

1 \$1,000 bond, Denver Gas and Electric Light Co., 5%, due 1951 . . . \$1,000.00

\$50,800.00

In addition there is \$200.00 cash laid aside for the Roebing Medal Fund.

Respectfully submitted,

W. T. SCHALLER, *Treasurer*.

Washington, D.C.

December 14, 1934.

*To the President of the Mineralogical Society of America:*

The Auditing Committee has examined and verified the accounts and report of the Treasurer for the fiscal year ending November 30, 1934. The Committee also certifies that \$200.00 cash is laid aside for the Roebing Medal Fund. The securities listed in the Treasurer's report are in the safety deposit box in the vaults of the American Security and Trust Company of Washington, D.C. All future coupons are intact and are attached to these securities with the following exceptions: Four bonds of the Trenton Mortgage and Title Guaranty Company of a total par value of \$4,000, have been changed to registered bonds (registered both for principal and interest) and the coupons detached and destroyed.

TOM. F. W. BARTH, *Chairman*

HERBERT INSLEY

GEO. STEIGER

#### PRESIDENTIAL ADDRESS

The address of Dr. John E. Wolff, retiring President of the Mineralogical Society of America, was delivered on Thursday, December 27 at 12:30 P.M. in the Henry Strong Auditorium before the joint assembly of all societies.

#### CRAZY MOUNTAINS OF MONTANA—SUPER-ALKALINE AND SUB-ALKALINE TERTIARY INTRUSIVE ROCKS AND THEIR PROBLEMS

BY JOHN E. WOLFF, *Pasadena, California*

(*Abstract*)

The paper begins with a brief topographic and geological description of the range, which lies some thirty miles east of the Frontal range and is bounded on the south by the Yellowstone river, on the north by the Musselshell, on the west by Shield's river, and on the east by the tributaries of the Yellowstone and Musselshell, respectively. The area is forty-five miles long from north to south and twenty-five miles wide, divided by Shield's river into a southern area of high and rugged peaks (over eleven thousand feet above tide) with deep canyons, and several small residual glaciers, and a lower northern area, flat-topped and less dissected.

The range contains a remarkable assemblage of intrusive igneous rocks, including in the southern half, a large diorite stock with a mile wide contact ring, forming in ground plan an elongated oval six and a half miles long north and south by four miles east and west—twenty-two square miles in area, with many dikes cutting the mass, and small laccoliths, sills, and thousands of dikes in the enclosing Fort Union (Eocene) sediments. Canyons have cut down over three thousand feet into

the stock affording ideal exposures and fresh specimens. None of the super-alkaline rocks occur in this southern area, except at the extreme western foot of the mountains, six miles distant from the stock.

In the northern area the super-alkaline rocks occur in profusion in laccoliths, thick and thin sills and dikes, and in three volcanic necks. No effusive rocks, however, occur anywhere in the range. The Fort Union sediments have been here intensely folded, the folds running north and south and the intrusive sills dip with them. One stock of laurdalite is exposed near the north end, a quarter square mile in area, with an associated complex of allied rocks. In the middle of this northern area rises a smaller dioritic stock, four square miles in area, analogous to the larger one in the south but not so well exposed. Here again the alkaline rocks show no direct connection by contacts or apophyses, and the relative age of the two series cannot thus be determined.

In the southern area of high peaks, formed by the stock and its satellites, the Fort Union beds dip gently north into the range at its termination north of the Yellowstone River, and dip inward on the east and west sides, thus forming a broad flat syncline. The axis of the structure trends north, with some gentle parallel folds, but the strata arch into a dome on approaching the stock, to dip away in all directions. The strata are tilted, crushed, and injected by the diorite at the contact. At the north end of the area the diorite plunges at a low angle beneath the overlying sediments, which soon become nearly horizontal. There has been east-west compression in this area, but it was gentle compared to that in the northern area.

At least twenty different types of igneous rocks may be identified including the following common varieties:

<i>Alkaline</i>	<i>Lime-alkali</i>
Theralite (basic shonkinite). This is the original rock on which Rosenbusch established his theralite family of plutonic rocks. It contains about twelve different minerals of unusual freshness and is hence excellent for beginners to study.	Diorite
Granite-porphry	Granite
Laurvikite	Aplite
Nephelite syenite	Essexite
Soelvsbergite	Gabbro
Alkali-syenites	Peridotite
Bostonite	Diorite-porphry
Syenite-porphry	Augite porphry
Syenite aplite	Biotite malchite
Alkali camptonite	Intermediate camptonites
	Diabase (and other porphyries)

On the basis of some thirty chemical analyses fifteen subranges of the C.I.P.W. classification are recognized in the double series. The silica ranges from 74% in the aplites to 40% in the peridotites. All the rocks show unusual amounts of BaO and SrO, reaching a maximum in the theralites of 0.76% BaO, 0.37% SrO, or 1.13% of the combined oxides. Na<sub>2</sub>O varies from 8.55% in nephelite syenite to 1.58% in picrite, and K<sub>2</sub>O from 6% in aplites to 0.85 in picrite. Soda is greater than potash in the entire series, and lime greater than magnesia, except in picrite.

Some mineral differences may be noted. Biotite is common in both series and is normal in the sub-alkaline rocks, but in the theralite it has 6° extinction angle to the cleavage, and 2V is about 17°. Barium is present spectroscopically.

The augites of the sub-alkaline types are diopside or pigeonite; in the alkaline, diopside in the center of crystals, becoming aegirite-augite and then aegirite at the periphery.

The hornblendes of the diorite series are pale green in the acid types to brown in the basic. In the alkaline series they are light green to yellow in acid rocks, and brownish-green in camptonites. One laccolith of theralite, rich in olivine, has a magnesian hastingsite, associated with the pyroxene.

The nephelite shows barium with the spectroscope.

The feldspars of the diorite series are normal orthoclase, micro-perthites in the aplites, and normal plagioclases, but in the nephelite syenites the anorthoclase phenocrysts have 1.13% of BaO+SrO, with both CaO and alkalis. In the theralite the orthoclase is a four component mineral (Ab 15, An 10, Or 67, Hyalophane 8). Sp. Gr. 2.59-2.61.

The lantern slides which illustrated this paper showed the magnificent exposures of the theralite, reaching a thickness of five hundred feet in Gordon's Butte and elsewhere, and will be reproduced in the completed monograph. Only a sketchy statement was made as to the possible origin and emplacement of these various rock masses, such as: that differentiation had occurred at depths, and in the emplacement different partial magmas were squeezed by orographic pressure into the places now occupied. A syenite magma was probably the immediate parent of the alkaline rocks: the reasons for these two suppositions are the facts that complementary dikes or sills are often found closely associated, and that in a neck of theralite, are blocks of alkali-syenite and alkali-granite brought up from depths, so that evidently there is here a large buried mass of syenite.

Pegmatites are wanting in the two series and pneumatolytic minerals such as tourmaline and other similar minerals are not present, so that the magma was "dry."

#### PRESENTATION OF PAPERS

*Thursday Afternoon, December 27th*

At 2:40 P.M. the Society proceeded to the reading of scientific papers, President John E. Wolff presiding. Papers presented Thursday afternoon, included 23 titles devoted to general mineralogy and related subjects. Abstracts of these papers are given below:

##### AMBER FROM MANITOBA, by T. L. Walker.

The chemical and optical characteristics of chemawinite, an amber from Cedar Lake, Manitoba. The insect fauna are described as revealed by an examination of part of the available material. The presence in the amber of a crystalline mineral, probably a hydrocarbon, for which, as a new mineral, the name *enelectrite* is proposed.

##### FURTHER STUDIES IN THE PYROXENE GROUP, by A. N. Winchell.

New data permit the presentation of new graphs showing the relations between variations in composition and in optical properties in the enstentite-diopside-hedenbergite system. Are end-members of variations properly called minerals?

## TOPAZ FROM DEVIL'S HEAD, by M. A. Peacock.

With field notes by Arthur Montgomery and Edwin Over, Jr.

