

PARAGENESIS OF THE NEWRY PEGMATITE, MAINE

H. J. FRASER, *Harvard University.*

The Dunton tourmaline deposit, which occurs in the town of Newry, Maine, has been known locally for a number of years because of the large tourmalines with pink centers and green or banded pink and green borders which it contains. The deposit is of additional interest mineralogically, not only because of the large crystals of spodumene and masses of amblygonite and pollucite which it contains, but also because of the varied and unusual mineral assemblage present.

The deposit has been briefly described by Bastin¹ and certain rare phosphates found there have been discussed by Palache.² The deposit was first opened during the summers of 1903 and 1904 in a search for gem tourmaline but, as the tourmalines were firmly embedded in their matrix, the difficulties of extracting the gems without shattering them were so great that the operations were abandoned. This quarry and others nearby were subsequently reopened during the summers of 1926 and 1927 under the superintendence of Mr. W. D. Nevel of Andover, Maine, in a search for commercial quantities of pollucite. Satisfactory quantities were obtained but mining has now ceased.

Due to the care with which Mr. Nevel collected all unusual minerals, it was possible to secure a very complete suite for the Harvard Mineralogical Museum. This suite formed the basis for the mineralogical data in this paper.

ACKNOWLEDGMENTS

The writer wishes to acknowledge his great indebtedness to Professor Palache whose constant assistance and constructive criticism were of the utmost value during the collection of the data and the preparation of this paper. Professor Palache made a crystallographic study of the tourmalines and constructed the figures given in this paper.

To Mr. H. Berman the writer is obligated for much assistance during the laboratory study of the minerals and the mineral sequence.

Mr. H. Butterfield visited and studied the Newry deposit in 1927 and the writer has drawn freely on his unpublished data.

LOCATION

The deposit is situated in the northeastern corner of the town of Newry, Oxford County, Maine. It occurs on the south side of the main highway which connects Andover and Rumford Point. A trail leaves the highway at a point 6.4 miles southeast of Andover and climbs westward about eight hundred feet to the quarry, which lies at an elevation of about 1525 feet above sea level and 4600 feet west of the main highway. Mining operations were confined to two outcrops, about 250 feet apart, which occur on the western side of the crest of the hill.

DESCRIPTION OF PEGMATITE

The wall rock surrounding the outcrops is a light green mica-schist composed essentially of muscovite, actinolite and quartz. This rock has been much disturbed so that near the outcrops, at least, the direction of schistosity is very variable. The schist has been penetrated by numerous pegmatite stringers of varying size which occur not only at the crest of the hill but also farther down on the slopes. The upper portion of the hill shows much pegmatite. The lower slopes near the main highway are composed principally of a quartz-mica-schist which is dark green in color.

Near the pegmatite contacts the schist has been altered with the development of mica, and the whole mass has been very extensively impregnated with tourmaline. This impregnation is especially evident on the hanging-wall side of the pegmatite. The distribution of the tourmaline crystals in the schist is very interesting. In many places the tourmalines are confined to very definite zones spaced at intervals of from three inches to several feet. These zones may run parallel for several tens of feet and in some places they definitely cut across the prevailing schistosity. The black tourmaline crystals occur oriented in all directions in the plane of a zone, but very rarely does one occur with its long axis at or near right angles to this plane. If the rock is broken parallel to one of these zones, almost a solid face of black tourmaline is exposed. Apparently the depositing solutions were very definitely guided along certain zones in the schist.

The pegmatite commonly has very sharp contacts with the schist. The dip and strike of the contact are very variable, but in general, the dip is steep, varying from 45° to 70° . The more southern of the two outcrops on which mining has progressed is roughly rectan-

gular in shape with a narrow arm running southward. The length north-south is about 160 feet and the greatest width is about 90 feet. The western contact is obscure, the others are very clear. Several schist pendants, with sharp contacts, occur in this quarry, and these together with the common sharp contact between schist and pegmatite and the abrupt changes in strike of the contact, which in places lies at right angles to its former course, clearly suggest that the pegmatite was forcibly injected along planes of weakness in the schist. This southern body which does not have any great lateral extent thus appears to be a pipe-like injection of pegmatite into the schist.

