tabular surface. Because of their twinning these crystals appear strikingly orthorhombic in form.

Associated with these hiddenite crystals are beautiful crystalline developments of dolomite, siderite, quartz, biotite, a complexly twinned mineral which appears to be adularia, pyrite and delicate rutile crystals. The most striking feature of these druses is the manner in which the crystals are implanted on the bare walls of the fissure, without any apparent alteration of the wall rock.

In both types of occurrence solution of the hiddenite crystals has been locally active resulting in partial destruction of the crystals. A number of pseudomorphs of colorless mica after hiddenite were found, and in many places the hiddenite crystals are coated with what appears to be minute scales of chlorite, hitherto called hisingerite. (*cf. U.S.G.S. Bulletin* 74).

The very complex structural history of the rocks containing the deposit, together with the several periods of mineralization, make it difficult to give a concise outline of the series of events which took place during its formation. For this reason, coupled with the shortness of our visit to the property, no speculations as to the source and character of the mineral-bearing solutions will be considered in this short paper.

THE GRANITE OF CONWAY, NEW HAMPSHIRE, AND ITS DRUSE MINERALS

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STATEMENT OF THE PROBLEM

A vertical sheet, in the plane of which numerous miarolytic cavities or druses occur was found in a New Hampshire granite quarry. This quarry, known as the "Redstone Red," is located in Conway Township at Redstone Station, Carroll County. The minerals of these druses offer considerable interest in themselves and a description of their more important features forms a part of this paper. Several of these minerals, however, occur as deuteric minerals in the body of the igneous rock away from this vertical sheet. These deuteric minerals and their probable contemporaneity with the minerals in the druses furnish a very interesting study in the problem of post-consolidation mineral formation.

LOCATION OF THE GRANITE AND ITS GENERAL FEATURES

The granite underlies an area about 25 by 35 miles in extent, mostly in Carroll County, east-central New Hampshire. It has been described by Hitchcock,[1] Villarella,[2] Perry,[3] and Dale.[4] Mr. M. K. Billings of Harvard University has recently prepared a thesis for the doctorate dealing with the geology of an area which includes some of this granite.

Although it is a member of the series called by Hitchcock the Pemigewasset series, the granite, which is of post-Devonian age, has not been named. The name Conway used to designate it by Hitchcock has been assigned by the U. S. Geological Survey to an important schist of the vicinity.

The "Redstone Red" quarry is located in the hill side which is the south end of a series of summits known as Black Cap, Middle Mountain and Rattlesnake Mountain. These hills are shown on the North Conway topographic sheet published by the U. S. Geological Survey. About 800 feet west of the "Redstone Red" quarry is the "Redstone Green" which has been opened in a more alkaline granite, probably a separate intrusion, and one in which no druse or pegmatite minerals were found.

The granite of which that at the "Redstone Red" quarry is typical is described by Dale[5] as a reddish to greyish white biotite granite of coarse grain without foliation or granulation. The mineral constituents in the order of their abundance are: perthitic feldspar, amethystine and smoky quartz, some separate oligoclase-albite, biotite (and in places hornblende), and with the following accessory minerals; ilmenite, apatite, fluorite and allanite.

An estimate of the average mineral composition based on Rosiwal measurements by Dale is as follows:

Feldspar	63.15%
Quartz	31.04%
Mica	5.81%

[1] Hitchcock, C. H.; The geology of New Hampshire, vol. **II**, pp. 142–143 (1877).

[2] Villarella, Juan d.; Los granitos de las canteras "Leahy," "Redstone," and "Bienvenue," Estados Unidos: *Bol. Soc. Geologica, Mexicana*, Tomo **VI**, pp. 49–53 (1907).

[3] Perry, J. H.; Notes on the geology of Mt. Kearsage, New Hampshire: *Jour. Geology*, vol. **11**, pp. 403–410 (1903).

[4] Dale, T. N.; The commercial granites of New England: *U. S. Geol. Survey Bull.* **738**, pp. 166–168 (1923).

[5] *Op. cit.*, p. 166.