Renewed operation in the pegmatites of Devil's Head, in the Pike's Peak region, have yielded a suite of noteworthy crystals of topaz associated with quartz, microcline, albite, fluorite and cassiterite. The collection includes some topaz crystals of outstanding size and regular development and many smaller crystals of unusually distorted habits. The forms observed are:  $c(001)$ ,  $b(010)$ ,  $g(130)$ ,  $l(120)$ ,  $m(110)$ ,  $X(023)$ ,  $f(011)$ ,  $y(021)$ ,  $h(103)$ ,  $d(101)$ ,  $i(113)$ ,  $u(112)$ ,  $o(111)$ , and  $r(121)$ , on the preferred parameters of Kokscharov. One crystal shows alteration to a mineral of the kaolin group, and they all exhibit corrosion effects, some of which are suitable for geometrical description.

## MORINITE FROM BLACK HILLS PEGMATITE, by J. J. Runner.

Preliminary examination of the physical, optical and chemical properties of a mineral from a pegmatite near Keystone, South Dakota, indicates that it probably belongs to the rare species morinite. The morinite occurs in veinlets replacing manganapatite and an unidentified mineral. These three minerals have apparently replaced amblygonite. A few small prismatic crystals of the morinite were obtained from cavities in the rock. The manganapatite and the amblygonite possess some unusual and interesting properties. Further studies of the properties of the morinite are being made which, it is hoped, will supply more complete data than are now available.

## PYROXMANGITE FROM IDAHO, by E. P. Henderson and Jewell J. Glass.

This study of the second occurrence of pyroxmangite, from Homedale, Idaho, confirms the composition of the original material from South Carolina and adds new and more complete optical data. The relationship between high iron rhodonites, pyroxmangite and sobralite is discussed and  $x$ -ray diffraction patterns of the rhodonites and pyroxmangite are compared.

## MINERALOGY OF SILICOSIS, by R. J. Colony.

Optical and  $x$ -ray study of the lung-ash of casualties from silicosis. An attempt to determine the presence of quartz, feldspar and other minerals in the ash of portions of the lungs of men exposed to rock-dust for a period of years, who have died as a consequence of such exposure, and whose clinical history is known.

## SILICA FRAMEWORK CRYSTALS AND THEIR STABILITY FIELDS, by M. J. Buerger.

The stable, high temperature forms of silica, tridymite and cristobalite, differ from the stable, low temperature form, quartz, principally by being open structures. Their open character is dynamically maintained by thermal agitations. It may also be statically maintained by inclusion of foreign ions, which therefore prevent re-packing at low temperatures to quartz structure. The foreign ion in question may enter the structure to balance the valence change brought about by substitution for  $Si^{4+}$ , some ion of lesser valence. If this substitution maintains the simple multiple proportions of the atoms, pure compounds are formed. The number of major polymorphous forms of the resulting compound is equal to  $n+1$ , where  $n$  is the number of remaining void spaces in the high-cristobalite-like phase of the compound. Thus,  $SiO_2$  has three,  $NaAlSiO_4$  has two, and  $Na_2CaSiO_4$  has only one major modification.

If the substitution does not maintain simple multiple proportions of all the atoms, the result is a solid solution rather than an ideal compound. This crystal cannot possibly have a quartz-like phase unless the valence balancing ion is hydrogen. This corresponds with chalcedony. Even if the valence balancing ions are present in amounts less than enough to fill half the void spaces, a tridymite structure may not be formed if these ions are not distributed in regular alternations. The natural tridymite and cristobalite minerals are therefore not necessarily metastable phases formed under permission of Ostwald's rule, but may be or may have been stable, impure silica. Levin and Ott's as well as Grieg's uninverted high-cristobalite at room temperature may also be impure silica.

XONOTLITE FROM FRANKLIN FURNACE, by L. H. Bauer, and H. Berman.

Xonotlite is found together with clinohedrite in a narrow vein cutting the ore, at Franklin, New Jersey. Optical determinations and an analysis establish the identity of the new occurrence of this rare mineral. The new find is noteworthy in that the crystals, although not terminated, are suitable for an  $x$ -ray crystallographic study. Preliminary examination shows that the crystals are monoclinic, and that the proper formula is  $\text{Ca}_3\text{Si}_3\text{O}(\text{OH}_2)$ .

LINEAR MINERALOGICAL ARITHMETIC, by A. L. Parsons.

A demonstration of the suitability of graphical methods for mineralogical problems involving chemical analyses where speed and accuracy are required.

PRELIMINARY NOTE ON A SERIES OF SYNTHETIC FLUOR-AMPHIBOLES, by N. L. Bowen.

During a study of the inversion of Mg, Fe'' pyroxenes in sealed tubes in the neighborhood of  $1000^\circ\text{C}$ ., it was necessary to resort to the use of a trace of NaF as a "catalyst" in some instances. A drusy coating of minute needle crystals of another phase formed on the pyroxene in these examples. These crystals have the properties of amphibole and are necessarily fluor-amphibole since no water was present. A pure magnesian end-member and a pure ferrous end-member were then prepared, as well as four of intermediate compositions. Members of the series are compared with their natural hydroxy-relatives in the cummingtonite-grünerite series. The extinction angles are slightly higher and the refractive indices notably lower than in corresponding members of the natural series. The lowering of refractive index is about the same as that produced in topaz by an equal substitution of fluorine for hydroxyl.

CHEMICAL FORMULA AND CRYSTAL SYSTEM OF ALLEGHANYITE, by Austin F. Rogers.

The formula  $5\text{MnO} \cdot 2\text{SiO}_2$  was assigned to alleghanyite. Water and fluorine were overlooked in the original analysis; a new analysis proves that the formula is  $2\text{Mn}_2\text{SiO}_4 \cdot \text{Mn}(\text{OH},\text{F})_2$ .

In thin-sections alleghanyite very much resembles chondrodite. It is similar to chondrodite in section angles in its orthorhombic syngony in twinning, in optical orientation, and in its internal structure as shown by an  $x$ -ray powder-photograph.

These findings prove beyond any reasonable doubt that alleghanyite is the manganese analogue of chondrodite and is isomorphous with it.

ASBESTOS, BARITE, CORUNDUM, RUTILE, AND VERMICULITE IN PENNSYLVANIA, by R. W. Stone.

Barite, corundum, and rutile, formerly produced and marketed in Pennsylvania, are no longer obtainable in commercial quantity. So-called asbestos "quarries," reported half a century ago, prove to be mere prospects on rare veins of cross-fiber chrysotile in serpentine. Vermiculite is known in two serpentine quarries. The occurrence of these minerals will be described.

HERDERITE FROM MAINE, by G. M. Yatsevitch.

Crystals of herderite— $\text{CaBe}(\text{OH},\text{F})\text{PO}_4$ —from Topsham, Maine, a new locality, exhibit several novelties: prismatic development in the direction of the  $c$ -axis, twinning on (100), and the new forms  $\alpha$ (104),  $\beta$ ?(115),  $\gamma$ (121). Herderite from a new find at Greenwood, Maine, shows the normal columnar development of the clinodome zone and known forms with the addition of  $\gamma$ (121). The crystallography of the species is revised and referred to new parameters,  $a:b:c=0.6307:1:1.2822$ ;  $\beta=90^\circ 06'$ , obtained by trebling the  $c$ -axis of Penfield. The revised form list contains 33 accepted forms (2 new) and 11 uncertain forms (1 new). Three described forms are rejected. For the accepted forms a suitable angle-table is given.

$x$ -RAY STUDY OF ARSENIDES AND ANTIMONIDES OF NICKEL AND COBALT, by Ralph J. Holmes.

The  $x$ -ray powder method has been employed and standard patterns of the following minerals established by the method of multiple comparison: smaltite-chloanthite, safflorite, rammelsbergite, skutterudite, glaucodot, niccolite, breithauptite, cobaltite, gersdorffite, ullmannite and löllingite. Of these only smaltite and chloanthite yield identical  $x$ -ray diffraction patterns. The  $x$ -ray diffraction patterns of the other minerals in this group are distinctive.