At the time of the writer's visit the footwall was so poorly exposed that little could be seen regarding banding in this area. Mr. Butterfield, who visited the quarry in 1927, reported that a layer of microcline about eight inches thick occurred along the footwall. Next to this was a zone of graphic granite, rather fine in grain, from five to eight feet thick and this graded into the central zone which contained the unusual and the precious minerals. No such banding may be observed on the hanging wall. Near the contact the graphic intergrowth is somewhat finer-grained and frequently there is a zone, always less than an inch in thickness, of black tourmaline just inside the contact. This tourmaline zone is very distinctly displayed in the northern quarry. The graphic intergrowth becomes much coarser towards the center of the pegmatite. It carries considerable quantities of lepidolite, the bunches of which become larger towards the center of the pegmatite. Spodumene and other lithia minerals tend to be concentrated in the central portion but their distribution is very irregular. Beyond a certain tendency for the unusual minerals to occur irregularly scattered through the central portion of the pegmatite and for the finer-grained graphic intergrowth of quartz and cleavelandite to occur near the contact, little indication of banding may now be observed in the deposit.

The northern pegmatite is more sill-like in form. The dip is around 50° east but varies considerably. The present excavation is about 100 feet long and 50 feet wide. The pegmatite outcrop continues to the north for some distance. The texture is coarser here than in the southern outcrop. Spodumene is present in large crystals, the largest recorded being ten feet long with a cross section of five by twenty-one inches. Amblygonite is especially abundant; one mass that was mined weighed nearly five hundred pounds.

There is no colored tourmaline here but in the southern pegmatite blue, green, red and zoned tourmaline occurs. Columbite is more abundant in the northern pegmatite but pollucite is apparently lacking. The uranium minerals occur mainly in this quarry. Otherwise the two pegmatite outcrops are similar.

MINERALOGY OF THE PEGMATITE

The following minerals were identified in an unusually complete collection of specimens, gathered in the main by Mr. W. D. Nevel and now contained in the Harvard Mineralogical Museum. In this paper a detailed description of the optical properties of the minerals is not given since most of the determinations were made on unanalyzed specimens. However, three rare phosphates from this locality which were of unusual interest, have been described together with analyses, by Palache.²

In the following paragraphs the minerals are arranged in the order of their approximate sequence, following Landes.³

Group 1 contains pyrite, black tourmaline, yellowish lepidolite, microcline and quartz. These minerals grade towards the center of the pegmatite into the group 2 zone which contains beryl (non-gem variety), apatite (high in manganese), red, green and blue tourmaline, microlite, columbite, cassiterite, quartz, mauve lepidolite, spodumene, cleavelandite and quartz. There is a minor break in the sequence at this point with some corrosion of the earlier formed minerals and a definite change in the composition of the minerals deposited. Then comes spodumene, pollucite, amblygonite and montebrasite, lithiophilite or triphylite, blue tourmaline, grey lepidolite and quartz.

At this point the sequence is definitely interrupted. There was extensive solution of the earlier formed minerals and the later minerals are characterized by a good crystal form and by deposition in vugs. These minerals, which constitute group 3, are albite, quartz, beryl (gem variety) green tourmaline (gem variety), beryllonite, rose quartz (in well-formed crystals), cookeite, siderite, eosphorite, francolite, herderite, reddingite, a red manganese phosphate and autunite. This marked the end of primary deposition.

Later percolating waters developed heterosite, manganite or other manganese oxides, chalcedony and opal, which together constitute group 4.

