the petrographic and *x*-ray studies.

The following conclusions in regard to the nature of leucoxene resulted from these studies: (a) most of the opaque gray compound known to petrographers as leucoxene is amorphous; (b) the composition of leucoxene varies chemically and mineralogically; (c) *X*-ray patterns of leucoxene are similar to those of anatase, sphene, and rutile; (d) one per cent of well crystallized sphene may show in an *x*-ray pattern, so it is not known if some *x*-ray patterns represent the bulk of the leucoxene sample or a few well-crystallized grains; (e) a small amount of water is present in many analyses of leucoxene; whether this water is combined as a hydrate of titanium oxide or is adsorbed on the smallest particles of an oxide of titanium is not established; (f) leucoxene should be retained as a petrographic term for the alteration product in which titania occurs in rocks, but it must not be used as a mineral name implying a definite mineral species.

MICROSCOPE AND REFRACTOMETER FOR INFRA-RED LIGHT

RENE J. BAILLY AND KENNETH A. HOLKE
Washington University, Saint Louis, Missouri

In 1947, at the annual meeting in Ottawa, R. Bailly described a method of mineral determinations in infra-red light. In this method the eyepiece of the microscope or refractometer is replaced by a photoelectric ocular, and the variations of the photoelectric current, produced by the observed phenomena can be read on a very sensitive galvanometer. Generally a current amplification is needed. The method is rather long and requires a precise reasoning.

R. Bailly has improved a new method, based on the same principles with the use of an electronic image converter tube as the main part of the ocular instead of an electric photocell.

The invisible infra-red image produced by the lenses of the microscope or refractometer, is focused on the front, half-transparent cathode of the tube. Inside the converter, a set of electronic lenses bundles the beam of electrons coming from the cathode and focuses them

---

* Published by permission of the Director, U. S. Geological Survey.

on a fluorescent screen, producing a visible image of the observed field. This image, whose definition is very high, is magnified by an optical device. In this process, neither galvanometer nor amplifier is needed. The high voltage is supplied to the electronic lenses by a small power unit.

The use of the microscope and refractometer in infra-red light is exactly similar to their use for studies in visible light.

Amongst several researches, the variation of refractive index with the chemical composition is studied for the spinels and particularly for the family of chromite.

THE SYSTEM $NaAlSi_3O_8$-$KAlSi_3O_8$-H_2O

N. L. BOWEN AND O. F. TUTTLE
Geophysical Laboratory, Washington, D. C.

In the presence of water vapor under pressure soda feldspar and potash feldspar crystallize readily from their glasses. At high temperatures they form a complete series of solid solutions showing continuous variation of optical properties and lattice spacing as measured by *x*-rays. Studies of the dry melts had indicated that the solid solutions are of the type having a minimum-melting mixture. This relation is established beyond question upon investigation in the presence of water. At a pressure of 1000 kg/cm^2 of water vapor the minimum lies at the composition 70% $NaAlSi_3O_8$ and the temperature is 843°C. This temperature is 220° below that observed in dry melts, the lowering being induced by the presence of somewhat more than 7% H_2O in the liquid phase or melt. Increase of pressure to 2000 kg/cm^2 produces a further lowering of only about one-third as much. When crystallized at still lower temperatures the complete solid solution relation no longer obtains and two feldspars form side by side.

THE ALTERNATING LAYER SEQUENCE OF RECTORITE

W. F. BRADLEY
Illinois State Geological Survey, Urbana, Illinois

Rectorite is a complex layer type hydrous alumino-silicate related to the better known mica-like minerals. The structural scheme of rectorite consists of contiguous pairs of pyrophyllite-like units separated by pairs of layers of water molecules. An equally apt description would be the alternation of one pyrophyllite unit with one vermiculite unit. The nature of the arrangement is confirmed by the preparation of the equivalent complex in which ethylene glycol proxies for water.

GENERAL ASPECTS OF DISORDER IN MINERALS

M. J. BUERGER
Massachusetts Institute of Technology, Cambridge, Massachusetts

The order-disorder relation is a particular and non-classical variety of polymorphism. Polymorphic transformations are governed by the Helmholtz free energy relation, $A=E-TS$. It can be shown that E, which appears as the latent heat of transformation, is always positive, i.e., heat is absorbed with increasing temperature. In the classical polymorphic transformation, this occurs at a single temperature and coincides with the discontinuity of crystal structure at the transformation temperature. In disorder, there is no discontinuity, the heat being absorbed over a temperature interval culminating in the critical temperature of complete disorder. In this sequence, the basic crystal structure is not altered.

Disorder is ordinarily discussed for metals. Since metals have extremely simple crystal structures, only a simple and degenerate variety of disorder can occur in them. In more general crystal structures, disorder can occur in four distinct varieties: (1) Differential Interchange Disorder, (2) Interstitial Disorder, (3) Orientational Disorder, and (4) Distortional Disorder. Incidentally, distortional disorder is the mechanism of the high-low transformations in quartz, tridymite, and cristobalite.

The critical temperature of complete disorder falls with decreasing crystal size, and this accounts for the stabilization of high temperature forms at room temperature. The disorder transformation is accompanied by symmetry changes, the lower temperature form having the lower (subgroup, or derivative) symmetry. This is responsible for transformation twinning.

THE OPTICS OF TRICLINIC ADULARIA

URSULA CHAISSON
University of Chicago, Chicago, Illinois

Adularia has been generally believed to be monoclinic. Sections of adularia from several localities studied on the universal stage show optical orientations inconsistent with monoclinic symmetry. Sections normal to (001) show approximately 8° inclined extinction; parallel to (001), 6°; parallel to $(\bar{1}01)$, 15°. The optical deviation from monoclinic symmetry is absent or very small in the core of the crystals but increases toward the surfaces. In the (110) and $(\bar{1}\bar{1}0)$ sectors, inclination of extinction from the (010) symmetry plane is clockwise; in $(1\bar{1}0)$ and $(\bar{1}10)$ it is anticlockwise. Adularia from St. Gotthard and Tavetschtal, Switzerland, Mt. Vesuvius, Italy, and Valencia, Mexico conform to this pattern.

In monoclinic adularia, as has formerly been determined, $n\alpha$ lies in the symmetry plane and is very near to the *a* axis. In triclinic adularia the plane containing $n\alpha$ and the *c* axis has rotated about the *c* axis and forms an angle φ with the original symmetry plane (010). The following values of φ were measured on adularia from given localities:

St. Gotthard	12	different specimens
	10	
Tavetschtal	9	different specimens
	7	
Valencia	10	different specimens
Mt. Vesuvius	9	different specimens

The deviation of φ is clockwise in sectors (110) and $(\bar{1}\bar{1}0)$ anticlockwise in $(\bar{1}10)$ and $(1\bar{1}0)$.