Certain conclusions seem warranted by the data already assembled:

1. The orthorhombic diarsenides safflorite and rammelsbergite are of more widespread occurrence than has been generally recognized. This is illustrated by the results of the examination of material from several American localities. All specimens labeled "chloanthite" from Franklin, N. J., give patterns of the rammelsbergite type. "Chloanthite" (chathamite) from Chatham, Conn., is apparently safflorite. Examination of the ore from Cobalt, Ont., confirms Thomson's conclusion regarding the occurrence of safflorite and also indicates that both smaltite-chloanthite and skutterudite are common minerals at that locality.
2. Arite generally assumed to be an intermediate member of the niccolite-breithauptite series appears to be a mixture of niccolite and breithauptite.
3. Safflorite, rammelsbergite and löllingite, which have generally been assumed to be isomorphous yield diffraction patterns of a distinctly different type.

NEW OCCURRENCES OF PHENACITE, by Frederick H. Pough.

The paper describes phenacite crystals from two new localities: Klein-Spitzkopje, Southwest Africa, and Amelia Courthouse, Virginia. Crystallographic study reveals several new forms and two distinct habits on the Klein-Spitzkopje crystals. Accessories on crystals from both localities are compared with those on phenacite from other occurrences.

## COLOR PHOTOGRAPHY IN MINERALOGY, by B. M. Shaub.

The value of natural color illustrations in visual instruction is of paramount importance in teaching subjects in which color is a distinguishing or diagnostic characteristic. Current developments in color transparencies and projection apparatus bring the use of this added and useful factor, color, to the aid of teachers in mineralogy and the allied subjects of optical mineralogy, petrography, gems and precious stones.

The technique of producing color transparencies from natural subjects or from colored illustrations is comparatively simple and does not involve special apparatus in addition to that required to make high quality black and white negatives.

The phenomena of birefringence, optical interference figures, dispersion and other optical properties of crystals can be more intelligently discussed by referring to the particular features under consideration either of the color plate itself or on screen projections. Textures, structures and genetic relationships of the constituent minerals in ores and rocks can be more readily explained to either large or small audiences by natural color illustrations.

These and other ways in which color plates may be adapted to mineralogical instruction will be discussed and illustrated.

## MAGNETITE IN TENNESSEE, by George M. Hall.

A mass of mica peridotite is exposed in Union County, Tennessee. Excellent octahedra of magnetite have been found on the surface as residual material. The basic igneous rock weathers rapidly while the magnetite appears to be very resistant. Also ilmenite and garnet are found associated with the magnetite but careful search did not yield good crystals.

A large part of the mica peridotite area will be flooded when the new dam at Norris is completed.

## BARITE IN THE RED BEDS IN COLORADO, by Arthur L. Howland.

A deposit of barite irregularly replacing a limestone of late paleozoic or Mesozoic age occurs in the southern part of South Park, Colorado. The barite is in coarse arborescent groups with good terminations or in aggregates of tabular crystals, the latter usually having a light blue color. The well developed forms are:  $c(001)$ ,  $m(110)$ , and  $d(102)$ .

OPTICAL PROPERTIES OF IMMERSION LIQUIDS OF THE  $\alpha$ -MONOCHLORNAPHTHALENE: METHYLENE IODIDE SERIES (1.635-1.750), by Newton W. Buerger.

The optical properties of the series  $\alpha$ -monochloronaphthalene: methylene iodide have been studied. The mixing curve shows that the two liquids do not form an ideal solution series. The composition of a liquid of any refractive index within the range, may, however, be calculated with the aid of a correction factor. This correction has been investigated and found to be independent of moderate variations in the indices of the end members. Any liquid and its optical properties may therefore be easily duplicated. Tables and diagrams showing the variations of refractive index with the wave length for the series are given.

## AUSTINITE, A NEW ARSENATE MINERAL FROM GOLD HILL, by Lloyd W. Staples.

This mineral occurs in the oxidized zone closely associated with adamite and limonite, at Gold Hill, Utah. Attention was first called to the probability of its

being a new mineral because of results obtained during the course of microchemical studies on the material. It is a basic arsenate of calcium and zinc with the formula  $\text{CaZn(OH)AsO}_4$  and belongs to the rhombic disphenoidal class ( $3A_2$ ) of the orthorhombic system. The symmetry was checked by a study of etch figures. The crystals are colorless, have a maximum length of about 1 mm., and most frequently are found to have a scepter habit. There are both right- and left-handed enantiomorphous crystals present. The axial ratio is  $a:b:c=0.657:1:0.832$ . The mineral is named in honor of Professor Austin F. Rogers, of Stanford University.

ADAMITE FROM GOLD HILL, by Lloyd Staples.

The adamite is found in the oxidized zone coating limonite, at Gold Hill, Tooele County, Utah. It occurs in two distinct habits, one as individual prismatic orthorhombic crystals that are pale honey yellow, and the other as fan-shaped rosettes that are colorless. The crystals average 1 mm. in length. The indices of refraction are  $\alpha=1.711, \beta=1.732, \gamma=1.756$ , all  $\pm 0.003$ , which are close to the values found for other localities. A great many crystals were measured and the axial ratio found to be  $a:b:c=0.9742:1:0.7095$  for this material. The new axial ratio lies between the extremes reported from other localities.

ENARGITE AND PLUMBOJAROSITE AT PICHER, by Alfred L. Ransome. (Introduced by Austin F. Rogers.)

A large mineral specimen from the Barr Mine, Picher, Oklahoma, is described. It consists primarily of sphalerite, chalcopyrite, and calcite, together with some gypsum, marcasite, covellite, sulphur, quartz, dolomite, galena, and anglesite. Along with the above mentioned minerals are small amounts of enargite and plumbojarosite which heretofore have not been noted from this district. It is thought that the presence of enargite may strengthen the recent theory that the ores are formed by solutions of magmatic origin rather than by meteoric waters.

SPHERULITIC CONCRETIONS OF DAHLLITE FROM WYOMING, by Duncan McConnell.

Microscopic examination and micro-chemical tests have shown that phosphate nodules, 3-4 cm. in size, from Ishawooa, Park County, Wyoming, are essentially dahllite (calcium carbonophosphate). The concretions are composed of radiating, crystalline dahllite and contain secondary spherulites and axiolites. Phosphate nodules do not ordinarily consist of dahllite nor is their structure ordinarily spherulitic altho in this case the spherulitic structure is well developed and is plumose in form.

#### MINERALOGICAL SOCIETY LUNCHEON

*Friday Noon, December 28th*

An informal luncheon was held at 1:00 P.M., Friday, December 28th in the Todd Union of the University of Rochester. President John E. Wolff presided and Dr. Alexander H. Phillips acted as toastmaster. Seventy-eight members and visitors attended the luncheon.

#### PRESENTATION OF PAPERS CONTINUED

*Friday Afternoon, December 28th*

The Society assembled at 2:00 P.M. in joint session with the Geological Society of America for the presentation of petrographic papers, President John E. Wolff presiding. Papers submitted are given in abstract below:



FUSION RELATIONS OF FELDSPATHOIDS, ALKALI FELDSPARS, AND SILICA, by J. F. Schairer and N. L. Bowen.

A study of the system,  $\text{KAlSiO}_4\text{-NaAlSiO}_4\text{-SiO}_2$  yields data of interest to the mineralogist and petrologist. The composition of the nephelites obtained may be expressed in terms of the molecules,  $\text{NaAlSiO}_4$ ,  $\text{KAlSiO}_4$ , and  $\text{NaAlSi}_3\text{O}_8$ . As a result of the incongruent melting of orthoclase the field of leucite extends to compositions considerably richer in silica than orthoclase and all alkali feldspars containing more than 48%  $\text{KAlSi}_3\text{O}_8$  melt incongruently with separation of leucite. The minimum-melting alkali feldspar has approximately the composition Ab 70 Or 30.