SIGNIFICANCE OF THE MINERAL SEQUENCE

The evidence indicating a separation of group 3 from group 4 is rather compelling, but that on which is based the separation of group 1 from group 2, and the subdivision of group 2, is not so convincing. The change from group 1 to group 2 is transitional, the transition being mainly one of texture, with the size of the constituent minerals increasing towards the center of the pegmatite. Such a transition may logically be expected since the later formed minerals and those formed in the central portion of the pegmatite were probably crystallized from a solution in which the proportion of water and other mineralizers was constantly increasing.

The fact that it is possible to arrange the minerals in a definite sequence suggests that the depositing solutions were undergoing continuous changes in composition. Before one mineral can replace another, the depositing solution must have undergone sufficient change in its composition or other conditions to permit the solution of the earlier formed mineral. Consequently the separation of a series of minerals into groups is really an indication of the degree of change in the depositing solution. If, however, this scheme were carried to the limit, every successive mineral would represent a successive group. Moreover many minor reversals of sequence are to be observed among the Newry minerals; quartz, for example, recurs many times in the general sequence. The recurrence of a mineral later in the general sequence is further evidence of fluctuations in the conditions of the depositing solutions and could hardly be considered as due, in all cases, to the ingress of fresh solution.

Group 3 stands very definitely delimited but its quantitative importance is small. The minerals comprising the group are either rare minerals, some of them being known in only a few other localities, or else they are minerals that have already been found in the sequence but here occur in unusually perfect crystals. It is doubtful if these minerals comprise as much as one per cent of the pegmatite. Their unusual nature or form excites much interest and, especially in a laboratory study, there is a tendency to overrate their quantitative importance, since in collecting one is always apt to gather the unusual and ignore the common minerals.

No new elements occur in group 3. The minerals are all characterized by their occurrence as crystals attached to the walls of solution cavities. It is difficult to estimate the time intervening

between the formation of the minerals of group 2 and group 3, but it seems most probable that this interval was short. It need be only of sufficient duration to permit the formation of solution cavities, a process which may be very rapid, and long enough to allow the solution to become again saturated so that the later minerals may be subsequently deposited.

The minerals of group 4 are products of alteration and consequently may have been formed at a much later date.

The available evidence indicates that the process by which the minerals of the three earlier groups were formed was continuous, the interval required for the solution of one mineral and the deposition of another being in most cases probably very short. It does not seem necessary to postulate the ingress of fresh supplies of solutions of different composition in order to produce the corrosion effects observed in this deposit. It is entirely possible that the quantitative composition of the solutions ascending from the source changed as time progressed, but the mineralogical evidence favors the idea that changes in the solution were brought about by deposition.

Certain minerals, for example lepidolite or quartz, recurred at numerous periods during the deposition. The frequent recurrence of these minerals probably indicates a local supersaturation of the solution with their constituents and not a bodily change of the solutions. The solution from which these minerals were precipitated, contained at least twenty-three elements. Conditions of equilibrium in such a solution must necessarily be nicely balanced and when the equilibrium is disturbed many minor adjustments, such as deposition of one constituent and re-solution of another, may be expected in the effort of the solution again to attain equilibrium. Numerous minor reversals in the general sequence of deposition are thus to be expected as a matter of course. But these minor variations should not, because of their greater local interest, be permitted to detract attention from the more general, yet orderly progress of deposition.

Warren and Palache⁴ found that there had been corrosion and replacement of the early minerals in the Quincy pegmatite; they believe that these pegmatites were formed by local segregations in the granite and consequently the replacement was probably accomplished by the same or similar solutions as those which deposited the earlier minerals.

The features shown in the Newry pegmatite are best explained by the assumption of a continuous process of deposition from ascending solutions which retained the same qualitative composition throughout the period of deposition.