Heating of triclinic adularia to 1000°C. for four days changed the optical orientation toward monoclinic symmetry.

EUDIALYTE AND EUCOLITE FROM SOUTHERN NEW MEXICO

STEPHEN E. CLABAUGH
University of Texas, Austin, Texas

Eudialyte and eucolite occur in Otero County, New Mexico, in small irregular dikes associated with the Wind Mountain laccolith, a conical mass of nepheline-analcime syenite porphyry about two miles in diameter. The laccolith is the largest of a group of Tertiary alkalic intrusives that make up the Cornudas Peaks of Texas and New Mexico located at the eastern margin of the Sierra Diablo Plateau about 50 miles east of El Paso. The eudialyte-bearing dikes are peripheral apophyses which penetrate short distances into contact metamorphosed limestones and shales of Permian and Pennsylvanian (?) age. Most of the eudialyte occurs in small subhedral to euhedral crystals about 0.5 to 3 mm in diameter; it is distributed irregularly in the dikes, and it is most abundant in narrow vein-like stringers that finger out into the calcareous rocks. The eudialyte ranges in color from rose pink and brown to colorless, and color is irregularly and zonally distributed in individual crystals. Eucolite occurs only as cores of some of the zoned crystals. A sample of eudialyte from the west side of Wind Mountain has the following indices of refraction:

$$\omega = 1.588 \pm .002$$
$$\epsilon = 1.593 \pm .002$$

The indices of different zones of some crystals differ by more than .005, and parts of the zoned crystals are essentially isotropic. The identity of the eudialyte was checked by quantitative spectrographic analysis. Aegirite, alkali feldspars, nepheline, analcime, apophyllite, zeolites, and contact metamorphic lime silicates are associated with the eudialyte.

Eudialyte has been reported from only two other localities in the United States, the Bearpaw Mountains, Mont., and Magnet Cove, Ark., but it is not uncommon as an accessory mineral in nepheline syenite pegmatite and related rocks in many other parts of the world, notably in the Fennoscandian region.

PETROLOGY OF THE RED RADIOACTIVE ZONES NORTH OF GOLDFIELDS SASKATCHEWAN

CHARLES E. B. CONYBEARE AND CHARLES D. CAMPBELL
The State College of Washington, Pullman, Washington

The red rocks that occur along faults and shear zones in the Precambrian granitic terrane north of Lake Athabaska are more radioactive than others in the area. They are mylonites ranging from protomylonite to ultramylonite, the latter generally forming anastomosing veinlets in the less intensely crushed types.

In the protomylonites the feldspar is deformed albite colored with hematite dust, especially along the cleavages; and unstrained minerals fill the interstices. In the more intensely crushed types the hematite dust permeates most of the rock; and the unstrained minerals, where present, form scattered aggregates or may locally replace the mylonite completely.

The first of these late minerals is clear albite, which forms rims on the red albite relicts. Then follow, in variable order and with repetitions, clear subhedral quartz and albite, specularite, and penninite containing radioactive anatase grains. The latest veins contain also pitchblende, calcite, and specularite. Oxidation products of pitchblende are locally abundant in solution cavities.

The early iron and later radioactive elements were introduced probably by solutions that rose along the mylonite zones. The other elements were probably present before mylonization; and all the late minerals, excepting pitchblende and calcite, may be products of recrystallization.

There is no evidence that the dusty hematite is an exsolution product of iron-rich feldspar.

SYNTHETIC QUARTZITE

H. W. FAIRBAIRN
Massachusetts Institute of Technology, Cambridge, Massachusetts

Quartz sand (grain size 125–250 microns) immersed in weak aqueous Na_2CO_3 solution is converted to sheared quartzite (grain size 100–200 microns) after a few hours' exposure to temperatures in the range 225°–450°C., confining pressures between 5,000 and 30,000 psi, and compressive loads between 35,000 and 115,000 psi. The principal feature of the experimental procedure is the use of a piston of rectangular cross-section and of a sand receptacle designed so that a biaxial strain is imposed on the quartz aggregate. The deformed prisms show shortening up to 60%, elongation up to 20%, and net decrease of volume up to 52%. Individual quartz grains have a maximum elongation of 2:1. Undulatory extinction bands are abundant, but no trace of deformation lamellae was found. There is little evidence of recrystallization. Both compaction and dimensional orientation are best developed in the upper range of temperatures and pressures used. Investigation of the lattice orientation (axis diagrams) of 35 deformed prisms shows random orientation for the most part. Calculation of the coefficient of correlation for each scatter diagram has also been carried out to test statistically this apparent randomness, but with inconclusive results.

Several similar experiments, using H_2O instead of Na_2CO_3, show a much lower degree of compaction and no trace of dimensional orientation; even, for example, after 6 days' exposure to 350°C., 30,000 psi confining pressure and 77,000 psi compressive load.

CONE-AXIS DIFFRACTION PATTERNS

D. JEROME FISHER
University of Chicago, Chicago, Illinois

Cone-axis x-ray pictures have been briefly described by Buerger (ASXRED Monogr. 1 1944). They are obtained when a lattice translation direction is given a precessing motion with respect to the direct beam, providing a flat film is placed in the holder normally occupied by the layer-line screen. The result is a series of diffracted spots which lie along concentric circles ("rings"), one for each level of the reciprocal lattice within range. A cone-axis photo bears about the same relation to a precession picture that a rotation film has to a Weissenberg.

While cone-axis photos are useful in determining the value of d^* in the precessing direction, they may also be employed to get diffraction symmetry and to check orientation; such uses will be illustrated. It is possible to index the spots of a cone-axis ring by a simple graphical procedure. This consists of making a trace-o-film enlargement of the spots to the proper scale to fit a precession photo of the same level. The trace-o-film is held in a framework on the arm of a universal drafting machine and its center is moved above a suitable guide circle drawn on the n-level precession photo. This recapitulates the actual motions of the precession instrument. Thus when a spot on the trace-o-film lies above a spot on the precession photo, the two have the same index, easily obtained from the precession picture. This technique will also be illustrated with simple cases that do not involve too many spots.

LIQUID IMMISCIBILITY IN THE Na_2O-SiO_2-H_2O SYSTEM.—PRELIMINARY DATA ON THE NA_2O-SiO_2-Al_2O_3-H_2O SYSTEM

I. FRIEDMAN
University of Chicago, Chicago, Illinois

The system $Na_2O-SiO_2-H_2O$ was investigated at 400° and 450°C. The water rich immiscible phase present at 250°, 300° and 350°C. has a critical endpoint at about 400°C.