THE DRUSES IN THE GRANITE

The quarry was visited by the writer in 1921 and again in 1926. He also studied material collected by Professor Charles Palache in 1918. In October, 1926, all of the druses to be seen in place in the quarry were confined to a single vertical sheet, striking N. 52° W.; the granite throughout the quarry being otherwise free from them. This sheet was at that time the north face of the quarry in its western part. In the eastern part the work had not been carried far enough north to reach the sheet. In thickness the sheet probably averages about a foot. Since a joint had opened parallel to it a large section of its face is open to view in the quarry wall. The sheet is in the nature of a pegmatite dike since it differs in mineralogical composition and texture from the normal phase of the granite, and consists dominantly of pink microcline feldspar, some of the crystals of which are large, disseminated biotite and random large crystals of allanite and ilmenite. Quartz, though not uniformly distributed, occurs locally in large crystals or as big masses. The miarolytic cavities, which have been simply spoken of above as druses, are of two kinds. Small ones are in places closely spaced. Elsewhere occur larger open cavities, the diameters of which reach 18 inches.

The larger cavities show in section a wall of biotite with microcline, then a zone of graphic granite which is finer grained on the wall side and coarser toward the open side. Zircon and allanite grains were found in a few instances in the graphic granite zone. There is, then, a lining of large euhedral and sub-hedral grains of pink feldspar and quartz which project into the cavity. These grains are in turn coated with small crystals of later minerals.

The larger cavities have thus a distinctly banded structure.

The smaller cavities lack this banded structure and appear rather as haphazard vugs due to selective solution of the microcline. They commonly contain only a few mineral species; albite, and biotite or chlorite being present in most, although fluorite is present in a very large number of them.

The larger cavities with the banded structure are considered to have been formed by entrapped gas in the pegmatite magma, but later entered by a succession of solutions bringing in new material. The smaller ones are due to the partial solution of the solid pegmatite. Koenigsberger[6] found these same two types of cavities in the Alpine granites. He stated that strongly compressed gas formed, during the time before the liquid magma was entirely solid, spherical or ellipsoidal cavities which he called "druses." These cavities are lined with minerals which were still crystallizing out of the granite. Then with progressive cooling of the magmatic waters, the pyrogenetic minerals of the granite were destroyed and cavities called "Kluften" (clefts) were made by

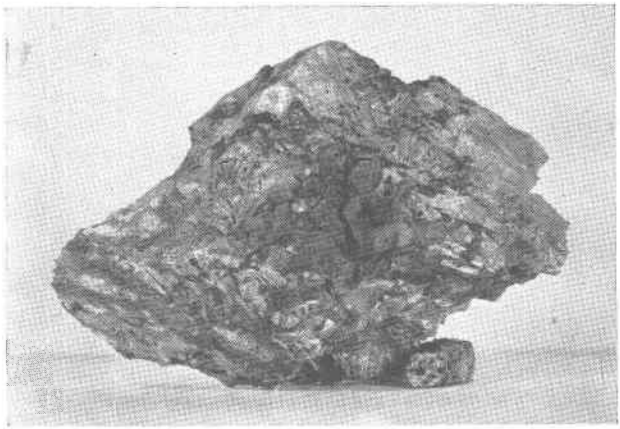

FIG. 1
Photograph of a druse showing lining of quartz and feldspar. 1/6 natural size.

solution and in which adularia, albite, epidote, quartz, fluorite, apatite, calcite, chlorite and zeolites formed.

These terms "druses" and "clefts" thus defined by Koenigsberger are here used with the meanings given to them by him. Figure 1 illustrates a druse, and Figure 2 is a photograph of a specimen containing many closely spaced clefts.

In this "Redstone Red" quarry there are many vugs which seem to have formed partly as druses, and to have been enlarged by the later solutions. Such vugs contain small crystals of microcline and quartz, with later albite, fluorite, chlorite, etc.

[6] Koenigsberger, J.; Die Minerallagerstätten im Biotitprotgein des Aarmassivs: *Neues Jahrb. f. Mineral. etc., Beilage Band,* vol. 14, pp. 117–118 (1901).

Landes[7] believes that most of the pockets in the pegmatites of Central Maine are secondary in nature.