METAMORPHIC DIFFERENTIATION AT SERPENTINE-COUNTRY ROCK CONTACTS, by A. H. Phillips and H. H. Hess.

Eskola has outlined the principles of metamorphic differentiation. This article presents examples of such differentiation at contacts between two solid rocks, serpentine and schist or gneiss. Hydrothermal solutions have permitted the migration of material both ways across the contact extracting certain constituents from one side and redepositing them on the other. A small amount of material has probably been brought in by the solutions and likewise material has been carried away by them; but for the most part the differentiation has been merely a redistribution of material already present.

Sharp bands or zones have been produced which are often monomineralic and strikingly different in composition from one another, but composed of minerals stable at the temperature and pressure obtaining and more nearly in equilibrium with their chemical environment (the adjacent rocks) than were the minerals of the original contact. Mineral and chemical compositions of the zones may be very different when formed under different physical conditions. Biotite forms on the country rock side of the contact and actinolite on the serpentine side at high temperatures whereas chlorite and talc, respectively, form at lower temperatures. Tracing the migration of one element, for example, K migrates from the country rock into the biotite zone, but the similarly situated chlorite zone formed at a lower temperature shows a loss of K. Thus migration of various elements during metamorphic differentiation is controlled by physical conditions as well as by the composition of the rocks, involved and, probably to a lesser extent, composition of the incoming solutions.

HYDROTHERMAL MINERALIZATION AT GRAVES MOUNTAIN, by W. D. Johnston, Jr.

Graves Mountain, a quartzite monadnock in the piedmont of eastern Georgia, has long been famous as a collecting ground for rutile, lazulite, and pyrophyllite. Additional minerals are kyanite, ilmenite, hematite, and quartz. Hitherto, the mineralization has been regarded as the result of dynamic regional (mesozone) metamorphism. As the hematite in the quartzite is developed from introduced pyrite, and as the kyanite in the quartzite is commonly marginal to quartz veins and occurs also in them, the writer regards the mineralization as hydrothermal rather than regional.

SCHILLER STRUCTURE, by R. J. Colony.

An inquiry as to the correct usage of the term "schiller structure," with a few illustrations of structures in hornblende which the writer, and others, have called "schiller structure," and which have been described by another group of authors without reference to the term.

True schiller structures in pyroxene are also illustrated and compared briefly with somewhat similar structures in hornblende. The conclusion is reached that only those structures productive of iridescence in incident light in favorably oriented grains in the thin sections, regardless of mineral species, should be called "schiller structures." The term should not be used in describing oriented inclusions that display no iridescence.

TOMICHI DOME FLOW, by J. T. Stark and C. H. Behre, Jr.

Tomichi Dome, an aphanitic igneous mass (T. 49 N., R. 4 E., Colorado) rises 2000 feet above the surrounding country. Generally interpreted as intrusive, it has not hitherto been studied in detail.

"Dome" here refers to topography, not to structure. The underlying beds dip generally southeastward. Overlying rocks are absent. The subjacent sediments range from Dakota to Pierre, but two miles east of the dome the Crookton thrust, dipping east, brings pre-Cambrian beds to the surface. A single sill, quartz-monzonite in composition, cuts the sediments.

The "dome" consists of 1700 feet of flows and breccia similar to the sill mentioned. Topaz is a prominent accessory mineral. Flow lines, phenocrysts with embaying glass, fine texture throughout, the accordance of the igneous mass and the segments, and the absence of baking in underlying rocks, all favor interpreting the mass as a flow.

Significant are (1) the flow nature despite the laccolith-like topographic form and (2) the similarity in composition—hence, probably also in age—of the flow to Laramide intrusive rocks in nearby regions.

GRANITIC INTRUSION IN THE ST. FRANCOIS MOUNTAIN, by Carl Tolman and R. L. Denham.

The igneous rocks of southeastern Missouri can be divided into three general petrographic groups; namely, granites, felsites (porphyry, rhyolite), and basic dike rocks. It was previously thought that the granites graded upward into the felsites, and that both were intruded generally by the basic dikes. More recent work has shown that the granite intrudes the felsite, and data is now accumulating to show that more than one period of intrusion is represented among the granites.

Intrusive relations between granites have been recognized, although the general similarity of the granites of southeastern Missouri and the character of their outcrops tend to make such relations obscure and their recognition difficult. The concept, that a number of intrusions are involved in the granites, and, further, that they are not cognate, is best indicated by Silver Mine and at Skrainka. The relations there indicate not only that two periods of granitic activity but also that sufficient time elapsed between periods for the intrusion of regionally distributed basic bodies. Distinctive accessory mineral assemblages and chemical analyses, as well as general petrographic character, have aided in the differentiation of the granites.

TECHNIQUE FOR THE INVESTIGATION OF ARGILLACEOUS SEDIMENTS, by R. H. Bray, R. E. Grim and P. F. Kerr.

The various methods that have been used to investigate the mineral composition of argillaceous sediments are briefly reviewed. The limitations of these methods as a means of obtaining complete specific data on the mineral composition of these rocks are discussed. A technique for this purpose is described which is based on the re-

removal of soluble salts and absorbed ions followed by dispersion and fractionation into size grades by means of sedimentation and super-centrifuging—the latter method being used to separate the material less than one micron in diameter into three fractions. The mineral constituents of the fractionated portions are identified by  $x$  ray, optical, and chemical analyses. The results of the analysis of several argillaceous sediments by means of this proposed method are given together with a discussion to show that a satisfactory complete determination of the mineral constituents, particularly of the finest fractions, is obtainable.

GENETIC RELATIONS OF SPHALERITE IN PEGMATITE, by Clarence S. Ross.

A large mass of sphalerite and albite was encountered in mining feldspar in the McKinney mine near Spruce Pine, N. C. The relations of minerals show that the sphalerite was one of the last to form—being later than albite, quartz, and muscovite, which are secondary.

MICROSCOPIC INVESTIGATION OF FRIEDENSVILLE ZINC ORE, by Donald McCoy Fraser.

The primary sulfides of the Friedensville, Pennsylvania, zinc deposit are sphalerite and pyrite. Their relations indicate that solutions which deposited a "black-jack" variety of sphalerite followed earlier solutions which partially crystallized and partially silicified the dolomitic limestone.

Pyrite shows a variety of contact relations to sphalerite, which are most easily explained by considering the pyrite to have been formed previous to, contemporaneously with, and after the sphalerite. The sulfide minerals occur as replacements of the limestone, as fissure fillings, and together with quartz, dolomite and calcite as the cementing material of limestone breccia present in some of the fractured zones.

Oxidized minerals include smithsonite, calamine, sphalerite, greenockite, goslarite, limonite and melanterite. Gangue minerals are quartz, calcite and dolomite.

The oxidized ore is chiefly concentrated along joints, bedding planes and in solution cavities. For the most part, it occurs as fillings of these openings and fractures but in places it replaces the limestone.

MYLONITIC SPHALERITE FROM FRIEDENSVILLE, PENNSYLVANIA, by Robert D. Butler.

The unique chert-like sphalerite from Friedensville, Pennsylvania, has long been familiar to mineralogists and is in many museum collections. Etched polished sections reveal textural features unlike those due to filling or metasomatic replacement.

A similar sphalerite is found in a quartz-sphalerite vein at Cherryfield, Maine, developed along a small shear zone within the vein, and clearly shows a mylonitic origin. In Maine, an inner zone of fine-grained sphalerite with crushed and drawn-out pyrite and quartz fragments is bordered by a region of sphalerite of intermediate grain size containing interstitial chalcopyrite and pyrrhotite, which, in turn, is bordered by an outer zone of relatively coarse-grained, highly twinned sphalerite containing exsolved chalcopyrite and pyrrhotite, with sphalerite twin lamellae bent and fractured. The fine-grained texture was caused by granulation of a plastically deformed coarse matrix. Recrystallization of strained crystals is shown as another method of new grain development.