Some of the stability relationships of albite and analcite in the system $Na_2O-SiO_2-Al_2O_3-H_2O$ will be discussed.

SURVEY OF THE MINERALOGY OF URANIUM

CLIFFORD FRONDEL
Harvard University, Cambridge, Massachusetts

The descriptive mineralogy of uranium is discussed with regard to (1) The status of existing descriptions of the known uranium minerals, (2) The directions of needed investigation, and (3) The methods of identification and study. Particular reference will be made to the crystal structure of uranium minerals of the formula-type $A(UO_2)_2(XO_4)_2 \cdot nH_2O$ and to the correlation of optical, physical and chemical properties therewith.

DISORDER IN SULFIDES

ALFRED J. FRUEH, JR.
University of Chicago, Chicago, Illinois

Heretofore metallurgists and physicists have made the most significant advances in the study of disorder, using for their examples intermetallic compounds. To use this knowledge to the fullest in initiating studies of disorder in minerals, sulfides were chosen, because of their submetallic character and because of the similarity between the covalent bonds in the sulfides and the metallic bond in the intermetallic compounds.

Bornite (Cu_5FeS_4), chalcopyrite ($CuFeS_2$), and stannite (Cu_2FeSnS_4) were chosen for laboratory study because these minerals are often found as the host minerals in exsolution textures. The presence of such textures is an indication that solid diffusion exists in the mineral at elevated temperatures. As all these minerals have two different atoms of similar size and properties (copper and iron), the chances of self-diffusion of these atoms in the structure and subsequent disorder when heat-treated would seem to be great.

X-ray, thermal, and electrical evidences indicate that bornite can exist in both a low and high temperature form, and that the structural difference between the forms is one of order-disorder. When thermally induced, the disorder first reaches a measurable magnitude at 170°C. and the critical temperature of complete disorder is reached at 220°C. By quenching in cold water, the high or disordered form can be retained, but if cooled slowly from the elevated temperature the low form is regained.

X-ray evidence indicates that both stannite and chalcopyrite can exist in a disordered form above a temperature of 600°C. However, as dissociation of these sulfides occurs below this temperature at atmospheric pressure, experimental technique has not yet been worked out to determine the thermal and electrical characteristics of the change.

THE SIGNIFICANCE OF GALLIUM AND GERMANIUM REPLACEMENTS IN SYNTHETIC FELDSPARS

JULIAN R. GOLDSMITH
University of Chicago, Chicago, Illinois

It is difficult to locate specific positions of Al and Si atoms in many silicates because of the approximately equivalent *x*-ray scattering power of these two atoms. In studying order-disorder relations in silicates, particularly in feldspars, location of these positions is desirable. The synthesis of feldspar structures in which Al^{+++} is replaced by Ga^{+++} and Si^{++++} by Ge^{++++}, and some of their crystal-chemical properties is discussed; the heavier elements make it possible to obtain more definite information on the degree of disorder. It is hoped that these gallium and germanium feldspars will help in the interpretation of some of the problems of the natural feldspars.

RHEOMORPHIC BRECCIAS

G. E. GOODSPEED
University of Washington, Seattle, Washington

Igneous intrusive breccias display the well-known features resulting from the injection, crystallization and reaction of an orthomagma. In contrast to these, many breccias in granitized areas contain undisturbed rock fragments and skialiths surrounded by granitic matrices which exhibit crystalloblastic textures and structures. These are considered to represent an intermediate stage of granitization and have been called replacement breccias.

Other plutonic breccias associated with granitization have crystalloblastic features similar to replacement breccias but differ from them by the presence of fluxion textures. At Cornucopia, Oregon, the matrices of some of these breccias show flow structures. At Sudbury, Ontario, some of the breccia dikes contain fragments which in part appear to merge into a crystalloblastic matrix having a pronounced flow structure. Other breccia dikes in this vicinity are filled with fragments of rocks of various kinds imbedded in a matrix replete with metamorphic minerals showing crystalloblastic features and marked flow alignment.

Breccias formed during metamorphism and exhibiting crystalloblastic features and flow structures cannot be adequately explained as orthomagmatic, but support the interpretation of movement of metamorphosed material. Since the mass flowage of this material can be included, but in a more restricted sense, under the broad definition of rheomorphism, it s suggested that breccias developed under such conditions be termed rheomorphic breccias.

ORBICULAR TINGUAITE DIKES NEAR BRYANT, SALINE COUNTY, ARKANSAS

FRED A. HILDEBRAND
University of Chicago, Chicago, Illinois

Tinguaite dikes probably of Cretaceous age have intruded the northwest edge of a 400 square mile province of phacolithic nepheline syenite intrusives in central Arkansas. The dikes are normal tinguaite and not metamorphosed Paleozoic pendants which also occur in this alkaline province.

The dikes vary in width from a few inches to 20 feet and occur in four parallel, linear zones spaced 200 to 500 feet apart. The zones are traceable for at least 2500 feet in a northeast-southwest direction and disappear beneath overlapping Tertiary sediments.

The dike magma was viscous and moved horizontally as well as vertically as evidenced by (1) linear flow lines along the unaltered wall rock contact (2) tortuous flow lines and eddy currents adjacent to wall rock protuberances and isolated, sparsely distributed, unaltered wall rock fragments and (3) cross-cutting flow lines analogous to schistosity in competent rocks. The wider dikes contain tabular phenocrysts of albite, while the narrower dikes contain small feldspathic spherulites.

The narrower dikes show unusually well developed orbicular structures heretofore not reported from alkaline rocks. The orbicules are 2 to 35 mm. in long dimension and consist of a tinguaitic nucleus and a peripheral banded zone about 1.5 mm. thick. In the peripheral zone bands of very fine grained aegirite alternate with bands of mixed nepheline, sodalite, potash and soda feldspars. There is no mineralogical difference between the orbicules and matrix, although there is a textural difference in that aegirite occurs as isolated aggregates in the matrix.

Contemporaneity of the orbicules with the late cooling stage is shown by their elongation in the direction of flow, denting of one by another, non-intergrowth, truncation by flow lines, and enclosure of flow lines.

BERYL AT MT. MICA, MAINE

CORNELIUS S. HURLBUT, JR.
Harvard University, Cambridge, Massachusetts

The discovery of gem tourmaline at Mt. Mica, Maine in 1820 was the beginning of nearly a century of gem mining at that locality. The last "pocket" opened in 1913 marked the end of active gem mining.