The paragenesis of the minerals in the druses and clefts indicates the following succession of events, a succession which may be divided for convenience into stages, although the stages probably overlapped without a break between any two:

1. An early formation of a pink microcline and a biotite of high mean refractive index, from a "pegmatite magma," that is, a magma rich in volatile constituents. The trapping of these volatile constituents formed (but did not fill) the larger cavities. Emanations continued to rise through the now formed pegmatite dike and began to fill the cavities with microcline and quartz and with a few other minerals,—ilmenite, zircon and allanite. The high index biotite no longer formed.

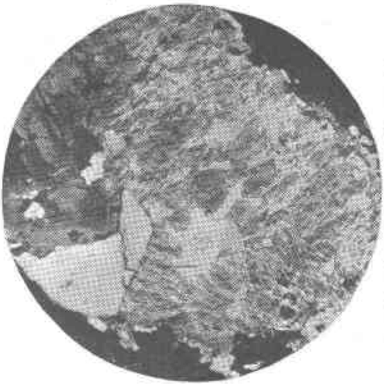

FIG. 2
Photomicrograph of a portion of a thin section of the granite showing intense albitization of the microcline. The white is albite, the grey microcline. Crossed nicols 30X.

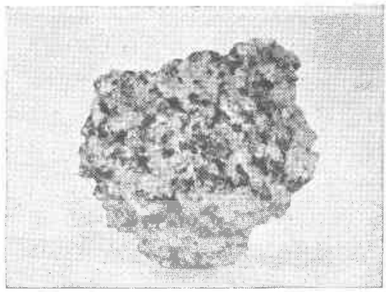

FIG. 3
Photograph of specimen containing many small clefts, lined with chlorite and albite crystals. ¼ natural size.

The first stage may be called the microcline stage.

2. A period of solution and albitization during which some of the microcline was dissolved, and if a void was left, a coating of glassy albite crystals was formed in parallel growth on the parent microcline surface, or the void was filled volume by volume by massive

[7] Landes, K. K.; The paragenesis of the granite pegmatites of Central Maine: *Amer. Mineral.*, vol. **10**, p. 364 (1925).

albite. These examples of albitization are very striking as they are also in so many of the New Hampshire and Maine pegmatites and as recently described by Schaller[8] in the California pegmatites.

This second stage was the time of formation of the small clefts as is fixed by the absence from them of microcline and quartz crystals, but the presence in them of albite and later minerals.

3. A period of formation of several minerals, the most important of which in quantity were fluorite and chlorite. The relative time of formation of the several minerals can not be fixed since only a few were ever found together. The minerals belonging to this stage are a green biotite of moderate refractive index, occurring in rosettes of tiny flakes; minute crystals of octahedrite and brookite, in one instance definitely and probably always as pseudomorphs of ilmenite; fluorite and fluor-apatite; several chlorite minerals of varying properties and several sulphides found in very minor amounts (pyrite, arsenopyrite, galena and sphalerite).

4. A stage of carbonate formation, closing the sequence of minerals of magmatic origin. Siderite formed first, followed by calcite which is found in a variety of habits. A green chlorite mineral of low mean refractive index formed contemporaneously with the carbonates.

Long after these four stages of mineral formation which had closely followed the intrusion of the granite, and represented the effects of its abyssal crystallization and cooling, another period began when the erosion surface was brought down near its present position and groundwater began to circulate through the granite and into the druses and cavities. Hematite and limonite formed as did a variety of nontronite which filled many of the smaller vugs with a light yellow powder.

INTERESTING FEATURES OF THE MINERALOGY OF THE DRUSES

The minerals of the clefts and druses made a fascinating study. Some of their most interesting and striking features will be enumerated.

1. Some of the quartz is very attractive in appearance due to its jet black color. Colorless, smoky and milky varieties of quartz occur. Many of the crystals are zoned, with colorless interiors and smoky exteriors. The crystallography of the grains is usually

[8] Schaller, W. T.; Genesis of lithium pegmatites: *Amer. Jour. Science*, (5) vol. X, pp. 278–279 (1925).

simple, for only the prism and the terminating rhombohedrons "*r*" and "*z*" occur on most of them. On a few the faces "*x*" and "*s*" were also observed. The "*m*" face is deeply striated on the majority of the crystals, and a tapering form due to the frequent alternation of the prism and the rhombohedron is the characteristic shape.

