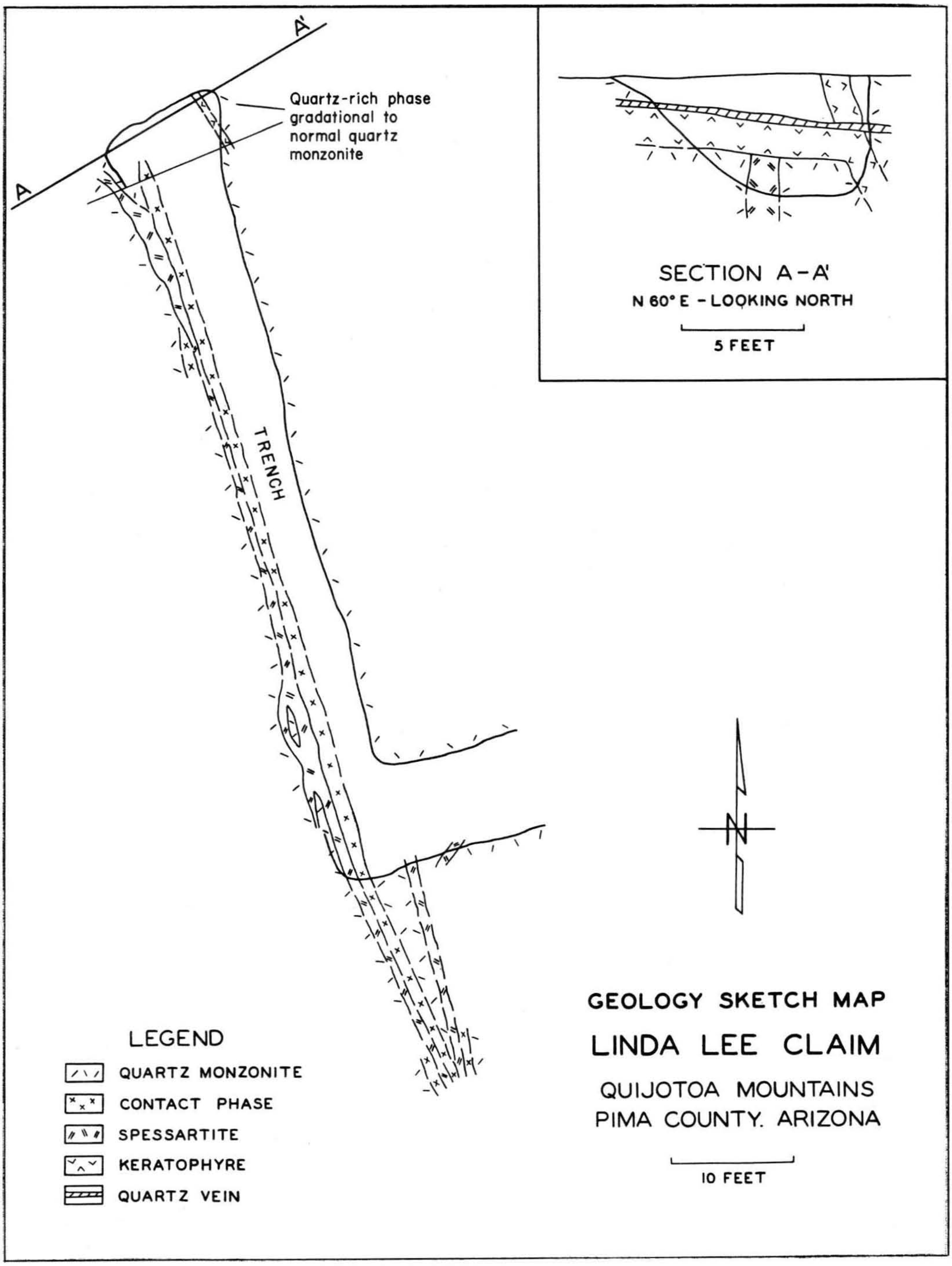

A
A'
Quartz-rich phase gradational to normal quartz monzonite
TRENCH
SECTION A-A'
N 60° E - LOOKING NORTH
5 FEET
N
LEGEND
QUARTZ MONZONITE
CONTACT PHASE
SPESSARTITE
KERATOPHYRE
QUARTZ VEIN
GEOLOGY SKETCH MAP
LINDA LEE CLAIM
QUIJOTOA MOUNTAINS
PIMA COUNTY. ARIZONA
10 FEET

A NEW OCCURRENCE OF ALLANITE IN THE QUIJOTOA MOUNTAINS, PIMA COUNTY, ARIZONA

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Allanite was discovered in the east flank of the Quijotoa Mountains, two miles south of Covered Wells, Pima County, Arizona, while prospecting for uranium in the early 1950's. The property was subsequently trenched but it proved to be of no economic significance.