In June 1949, while mining feldspar a few hundred feet from the old gem workings, a new pocket was opened. This pocket is one of the largest found at Mt. Mica and measured about 20′×4′×5′. The lining of the pocket was mostly albite and muscovite, but a portion was of columnar beryl. Lying on the floor of the pocket were many colorless to white beryl crystals of unusual habit, completely terminated, and displaying many rare forms. Spectrographic analysis of these crystals shows the presence of approximately 1.0% lithium, 1.5% cesium and 0.1% rubidium.

THE ROLE OF YTTRIUM AND OTHER MINOR ELEMENTS IN THE GARNET GROUP

HOWARD W. JAFFE
U. S. Bureau of Mines, College Park, Maryland

Several minor and trace elements, notably yttrium, scandium and zinc are very common in garnets. The frequent occurrence of several of these in particular varieties of garnet suggests isomorphism. Yttrium, heretofore considered to be a rare constituent of garnets, is very prevalent in spessartites. It has been found to occur in concentrations of greater than 2 per cent Y_2O_3 in a few manganese-rich garnets. The frequent association of yttrium and manganese in spessartites suggests that ions of Y^{+3} with an ionic radius of 1.06 A have replaced ions of Mn^{+2} having an ionic radius of .91 A, the values being those of Goldschmidt. Scandium is most abundant in pyropes and Sc^{+3} with an ionic radius of .83 A may substitute for ions of divalent Mg (.78 A) or possibly for divalent Fe (.83 A) if sufficient almandite is present. Zinc is a common trace element in manganese, iron and magnesium-rich garnets and ions of divalent Zn (.83 A) may proxy for those of divalent iron. Other trace constituents detected in garnets include Ga, Ti, Na, Li, Dy, Gd, La, Ce, Nd, Pr, Sr, Ba, F, H_2O and Cb. Their hypothetical isomorphous relations to the major constituents are discussed. Included in the data are 7 new quantitative yttria determinations, visual spectroscopic analyses of more than 70 garnets and spectrographic analyses of 2 yttria precipitates obtained from spessartites.

HYDROXYL IN MINERALS

W. D. KELLER AND E. E. PICKETT
University of Missouri, Columbia, Missouri

Water may occur in minerals as mechanically held, evaporable "free" water, as loosely held "water of crystallization," and as more tenaciously held "water of constitution." Free water and tightly held hydroxyl (OH) may be differentiated in powdered minerals by their absorption of the infrared spectrum.

The OH group may be singly (monomeric) bonded to other elements in the crystal and therefore vibrate freely. Dimeric and polymeric bonding, where two or more OH groups share resonating mutual bonds, are indicated as also present by infrared absorption. Examples of the several bond types are illustrated by absorption spectrograms of clay minerals, opal, zeolites, and other hydrated minerals.

SURFACE AREA OF DEEP SEA SEDIMENTS

J. LAURENCE KULP AND DONALD R. CARR
Lamont Geological Observatory (Columbia University), Palisades, New York

The application of the radioactive inequilibrium method of age determination to unconsolidated ocean sediments is based on the preferential adsorption of ionium and radium ions on the surface of precipitating particles. The adsorptive properties of the sediment depend both on the chemical nature and the surface area of the particles. The chemical nature of the sediments can be ascertained from the mineralogy. For a constant mineral type the number of ions adsorbed will be proportional to the surface area. Therefore a knowledge of the mineralogy and the surface area of the material will permit the use of sediments of varying lithology in age determination by the radioactive inequilibrium method.

The surface areas of about 50 representative core samples have been obtained by the Emmett-Brunauer gas adsorption method. Values range from 2 square meters per gram for fine red silt to 40 sq. m./gm. for very fine inorganic calcium carbonate. Deep water

red clay has a surface area of about 25 sq. m./gm. while the more common green clay from shallower water ranges from 10–15 sq. m./gm.

Implications of this quantitative information in age determination and ocean bottom geology will be discussed.

THE GEOMETRY OF TRICLINIC ADULARIA

FRITZ LAVES
University of Chicago, Chicago, Illinois

Thin sections of adularia show some optical deviations from monoclinic symmetry. These deviations are negligible at the core of the crystals, increase toward the surfaces, and reach a maximum in the area of the acute angle $(110) \wedge (\bar{1}10)$. *X*-ray pictures of this area show that the (110) and the $(\bar{1}10)$ sectors bear a symmetrical relationship to the plane (010) which is the symmetry plane in monoclinic adularia. The composition plane between these sectors is irregular in direction averaging close to (100) with an error of about 10°; it is always parallel to the *c* axis.

X-ray precession pictures of material from Mt. Vesuvius, Italy showed definite triclinic symmetry. Pictures were made of I, the (110) sector, and II, the $(\bar{1}10)$ sector. Precession axes were $[100]$, $[\bar{1}00]$, $[001]$, $[00\bar{1}]$, $[101]$, $[\bar{1}0\bar{1}]$.

Results: (I) $\alpha = 89°50' \pm 5'$; $\beta = 116°$; $\gamma = 90°39' \pm 5'$
(II) $\alpha = 90°10'$; $\beta = 116°$; $\gamma = 89°21'$

The relationship between parts I and II fulfills no known law. They are, as stated above, simply symmetrical to the (010) symmetry plane of "monoclinic" adularia. This fact plus other considerations to be discussed imply that the adularia originally grew as a monoclinic crystal and later underwent a progressive change from the surface inward to a triclinic modification. *X*-ray as well as optical measurements of the core of the crystal with the triclinic system of coordinates given above showed no deviation from monoclinic symmetry.

Heating at 1000°C. for four days produced some optical change; the crystal became "less triclinic." The *x*-ray pictures still showed triclinic symmetry.

The combination of the optical and the *x*-ray measurements shows that the optical nα axis which is close to the geometrical *a* axis in monoclinic adularia deviates in triclinic adularia in the same direction as the geometrical *a* axis. The geometrical deviation is 39′ ($\gamma = 90°39'$); the corresponding optical deviation is about 10°.

THE PHYSICAL ANALYSIS OF POLYCOMPONENT GARNET

S. BENEDICT LEVIN
Signal Corps Engineering Laboratories, Fort Monmouth, New Jersey

The widespread occurrence and compositional variation of garnet, in relation to the character of the rock facies in which it is indigenous, make it a useful diagnostic mineral in many petrologic problems. This places a premium on methods for the relatively rapid and accurate determination of garnet composition, especially where many specimens or very small amounts of clean material are involved. For detailed compositional correlation the 3-component solutions afforded by the triangular diagrams of Ford and Winchell do not suffice, since most garnet specimens (probably over 85%) contain 4 or 5 of the theoretical component "molecules" in significant amounts, that is, one mol per cent or more. Good 4-component solutions are afforded by the measurement of 3 physical properties which are independent (non-parallel) functions of the compositional variation, viz: index of refraction n, specific gravity G, and lattice constant a_0. These values may readily be applied to an algebraic solution or to the tetrahedral graphical solution of Philipsborn, and (with the same data) will yield quantitative results considerably better than the geometric estimates of Stockwell.

