-es. It will ultimately mean higher relative importance of processes for changes in the geographic distribu- e iron industry, and a modification American iron trade with that of

s[1] that when the higher grade de- exhausted "the cost of production lower grade ores and those remote the end we shall have to resort to hich the iron ore is separated from eminated as grains. This upward ard grade in the utility of the metal lly, it may be some centuries from forced to an economy in the use of sed by folk two hundred years ago, own at sea, or rusted back to earth, ts. In this stage, when it becomes may continue to be the helper of d, but its power for help will be

. 1905, pp. 230–247.

THE SOUTHERN KLONDIKE DISTRICT, ESMERALDA COUNTY, NEVADA.—A STUDY IN METALLIFEROUS QUARTZ VEINS OF MAGMATIC ORIGIN.[1]

JOSIAH EDWARD SPURR.

LOCATION.

Several years ago, before the discovery of ore at Tonopah, Nevada, ore was found and mined about nine or ten miles south of this now flourishing district. The production of the older camp has never been great, so that it is little known, but the geological features of the ore deposits and their petrographical relations to the surrounding rocks, inasmuch as they bear directly on certain questions of genesis, are of great scientific interest.

There are two main portions of the district, the Southern Klondike proper and East Klondike, separated by an interval of about a mile.

The occurrence, which it is the purpose of this paper to describe, is located in the Southern Klondike camp proper. In the East Klondike region the ore is associated with Tertiary rhyolite and will not be further considered.

GEOLOGY.

The country rocks of the Southern Klondike region include sediments, volcanics and granitic intrusives. The district is situated within an area of Palæozoic limestone whose exact age is unknown but which is thought to be Cambrian or Silurian, owing to its analogy to similar rock of determined age in adjacent regions (as at Silver Peak). The limestone area, so far as known, is not more than a few miles in diameter and is surrounded by Tertiary volcanics, chiefly rhyolite.

At the Klondike mines the limestones are cut by a long, dike-like intrusion of a peculiar granitic, highly siliceous rock, which will

[1] Published by permission of the Director of the United States Geological Survey.

be later described. At a distance from the intrusive the limestone is of a fine blue color, sometimes crystalline, often thin-bedded and slaty. As one approaches the dike, especially where this is thickest, the sediments are seen to be highly metamorphosed. Some of the limestone has been altered to marble and the slaty portions have been changed to knotted and spotted schists and dense siliceous hornstone. Microscopic study shows that the schists and hornstones are composed of quartz, muscovite, calcite, epidote, garnet, etc., in varying proportions. In one variety of spotted schist the spots consist of fibrous green amphibole.

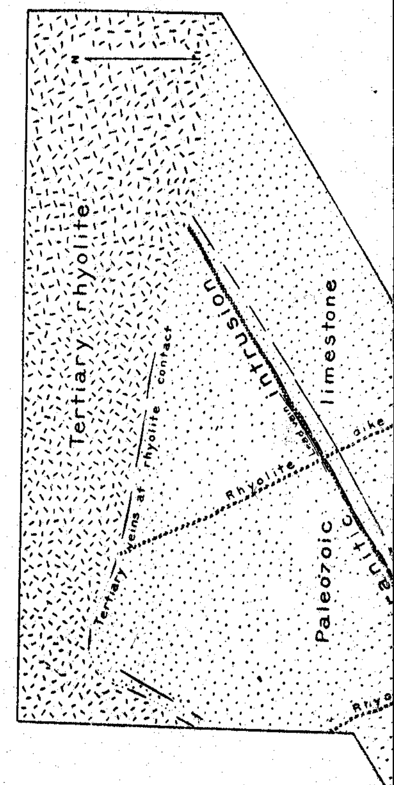
NATURE OF THE GRANITIC INTRUSION.

The granitic intrusion, as shown on the map (Fig. 30), extends for nearly a mile with a general course of N. 60° E. and a northwest dip. It has an average thickness of about 15 feet and for most of its course is nearly straight. On the southwest end it terminates in an irregular knob, about 100 yards in its longer, and about one-third as much in its shorter diameter. At the northeast end the dike is cut off by Tertiary rhyolite. It is therefore probably pre-Tertiary in age.

The granitic rock is lithologically of a varied character. Some portions are very fine-grained and others coarse, the two textures grading rapidly into one another. It contains nests of pegmatite, which pass by transitional stages into masses and veinlets of pure quartz. There are also masses of quartz segregated in the midst of the granitic rock, with no intermediate pegmatitic stages.