The deposit occurs as a roughly north-south zone cutting through quartz monzonite. The north end of the deposit disappears in a spessartite intrusion which also cuts the quartz monzonite. The south end of the zone was not defined although it was traced for about two miles along the strike. Allanite is highly concentrated as disseminations and pods in the northernmost 100 yards of the zone.

The spessartite, which is well exposed in the north pit (see Geology Sketch Map), is a dense, green rock with megascopically visible grains of yellow sphene. In thin section, early euhedral actinolite crystals are seen in a groundmass of later andesine. The early actinolites are pseudomorphically replaced by single epidote crystals which, in turn, are often replaced by a second generation of small to microlitic actinolites. Sphene and apatite are the only accessories. The mode of this dike is shown in Table I (W131-814).

Allanite-bearing zones, which shall be referred to as the contact phase, have sharp contacts with the dike and with the quarts monzonite wallrock.

The mineral assemblage of the contact phase is very distinctive. Allanite occurs as anhedral crystals up to 3 cm. in length or as zoned cores of epidote crystals. The allanite exhibits strong dispersion of the optic axes ($r > v$) and intense but variable pleochroism. The pleochroic formula is as follows: X is greenish-grey or pink; Y is red or greenish-black; and Z is yellow-brown to almost colorless. The optic sign is negative and 2V is about 25^{o}. Allanite occurs in the contact phase in amounts varying from 2 to 40%. Other minerals may be present in the contact phase in amounts varying within the following limits: quartz 1/2 to 3%, tremolite 2 to 40%, apatite 1 to 65%, calcite 0 to 75%, actinolite 2 to 95%, epidote 0 to 40%, sphene 0 to 1%, and leucoxene, rutile, zircon, clinochlore, sericite, albite An_O, and oligoclase in traces. Uranophane has been observed as fracture coatings. An estimated mode of the contact phase is shown in Table 1 (W131-620).

The paragenesis of the contact phase is clear cut. Apatite is early and euhedral; it forms crystals up to 10 cm. in length. Later quartz may fill interstices between apatites. The quartz is sometimes partly replaced by actinolite although some actinolite is earlier and essentially contemporaneous with apatite. Epidote, including allanite, may be earlier than apatite but is is usually later than both apatite and actinolite. Sphene is late and calcite is the latest. Calcite occurs as veinlets which cut across all other features. If feldspar is present it is usually albite although oligoclase has been noted.

The quartz monzonite near the contact phase is extensively altered. The pyrogenic potash feldspar seen in unaltered samples is lacking and the oligoclase is albitized. The mode of the altered wallrock is shown in Table 1 (W131-625). The calcium released by the alteration is present as epidote but the constituents of epidote have probably in part migrated from the wallrock and some of the calcium has probably reacted with soda carried in the pyrogenic potash feldspars to form more albite.

Sphene in the wallrock has partially replaced rutile. The rutile has in turn replaced an opaque mineral which may be davidite. This is of interest since davidite has been described from the nearby Pandora Prospect by A. Pabst and R. W. Thomssen (1).

Locally a quartz-rich phase has developed in the quartz monzonite wallrock. It shows roughly the same sequence of crystallization as the contact phase. In this rock, however, sphene is especially abundant and epidote appears to have been introduced. This rock is modally described in Table 1 (W131-813).

A spessartite intrustion several hundred feet to the north of the pit is a coarser grained equivalent of the spessartite dike although some interesting differences do exist. Andesine is present and epidote occurs as single crystal pseudomorphs after actinolite. However, quartz is present as a late crystallization product which has reacted with the andesine to form myrmekite. The mode of this rock is shown in Table 1 (W131-812).

Orthoclase and some late albite occur with quartz as a late granophyric product in the spessartite. This late keratophyric stage is of interest since a late keratophyre dike system cuts all other units at the north end of the pit (see Geology Sketch Map).

The keratophyre is reddish in color and is a soft, altered rock. The feldspars are albite and orthoclase which are present in equal amounts. Both are subhedral to anhedral and are of uniform size. Crystallization of the two types is probably roughly contemporaneous. The albite is especially rich in disseminated hematite which is responsible for the red color of the rock. Clinochlore is present in small amounts as an alteration product of the mafites. Sericite is an abundant alteration product of the feldspars.

The keratophyre probably represents a late granophyric stage in the history of the spessartite intrusion. An associated quartz vein lies above the keratophyre and is everywhere associated with it. This may indicate that the keratophyre represents an unmixed oxykeratophyre (quartz-keratophyre) with the late quartz phase introduced into the wallrock last.

Control of the formation of the contact phase is probably structural. Other bands of epidote-actinolite assemblages occur in the quartz monzonite in a rectilinear pattern which suggests their formation along fractures. Some minor offsets of the contact phase were also noted. These are post mineralization as evidenced by the granulation of the minerals.

The analyses given in Table 2 indicate that the quartz-rich phase developed in the quartz monzonite wallrock in the vicinity of the contact phase has lost nearly all of its original Al_20_3, Na_20, and Fe_20_3. Since these elements are nowhere abundant in the area it must be assumed that they have travelled down a gradient away from the contact phase.