For most occurrences, however, only a 5-component solution in terms of pyrope, almandite, spessartite, grossularite, and andradite, will account for 99% or more of each garnet specimen. Such solutions are afforded by supplementing the 3 physical measurements (n, G, a_0) with a rapid partial chemical analysis for either MnO or FeO. With these 4 measured quantities, and the summation to 100% providing the fifth, it is possible to set up and solve 5 simultaneous equations to yield the values of the 5 unknowns, i.e. the molecular proportions of the 5 component molecules. In connection with a recent study of Adirondack garnets, a general solution of the 5 simultaneous equations has been made and the algebraic calculations thereby abbreviated to about 20 minutes of machine calculating. In laboratories having the usual equipment, an x-ray diffraction camera, thermally calibrated high-index liquids, a micro-pycnometer, etc., this composite method results in considerable saving of time over wet chemical methods, especially where many analyses are needed. By measuring N to $\pm .001$, G to $\pm .005$, a_0 to $\pm .002$ Å, and MnO to $\pm .2\%$, results accurate to ± 1 mol per cent are obtained. Examples from the author's recent work are cited in illustration.

PETROLOGY OF BIG BEND NATIONAL PARK

JOHN T. LONSDALE AND ROSS A. MAXWELL
University of Texas, Austin, Texas

In the southern part of the Big Bend region, Texas, including the Big Bend National Park, occurs a great development of early Tertiary intrusive igneous rocks along with a thick section of pyroclastics and lava flows. The latter apparently once covered a large part of the area. Intrusive masses are mainly restricted to the southern part of the region but are abundant also in the Davis Mountains to the north.

The intrusive masses include a few larger plutons, stocks (?) and laccoliths emplaced under a cover of 3000–4000 feet of Tertiary and/or Cretaceous strata. There are many smaller laccoliths, sheets, sills and dikes.

The intrusive rocks are mainly fine grained with a few of coarser texture. Forty-two chemical analyses show a nearly complete gradation from silicic to mafic types. The suite is alkalic and generally sodic with phosphorus and titanium prominent in the intermediate and mafic members. These also exhibit considerable differentiation *in situ* with prominent formation of analcime. The silicic members do not exhibit marked differentiation but a considerable variation from mass to mass. It is possible that more than one sequence of intrusion is present. In the park area silicic sodic intrusives were late in the sequence.

The lava flows do not show the extensive variation of the intrusive rocks. They include however similar alkalic and other types and belong in the same suite. Vents have not been specifically determined but certain irregular plug-like masses in the southern Chisos Mountains probably were feeders for part of the rhyolitic lavas.

A PRELIMINARY ACCOUNT OF THE NATURALLY OCCURRING ANTIMONY OXIDES

BRIAN MASON AND CHARLES J. VITALIANO
Indiana University, Bloomington, Indiana

Among the naturally occurring antimony oxides the following phases have been recognized: senarmontite, Sb_2O_3, isometric; valentinite, Sb_2O_3, orthorhombic; and an isometric phase with the pyrochlore structure, and with the ideal composition $Sb^{III}Sb^{V}_2O_6(OH)$. The latter phase is by far the most common of the oxidation products of antimony minerals. Its composition and physical properties are exceedingly variable, due to the ready substitution of the antimony by other elements, and to the incomplete filling of some of the lattice positions. This appearance of vacant lattice positions is evidently largely responsible for the extreme variability of density and refractive index in this phase. Recorded values for the density range from 3.5 to 5.6, and of the refractive index from 1.6 to 2.1. This phase includes both the cervantite and stibiconite of the mineralogical texts. The phase Sb_2O_4 has not been recognized among the naturally occurring antimony oxides and its occurrence is questionable; the material that has been described as cervantite, with the supposed formula Sb_2O_4 (theoretical composition is $Sb=79.2$, $O=20.8$) is actually the above described isometric phase (theoretical composition for $Sb^{III}Sb^{V}_2O_6(OH)$ is $Sb=76.4$, $O=21.8$, $H_2O=1.88$).

NICKEL-COPPER-GOLD MINERALOGY AT THE MACKINAW MINE, SNOHOMISH COUNTY, WASHINGTON*

CHARLES MILTON

U. S. Geological Survey, Washington, D. C.

A remarkable nickel deposit, the Mackinaw Mine, Snohomish County, Washington, is one of the few known in which the nickel sulfides and arsenides are not accompanied by pyrrhotite. The ore minerals are pentlandite, maucherite, niccolite, chalcopyrite and cubanite, magnetite, vallerite, sphalerite, and gold. There are two distinct types of ore, one containing pentlandite with little or no nickel arsenides or gold, the other, nickel arsenides and gold without pentlandite (or sphalerite). In many respects the mineralogy of this deposit resembles that of the Alistos mine, Sinaloa, Mexico, described by Krieger and Hagner in 1943 and then believed to be unique.

* Published by permission of the Director, U. S. Geological Survey.

PEROVSKITE FROM CALIFORNIA

JOSEPH MURDOCH

University of California, Los Angeles, California

The first California find of perovskite is from the 910 level of the Commercial quarry at Crestmore, Riverside County. The mineral occurs as brilliantly shining, deep yellow octahedral crystals up to one mm. across. These are occasionally modified by small cube faces. Thin sections show the usual multiple twinning parallel to (100), and the individual lamellae are rather strongly birefringent. The perovskite is found in granular calcite, associated with numerous skeletal octahedral crystals of nearly black spinel, which in section is pale green in color.

HAUCHECORNITE

M. A. PEACOCK

University of Toronto, Canada

A good small crystal of hauchecornite from the Friedrich mine, Hamm a.d. Sieg, Westphalia (Harvard Mineralogical Museum, 89710) is a thick square basal tablet *c*(001) combined with the tetragonal prisms *a*(010), *m*(110), and the tetragonal bipyramids *q*(011), *p*(021), *e*(111) ($a:c=1:0.7404$, goniometric and *x*-ray). Rotation and Weissenberg photographs around the *c*-axis and an *a*-axis show the Laue symmetry $4/mmm$, $a=7.28$ kX, $c=5.39$ kX ($\lambda CuK\alpha_1=1.5374$ kX), and the probable spacegroup $P4_22$. With the specific gravity 6.36 measured on this crystal (17 mg.) the four existing analyses on picked material indicate the cell content $Ni_8(Bi, Sb)_2S_8$. Strongest *x*-ray powder lines for identification: 2.79

kX (10), 2.39 (6), 2.30 (6), 4.34 (5), 1.861 (5). Hauchecornite is thus a well-defined mineral species.