DESCRIPTION OF THE MINERALS GROUP 1

The minerals of this group constitute the ordinary pegmatite and therefore comprise the major portion of the deposit. They are, in order of deposition, pyrite, black tourmaline, lepidolite, microcline, and quartz. There is little doubt but what these minerals represent the earliest phase of pegmatitic deposition. Frequently it is the only phase exhibited. When more unusual minerals are present, they are commonly found in the interior of the pegmatite and both their position and their mode of occurrence is such as to suggest that they have formed at a later period.

The black tourmaline which is so well developed along certain zones of permeability in the schist, is included in this class although there is little evidence to prove that it was formed at this period rather than at some later date.

The minerals of this group are tightly intergrown with no interstitial spaces visible, except where there has been later solution activity.

Pyrite. The only pyrite seen was as inclusions in black tourmaline. It had a good euhedral form. It may have developed, due to excess of iron, in the course of the crystallization of the tourmaline.

Tourmaline. All of the tourmaline in this group is of the black variety. It generally shows good crystal forms, although the crystals are rarely large. Frequently this tourmaline occurs concentrated in a narrow band at the pegmatite contact. It also occurs scattered through the pegmatite and in the neighboring schists. It may show either a core or an internal layer of quartz.

Lepidolite. The lepidolite of this group has a yellowish color, sometimes closely resembling that of muscovite, but the minerals may be distinguished by means of a flame test. The lepidolite commonly has a subhedral form and occurs in bunches of from one-half to six inches in diameter.

Microcline. Microcline is quantitatively the most important mineral of this group. It often occurs in fairly large crystals, some of which are over a foot in length.

Quartz. Quartz is abundant, often occurring in masses equal to that of the microcline. Since in many places it was the last mineral to crystallize, it commonly occurs in anhedral forms, filling in and wrapping around the earlier minerals. It is commonly shattered.

MINERALS OF GROUP 2

The minerals placed in group 2 are those which give the distinctive character to the Newry deposit. They include highly colored minerals and some are in large and well formed crystals; all are tightly intergrown without interstitial spaces. They are marked by the increasing importance of the alkali elements sodium, lithium and caesium, and there is definite evidence of replacement of earlier minerals with sequence quite clearly displayed.

The change that occurred in the composition of the solutions during the time that this group was being deposited appears to have been so gradual that there was no definite break either in the sequence or composition of the minerals. However, the widespread development of cleavelandite and quartz which preceded the main deposition of the lithium minerals seems to indicate a transitional period at that time.

Tourmaline. In some respects the most notable mineral in this deposit is lithia tourmaline. Crystals up to a foot and more in length and three or four inches through are tightly frozen in the pegmatite; deep pink in the center, the outer coating is generally light green and this vivid coloring and rounded, triangular outline made them striking objects, especially in the quarry openings. The tourmaline is at times uniformly colored, pink or clear green throughout and such crystals, although imbedded in quartz or spodumene, may sometimes be extracted with distinct termination. In parts of the pegmatite the tourmaline is light to dark blue in clear transparent crystals generally enclosed in quartz or amblygonite. It would appear that such crystals were attached at one end and grew out into an open space or a liquid-filled cavity. The tourmalines are often replaced by later minerals. In several specimens a layer of lepidolite was formed around a tourmaline crystal and in one specimen there were several alternating layers of lepidolite and quartz around a tourmaline crystal.

Another phase of green lithia tourmaline is in slender needles intergrown between the leaves of books of mica both muscovite and lepidolite or in radiating "sun-bursts" in cleavelandite. These are

certainly later than the mica for in one case a mica crystal, fractured by movement of the rock, showed a tourmaline traversing the open crack.

Still another phase of tourmaline is widely distributed at Newry. It is opaque and granular of a bright blue color and always appears as borders about triphylite or in veins cutting it. It is clearly replacing the phosphate. Whether it is formed before or after the associated siderite could not be established.

The evidence is clear that lithia tourmaline in one form or another was being deposited from the beginning to the end of the formation of the minerals of Group 2.