At Friedensville, metasomatic replacement is apparent in the wall-rock pyritic sphalerite veinlets, but some of the massive ore is characterized by mylonitic facies, semi-schistose facies, and recrystallized facies. These are related to the deformation,

which preceded the formation of later pyrite and recrystallization of some of the sphalerite. The habits of pyrite and sphalerite, and the texture, are in contrast to the habits and texture in veinlets in the country rock and are quite similar to those observed in the Maine sphalerite. It is concluded that the peculiar chert-like sphalerite from Friedensville was formed by shearing forces which acted on originally coarser-grained sphalerite to produce mylonitic material.

FLUID INCLUSIONS IN SPHALERITE AND GALENA OF THE JOPLIN REGION, by W. S. Tangier Smith.

In the sphalerite of the Joplin region there are two distinct types of fluid inclusions, a larger and a smaller, the former, at least, occurring also in galena. The larger inclusions carry a strong solution of sodium and calcium chlorides, and, in the sphalerite, are opaque and of irregular shape. The smaller are of the ordinary bubble-bearing type of fluid inclusions and of uncertain composition.

Both types of inclusions are found in both primary and secondary sphalerite, and observations indicate that the larger, if not both, are of secondary origin; that they have been formed at normal underground temperatures; that their cavities are due to relatively recent solution; that the liquid of the inclusions is, like the ores themselves, merely a concentrate from dilute solutions; finally, that the concentration from underground waters of small amounts of substances readily soluble in water is not limited to the sulphide ores, but is also to be found in the ore gangues, and even, apparently, in all the rocks of the region, different substances, or differing proportions of the same substances, having been concentrated in different rocks. These concentrations are probably, for the most part, interstitial, rather than in the form of fluid inclusions.

MICA PERIDOTITE IN TENNESSEE, by George M. Hall and H. C. Amick.

Mica peridotite occurs in Union County, Tennessee, in two small areas. Safford, in his *Geology of Tennessee*, described these rocks as metamorphic, and Gordon in an abstract presented at a previous meeting of this society, called attention to the occurrence of mica peridotite. Because of failing health he was unable to finish the necessary field work and complete the paper.

Subsequent study by the writers has shown that the rock crops out in two irregularly shaped masses, surrounded by sedimentary rocks, along a line which extends northeast-southwest. The soil is thick, and the contact with the surrounding rocks is poorly exposed. The irregular outlines of the masses suggest that they are plugs rather than a discontinuous or interrupted dike.

Masses of igneous rock crop out in the vicinity of a fault which brings the Chattanooga black shale (Mississippian) in contact with the Rome shale (Cambrian). The writers collected some fossils from sandy beds which were identified as Helderberg (Becraft). A short distance away similar beds are found at the base of the Hancock (Devonian) dolomite.

The igneous rock is rich in altered biotite, serpentine, and magnetite. Garnet and ilmenite are less abundant. Although prospect pits have been dug in each mass, only altered rock is available.

Igneous masses are apparently intrusive into the Paleozoic rocks, and although some of the Hancock dolomite has apparently been digested, there is little or no evidence of metamorphism of the surrounding rocks. Examination of the rock in the

field and under the microscope shows that the material is, in part, clastic. A brachiopod, in an included piece of dolomite, has been found in the mica peridotite, and under the microscope some organic material closely resembling radiolarian fragments.

METALLOGENETIC RELATIONS OF PORPHYRY AND QUARTZ DIABASE, by Edward Moore Burwash.

This is a tentative presentation of the metallogenetic relations of porphyry and quartz diabase. Facts observed in northern Ontario show: (a) Gold-bearing quartz veins, in nearly all instances, are found genetically related to quartz porphyry, granite porphyry, or syenite porphyry; (b) argentiferous calcite veins are similarly associated with quartz diabase.

General considerations are as follows: (a) Silica is in excess in all these rocks; (b) mineralizers are, therefore, presumably abundant; (c) the normal order of crystallization is reversed; (d) the veinstones correspond to essential magmatic ingredients, the ore-minerals to accessories and fluxes; (e) the order of crystallization is related to (i) fusibility, (ii) solubility, (iii) fluxes.

Tentative conclusions are: (a) The excretion of vein matter (gangue) is prior to the mineralization, but both may be from the same magma; (b) this is due to the order of crystallization.

MONGOLIAN MAGMAS, by George W. Bain.

According to Berkey and Morris, the rocks of inner Mongolia are divided into six main age groups. Their collections are the basis of this laboratory study. Most of the collection was studied petrographically, and 46 specimens, selected to represent the range of types in each group, were analyzed.

Beginning with the Tertiary lava flows, or youngest, each older group shows increasing complexity of secondary structures and increasing simplicity of primary structures. Deuteric and pegmatitic effects are eminently more abundant in all Tertiary rocks than in those of earlier date; in fact, "end stage" activity leaves a progressively more intense mark as younger series are examined.

Chemical analyses show increased content of granitic constituents such as alkalis, especially potash, and diminished content of gabbroic constituents such as lime and magnesia, over all those representing rocks of greater age. Petrographic study allies the granitic constituents with deuteric and pegmatitic minerals. Structural occurrence of this group of minerals suggests that pegmatitic solutions made the granitic rocks, and made later series of rocks increasingly granitic—an explanation of structure more probable than that granite has made the pegmatite.

ORIGIN OF DARK INCLUSIONS IN TONALITE, by Cornelius S. Hurlbut, Jr. (Introduced by E. S. Larsen, Jr.)

The rather uniformly distributed dark inclusions in a tonalite from southern California are flattened and discoidal in nature, showing that they were at one time plastic and have been drawn out and oriented parallel to the flow direction of the rock. Relic minerals and structures found in them point rather conclusively to the fact that the included material was contributed by an older gabbro. After introduction into the tonalite magma, the gabbro fragments have undergone reaction that has rendered them mineralogically similar to the tonalite.

## TRAVERTINE NEAR LEXINGTON, VIRGINIA, by Edward Steidtmann.

Cascade, fan, pool, and channel travertine occur near Lexington, Virginia. Cascade deposits are tough and mossy or algal, the others ashy. Cascade calcite grew on algae and mosses and plainly shows summer and winter layers; the former being thicker, darker, more porous, more vividly fossiliferous, and lower in detritus. Cascade deposits attain 100 feet in thickness, the others 30 feet. The latter, as a rule, are neither algal nor mossy, although they contain organic matter and show numerous banded concretions around tree trunks. Their detrital content is higher and sometimes pebbly.

Travertine is forming now on mosses and algae of the cascades and as an encrustation in the pools. Muddy, deep waters and fixed ice retard algae and mosses, and thereby hinder travertine retention. The plants are favored by clear, shallow, aerated water. By their growth and calcification they create the last two conditions. Muddy waters are now causing erosion to exceed retention.

Feeder spring waters contain from three to four times as much  $\text{CaCO}_3$  in solution as is the case in waters adjusted to the partial  $\text{CO}_2$  pressure of the air. Successive stations downstream show progressive loss of  $\text{CaCO}_3$ , but supersaturation persists even at the foot of cascades 130 feet high. Creek waters became adjusted by vigorous aëration after seven hours, and after two weeks of static exposure.

## GENESIS AND STRUCTURAL RELATIONS OF ABSAROKA VOLCANICS, by John T. Rouse.

Volcanic rocks of the Absaroka Mountains occur in two groups, each group containing a lower acid breccia, a middle basic breccia, and an upper series of basalt sheets. The basalt sheets, because of their relatively uniform thickness over wide areas, serve as a valuable datum plane for determining the structural evolution of the region. The volcanics bury a land surface which, in pre-volcanic time, was quite rough. Field work to date indicates that the volcanic rocks were erupted from many small vents rather than from a few large volcanoes. The pyroclastics are represented by (1) water laid tuffs, (2) explosive volcanic materials, (3) flow breccias, (4) mud flows.

Xenoliths of pre-Cambrian and Paleozoic rocks are abundant in many of the pyroclastics, their distribution in the breccias being closely related to the present outcrops of pre-volcanic rocks. In the basal portion of some of the early acid breccias the majority of the fragments are Paleozoic and pre-Cambrian rocks, whereas in the upper parts of the same breccias the fragments are almost entirely volcanic rocks. This would indicate a blowing out of fragments of the adjacent country rock during the early stage of eruption, whereas the later stage was confined to eruption of volcanic material.