PRELIMINARY REPORT ON THE SYSTEM LEUCITE-SiO_2-FeO

EDWIN ROEDDER
Columbia University, New York, New York

A fairly complete reconnaissance has been made of this plane through the tetrahedron representing the more general system K_2O-Al_2O_3-SiO_2-FeO. An equilibrium diagram for the condensed system (each composition including Fe_2O_3 to the amount representing equilibrium with the pure iron crucibles) is given, along with a plot of the per cent Fe_2O_3 present at the liquidus temperature. The equilibrium diagram shows that the flat liquidus surface of fayalite covers a large portion of the system, it being the primary phase even in compositions very close to the binary potash feldspar-silica eutectic. The significance of these results in the crystallization-differentiation of natural magmas is discussed briefly.

GEOLOGY OF THE IRWIN DISTRICT OF COLORADO

ARTHUR A. SOCOLOW
Southern Methodist University, Dallas, Texas

The Irwin District, west of Crested Butte, in Gunnison County, Colorado, is an area of geologic interest that goes beyond the local coal and silver deposits. The region has had a complex structural, stratigraphic, and intrusive history.

Through a thick series of sediments of varying ages and lithologies have come up a number of intrusive bodies, ranging from tremendous laccoliths to a swarm of dikes and sills.

This paper deals with some of the findings relating to the emplacement of the various igneous bodies. The deuteric effects, the structural deformation, the related hydrothermal deposits and the hydrothermal alteration are all discussed.

Intense epidotization of the sediments is a result of deuteric activity, but intensity is a function of type of igneous body, distance from contact and distance from original source of the igneous material.

Intrusion of the igneous material was apparently responsible for intense faulting and some folding. The faults became favorable loci of deposition of hydrothermal solutions which represented the end stages of igneous activity. The rich veins of arsenopyrite, native silver, gold, and ruby silver have made the area famous. The hydrothermal alteration of the igneous and sedimentary rocks is intense and has been studied by the writer.

DACITES FROM LAUGHLIN PEAK, COLFAX COUNTY, NEW MEXICO

HELEN STOBBE
Smith College, Northampton, Massachusetts

Laughlin Peak, one of 7 eroded volcanic cones of dacite in northeastern Colfax County, New Mexico, is located 11 miles north of Chico. In a previous paper the writer described specimens from this cone as vitrophyres, because of the large proportion of glass and lack of chemical data. Study of additional specimens and a chemical analysis show that the rocks from Laughlin Peak, the northeast side and top are similar to dacites on the other cones.

Hand specimens are pale-gray or gray and pink-banded, fine-grained, vesicular rocks. Micrometric analyses range as follows: Glass 83%–65%, plagioclase 21%–12%, hornblende

8%–1%, magnetite 14%–2%. The average mode of 7 slides is glass 73%, plagioclase 16%, hornblende 3%, magnetite 7%. The feldspar is oligoclase ($Ab_7 An_3$); hornblende usually the basaltic variety.

The norm (in part) calculated from the chemical analysis follows: Quartz 26%, orthoclase 15%, albite 36%, and anorthite 12%. Orthoclase slightly exceeds anorthite. Therefore the rock is close to the border between rhyolites and dacites, and could be called a soda-rhyolite or rhyodacite. The chemical analysis and norm are similar to those from Red Mountain and Cunningham Butte.

There is no marked difference chemically between these rocks. Although Laughlin Peak specimens are less crystallized, they do not differ mineralogically from the dacites of the other cones, Towndrow Peak and Red (or Bell) Mountain, both on Johnson Mesa, Cunningham Butte, Green Mountain, Raspberry Peak and Palo Blanco—the large cone 8 miles southeast of Laughlin Peak.

NONTRONITE AT BINGHAM, UTAH

BRONSON STRINGHAM AND ALLEN O. TAYLOR
University of Utah, Salt Lake City, Utah

Nontronite has been found in abundance on the upper southwest levels of the Kennecott Copper Mine at Bingham, Utah. The rocks in this area were originally arkosic quartzites with dolomitic and/or argillaceous impurities. Contact action in these rocks has developed interstitial diopside, tremolite and pyrophyllite. Nontronite is present in localized areas as a weathering product of these minerals and orthoclase, where pyrite was present to supply iron for its development. Chemical analysis shows the mineral to have the formula

$$(Al_{.59}Fe_{1.02}Mg_{.31})(Al_{.52}Si_{3.48})O_{10}(OH)_{2x.38}.$$

Differential thermal curves show a double endothermic peak between 600 and 700°C. as would be expected of a low iron nontronite.

ON THE CRYSTAL STRUCTURE OF BORNITE FROM ILLOGAN, CORNWALL

G. TUNELL AND C. E. ADAMS
University of California, Los Angeles, California

A rotation photograph and a set of equi-inclination Weissenberg photographs were made of a single crystal of bornite from the Carn Brea Mine, Illogan, Cornwall, using filtered cobalt radiation. Although the three crystal axes are equal in length within the error of our determination, and the three interaxial angles are 90°, the structure is not truly cubic. The unit cell is pseudo-cubic with $a_0 = 32.8$ Å. The structure is approximated by the following arrangement in a cubic cell with $a_0' = 5.47$ Å $(= \frac{1}{6} \times 32.8$ Å$)$: four copper or iron atoms distributed statistically over the four positions $\frac{1}{4}\frac{1}{4}\frac{1}{4}$, $\frac{3}{4}\frac{3}{4}\frac{1}{4}$, $\frac{1}{4}\frac{3}{4}\frac{3}{4}$, $\frac{3}{4}\frac{1}{4}\frac{3}{4}$, two copper or iron atoms distributed statistically over the four positions $\frac{1}{4}\frac{3}{4}\frac{1}{4}$, $\frac{3}{4}\frac{1}{4}\frac{1}{4}$, $\frac{1}{4}\frac{1}{4}\frac{3}{4}$, $\frac{3}{4}\frac{3}{4}\frac{3}{4}$, the total number of copper atoms in this cell being five and the total number of iron atoms being one on the average; four sulphur atoms on the positions 000, $\frac{1}{2}\frac{1}{2}0$, $0\frac{1}{2}\frac{1}{2}$, $\frac{1}{2}0\frac{1}{2}$. This approximate structure yields calculated intensities for all the strong and medium spots in good agreement with those observed; it yields small or zero calculated intensities for all the weak spots. The weak spots for which the calculated intensities are zero prove that the structure is actually more complicated, but the nature of the deviations from the approximate arrangement has not been found in our work.