Beryl. The beryl of this period is in coarse crystals with a tabular habit parallel to the basal pinacoid. They are of moderate size, up to five inches in diameter, pale green to greenish white in color and opaque. The high indices of refraction are suggestive of caesium beryl.

Apatite. Apatite is rare and the specimens found were poorly crystallized. The high indices and green color of the apatite suggest that it contained considerable manganese.

Microlite. Microlite is commonly present as well formed octahedrons in cleavelandite. The color varies from yellow to dark brown. In places the crystals are fairly large octahedrons, up to three-fourths of an inch in diameter. Spectroscopic analyses by Mr. Gedney have indicated the light yellow colored mineral is microlite and the dark brown mineral pyrochlore.

Cassiterite. A few crystals of cassiterite were found commonly imbedded in cleavelandite.

Columbite. Columbite is present in two distinct generations. The first generation occurs in excellent crystals and is definitely earlier than the cleavelandite. Some of these crystals reach a maximum of four inches in length. The second generation, chiefly mangano-columbite, is formed as platy masses, intergrown with or replacing cleavelandite or intersecting tourmaline. Sometimes the columbite is seen as flat thin crystals formed between the lepidolite "books."

One crystal was secured which showed a termination projecting into an opening in cleavelandite. This was measured by Mr. Berman and is shown in figure 1. It is a very complex combination, tabular parallel to the front pinacoid. (The drawing and symbols are in the position of Schrauf and Goldschmidt, not that of Dana.)

It shows the forms $c(001)$, $a(100)$, $b(010)$, $g(110)$, $m(130)$, $z(150)$, $d(170)$, $k(011)$, $l(012)$, $f(032)$, $e(201)$, $u(111)$, $n(211)$, $s(221)$, $\pi(231)$, $\beta(121)$, $o(131)$.

Mica. Both muscovite and lepidolite occur in the Newry pegmatite in broad plates, although the first is much the more common. Plates of lepidolite up to eleven inches broad, shot through with green tourmaline were abundant in one quarry. In addition there

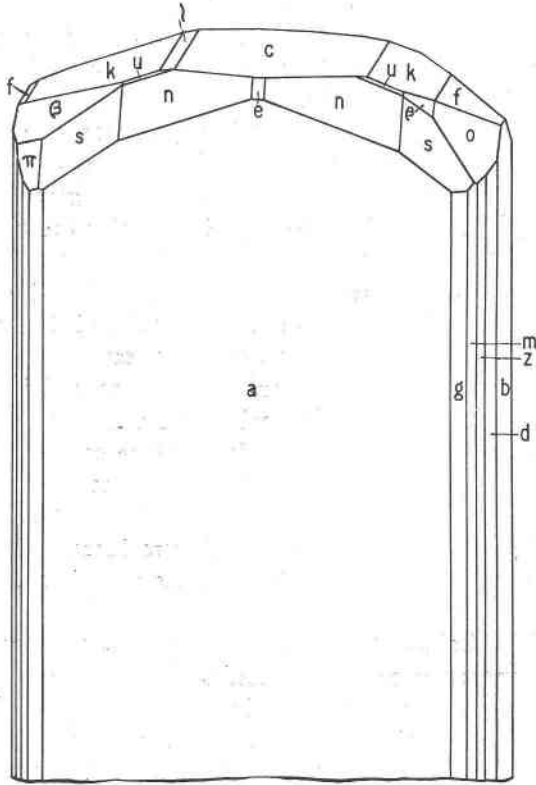


FIG. 1. Manganocolumbite, Newry, Maine.

are two generations of coarse-to-fine-grained lepidolite. The earlier is mauve in color and frequently encloses amblygonite, spodumene, tourmaline and other minerals and is in turn included by still later ones. The later generation is grayish in color and appears to be considerably later than the cleavelandite. It has been suggested that the gray lepidolite contained rubidium but this has not been confirmed.