2. The microcline is red-brown, to pink in color. Crystals as large as 10 inches in diameter were seen in the quarry, although the majority of them are smaller. Many crystals exhibit a pretty schiller on the murchisonite parting. Only the common crystal faces "*m*," "*z*," "*b*," "*c*," "*x*," and "*y*" are represented on most of the crystals although a few were noted on which the "*n*" face was developed. One Mannebach twin was found, while Baveno twins are not rare among the crystals.

3. The crystals of albite are very interesting because of the remarkable uniformity with which they grew in parallelism with the parent microcline grain. This was illustrated especially well by the albite crystals found growing to the surface of a Baveno twin of microcline. On the adjacent (010) faces of the twin (across the twin plane) the tiny albite crystals which are tabular parallel to their *a* and *c* axes lie flat on their (010) faces. On the two adjacent (001) faces of the Baveno twin of microcline the tabular albite crystals stand erect on their (001) faces. On the microcline twin the Baveno twin line is offset slightly in one place, so that the (010) face and the (001) face are together in the same plane. On one side of the offset twin line the little tabular albite crystals perched on the microcline face stand erect on their (001) faces, while on the other side of the line they lie flat on their (010) faces.

4. Zircon occurs in very small crystals, consisting of the pyramid, with only a suggestion of the prism.

5. The chlorite is of interest because of the variety of species represented in the druses and clefts. Plates of strigovite with an average refractive index of 1.660 occur in some, while curved worm-like books of pro-chlorite of a mean refractive index of 1.630 were found in others. Tiny green flakes of penninite were found interlaminated with tabular crystals of calcite, and coating crystals of quartz and feldspar.

6. Apatite, although of rare occurrence, is represented in a few clefts by gem quality crystals. On one, the following faces

were identified on the goniometer: "*c*," "*x*," "*y*," "*R*," "*n*," "*s*," "*m*" and "*mu*."

7. The abundance of the fluorite attracts immediate attention upon studying the clefts and druses. Along the face of the quarry opened in the plane of the sheet, hundreds of small clefts are visible. Many of these contain a single crystal of fluorite one-eighth to one-third as large as the cleft. Some of the crystals have an unusual form. Such had begun to grow as a simple cube, modified slightly by the octahedron, but later a new and smaller cube began to grow on each exposed larger cube face. Now, each cube face has a smaller cube perched upon it. In color the fluorite varies from purple to colorless.

8. The calcite is attractive because of the variations in its habit. Drusy coatings of dog-tooth spar represent one habit; rosettes of small flat plates are a second, while larger pearly plates fill cavities two to three inches in diameter. It is with this platy calcite that the penninite is intergrown.

9. Pseudomorphs occur in many of the clefts and druses and add appreciably to the interest of their study. Rhombs of hematite after siderite, and aggregates of brookite and octahedrite after ilmenite were found. An unidentified pseudomorph was found in one druse. It consists of a shell of fine granular reddish brown siderite, it is hollow inside. The shape is that of an orthorhombic or monoclinic mineral, and may be a pseudomorph of a feldspar grain.

DEUTERIC MINERALS IN THE GRANITE AWAY FROM THE PEGMATITE ZONE

A deuteric mineral was defined by Sederholm[9] as one formed in a solid igneous rock by metasomatic changes which have taken place in direct continuation of the consolidation of the magma from which the rock crystallized. This process of mineral formation was further discussed by Kemp[10] and by Colony.[11] The writer[12] has elsewhere described deuteric minerals in some granodiorites of Idaho, and has given criteria for their recognition. Spurr[13] was probably one of the first in this country to recognize that many

[9] Sederholm, J. J.; On synantetic minerals and related phenomena: *Bull. de la Commission Geologique de Finlande*, No. **48**, pp. 141–142 (1916).

[10] Kemp, J. F.; After effects of igneous intrusion: *Bull. Geol. Soc. Am.*, vol. **33**, p. 237 (1922).