ASSIMILATION (?) OF MICACEOUS SCHIST BY DIABASE

W. HAROLD TOMLINSON
Springfield, Pennsylvania

Inclusions of highly altered micaceous schist in diabase were found by the author in the Umble Farm Quarry at Safe Harbor, Pa.

Rising through the magma these inclusions left a tubular trail. In cross section they show, megascopically, a rounded contour and are surrounded by a zone of hybrid rock of fairly uniform composition which sharply separates the inclusions from the diabase.

There is a close resemblance between this hybrid rock and some abnormal phases of the diabase formation exposed at other localities. Mineral and chemical compositions of the inclusions, the hybrid rock and the diabase are given.

No conclusions seem warranted but the occurrence suggests a possible origin for certain phases of the diabase intrusives.

HIGH-TEMPERATURE ALBITE

O. F. TUTTLE AND N. L. BOWEN
Geophysical Laboratory, Washington, D. C.

Synthetic albite has optical and *x*-ray properties notably different from natural albite of granites and pegmatites, but like those of albite from some volcanic rocks. On prolonged heating at high temperatures pegmatitic albite inverts to a modification identical with the synthetic material. In the presence of fluxes the change takes place as low as 700°C. Albite twinning is observed in both forms.

MELONITE FROM BOULDER COUNTY, COLORADO

ERNEST E. WAHLSTROM
University of Colorado, Boulder, Colorado

Polished-section and *x*-ray studies of the telluride ores of Boulder County, Colorado, establish the fact that melonite ($NiTe_2$) in small amounts is widespread and is an early mineral in a complex epithermal sequence including a variety of sulfides, tellurides, and gangue minerals.

THE EFFECT OF POTASSIUM ON THE NEPHELINE-CARNEGIEITE TRANSFORMATION

EDWARD WASHKEN AND M. J. BUERGER
Massachusetts Institute of Technology, Cambridge, Massachusetts

When the temperature of a melt of composition $NaAlSiO_4$ is lowered through its freezing point, crystals of carnegieite form. Carnegieite transforms sluggishly into nepheline at 1248°C. If one wishes to obtain nepheline directly from a melt this may be done by reducing the freezing point of the melt below this transformation point by the addition of a flux like lithium fluoride. Obtaining single crystals of nepheline by this method involves certain difficulties.

Recent crystal structure studies show that the composition $NaAlSiO_4$, while natural to carnegieite, is foreign to nepheline, and indeed is clearly forced on the crystals of nepheline by the above method of production. Normal nepheline requires one alkali atom in four to be potassium. In confirmation of this finding, naturally-occurring nepheline has a composition tending toward $KNa_3Al_4Si_4O_{16}$. Since the K atom is large for the available alkali sites in the carnegieite structure the composition $KNa_3Al_4Si_4O_{16}$ is foreign to carnegieite. It would appear possible to avoid the formation of carnegieite by cooling a melt of that composition.

Crystallization experiments show this line of reasoning to be correct. The x-ray powder pattern of the product obtained by cooling a melt of the composition $KNa_3Al_4Si_4O_{16}$ is found to agree with the pattern of natural nepheline.

This work was carried on in the Washken Laboratories, Cambridge, Massachusetts, under a development contract with the Squier Signal Laboratory, U. S. Army Signal Corps, Fort Monmouth, New Jersey.

GEOLOGY OF THE SILVER LAKE TALC AREA, SAN BERNARDINO COUNTY, CALIFORNIA

LAUREN A. WRIGHT
California Division of Mines, San Francisco, California

The commercial talc-tremolite deposits near Silver Lake are within a persistent feldspar- and diopside-rich member of a highly metamorphosed pre-Cambrian sedimentary series. The deposits are elongate and lenticular and represent nearly complete replacement of carbonate strata. Other metasediments in the series include vitreous quartzite; marble containing disseminated forsterite, serpentine, chondrodite (?) and talc; quartz-muscovite schist; and quartz-biotite schist.

The quartz-biotite schist is commonly migmatitic; it also contains masses of microcline-quartz gneiss. An andesine-biotite-hornblende lamprophyre occurs as irregular bodies and dikes within the metasediments. Quartz diorite, which locally grades into and intrudes the lamprophyre, is the most extensive rock in the area. It intrudes the metasediments as sills and surrounds large residual metasedimentary islands. All of these metasedimentary and igneous rocks have been intruded by felsic dikes. The metasediments, in general, dip uniformly southward, as do planar structures in the gneiss, lamprophyre and quartz diorite.

The commercial deposits consist mostly of tremolite, but talc-concentrations are common near the walls and are apparently alterations of tremolite along shear zones. The tremolite rock contains local residual masses composed of earlier metamorphic minerals. Forsterite (?), the first of these early minerals to form, has been partly to wholly replaced by talc and tremolite of and early generation; calcite and serpentine have locally replaced this tremolite. Serpentine veinlets intricately traverse the residual masses but do not extend beyond their borders. The late-generation tremolite formed contemporaneously with the intrusion of felsic dikes.

THE JADEITE PROBLEM

HATTEN S. YODER, JR.
Geophysical Laboratory, Washington, D. C.

The jadeite problem is re-opened and new data are presented which redefine the probable stability range of jadeite. The mineral is known to occur in only three places; as small masses in serpentine with albite, or nepheline, or both, in Burma, and with albite and quartz in Japan. No specimens have been found in situ in the Central American occurrence. The interest in jadeite is mainly due to the theory that it is a high pressure mineral. If a reaction is known to be possible on other grounds, it will proceed under pressure in the direction of smaller volumes. However, the mere fact that the supposed products are of smaller volume than the reactants is not sufficient basis for inferring that the reaction will take place. All attempts to synthesize jadeite, even at pressures up to 4000 atmospheres, have been unsuccessful.

Although no direct structure determination appears to have been made, the common assumption that jadeite has a structure similar to diopside is justified by an indirect method. It is suggested that the coordination of sodium is probably less than normally assigned and that the "excess" aluminum occupies silica positions.

The temperature of formation is believed to be less that 800°C. since the mineral melts metastably at a temperature at least as low as 800°C.; it occurs with low temperature albite (<700°C.); it occurs in a reaction zone against serpentine (<500°C.); its chemical equivalents, nepheline+albite, are stable in the presence of water down to 600° and 3000 atmospheres; and its glass fails to crystallize dry below 800°.

A new analysis of jadeite and data on the diopside-jadeite and acmite-jadeite joins are given. The jadeite problem is considered to be distinct from the eclogite problem.