Cleavelandite. Cleavelandite, the platy variety of albite, is one of the commonest minerals of this group and makes up a large part of the deposit. It sometimes occurs in large masses and has extensively replaced the earlier minerals which now appear as inclusions in it.

The color of the cleavelandite varies from a dull white to a pale blue. Some of the dull, opaque cleavelandite appears to have been much altered and all of the cleavelandite was very susceptible to the later solution corrosion. Often the cleavelandite is colored brown to black by manganese stains, and many small pockets and solution cavities have been developed in it. The later pocket-occurring minerals are frequently formed in these cavities, thus giving rise to an apparent association between the cleavelandite and these minerals.

Quartz. The quartz of this class is generally anhedral and is commonly intergrown with cleavelandite. In places however, group 2 quartz may show good crystal forms, but it then appears to belong to a slightly later period of deposition.

At this point in the sequence of group 2, there appears to be a minor break in the continuity of deposition. The later minerals are commonly of unusual composition. Their order of sequence is not, in all cases, as definite as that of the earlier minerals. The majority of these minerals were definitely later than the cleavelandite but there was some overlapping.

Spodumene. Spodumene is one of the most characteristic minerals of this group. It is commonly developed in large masses and often in good crystals. In the northern pegmatite some of the crystals were over ten feet in length. A structure not before recognized in spodumene was shown by a large crystal fragment. A series of bands traverses the cleavages much as pericline twin lamellae appear in plagioclase. The bands are one or two mm. wide, fairly even but interrupted, sometimes gently curved. Their general attitude in the block is nearly parallel to the basal pinacoid. That they are due to twinning of some sort is certain but the law was not determined. There is no sign of alteration in the spodumene.

Spodumene very commonly encloses mauve lepidolite. Sometimes it is earlier than cleavelandite, sometimes they appear nearly contemporaneous, but the bulk of the spodumene was probably formed after the lepidolite.

Pollucite. Locally pollucite is fairly common. It occurs closely associated with spodumene and in such a manner as to appear to be

replacing it. Pollucite is commonly found in fractured masses, the fractures being filled with a dull white variety of chalcedony. This association is so general in this deposit that it can often be used as a criterion to distinguish pollucite from quartz. The occurrence of pollucite at Newry has been briefly described by Fairbanks⁵ who reported that lepidolite and caesium-beryl were the best indicators of the presence of pollucite at Newry.

Amblygonite and Montebрасite. These two minerals are developed rather locally, although they may occur in very large masses. Commonly they show good crystal form. They often enclose cleavelandite and other earlier minerals and sharp crystals of amblygonite are found in massive lepidolite. The distinction between amblygonite and montebрасite is based chiefly on the difference in their optical properties.

Triphylite. This mineral is abundant and very noticeable in the pegmatitite. Areas from a few inches to a foot across were seen showing the good cleavage characteristic of this mineral. It is white to pale blue in color when fresh. It is generally surrounded by a border of bright blue massive tourmaline which also forms veins and irregular replacement areas in the triphylite. Some of the crystals are also marked by the brilliant purple coating of heterosite (purpurite) to which it has altered. Mixed with the tourmaline and clearly also a replacement is light brown granular siderite.

Sphalerite. Sphalerite occurs in small quantities at Newry. It is enclosed and replaced by massive blue tourmaline.

Pitchblende. Pitchblende has been found in small amounts at Newry. It is largely altered to colored crusts—orange gummite and lemon yellow autunite, the latter strongly fluorescent with a green color under the spark gap. In one specimen pitchblende is in immediate contact with cassiterite.

MINERALS OF GROUP 3

These minerals are all developed in pockets and hence their position in the classification is readily ascertained.

Albite. The albite of this class occurs as very well-formed crystals attached to the walls of cavities. It thus differs in form from the earlier, platy variety, cleavelandite. With the albite are found good quartz crystals.

Beryl. The beryl of this type is the gem variety. It is found in excellent crystals, often well terminated. Its color is green, it is transparent and sometimes free from flaws.