The principal minerals of the rock are quartz, feldspar and muscovite. These are present in all relative proportions, the variation in mineralogy being especially marked in the large knob which terminates the intrusion at the southwest end. The predominant type contains all three minerals, but in some places large masses are made up of quartz and feldspar only and in others of muscovite nd quartz only. All of the rocks contain much quartz.

The intrusive mass may, therefore, be divided into four readily



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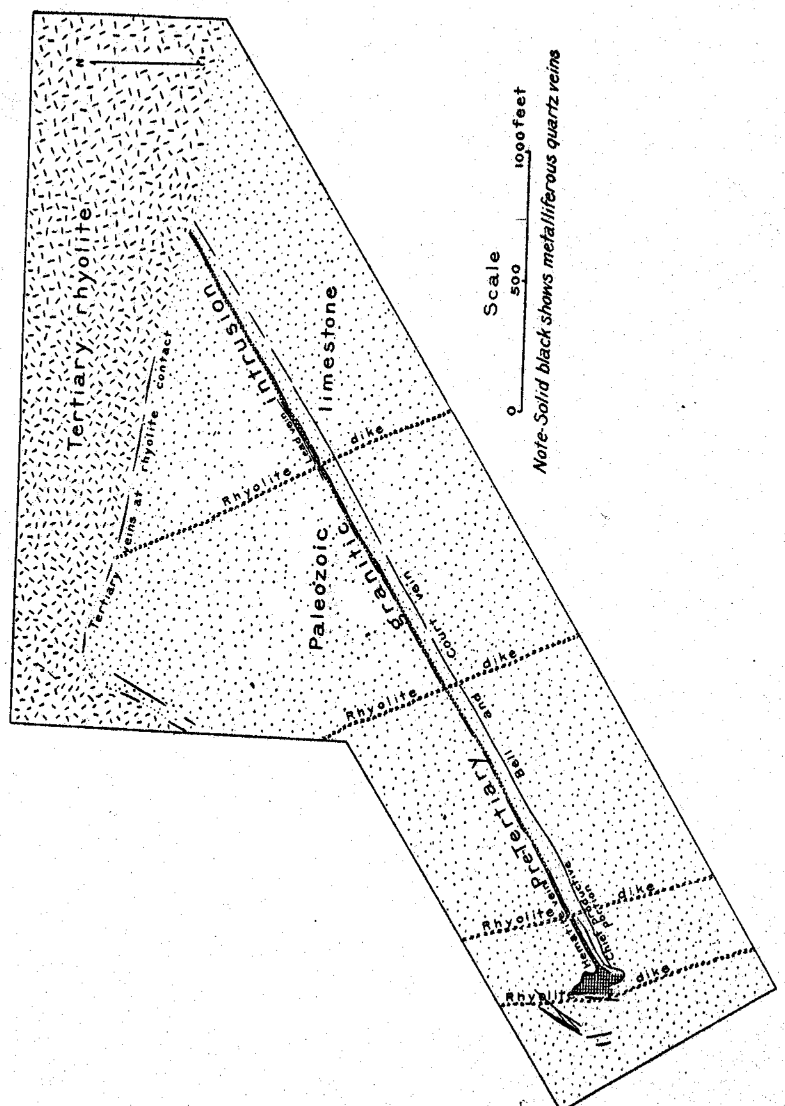

FIG. 30. Sketch map showing geologic conditions in the Southern Klondike district, Esmeralda Co., Nevada.

distinguished phases. Arranged in the order of their relative abundance these are:

1. Quartz-muscovite-feldspar rock (muscovite-granite).
2. Quartz-feldspar rock (alaskite).
3. Quartz-muscovite rock.
4. Quartz rock.

DETAILED DESCRIPTION OF ROCK TYPES.

1. *Quartz-muscovite-feldspar rock.*—From a study of numerous thin sections this rock is seen to vary greatly in the proportions of quartz, feldspar and muscovite which it contains, the muscovite, however, being always subordinate to the quartz and to the feldspar. Of the two last-named minerals, sometimes the one and sometimes the other is in excess. The species of feldspar include orthoclase, microcline and albite or oligoclase-albite. All varieties are usually fresh and unaltered, although kaolinization due to weathering is to be occasionally observed.