[11] Colony, R. J.; The final consolidation phenomena in the crystallization of igneous rocks: *Jour. Geology*, vol. **31**, p. 170 (1923).

minerals which were usually considered as belonging to an early stage of magmatic crystallization, are in reality late. Bowen[14] and Washington[15] have further discussed this phase of the problem.

Schaller[16] has studiously examined the replacement of early minerals in pegmatites by later minerals and has raised the question whether this process of replacement holds in the genesis of common igneous rocks. He asks if hydrous minerals such as the hornblendes and biotites are reaction products in an already solid igneous rock rather than original pyrogenetic minerals. This idea of the formation of these two minerals cannot be universally applied since those minerals occur as phenocrysts in lavas and tuffs which are the quenched equivalents of plutonic types. The writer believes that many pyrogenetic minerals, however, have continued growing by replacement of adjacent minerals after the rock was solid, by addition of material brought in by solutions from below.

In a recent paper Fenner[17] has given a very detailed discussion of the progression of crystallization in igneous rocks and has explained the importance of volatile agents in this progression.

An excellent discussion of the changes that have gone on in igneous rocks during and following their consolidation is given by Grubenmann and Niggli.[18] They divide the changes into three stages; the liquid magmatic, the pneumatolytic, and the hydrothermal. Changes of the liquid stage are the resorption or making-over of olivine, the replacement of lime-rich plagioclase by soda-rich, the change of pyroxene into hornblende, and some types of unmixing. Changes during the pneumatolytic stage: the nepheline

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The magnetite iron deposits of southwestern New York: *New York State Museum Bulletin*, **249–250**, p. 120 (1923).

[12] Gillson, J. L.; Granodiorites in the Pend Oreille district of northern Idaho: *Jour. Geology*, vol. **35**, pp. 21–30 (1927).

[13] Spurr, J. E.; The Ore Magmas, *New York*, vol. **1**, pp. 330–331 (**1923**).

[14] Bowen, N. L.; The order of crystallization in igneous rocks: *Jour. Geology*, vol. **20**, pp. 457–468, (1912).

[15] Washington, H. S.; Deccan traps and other plateau basalts: *Bull. Geol. Soc. Am.*, vol. **38**, p. 765 (1922).

[16] Schaller, W. T.; Genesis of lithium pegmatites: *Amer. Jour. Science* (5), vol. **X**, pp. 278–279 (1925)·

Mineral replacements in pegmatites: *Amer. Mineral.*, vol. **12**, pp. 62–63 (1927).

[17] Fenner, C. N.; The Katmai magmatic province: *Jour. Geology*, vol. **34**, pp. 743–760 (1926).

[18] Grubenmann, U. and Niggli, P., Die Gesteinsmetamorphose, **I**, pp. 183–188, *Berlin*, 1924.

is replaced by sodalite, orthoclase by albite, scapolite is formed, and such minerals as topaz, tourmaline, fluorite, zircon, cassiterite, etc. are introduced. The enrichment of the magma in water was the principal cause of the distillation of these volatile emanations, although volatile fluorides, chlorides and boron compounds are also distilled. In the hydrothermal stage these exhalations are replaced by H_2O and CO_2. The solutions become more dilute, the temperature has fallen and is in the range between 400° and 100°. Serpentine, talc, kaolin, pyrite, sericite, chlorite, titanite, alunite zeolites, etc., form in this final stage.

The microscopic study of the thin sections of the granite from the "Redstone Red" quarry showed that the period of mineral formation did not close with the final consolidation of the rock, and the crystallization of the last pyrogenetic mineral.

The most conspicuous example of this post-consolidation mineral formation was the albitization of the microcline. So completely was the microcline albitized that evidence of it can be seen in granite fragments with the naked eye. In thin section the albitization is shown by the pronounced development of injection perthite (Figure 3). This type of perthite is distinguished from the ordinary perthite described by Warren[19] and Alling[20] by the following features:

1. It is not confined, as is ordinary perthite, to rudely parallel plates in the host mineral, for here the albite component is of most irregular distribution. In many crystals seen in section, one end of an original microcline grain is now entirely albite, while the other end contains little or none. The middle zone of the microcline crystal contains residual masses or islands of unreplaced microcline in a groundmass of albite. This is proof that the feature is not ordinary perthite, in which the relative proportions of the two kinds of feldspar should be about uniform throughout the crystal, and not greater than a moderate amount of one in the other. The proof of replacement of microcline by albite, if not convincing in its very appearance, is clinched by the second characteristic, seen in many grains, which is:

[19] Warren, C. H.; A quantitative study of certain perthitic feldspars: *Proc. Amer. Acad. Arts and Sciences*, vol. **51**, pp. 127–154 (1915).