LIST OF FORMER OFFICERS AND MEETING PLACES

By recommendation of the Council, a complete list of past officers is printed in the proceedings of the annual meeting of the Society:

	Presidents	Vice-Presidents
1920	Edward H. Kraus	Thomas L. Walker
1921	Charles Palache	Waldemar T. Schaller
1922	Thomas L. Walker	Frederick A. Canfield
1923	Edgar T. Wherry	George F. Kunz
1924	Henry S. Washington	Washington A. Roebling
1925	Arthur S. Eakle	Herbert P. Whitlock
1926	Waldemar T. Schaller	George Vaux, Jr.
1927	Austin F. Rogers	George L. English
1928	Esper S. Larsen	Lazard Cahn
1929	Arthur L. Parsons	Edward Wigglesworth
1930	Herbert E. Merwin	John E. Wolff
1931	Alexander H. Phillips	William F. Foshag
1932	Alexander N. Winchell	Joseph L. Gillson
1933	Herbert P. Whitlock	Frank N. Guild
1934	John E. Wolff	William A. Tarr
1935	Clarence S. Ross	Ellis Thomson
1936	William S. Bayley	Harold L. Alling
1937	Norman L. Bowen	H. V. Ellsworth
1938	Ellis Thomson	Kenneth K. Landes
1939	Max N. Short	Burnham S. Colburn
1940	William F. Foshag	Ian Campbell
1941	Frederick E. Wright	William J. McCaughey
1942	Arthur F. Buddington	Martin J. Buerger
1943	John F. Schairer	John W. Gruner
1944	R. C. Emmons	Harry Berman
1945	Kenneth K. Landes	George Tunell
1946	Paul F. Kerr	S. B. Hendricks
1947	M. J. Buerger	Carl Tolman
1948	M. A. Peacock	Adolf Pabst
1949	John W. Gruner	J. D. H. Donnay

Secretaries

1920–1922	Herbert P. Whitlock
1923–1933	Frank R. Van Horn
1933–1934	Albert B. Peck
1934–1944	Paul F. Kerr
1944–	C. S. Hurlbut, Jr.

Treasurers

1920–1923	Albert B. Peck
1924–1929	Alexander H. Phillips
1929–1930	Albert B. Peck
1931–1940	Waldemar T. Schaller
1941–	Earl Ingerson

Editors

1920–1921	Edgar T. Wherry
1922–	Walter F. Hunt

Councilors

1920 Arthur S. Eakle, Frank R. Van Horn, Fred E. Wright, Alexander H. Phillips.
1921 Frank R. Van Horn, Fred E. Wright, Alexander H. Phillips, Austin F. Rogers.

1922 Fred E. Wright, Alexander H. Phillips, Austin F. Rogers, Thomas L. Watson.
1923 Alexander H. Phillips, Austin F. Rogers, Thomas L. Watson, Esper S. Larsen.
1924 Austin F. Rogers, Thomas L. Watson, Esper S. Larsen, Arthur L. Parsons,
1925 Thomas L. Watson, Esper L. Larsen, Arthur L. Parsons, William F. Foshag.
1926 Esper S. Larsen, Arthur L. Parsons, William F. Foshag, William A. Tarr.
1927 Arthur L. Parsons, William F. Foshag, William A. Tarr, Alexander N. Winchell.
1928 William F. Foshag, William A. Tarr, Alexander N. Winchell, Ellis Thomson.
1929 William A. Tarr, Alexander N. Winchell, Ellis Thomson, Clarence S. Ross.
1930 Alexander N. Winchell, Ellis Thomson, Clarence S. Ross, Paul F. Kerr.
1931 Ellis Thomson, Clarence S. Ross, Paul F. Kerr, William S. Bayley.
1932 Clarence S. Ross, Paul F. Kerr, William S. Bayley, William J. McCaughey.
1933 Paul F. Kerr, William S. Bayley, William J. McCaughey, Kenneth K. Landes.
1934 William S. Bayley, William J. McCaughey, Kenneth K. Landes, E. P. Henderson.
1935 William J. McCaughey, Kenneth K. Landes, E. P. Henderson, J. F. Schairer.
1936 Kenneth K. Landes, E. P. Henderson, J. F. Schairer, Arthur F. Buddington.
1937 E. P. Henderson, J. F. Schairer, Arthur F. Buddington, Arthur P. Honess.
1938 J. F. Schairer, Arthur F. Buddington, Arthur P. Honess, R. C. Emmons.
1939 Arthur F. Buddington, Arthur P. Honess, R. C. Emmons, Carl Tolman.
1940 Arthur P. Honess, R. C. Emmons, Carl Tolman, D. Jerome Fisher.
1941 R. C. Emmons, Carl Tolman, D. Jerome Fisher, Martin A. Peacock.
1942 Carl Tolman, D. Jerome Fisher, Martin A. Peacock, Adolf Pabst.
1943 D. Jerome Fisher, Martin A. Peacock, Adolf Pabst, C. S. Hurlbut, Jr.
1944 Martin A. Peacock, Adolf Pabst, Michael Fleischer S. J. Shand.
1945 Adolf Pabst, Michael Fleischer, S. J. Shand, R. E. Grim.
1946 Michael Fleischer, S. J. Shand, R. E. Grim, Joseph Murdoch.
1947 S. J. Shand, R. E. Grim, Joseph Murdoch, H. H. Hess.
1948 R. E. Grim, Joseph Murdoch, H. H. Hess, Clifford Frondel.
1949 Joseph Murdoch, H. H. Hess, Clifford Frondel, Lewis S. Ramsdell.

Annual Meeting Places

1920 Chicago, Illinois
1921 Amherst, Massachusetts
1922 Ann Arbor, Michigan
1923 Washington, D. C.
1924 Ithaca, New York
1925 New Haven, Connecticut
1926 Madison, Wisconsin
1927 Cleveland, Ohio
1928 New York, N. Y.
1929 Washington, D. C.
1930 Toronto, Canada
1931 Tulsa, Oklahoma
1932 Cambridge, Massachusetts
1933 Chicago, Illinois
1934 Rochester, New York
1935 New York, N. Y.
1936 Cincinnati, Ohio
1937 Washington, D. C.
1938 New York, N. Y.
1939 Minneapolis, Minnesota
1940 Austin, Texas
1941 Boston, Massachusetts
1942 No meeting held
1943 No meeting held
1944 No meeting held
1945 Pittsburgh, Pennsylvania
1946 Chicago, Illinois
1947 Ottawa, Canada
1948 New York, N. Y.
1949 El Paso, Texas

Recipients of the Roebling Medal

Charles Palache, December 1937
Waldemar T. Schaller, December 1938
Leonard James Spencer, December 1940
Esper S. Larsen, Jr., December 1941
Edward H. Kraus, February 1945
Clarence S. Ross, December 1946
Paul Niggli, December 1947
William Lawrence Bragg, November 1948
Herbert E. Merwin, November 1949