The muscovite is partly coarse and partly fine. In some thin sections it is all coarse, like the typical muscovite of granite; in others a large proportion is fine-grained and approaches in appearance the fine-grained variety of muscovite which is called sericite and which is often derived from the alteration of feldspar. In this rock, indeed, the feldspar is frequently intergrown with fine, small blades of muscovite and in such cases the latter mineral might be taken on casual examination to be a secondary product. Since the feldspar is fresh, however, the muscovite is undoubtedly contemporaneous with it.

The quartz encloses crystals of feldspar and muscovite and seems to have been the last mineral to crystallize.

There are no dark ferromagnesian minerals present. Accessory minerals include greenish-white garnet and small crystals of hematite, which are pseudomorphous after probable primary pyrite.

2. *Quartz-feldspar rock.*—The quartz-feldspar rock is connected by transitional stages with the quartz-feldspar-muscovite rock and like that rock it has an allotriomorphic granular structure and generally a medium fine texture. The essential miner-

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Accessory minerals include
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als, quartz and feldspar, are present in varying proportions. The feldspar includes the species orthoclase, microcline and albite, and is sometimes turbid from kaolinization. It is occasionally slightly altered along cracks to fine muscovite (sericite), as a result, probably, of weathering processes. This secondary muscovite is to be carefully distinguished from the ordinary original muscovite of these rocks.

Accessory minerals include apatite, colorless garnet and titanite.

3. *Quartz-muscovite rock.*—The quartz-muscovite rock is connected by transitional phases with the two types above described. It is characterized by an allotriomorphic granular structure with a texture varying from medium coarse to medium fine. Typically it contains no feldspar whatever. The proportions of the essential minerals, quartz and muscovite, are variable, sometimes one and sometimes the other being predominant.

The muscovite is of two kinds, one coarse and one fine. There is often a transition between the coarse and the fine, but in general the two sizes belong to distinct classes, and illustrate different conditions of consolidation. Frequently most of a given thin section is made up of coarse intercrystallized quartz and muscovite, with typical granitic texture. This muscovite is primary, and is usually intergrown with the quartz, with which it is contemporaneous. In some cases large flakes of muscovite (often with a radial arrangement) are earlier than the quartz. The fine-grained muscovite is also intergrown and contemporaneous with fine-grained quartz, and this intergrowth frequently forms a second generation, later than the coarse quartz and muscovite. In certain sections the coarse muscovite may predominate, in others the fine. Both varieties seem plainly original. In some cases small matted areas of muscovite and quartz suggest, as a possible hypothesis, that these minerals have formed by the alteration of original feldspars. Nevertheless there is no question but that the coarse and the fine muscovite are of similar and nearly contemporaneous formation, as shown by frequent transitions from one to the other; and if the finer muscovite has in places resulted from the alteration of feldspar, the recrystallization must have taken place during the rock's consolidation. This change, if there was such, was also probably effected before the consolidation of the quartz, for the quartz encloses not only the coarse muscovite, but in many cases the fine fibres.

Accessory minerals in the quartz-muscovite rocks include pseudomorphs of hematite after pyrite, and occasional small garnets.

4. *Quartz rock.*—Quartz "veins," which are a phase of the intrusive magma, arise by diminution and withdrawal of the feldspar and muscovite. Thin sections of these quartz veins usually show the presence of a small and variable amount of muscovite.

Accessory minerals include hematite and pyrite. In some localities these iron minerals have bunched together in the quartz, so that they make up what often appears to the naked eye to be a mass of pure iron ore. Near the surface the pyrite has altered entirely to hematite and limonite. Thin sections show that in the interstices between the separate hematite crystals there is granular quartz, which has solidified subsequent to the metallic minerals. Fine muscovite is also present.

CHEMICAL CHARACTERS.[1]

Following are analyses of the different types of rocks described above:

TABLE I.

1. *Quartz-feldspar-muscovite rock (Muscovite Granite).*

	Spec. No. 108.	No. 86.
SiO_2	71.80	75.64
Na_2O	3.50	4.22
K_2O	5.20	3.64

TABLE II.

2. *Quartz-feldspar rock (Alaskite).*

	No. 92.
SiO_2	70.32
Na_2O	2.65
K_2O	7.90

METALLIFEROUS VEINS.