[20] Alling, Harold L.; The mineralography of the feldspars: *Jour. Geology*, vol. **29**, pp. 219–224 (1921); vol. **31**, pp. 283–291 (1923).

The potash-soda feldspars: *Jour. Geology*, vol. **34**, p. 601 (1926).

2. The albite component is in optical orientation with the outermost rim of an adjacent zoned plagioclase.

This process of albitization has been described by Brögger,[21] Landes,[22] Schaller,[23] Hess,[24] Colony,[25] Warren,[26] Geijer,[27] Grubenmann and Niggli,[28] and others.

The process of albitization of the feldspar in basic rocks is even better known, but it has not always been due to the introduction of soda, but rather to a breaking down of the plagioclase. It was in this sense that the term was used by Geikie.[29] Descriptions have been published, for example, by Becke,[30] Dewey and Flett,[31] Harker,[32] M'Lintock,[33] Shannon,[34] Fenner,[35] and Reynolds.[36]

[21] Brögger, W. C.; Die Mineralien der Syenitpegmatitgange der sudnorwegischen Augit—und Nephelinsyenite: *Zeit. Krist.*, vol. **16**, p. 559 (1890).

[22] Landes, K. K.; The paragenesis of the granite pegmatites of Central Maine: *Amer. Mineral.*, vol. **10**, p. 373 (1925).

[23] Schaller, W. T.; Genesis of the lithium pegmatites: *Amer. Jour. Science*, (5) vol. **X**, pp. 278–279 (1925).

Mineral replacement in pegmatites: *Amer. Mineral.*, vol. **12**, pp. 62–63 (1927).

[24] Hess, F. L.; The natural history of the pegmatites: *Eng. Min. Jour.-Press*, vol. **120**, p. 293 (1925).

[25] Colony, R. J.; The final consolidation phenomena in igneous rocks: *Jour. Geology*, vol. **31**, p. 170–175 (1923).

[26] Warren, C. H.; Petrology of the alkaline granite and porphyries of Quincy and Blue Hills, Mass.: *Proc. Amer. Acad. Arts & Sciences*, vol. **49**, p. 214 (1913).

[27] Geijer, Per; Reference not given, quoted by Sederholm, J. J.: *Bull. de la Commission Geologique de Finlande*, No. **48**, pp. 133–134 (1916).

[28] Grubenmann, U. and Niggli, P.; Die Gesteinsmetamorphose, **I**, p. 184. *Berlin*, 1924.

[29] Geikie, A.; Textbook of Geology, *London* and *New York*, vol. **2**, p. 790 (1903).

[30] Becke, F.; Petrographische Studien am Tonalit der Rieserferner: *Tschermaks Min., Pet. Mitt.*, vol. **13**, p. 420 (1892).

[31] Dewey, Henry and Flett, J. S.; British pillow lavas, and the rocks associated with them: *Geol. Magazine*, vol. **8**, pp. 202–209; 241-248 (1911).

[32] Harker, Alfred; Petrology for students, 6th Ed., *London*, p. 197 (1923).

[33] M'Lintock, W. F. P.; On the zeolites and associated minerals from the Tertiary lavas around Ben More, Mull: *Trans. Royal Soc. Edinburgh*, vol. **51**, pp. 1–33 (1915).

[34] Shannon, Earl V.; The mineralogy and petrology of intrusive Triassic diabase at Goose Creek, Louden Co., Virginia: *Proc. U. S. Nat. Museum*, vol. **66**, p. 83 (1924).

[35] Fenner, C. N.; The Watchung basalt and the paragenesis of its zeolites and other secondary minerals: *Annals New York Acad. Science*, vol. **21**, No. 2, p. 121 (1910).