Many large limestone blocks have been found in the early basic breccia, the largest measuring  $200 \times 125 \times 50$  feet. Some structures found in Paleozoic rocks, where they are intimately associated with the volcanics, suggest structural processes which might be analogous to those described by Reeves in the Bearpaw Mountains.

## ROCKS FROM ADELIA LAND AND THE ANTARCTIC ARCHIPELAGO, by Duncan Stewart, Jr.

A quantitative petrographical study was made of the composition of various igneous and metamorphic rocks from Adelia Land and the Antarctic Archipelago, Antarctica.

GREENALITE, by Fred Jolliffe.

The examination of rather pure specimens of Mesabi greenalite rock has permitted more exact determinations of the properties of this mineral than have hitherto been made. These allow more definite statements on the nature and origin of the mineral, and on the derivation of some of the Mesabi iron ores therefrom.

The results indicate that greenalite is a definite mineral, distinct from other known species, and having the following properties: Specific gravity 3.0; isotropic;  $N_F 1.686$ ,  $N_D 1.674$ ,  $N_C 1.670$ ; composition closely represented by the formula  $2H_2O \cdot 3FeO \cdot 4SiO_2$ . Its alteration proceeds as follows: (A) to iron oxides and hydroxides by the oxidizing and leaching action of surface waters; (B) to an aggregate of minute green crystals associated with small opaque green masses (herein called metagreenalite) by simple crystallization; (C) to a light-coloured fibrous mineral (possibly a new species) through the agency of magnesium-bearing waters not of surface origin; (D) to an intergrowth of magnetite and amphiboles in the vicinity of heated igneous bodies.

The habit and properties of greenalite strongly indicate that it is of colloidal origin deposited as a chemical precipitate from water which received their iron and silica directly from igneous sources, and that it owes its granule form to purely physical processes (surface tension, osmotic pressure) acting on the semi-fluid gel precipitate.

ORIGIN AND OCCURRENCE OF FULGERITES IN THE ATLANTIC COASTAL PLAIN, by Julian J. Petty.

Nearly one hundred occurrences of fulgerite have been found in nine pits in the Cretaceous sands of North and South Carolina. The fulgerites range from  $\frac{1}{8}$  of an inch to 1 inch in diameter, averaging about  $\frac{3}{8}$  of an inch. In cross-section they are either roughly circular, oval or compressed. The external surface is rough with either spiny, corrugated or wing-like projections. The tubes extend nearly vertically downward. They frequently branch and sometimes the branches re-unite. The maximum depth to which they have been traced is about 60 feet. The fulgerites are surprisingly abundant, with an average of several per acre in the areas that could be examined in detail. This abundance is probably explained by the good drainage and the unusually pure quartz sands.

SCHEELITE-BERYL DEPOSIT AT OREANA, by Paul F. Kerr.

In the spring of 1934 a tungsten bearing pegmatite dike was discovered in the Humboldt Range near Oreana, Nevada, about five miles north of Dumortierite Canyon. The dike varies from two to five feet in width and has been exposed by prospecting for about 2600 feet. Although narrow, it contains high grade concentrations of scheelite which are now being mined by means of a small shaft and tunnels.

The pegmatite occurs along the margin of a quartz-monzonite intrusive. It cuts a much sheared older intrusive presumably a metadiorite and limestone strata of Triassic age. In places the pegmatite grades into a high temperature vein of massive quartz with associated tourmaline. The portions carrying tungsten appear to be a true pegmatite consisting essentially of both massive and crystalline scheelite associated with alkali feldspars, beryl, mica and fluorite. A mineral sequence may be observed with scheelite following beryl and preceding the fluorite stage of mineralization.

## PRESENTATION OF PAPERS CONTINUED

*Saturday Morning, December 29th*

The Society assembled at 9:15 A.M. Saturday, December 29th, for the presentation of papers on sedimentary petrology, chemical mineralogy, crystallography and crystal structure. Eighteen papers were given Saturday morning accompanied by an abundance of enthusiastic discussion particularly in the field of crystallography and crystal structure. President John E. Wolff and Dr. W. S. Bayley divided the task of presiding over the morning session. Papers presented were as follows:

DISTRIBUTION OF THE HEAVY MINERALS IN THE CRETACEOUS CLAYS OF NEW JERSEY, by Alfred C. Hawkins.

Microscopic measurements and counts on elutriated residues from these clays show a systematic distribution of heavy minerals, both stratigraphically and areally, which throws much light upon the origin and details of deposition of the clays and associated sands.

ACCESSORY MINERAL SUITES IN THE GRANITES OF MISSOURI, by Carl Tolman and H. L. Koch. (Presented by permission of the State Geologist of Missouri.)

The accessory mineral residues of 127 samples of the granites of southeastern Missouri have been prepared and examined. The samples were collected not only as representative of possible granitic types and separate intrusions but also to represent a general areal sampling of the granitic rocks as a whole.

The varietal character of the most important primary accessories varied so greatly, both in individual samples and also throughout the granite as a whole, that this feature could not be used as a fundamental basis for the distinction of types. It was found, however, that the different samples showed such differences in kinds and relative amounts of the important accessories as to distinguish well defined groups. The rock groups distinguished on this basis also showed a reasonable constancy in general petrographic character and logical distribution.

DIFFERENTIATION OF THE ONONDAGA FORMATION BY MEANS OF HEAVY MINERALS, by A. E. Alexander.

A recently opened quarry in Erie County, New York, revealed a disconformity in the Onondago formation. (Disconformity is here used in the English sense, following L. D. Stamp.) A one- to two-inch layer of shale sharply defines the chert above from the limestone below. In the coniferous limestone proper, chert nodules are separated from the subjacent limestone by well developed stylolitic structures. Of interest to the mineralogist is the presence of the coral "Favosites," the septae of which are lined with minute calcite crystals. Of interest to the oil geologist is the existence of petroleum in the interstices of this same coral. Small pieces of the oil saturated fossil will burn for a short time following ignition. The investigation of light and heavy mineral fractions is still being continued at present writing.

SYSTEM,  $MgO-FeO-SiO_2$ , by N. L. Bowen and J. F. Schairer.

Because of the great importance of ferromagnesian silicates as rock-forming minerals, the system,  $MgO-FeO-SiO_2$ , has been investigated.

No ternary compounds are formed. The system is dominated by three series of solid solutions, the oxide series,  $MgO-FeO$ , which is complete, the olivine series,



$Mg_2SiO_4$ - $Fe_2SiO_4$ , likewise complete, and the pyroxene series,  $MgSiO_3$ - $FeSiO_3$ , which is only partial, as  $FeSiO_3$  does not exist as such in the crystalline state, although solid solutions containing nearly 90 per cent of that molecule are formed.

The olivines constitute a simple system of the same type as the plagioclases, which permits calculation of their latent heats of melting.

The pyroxenes are much more complex. They melt incongruently with separation of olivine in the magnesia-rich members and again incongruently in the iron-rich members, but in the opposed manner, i. e., with separation of free silica. In addition, the pyroxenes exhibit two crystalline forms, the orthorhombic (enstatite—hypersthene series), stable at low temperatures, and the monoclinic (clino-enstatite—clino-hypersthene series), stable at higher temperatures.

By reason of the prevalence of solid solution and incongruent melting, fractional crystallization has important consequences.

The optical properties of the solid solution series have been determined.

SYSTEM  $CaO$ - $MgO$ - $SiO_2$ , by Nelson W. Taylor and Francis J. Williams.

Reactions between solids in the absence of the liquid phase in the system  $CaO$ - $MgO$ - $SiO_2$  have been investigated. An attempt has been made to reproduce thermal metamorphism and to find what minerals could be produced by thermal treatment alone. Natural minerals, as well as chemically pure oxides and carbonates, were used as raw materials.