Close to the contact of the intrusive granitic mass with the limestone, and following the contact on the southeast side for the whole length of the intrusion, is a quartz vein (see map, Fig. 30) which, near the surface, carries sporadic high values in gold and

[1] Of the accompanying analyses, Nos. 87 and 88 were made by Dr. W. F. Hillebrand, and the others by Dr. E. T. Allen, of the U. S. Geological Survey.

3 *and* 4. *Quartz-muscovite Rock*[illegible]

	No. 87.[1] a	No. 87.[1] b	No. 97.	No. [illegible]
SiO_2	71.38	72.69	73.64	74.0[illegible]
Al_2O_3	14.31[2]	13.42[2]		
Fe_2O_3	.66	.97		
FeO	.28	.32		
MgO	.25	.26		
CaO	2.22	1.97		
Na_2O	.15	.21	.54	.92
K_2O	3.79	3.36	4.84	4.65
H_2O-	1.60	2.36		
H_2O+	3.03	2.60		
TiO_2	a little	a little		
CO_2	1.42	.97		
P_2O_5	a little	a little		
SO_3	none	none		
Cl		trace		
F	.17	.25		
S	none	none		
MnO	a little	a little		
Li_2O				
	99.26	99.38		
Less O=Fe	.07	.10		
	99.19	99.28		

silver. Its average distance [illegible]
the maximum about 100. T[illegible]
ers, the Bell and Court vein.
the southwest or knobbed end
silver (chiefly in the form o[illegible]
is relatively more abundant
than at the surface itself. T[illegible]
considerable lead carbonate,
below the surface to 50 or 60
in both gold and silver, assay[illegible]
$60 or $70 gold, or even high[illegible]
phide occurs, whose oxidatio[illegible]
bonate. This resembles the

[1] This analysis indicates the pre[illegible]
(probably infiltrated) not revealed

[2] Incl. a little TiO_2 and P_2O_5.

[3] With a little TiO_2 and P_2O_5.

[4] By ignition.

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US VEINS.

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87 and 88 were made by Dr. W. F.
Allen, of the U. S. Geological Survey.

TABLE III.

3 and 4. Quartz-muscovite Rock. Series Transitional into Quartz Veins.

	No. 87.[1] a	No. 87.[1] b	No. 97.	No. 91.	No. 88.	No 116.	No. 90.	No. 96.	No. 99.	No. 117.
SiO_2	71.38	72.69	73.64	74.08	75.51	76.39	79.40	84.58	94.34	96.82
Al_2O_3	14.31[2]	13.42[2]			14.28[3]					
Fe_2O_3	.66	.97			1.09					
FeO	.28	.32			.38					
MgO	.25	.26			.28					
CaO	2.22	1.97			.34					
Na_2O	.15	.21	.54	.92	.20	.52	.82	.45	.21	.22
K_2O	3.79	3.36	4.84	4.65	4.69	3.98	3.68	2.87	.16	.17
H_2O-	1.60	2.36								
H_2O+	3.03	2.60			3.36[4]					
TiO_2	a little	a little			a little					
CO_2	1.42	.97								
P_2O_5	a little	a little			a little					
SO_3	none	none								
Cl		trace			trace					
F	.17	.25			.20					
S	none	none								
MnO	a little	a little			trace					
Li_2O					trace					
	99.26	99.38			100.33					
Less O=Fe	.07	.10			.08					
	99.19	99.28			100 25					

silver. Its average distance from the intrusive contact is 75 feet, the maximum about 100. This vein is called, from its discoverers, the Bell and Court vein. Its chief productive portion is near the southwest or knobbed end of the dike. The values are mostly silver (chiefly in the form of chloride), with some gold. Gold is relatively more abundant a short distance below the surface than at the surface itself. The most superficial zone, marked by considerable lead carbonate, extends from about 20 or 30 feet below the surface to 50 or 60 feet. Some of these ores are rich in both gold and silver, assaying up to 200 to 300 oz. silver, and $60 or $70 gold, or even higher. Occasionally a black-gray sulphide occurs, whose oxidation has resulted in some copper carbonate. This resembles the compound known as *stetefeldtite*,

[1] This analysis indicates the presence of a considerable amount of calcite (probably infiltrated) not revealed by the thin section.

[2] Incl. a little TiO_2 and P_2O_5.

[3] With a little TiO_2 and P_2O_5.