[36] Reynolds, S. H.; Igneous rocks of the Tortworth inlier: *Quart. Jour. Geol. Soc. London*, vol. **80**, p. 107 (1924).

That feldspar is deposited by solutions was long ago established by Michel Levy,[37] and a number of examples of the formation of secondary albite are given by Hintze.[38]

Further evidence of post-consolidation mineral formation in the granite of the "Redstone Red" quarry is given by the biotite. Many grains of this mineral have protuberances which interlock in a complicated manner with the late albite. Several instances of graphic structures of biotite and albite were noted, while a few of biotite with fluorite were seen. The biotite could not have been entirely deuteric, its stage of growth apparently overlapped from the pyrogenetic into the deuteric. This observation of the form of biotite is similar to one made by Sederholm.[39]

The association of zircon, allanite, apatite, and minute blebs of a green mineral of high refractive index, unidentified, only with the peculiar biotite-albite structures is very suggestive that these minerals formed also by late emanations since these minerals are absent from areas in the slides where injection perthite had not formed. The grouping together with them of considerable fluorite strengthens the suggestion, for fluorite in granites is certainly always a deuteric mineral. Allanite is unusually abundant for a normal granite. The writer[40] has elsewhere noted allanite as a deuteric mineral.

The epidotization of the granite was due to post-consolidation mineral formation, but in the "Redstone Red" quarry is not a conspicuous feature. Chloritization of the biotite, is, however, more general, and it belonged to the sequence of deuteric mineral formation.

INTERPRETATION

The druses and cavities in the pegmatite zone have left a record of a long continued progression of solutions which passed upward through the granite after it had consolidated. These emanations followed readily through the pegmatite zone, but with more

[37] Levy, Michel; *Bull. Soc. Geol. France*, **IX**, referred to by Erdmannsdörfer, O. H., Petrographische Untersuchungen an einigen Granit Schieferkontakten der Pyrenäen: *Neues Jahrb. f. Mineralogie, etc. Beilage Band*, vol. **37**, p. 763 (1914).

[38] Hintze, C.; Handbuch der Mineralogie, *Leipzig*, pp. 1433–1454 (1892).

[39] Sederholm, J. J., *op. cit.*, p. 130.

[40] Gillson, J. L.; The granodiorites of the Pend Oreille district of northern Idaho: *Jour. Geology*, vol. **35**, p. 27 (1927).

difficulty they also passed through the body of the solid granite and brought about changes in its mineral composition.

The paragenesis of the minerals has left a record of the changing character of these emanations; first of high temperature and a composition rich in soda, and containing some of the rare earth elements; they were later rich in fluorine and many other elements; while still later and as the temperature fell carbonates formed.

This progress of post-consolidation mineral formation here illustrated is so similar to that described by others that it is believed that it can now be considered as one of the normal accompanying features of large scale intrusion. The effects of these emanations must be sought in the study of all intrusive rocks.

I know not what part of these emanations were volatile and what part liquid. Thus the words "pneumatolytic" and "hydrothermal" have been avoided. Deuteric minerals illustrate, however, as do the widely disseminated minerals of contact metamorphic zones, the power of these igneous emanations to pervade solid rock without visible channel or fissure, a fact to which Kemp, for example, has already called attention.[41]

FAMOUS MINERAL LOCALITIES: CRESTMORE, RIVERSIDE COUNTY, CALIFORNIA

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The place known as Crestmore is a suburban station situated a few miles west of Riverside, and is easily reached in a few minutes by electric train or auto. Its proximity to the city makes it one of the most convenient of collecting places, because the full day can be utilized at the quarry and even the boxing and shipment of the material can be done there.

The Riverside Portland Cement Company has its plant here, and uses both the limestone and the underlying granodiorite for its manufacture of cement. During active work with its constant blasting, a permit should be obtained to go on the floor of the quarries but this is freely given by the officials and no objection is made to the amount of material collected and shipped.

The mass of limestone appears as two contiguous hills, separated by a narrow swale, and joined by a lower ridge, and the hills rise a few hundred feet above the surrounding plain. The south hill,

[41] Kemp, J. F.; The pegmatites: *Econ. Geology*, vol. **19**, pp. 711–712 (1924).