Tourmaline. The tourmaline of this group is of gem quality, generally green or blue in color and showing good crystal form. Several of these crystals were measured and showed the forms: $m(10\bar{1}0)$, $a(11\bar{2}0)$, $r(10\bar{1}1)$, $\epsilon(10.0.\bar{1}0.1)$, $o(02\bar{2}1)$, $\beta(09\bar{9}2)$, $x(12\bar{3}2)$, $v(13\bar{4}1)$, $t(21\bar{3}1)$, and $u(32\bar{5}1)$. The two distinct habits are shown in the figures. No. 2 is a dark blue crystal characterized by the large faces of the steep positive rhombohedron. No. 3 is a clear green color and shows two negative scalenohedrons developed in perfect symmetry. Other crystals of this type also show in addition

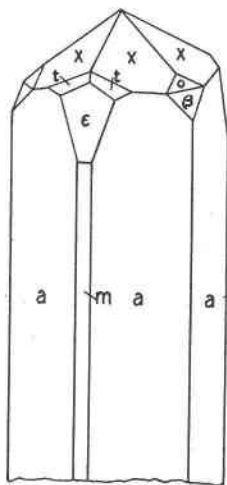


FIG. 2.

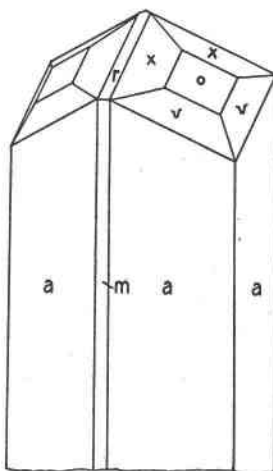


FIG. 3.

Tourmaline, Newry, Maine.

two positive scalenohedrons. Crystals of tourmaline such as these have been found at many of the Maine pegmatite localities but seem never to have been figured. It seemed therefore worth while to place these on record. Sometimes small radiating masses of blue-green tourmaline crystals are formed on quartz or albite crystals and project out into open spaces. These radiating tourmalines are to be distinguished from the earlier, fibrous solution remnants. In one place a group of the later was seen joining above and below to the original tourmaline crystal. Apparently these fibres represent less soluble parts of the original crystal.

Beryllonite. The fresh mineral is white and shows perfect basal cleavage and less perfect orthopinacoidal cleavage. The crystals, which are up to 3 inches in diameter, are generally attached to

cleavelandite although rarely they are attached to the wall of a cavity. In places the crystals include early minerals, notably green tourmaline.

The beryllonite is often altered and stained with manganese. The alteration varies from a coating of herderite to complete destruction of the crystals and the development of a cavity or a pseudomorph. As the material alters it sometimes develops a fibrous structure parallel to the vertical axis. An analysis together with the optical properties of this mineral has been published by Palache and Shannon.²

Cookeite. In some places there has been formed a white, micaceous mineral whose optical properties are close to those given for cookeite. This mineral is commonly seen coating the other pocket minerals and also some of the earlier minerals. In places it appears as an alteration product after cleavelandite.

Siderite. The presence of siderite in this group is somewhat doubtful, it may belong to a later period. It is present as well formed crystals, and commonly is altered to limonite.

Rose Quartz Crystals. The occurrence of rose quartz in well formed crystals is not common. It is present at Newry in excellent crystals which are fastened on to the wall of the cavities and project out into the open spaces. The crystals consist of a six-sided prism, up to three-eighths of an inch in length, with six pyramidal faces. Generally the crystals are very closely spaced. Francolite and herderite have been deposited on these quartz crystals.