[4] By ignition.

which is a copper-antimony-silver compound, containing generally also gold. Such specimens are said to assay as high as 4,000 oz. to the ton. Some portions of the vein contain bunches of galena, a mineral from which the lead carbonate is probably derived by oxidation. Pyrite, some of it slightly cupriferous, is frequent. Among other minerals of the vein are siderite, calcite and hematite, and in one place a streak rich in wad (manganese oxide) was found. All these minerals, however, are in the petrographic sense accessory, the vein being almost entirely quartz.

From workings near the surface about $33,000 worth of ore has been shipped, consisting of 100 tons, averaging over $300 a ton; but the average tenor of the vein is exceedingly low, running from 2 or 3 oz. down to ½ oz. of silver.

The vein cuts at a small angle across the stratification of the sedimentary rocks, and is essentially a silicified shear zone. It follows the irregular curves of the knob-like mass at the south end of the alaskite intrusion so faithfully as to show a definite genetic connection with the dike. Plainly the shear zone was caused by the disturbance produced by the intrusion.

The quartz of the vein is partly white granular vein-quartz, partly jasperoid. It frequently contains numerous liquid inclusions, which enclose gas bubbles.

The vein described above is the only one that has been productive of commercial ore. There are, however, other vein formations. Parallel to the productive portion of the Bell and Court vein and between it and the intrusive contact, is a vein of jasperoid and quartz, carrying values up to $1 and $2 per ton (chiefly silver, with some gold). This jasperoid vein, representing, like the Bell and Court vein, a silicified shear zone parallel to the contact, appears to run into the Bell and Court vein on the south and there unite with it. Other veins of jasperoid or white quartz, or both, less persistent than those above mentioned, occur near the contact, in the intruded limestone. They mostly follow the stratification of the limestone, which is nearly parallel to the strike of the dike, but sometimes are diagonal to the formation. They are often iron-stained, and contain a little silver and gold. Under the microscope they show interlocking grains of quartz containing small crystals of magnetite.

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Half a mile northeast of the productive portion of the Bell and Court mine, but close alongside a barren portion of the same vein, the writer studied a segregation of quartz within the granitic (alaskite) dike. At this locality crystals of galena and pyrite occur both in the quartz and in the adjacent extremely siliceous alaskite. Under the microscope the galena is seen to be contemporaneous with the quartz, and the quartz also encloses a very little accessory contemporaneous muscovite.

In places at the very contact of the intrusive rock with the limestone, especially near the knob which terminates the intrusion on the southwest side, there is a deposit of hard, nearly solid, hematite which reaches a maximum of 10 or 15 feet in thickness. This hematite has been shown to be largely derived from the oxidation of original pyrite, which was formed along the intrusive contact, in the granite and probably also in the limestone. These masses often contain pure quartz in considerable quantity, similar in appearance to that of the Bell and Court vein, and mixed with the hematite in all proportions. By a diminution of the hematite, phases arise which consist of quartz carrying disseminated oxidized pyrite, and by further diminution of the iron a nearly pure quartz originates. These different phases may be found along the same contact, and practically along the same vein. Such pyrite-bearing quartz veins follow the contact closely and occur especially in the granite (at the contact). In most localities, instead of a single vein, there is a band of large and small vein-like quartz masses, which are identical in nature with the segregated quartz bodies found elsewhere in the granite. These pyrite- or hematite-bearing veins sometimes occur on one margin of the dike, sometimes on both, and again are entirely wanting. This irregularity is characteristic also in a vertical sense, for in one place where workings have been sunk on a deposit of hematite for 30 or 40 feet, it has been found to decrease to almost nothing. The hematite is said to carry small amounts of gold, silver and lead, the average value being perhaps $2 to the ton. None of it has been mined.

About one-half a mile northeast of the knobbed end of the granitic intrusion, there is, on the northwest side of the dike, a quartz vein similar, in nature and location, to the hematite-bearing veins, but containing considerable galena instead of oxidized pyrite. This "lead vein" may be traced continuously 200 or 300 yards, but is usually barren. It wedges out in the limestone in such a way as to indicate that it fills an opening caused by the granitic intrusion.

Mineralization Connected with the Tertiary Rhyolite.—Rhyolite forms several thin southwest-striking dikes, which trend at right angles to the alaskite dike and are intrusive into the limestone, the alaskite, and the veins associated with the alaskite. The veins, alaskite and limestone, are cut off by a large mass of similar rhyolite on the northeast. This rock contains phenocrysts of quartz and orthoclase, in a glassy ground-mass. Biotite is scarce and is usually altered.