The materials were ground, mixed, pressed into discs, and subjected to varying thermal treatment. A sample was heated at each of the following temperatures:  $600^\circ C$ ,  $800^\circ C$ ,  $1000^\circ C$ , and  $1200^\circ C$ , for 20 hours, and  $1100^\circ C$  for 104 days. *X*-ray patterns of the raw materials, their decomposition products, and the desired products were made. The heat-treated specimens were subjected to *x*-ray analysis to identify their crystalline products. Wollastonite, dicalcium silicate, enstatite, forsterite, monticellite, diopside, and akermanite have been identified from reaction mixtures calculated to give these compounds or other compounds closely related in composition.

These results are correlated with the observations of Harker on thermal metamorphism of siliceous limestones and dolomites, and it is shown that the results of the present work closely parallel Harker's observations.

The mechanism of the reactions between these solids has been shown to be an interdiffusion whose speed depends inversely on the firmness of binding or the structural stability of the reaction product.

*X*-RAY DATA ON THE SYSTEM  $K_2SO_4$ - $MgSO_4$ - $CaSO_4$ , by Lewis S. Ransdell.

*X*-ray powder photographs of fused samples of  $K_2SO_4$ ,  $MgSO_4$  and  $CaSO_4$  show only a continuous isomorphous series with  $K_2Mg_2(SO_4)_3$  and  $K_2Ca_2(SO_4)_3$  as end-members. No other compounds were observed. The members of this series are simple cubic, with four molecules in the unit cell, and the length of the cube edge varies from  $9.96\text{\AA}$  for the  $Mg$  to  $10.36\text{\AA}$  for the  $Ca$  end-member.

SYNTHESIS, CONSTITUTION, AND OPTICAL PROPERTIES OF THE NOSELITE-HAUYNE SERIES, by Tom. F. W. Barth.

The compounds,  $Na_3Al_6Si_6O_{24}.SO_4$  and  $Na_6Ca_2Al_6Si_6O_{24}.(SO_4)_2$ , were made in silica bombs at  $900^\circ$  and  $1000^\circ$ , respectively. They form the chief constituents of the minerals noselite and hauyne. New *x*-ray diffraction data gave conclusive proof

that artificial noselite is isomorphous with  $T^1_d$  and not with  $T^4_d$  as suggested by Machatschki and consequently that Al and Si must appear as variate atoms in a 12-fold position as previously contended by me. (This is shown by reflections from e.g., (111) as well as from various other planes which are systematically extinct in  $T^4_d$ .)

The structure of artificial hauyne can be described in terms of  $T^4_d$  (reflections like (111) are missing), but it is an important fact that the same structure also may be described in terms of  $T^1_d$ , for only in this way can the isomorphous relation to noselite be understood.

The length of the edge of the unit cell,  $a_0$  and the index of refraction,  $n$ , for pure noselite and for pure hauyne are as follows:

	Noselite	Hauyne
$a_0$	9.05	9.14 $\pm$ 0.01
$n$	1.450	1.505 $\pm$ 0.003

It is worth noting that the refractive index of pure noselite as a consequence of the extremely open structure is lower than that of sodalite.

#### STUDIES IN THE CHROMITE GROUP, by James S. Wishart.

A study of the chromites occurring in a series of related rocks from South Africa shows that with change in composition of the silicate minerals, the composition of the chromite varies. The change in composition is accompanied by slight changes in the physical properties of the chromite.

Study of the analyses indicates that the spinel minerals, especially magnesio- and ferro-aluminates, chromates and ferrates have an order of crystallization which is comparable to the feldspars. This conclusion is supported by a study of occurrences of spinel minerals, by a study of melting points of oxides found in the spinels, and by the melting points of some of the spinels themselves.

Bowen's Y-shaped reaction principle diagram is altered to introduce a series of spinel minerals between the ferro-magnesian silicates and the feldspars.

#### MICROSCOPE OPTICS, by L. V. Foster.

Microscope objectives are made in three degrees of correction. They are apochromatic, semi-apochromatic, and achromatic. Microscope eyepieces are made in varying degrees of achromatism. These characteristics will be described and it will be shown how combinations can be chosen to secure the best general results.

#### USE OF THE TERM SYNGONY IN GEOMETRICAL CRYSTALLOGRAPHY, by Austin F. Rogers.

Simple, accurate definitions of the six crystal systems may be given in terms of the four known types of zones: clinogonal, orthogonal, tetragonal, and hexagonal. Of these all but the clinogonal retain their special character with change of temperature. Since temperature is taken into account, this means that crystal system is a physical-geometrical concept.

Instead of using the term syngony as a synonym of crystal system, as Fedorov does, it seems better to employ it in a purely geometrical sense. Syngony then is used not only for the various symmetry classes of a given system, but also for crystals of other systems which temporarily have the geometrical requirements of the given system at a specified temperature.

The name of the system furnishes a name for the syngony characteristic of the system. And to the six syngonies thus defined there is added a seventh, the diclinic,

formerly used as a system name, but here revived for the particular syngony in which one of the interzonal angles  $\alpha$ ,  $\beta$  or  $\gamma$  is  $90^\circ$ .

Crystals of the triclinic system may have either triclinic, diclinic, monoclinic, or orthorhombic syngony; examples of all of these are known. Asymmetric and centrosymmetric crystals are assigned to the triclinic system regardless of the type of syngony but the characteristic syngony is triclinic. And similarly for the five remaining systems, syngonies other than the characteristic one may be given.

The concept of syngony here set forth is believed to be important in advanced geometrical crystallography.

#### CRYSTALLOGRAPHY OF MULLITE, by Harry Berman.

Artificial mullite crystals having a good prism zone and a single terminal form yielded the crystallographic elements  $a:b:c = .982:1:.752$ . These values are sufficiently near to sillimanite elements to indicate that one cannot distinguish the two crystallographically. The crystallographic elements differ only slightly from those earlier found by  $x$ -ray methods.

#### CRYSTAL CLASSIFICATION AND SYMBOLISM, by D. Jerome Fisher.

The chief object of this paper is to present a classification of crystals in which these bodies are so arranged that existing symbolism and nomenclature are more readily comprehended. This is done by means of a chart with columns based on axes and axes-planes, according to Schoenflies' divisions for point-group nomenclature, and rows based primarily on the symmetry of the crystal axes. Controversial matters and recent terminology of Europeans are discussed in the light of a brief historical treatment of the subject.

#### DERIVATION OF THE FOURTEEN BRAVAIS SPACE-LATTICES, by Lewis S. Ramsdell.

The fourteen space-lattices are derived in an elementary way from the two fundamental properties of crystals, namely, homogeneity and variation of properties with direction.

#### CRYSTAL STRUCTURE OF CALAVERITE, by G. Tunell and C. J. Ksanda.

Crystals of calaverite from Cripple Creek, Colorado, have been studied by means of the Weissenberg  $x$ -ray goniometer (with use of Cr— and Cu— radiation) and by means of the two-circle reflection goniometer; powder spectrum photographs have also been made with Cr—, Fe—, Cu—, and Mo— radiation. The structural lattice has elements analogous to the fundamental morphological elements of Goldschmidt, Palache, and Peacock (their S—elements).  $X$ -ray analysis shows that there are two "molecules" of  $\text{AuTe}_2$  in the unit cell. Goldschmidt, Palache, and Peacock concluded that calaverite belongs to the monoclinic system; the systematic extinctions of the  $x$ -ray diffraction effects on our films limit the monoclinic space groups possible for calaverite to three,  $C2/m$  ( $C_{2h}^3$ ),  $C2$  ( $C_2^3$ ),  $Cm$  ( $C_s^3$ ), the extinctions of these three space groups being identical. By means of the intensities alone all arrangements in  $Cm$  have been excluded. The arrangement of the atoms in calaverite can be realized in either the space group  $C2/m$  or  $C2$  and the values of the parameters have been determined by means of the intensities of the diffraction lines alone.