Eosphorite. Eosphorite is one of the commonest phosphates at Newry. It occurs as a pocket mineral, sometimes formed on quartz crystals in the open cavities, sometimes as a fan-shaped aggregate on albite and occasionally it may be seen cutting across beryllonite crystals. The color varies from opaque brownish black to a transparent light brown and almost to a yellow. It seems probable that there is a considerable variation in the manganese and iron content and that the darker colored material from the northern pegmatite approaches childrenite in composition. The eosphorite crystals are of the same habit as those of Buckfield, a pyramid combined with front and side pinacoids. Its analysis and optical properties are given by Palache and Shannon.²

Francolite. Francolite occurs as light-colored radiating masses on albite, quartz and other crystals. It is sometimes stained a dark brown by iron and manganese solutions. Francolite is common but

the radiating masses seldom exceed an eighth of an inch in diameter.

Herderite. Herderite commonly occurs in this deposit as small "gum drop" masses varying in color from yellow to black. The color variation is probably due to staining by impurities. The "drops" of herderite are commonly perched on albite, quartz, francolite or other crystals. It may also occur in considerable quantities as a botryoidal coating lining cavities or coating beryllonite crystals. The coating on the beryllonite is evidently an alteration product, but the other occurrences have definitely been formed from solutions. It is one of the last minerals to be formed. While it is not an uncommon mineral in the pegmatites of this region, its occurrence in these radial fibrous forms is unusual. Palache and Shannon² have published an analysis of this species.

Reddingite. On one specimen a reddish brown mineral was observed as a radial fibrous deposit on herderite. The optical properties of this mineral were near those given for reddingite and the mineral gave a good microchemical test for phosphorus. From these data it was concluded that the mineral was reddingite.

Unknown Red Manganese Phosphate. On several specimens a reddish brown mineral occurred on the herderite and elsewhere. This mineral was in small radiating needles. It has been described by Landes³ and the mineral from Newry as very similar in appearance to that from Buckfield. It occurs in such minute quantities that its identification is extremely difficult.

MINERALS OF GROUP 4

These minerals are the result of supergene processes. One striking feature of this period is the extensive development of a brown or black manganese stain. Among the minerals of this group are manganite and other manganese oxides which probably have developed by alteration of the earlier minerals. Limonite has developed in places, probably from the decomposition of siderite. Heterosite has formed by the alteration of triphylite. Chalcedony has formed in and around pollucite. Locally, opal has deposited on quartz crystals.

CONCLUSION

The pegmatite at Newry fails to show any noteworthy banding or zoning of its constituents. A detailed examination of the mineral sequence however, shows that there is a rather close parallelism,

mineralogically, with the pegmatites at Buckfield and elsewhere, as described by Landes. From the structural and textural data available there appears to be sufficient evidence to show that there were at least three definite periods during the formation of the pegmatite. The first and second periods were transitional but the second and third periods were definitely separated by a period of extensive replacement activity which however was very local in its action. The evidence indicates that the entire process was essentially continuous.

During the first period the solutions deposited mainly silicates; the second period began with the deposition of silicates, and then changed to lithium silicates and phosphates; the third period was one of deposition of manganese, iron, aluminum, and beryllium phosphates. After the main period of deposition had ceased, super-gene processes became effective to a slight extent.

BIBLIOGRAPHY

- ¹ Bastin, E. S. Geology of the Pegmatites and Associated Rocks of Maine *U. S. G. S. Bull.*, **445**, 1911, p. 76-78.
- ² Palache, C., and Shannon, E. V. Beryllonite and other Phosphates from Newry, Maine, *Am. Mineral.*, **13**, 7, 1928, p. 393-396.
- ³ Landes, K. K. The Paragenesis of the Granite Pegmatites of central Maine, *Am. Mineral.*, **10**, 11, 1925, pp. 355-411.
- ⁴ Warren, C. H., and Palache, C. The Pegmatites of Riebeckite—Aegerite Granite of Quincy, Mass., *Proc. of the Am. Acad.*, **XLVII**, 4, 1911, p. 145.
- ⁵ Fairbanks, E. F. The Importance of Pollucite, *Am. Mineral.*, **13**, 1928, p. 24.