Some silicification and ore deposition has accompanied the rhyolite intrusion. In one locality, where a small rhyolite dike has cut across the Bell and Court vein, the ore was very rich for 3 inches away from the intrusive contact, beyond which it was barren. This indicates either subsequent mineralization (later than the original ore deposition), or concentration of preëxisting values by the solutions attendant upon the rhyolitic intrusion. More definite proofs of mineralization mark the contact of the main rhyolite mass, which is intrusive, and trends irregularly but in a generally different direction from that of the alaskitic intrusion. The contact of the rhyolite and the intruded limestone is marked by irregular large reefs of iron-stained quartz and jasperoid, of a nature very similar to that which characterizes the contact of the granitic intrusion. The reefs contain some gold and silver, and have been prospected but not mined. This Tertiary mineralization is not believed to have any immediate genetic connection with the pre-Tertiary mineralization which is the main subject of this paper.

GENERAL CONCLUSIONS.

NATURE AND ORIGIN OF THE VARIATIONS OF THE GRANITIC ROCK.

Character of the Magma.—The granitic magma, intrusive in this locality, was siliceous and alkaline, varying considerably in

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Origin of Muscovite.—In
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[1] The Silver Peak geology is to
paper by the writer (published by the

the proportion of soda to potash and in the amount of silica, as is shown by the analyses from the different portions. This considerable range of composition in different parts of alkaline (alaskitic) intrusions has been observed in other places, as for example, by the writer at Silver Peak,[1] in Nevada, and seems to be characteristic of this class of rocks. It also conforms with what is known as to the irregular segregation of elements in pegmatitic rocks, which are closely related to alaskites. In both cases the segregation may be explained by the assumption of relatively slight viscosity of the magma, which property has permitted strong currents to bring about the migration and massing of like materials. This assumption is warranted by other considerations which cannot be repeated here, but which show that siliceous magmas are in a relatively aqueous and fluid condition.

Relation of Rock Types.—The typical minerals of the Southern Klondike intrusive rock are quartz, feldspar, and muscovite. The feldspar is alkaline, the chief species being orthoclase and albite. When all three minerals are present the rock is a type which has been called muscovite-granite. Frequently, however, muscovite is rare or wanting, when the rock becomes an alaskite. Again, feldspar may be wanting, the result being quartz-muscovite rock, and finally, both muscovite and feldspar may be wanting, when quartz rock results. The typical method of transition into quartz rocks in this district is by diminution of the muscovite, which is analogous to the transition of alaskite into quartz rock by the diminution of feldspar, a change which has been observed in various districts, as at Silver Peak. Indeed, in all the phases of the Southern Klondike intrusion, an intimate relation between the muscovite and the feldspar (orthoclase) has been noted.

Origin of Muscovite.—In all the rocks there is some evidence of two generations of crystallization, the first having resulted in coarser crystals, the second in relatively fine ones. A given rock may be made up mostly of one generation or of the other, or both. The muscovite, like the quartz, occurs in these two generations. The coarse variety of muscovite is like that

[1] The Silver Peak geology is to be made the subject of a professional paper by the writer (published by the U. S. Geol. Surv.).

variety often called sericite. But the transitions between the two varieties are convincing as to their common origin. In the muscovite granite and in the alaskite, blades of the fine muscovite in feldspar frequently suggest a secondary origin; but in such cases it is probably essentially primary, since similar blades are also enclosed in the quartz of the same thin sections. The fine muscovite in feldspar therefore represents either earlier-crystallized fibres enclosed in later feldspar or the partial alteration of the feldspar to muscovite, before the final consolidation of the rock. That at least part of the fine included muscovite is actually secondary to the feldspar is shown by its distribution in zones parallel with the cleavages and with the margins of the crystals. In the quartz-muscovite rocks there are also often areas of fine muscovite and quartz, which are surmised to be due to the total alteration of original feldspars, but this fine muscovite is transitional in the same thin sections into the coarse muscovite typical of granites, and all have evidently been formed by the same processes.

The analyses of the quartz-muscovite rocks show that they have a chemical composition like that of many quartz-orthoclase rocks or alaskites, the place of the orthoclase of these rocks being typical of granites, and the finer grained phase resembles the taken by muscovite and quartz and having together practically the same chemical composition as the orthoclase.