#### FRIEDEL'S LAW OF MEAN INDICES, by J. D. H. Donnay.

By means of this law, approximate values for the axial elements can be computed

from the list of observed forms (without measuring any interfacial angle on the crystal).

According to G. Friedel, the Law of Mean Indices holds good independently of the choice of the primitive form. This statement does not appear to be valid in all cases, as shown by examples.

CRYSTALLOGRAPHIC EXPRESSION OF RESULTS OF THE THEORY OF SPACE GROUPS,  
by W. V. Howard.

In order to demonstrate the close relationship which exists between the external and internal symmetry of substances, it is proposed to change the position of the origin in the analytical expression of the results of the theory of space groups to the center of the cell. In this way, the special positions are found to have a close relation, not only to the crystal forms existing in the crystal classes to which the space groups belong, but also to the important planes determined during *x*-ray analysis.

Consideration is also given to the symmetry of the equivalent positions with a view to establishing a much closer relation between the internal and external symmetry of substances than appears to exist at present.

It is believed that the proposed coordinates will also greatly simplify the determination of the space group and the positions of the atoms following *x*-ray analysis.

CHOICE OF CRYSTALLOGRAPHIC ELEMENTS, by M. A. Peacock.

The choice of crystallographic elements is controlled by certain generally accepted conventions and a number of partly conflicting guiding principles in the use of which there is naturally a lack of agreement. The following principles are distinguished and briefly discussed: highest real symmetry; highest pseudosymmetry; simplest cleavages; simplest indices; complication; reticular density; structure cell; isomorphism and homeomorphism. A general procedure leading to satisfactory elements is outlined but the adoption of a set of fixed rules is avoided. Such rules have practical value outside the field of mineralogy, but they do not solve a problem whose real solution still lies in the little-studied relations between the form and structure of crystals.

APPLICATION OF PLANE GROUPS TO THE INTERPRETATION OF WEISSENBERG  
PHOTOGRAPHS, by M. J. Buerger.

The Weissenberg method makes it possible to investigate the reciprocal lattice of a crystal directly. Each Weissenberg photograph is a projection of a single plane of the reciprocal lattice which embodies both point-group and translation-group properties. All possible Weissenberg patterns can therefore be predicted from a systematic study of plane point-groups and plane translation-groups. There are 10 plane point-groups, each giving a unique Weissenberg distribution of reflection positions and intensities. A few appropriately chosen photographs permit an unequivocal determination of the centrosymmetrical symmetry class of the crystal investigated. Suitable tables are provided for this purpose. There are 5 plane translation-groups. It is shown that these lead to 15 possible Weissenberg patterns, each a projection of a possible reciprocal lattice level. A few appropriately chosen photographs provide data for a unique determination of the reciprocal lattice type, from which the particular Bravais lattice type follows at once. Suitable tables for this

purpose have been prepared. This method is purely geometrical and avoids analytical procedure, including indexing of reflections. The similar projection properties of the equi-inclination beam Weissenberg method, makes it possible to determine the Bravais lattice without construction, by the inspection of several Weissenberg negatives, singly and superposed. The same methods may be applied to the determination of the space group.

The reading of the papers was completed at 1:00 P.M. It was moved by Dr. Waldemar T. Schaller, seconded by Dr. Walter F. Hunt and voted unanimously that the following resolution be inscribed upon the minutes of the meeting and a copy be sent to Dr. Harold L. Alling, Chairman of the Local Committee:

"The membership of the Mineralogical Society of America wishes to express its appreciation of the extremely cordial entertainment, the efficient arrangement and operation of facilities for the meetings and the generous hospitality of the Local Committee of the University of Rochester."

With no further business to come before the Society, President John E. Wolff declared the meeting adjourned at 1:05 P.M.

At various times during the sessions of the Society, the following persons registered their attendance. In addition there were many others whose names were not recorded.

Alice S. Allen	E. N. Cameron	D. J. Fisher
Andrew G. Alpha	Grace M. Carhart	Frank C. Foley
J. W. Ambrose	R. W. Chapman	W. F. Foshag
Olaf Andersen	J. R. Chelikowsky	L. V. Foster
R. J. Anderson	J. W. Coburn	Dean F. Frasc�e
	Wm. B. Colburn	Donald M. Fraser
Geo. W. Bain	R. J. Colony	B. C. Freeman
J. D. Barksdale	Mary E. Cooley	A. H. Fretz
Tom. Barth	John R. Cooper	
A. M. Bateman		Alton Gabriel
W. S. Bayley	A. L. Day	Joseph L. Gillson
C. H. Behre, Jr.	W. C. Dennis	Jewell Glass
G. K. Bell, Jr.	M. V. Denny	C. E. Gordon
Marland P. Billings	J. D. H. Donnay	L. C. Graton
Bennett Frank Bine	Edward C. Dopples	O. R. Grawe
N. L. Bowen	J. L. Dyson	Ralph E. Grim
S. R. Brockmier		
J. L. Browne	R. S. Edmundson	E. P. Hall
A. F. Buddington	R. C. Emmons	George M. Hall
M. J. Buerger	George L. English	A. C. Hawkins
Newton W. Buerger	Maurice Ewing	J. S. Hawley
J. D. Burfoot		E. P. Henderson
R. D. Butler	A. D. Falck, Jr.	H. H. Hess
E. M. Burwash	G. T. Faust	Wm. O. Hickok
	C. N. Fenner	Ralph J. Holmes
C. K. Cabeen	Chas. R. Fettke	A. P. Honess
C. E. Cairner	Sue Fields	Henry Hotchkiss

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|---------------------|--------------------------|---------------------|
| J. L. Hough         | V. R. Page               | C. B. Slawson       |
| W. V. Howard        | C. Palache               | Dudley T. Smith     |
| A. L. Howland       | Elwyn L. Parry           | Hugh S. Spence      |
| W. F. Hunt          | A. L. Parsons            | L. E. Spock         |
| C. S. Hurlburt, Jr. | M. A. Peacock            | Leonard H. Starbird |
| D. E. Jensen        | Joe Webb Peoples         | H. T. Stark         |
| Albert Johannsen    | S. S. Philbrick          | D. W. St. Clair     |
|                     | Alexander H. Phillips    | Edw. Steidtmann     |
|                     | F. H. Pough              | E. H. Stevens       |
|                     | G. W. Prescott           | Duncan Stewart, Jr. |
|                     |                          | R. W. Stone         |
| R. W. Karpinski     | A. W. Quinn              |                     |
| Paul F. Kerr        |                          | Nelson W. Taylor    |
| Louise Kingsley     |                          | Ellis Thomson       |
| Edward H. Kraus     | Lewis S. Ramsdell        | C. Tolman           |
| Lois A. Kremer      | R. D. Reed               | George Tunell       |
| Philip Krieger      | W. A. Rice               |                     |
| P. D. Kryne         | John L. Rich             |                     |
|                     | H. Ries                  | Stephen Varni       |
| E. S. Larsen        | Austin F. Rogers         | J. S. Vhay          |
| Harriet Lee         | Clarence S. Ross         | H. N. Vieweg        |
| J. B. Lucke         | J. T. Rouse              |                     |
|                     | Chalmer J. Roy           | Allen W. Waldo      |
| J. P. Marble        | J. J. Runner             | T. L. Walker        |
| James H. C. Martens |                          | Freeman Ward        |
| J. E. Maynard       | Edward Sampson           | E. Wight            |
| Evans B. Mayo       | J. F. Schairer           | Kenneth P. Wilson   |
| G. R. Megalklin     | W. T. Schaller           | A. N. Winchell      |
| Benj. L. Miller     | Marion R. Schmidt        | H. W. Winchell      |
| Ralph L. Miller     | B. M. Shaub              | James S. Wishart    |
| Anna Minkofski      | Joseph T. Singewald, Jr. | John E. Wolff       |
| Chas. B. Moke       | Quentin D. Singewald     |                     |
| Berlen C. Moneymoke | D. C. Skeels             | John A. Young, Jr.  |
| E. S. Moore         |                          |                     |
| James F. Morton     |                          |                     |