The contact phase shows an enrichment in CaO, P_20_5, CO_2, and H_2O with a sympathetic reduction in silica. Much of the CaO present has been derived from the albitization of the oligoclase in the quartz monzonite wallrock. Most of the phosphorus has apparently been introduced from another source at an early state. However, it seems likely that apatite in the silica-rich phase of the quartz monzonite may have been concentrated by a redistribution of accessory apatite in the quartz monzonite. There is no evidence that either water or CO_2 have been derived from the quartz monzonite. It seems likely that these two components are late residual accumulations of the spessartite intrusion but that their accumulation in the site of the contact phase is earlier than the intrusion of the spessartite dike. This idea is supported by the fact that the intrusion of spessartite is more altered than the spessartite dike.

The spessartite dike shows sharp contacts with the contact phase but it is locally gradational to the quartz monzonite. This evidence, coupled with that given previously, indicates that the contact phase is not a segregation of the spessartite dike but that it was brought into existance prior to the intrusion of the dike. Thus a sequence of events can be deduced, beginning with the intrusion of the spessartite and associated fracturing of the quartz monzonite host. A ready exchange of materials occurred in some fractures with the necessary heat and volatiles supplied by the spessartite intrusion. The result of this material transfer was the contact phase. The contact phase was then intruded by a dike of spessartite and last in the sequence was the intrusion of the keratophyre and associated quartz.

It is worthy of note that in other areas along the trend of the contact phase, where no allanite is present, apatite and actinolite are ubiquitous. In some cases tourmaline is present in large amounts, suggesting that the dike is not directly responsible for the mineralization.

The presence of the keratophyre is of interest since it indicates that the spessartite was large enough and had a long enough history to expel a quartz keratophyre which in turn separated into quartz and a normal keratophyre. These seem to be conditions favorable to the concentration of elements which would normally occur as minute traces in a dioritic magma.

A few hundred yards south of the area on the map a small shaft is located on a radioactive sulfide-oxide assemblage. Thin sections of this assemblage show large euhedral apatites surrounded by later subhedra of allanite. Some allanite fills cracks in apatite crystals. Magnetite is later than allanite and pyrite is last. The pyrite occurs as anhedral disseminations. Secondary gypsum, metatorbernite, and jarosite have formed at the expense of these minerals.

The writer wishes to acknowledge the aid and encouragement given him by Richard W. Thomssen throughout this study. The writer is also indebted to Professor John W. Anthony for reading the manuscript and to Mr. Milt Graf for giving permission to examine the property.

REFERENCES

A. Pabst and R. W. Thomssen, Davidite from the Quijotoa Mountains, Pima County, Arizona, (Abstract), Official Program, G. S. A. Cordilleran Section, Fifty-Fifth Annual Meeting, 1959.

Table 1

Modes of rocks described as determined with the integrating stage of Hunt and Wentworth (three traverses per thin section)

	W131-620 Contact Phase	W131-814 Spessartite Dike	W131-812 Spessartite Intrusion	W131-813 Quartz Phase	W131-625 Albitized Wallrock
Quartz	1.28	-	5.16	69.81	28.82
Allanite	12.54	-	-	-	-
Actinolite	31.57	25.52	7.05	21.83	11.09
Tremolite	12.28	-	-	-	-
Epidote	3.92	47.62	19.11	3.85	6.13
Sphene	tr	-	-	1.03	1.39
Andesine*	-	24.60	49.17	-	-
Albite*	-	-	-	-	25.11
Oligoclase*	-	-	-	-	28.07
Apatite	22.23	.67	-	3.87	-
Clinochlore	-	-	19.51	-	-
Calcite	16.20	-	-	-	-

* Andesine An_{40}

Albite An_{0}

Oligoclase An_{20}

Table 2

Analyses derived from the modal analyses of Figure 1

	W131-620 Contact Phase	W131-814 Spessartite Dike	W131-812 Spessartite Intrusion	W131-813 Quartz Phase	W131-625 Albitized Wallrock
SiO_2	29.63	45.10	49.72	83.19	72.51
Al_2O_3	1.67	14.08	19.61	0.59	12.13
Na_2O	-	1.70	3.40	-	5.63
CaO	28.94	16.86	9.31	6.01	4.37
FeO	7.01	4.45	6.75	3.73	1.93
MgO	7.41	3.53	4.07	2.96	1.53
Fe_2O_3	2.62	11.46	4.60	0.93	1.48
Ce_2O_3	3.45	-	-	-	-
P_2O_5	10.18	.32	-	1.77	-
CO_2	7.13	-	-	-	-
H_2O	1.16	1.14	1.78	0.89	0.20
TiO_2	-	0.65	-	0.42	0.57
total	99.20	99.29	99.24	100.49	100.35

Note: These analyses are derived from the modes by assuming a certain composition for each of the constituent minerals. Epidote and actinolite were checked for iron content by optical methods. All rare earths in allanite are reported as ceria.