The conclusion arrived at is that orthoclase has been attacked during consolidation, and partially altered to muscovite of varying degrees of coarseness. There is no reason to separate this secondary muscovite in nature and origin from true granitic muscovite.

The crystallizing agent was probably fluorine in the residual magma, for fluorine has been found to be necessary to the artificial production of mica,[1] and the analyses given above show the presence of fluorine in these rocks, undoubtedly contained in the muscovite. Analyses of muscovites from other districts typically show the presence of fluorine. The coarser muscovite of the rocks may also have been crystallized by the action of fluorine

[1] Doelter, "Chemische Mineralogie," p. 161.

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upon the orthoclase molecule in the magma. This supposition concurs with the suggestion of Bischof.[1]

According to this explanation, the orthoclase molecule in the original intrusive magma in this district has crystallized entirely as orthoclase where fluorine was scanty, and quartz-orthoclase rock or alaskite has resulted. In those portions of the intrusive mass where fluorine was abundant, the orthoclase molecule has crystallized entirely as muscovite, and the result is quartz-muscovite rock. Where, however, the albite molecule was present in the original magma, alaskite or muscovite granite has formed, since muscovite cannot be formed directly from the albite molecule, and the resulting rock in this case always contains feldspar. These conclusions connote the idea that muscovite-granite is a crystallization phase of an alaskite magma, and is to be classed with the alaskites rather than with the granites.

Relation to Other Districts.—The features of this district are analogous to those at Belmont, Nevada, about 70 miles north of the Southern Klondike. Here, as the writer has noted in a previous paper,[2] a granitic intrusion similar in nature to that at the Klondike has cut through Silurian limestone-slates and is attended by ore deposits. The Klondike rock is also like that long known in the Ural Mountains under the name of beresite, which, as the writer has pointed out, is likewise the equivalent of some of the rock of the Belmont intrusion. From the literature concerning the Russian beresite, and from the examination of specimens and thin sections, as well as the recollections of a personal visit, the writer believes that the nature and genesis of the Russian beresite is similar to that of the rock in these Nevada localities. More recently the writer has studied similar phenomena at Silver Peak, Nevada.

The rocks in all these localities are regarded as ultra-siliceous phases of granitic magmas having the chemical composition of alaskite. The presence of much water and mineralizers in the magma has permitted irregular segregation of the alkalies. Crystallization in the presence of a varying amount of fluorine has produced, from the quartz-orthoclase magma, either musco-

[1] "Chemische und Physikalische Geologie," Vol. 2, p. 744.
[2] *American Journal of Science*, Vol. X., Nov., 1900, p. 355.

vite granite, alaskite, or quartz-muscovite rock; and from the quartz-orthoclase-albite magma muscovite-granite or alaskite. Segregation of the quartz has produced quartz veins which are mineralogically transitional either from the alaskites or (in the presence of a considerable amount of fluorine at the time of their consolidation) from the chemical equivalents of the alaskites, the quartz-muscovite rocks.

The whole intrusive mass in the Klondike district then, as well as that at Belmont, is a beresite, like that in Russia, the name signifying the peculiar character of the rock as first described at Beresovsk. Chemically it is alaskite and mineralogically it is muscovite granite (more properly muscovite alaskite), alaskite, and quartz-muscovite rock. If a special name is necessary to denote the variety of granitic rocks, consisting essentially of quartz and muscovite, the name esmeraldite may be applied, derived from the name of the county in which the Klondike district lies.

The Origin of the Ores.—In all the above cases where these peculiar beresitic phenomena have been noted, ore deposits are genetically connected with the intrusions. The ore deposits appear to be due to the action of the same residual siliceous magmatic waters and gases which have played so important a part in the consolidation of the intrusive rock. These mineralizers have brought about concentration of metals, which were also residual from the principal and earlier-crystallized portion of the magma.

In the Klondike district, the pegmatitic quartz segregated in the midst of the granitic intrusion, indicates that the end product of crystallization was quartz, which was deposited by residual siliceous magmatic solutions. The more or less metalliferous veins of jasperoid and white quartz at and near the intrusive contact are part of the phenomena of the zone of contact metamorphism, and seem to be due also to the siliceous granitic solutions. The deposits of pyrite and hematite at the contact of the intrusive rock also represent a phase of the contact metamorphism, having probably been formed by residual solutions rising along the contact and depositing quartz, pyrite, and hematite, both in the granite and in the intruded limestone.

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