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THE CHIEF LITHIUM PEGMATITE, DEVILS HOLE, FREMONT COUNTY, COLORADO[1]

E. WM. HEINRICH AND RICHARD W. VIAN, *Department of Geology and Mineralogy, The University of Michigan, Ann Arbor, Michigan*

ABSTRACT

The chief pegmatite, near Texas Creek, Fremont County, Colorado, is the sole Li pegmatite in a large dike swarm. The cleavelanditic bodies, one of which carries lepidolite, are fracture-controlled replacement units localized in the thick lower "tail" of the dike which strikes at right angles to the rest of the pegmatite. The accessory mineral assemblage (apatite, beryl, Bi-carbonate, columbite, lepidolite, rose muscovite, spessartite, topaz, colored tourmalines, zinnwaldite) shows striking and close similarities to those of the Brown Derby pegmatite of Colorado and the Harding and Pidlite pegmatites in New Mexico. The Brown Derby and Harding dikes are of the same age, and it is suggested that the Chief and Pidlite pegmatites also are part of the same petrologic province on the basis of their accessory mineral and elemental assemblages.

INTRODUCTION

The chief pegmatite is in the SE. ¼, Sec. 17, T. 18 S., R. 73 W., approximately one airline mile north of the well-known Devils Hole (Zingheim) pegmatite (Hanley *et al.*, 1950). The deposit lies approximately five miles north of the post office of Texas Creek, which is on the south side of the Arkansas River, about 26 miles west of Canon City. Texas Creek, a station on the Denver and Rio Grande Western Railroad, is on U. S. Highway 50. From Texas Creek a steep dirt road extends generally northwardly for about six miles across a divide on into the Devils Hole, a conspicuous topographic basin. The deposit lies on the northern side of Antelope Gulch, about ¼ mile west of the junction between Antelope and East Gulches (Fig. 1).

The pegmatite, which is on several of a group of five claims (Chief Nos. 1–5), was located by P. A. Weatherson and Sidney G. McClue on June 11, 1957. The early history of the deposit is not well-known. Apparently it was worked for feldspar in the early or middle 1950's. During that time some feldspar was sold to the feldspar mill of the International Minerals and Chemicals Corporation in Canon City, Colorado. However, lithium minerals were rumored to have been found in this area as early as 1956. The Chief pegmatite was explored for lithium and beryllium in the late 1950's by William McClelland.

The deposit was first examined by Heinrich in 1959 and mapped by him in 1960. It was restudied by Vian in 1962 as part of his general investigation of the geology of the area (Vian, 1965).

[1] Contribution No. 265, Mineralogical Laboratory, The University of Michigan, Ann Arbor, Michigan.

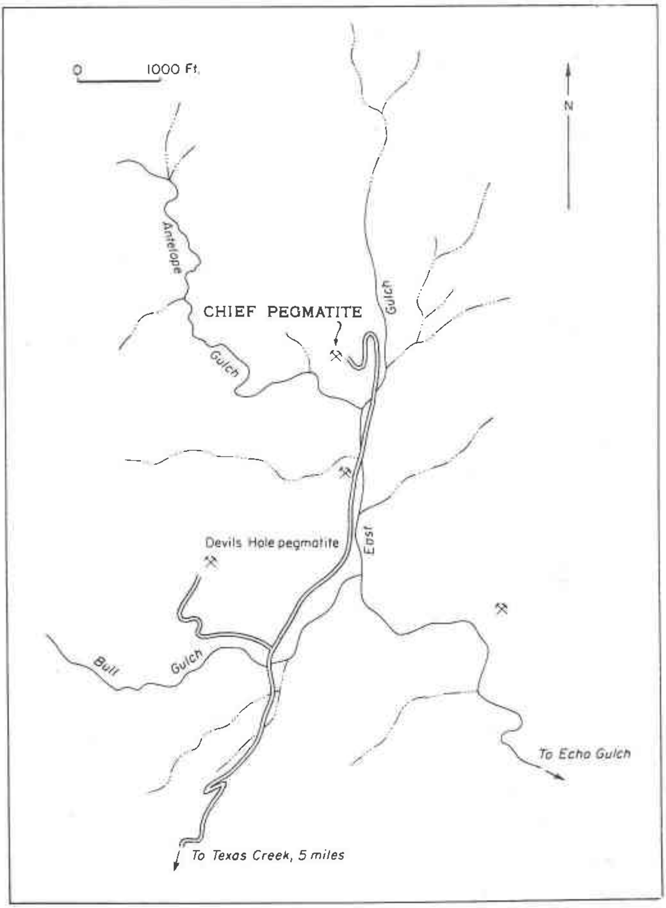

FIG. 1. Index map of the Devils Hole area, showing location of the Chief pegmatite.

General Geology

In the vicinity of the pegmatite the country rocks are gneisses and schists of the Idaho Springs formation: hornblende gneiss, calc-silicate gneiss, cordierite gneiss, quartzite and muscovitized nodular sillimanite gneiss. Their foliation strikes generally north to northeast and dips southeastward (Vian, 1965). Numerous granitic pegmatites, some of considerable size, crop out on the valley sides of Devils Hole. The most important commercially, and the most interesting mineralogically, has been the Devils Hole deposit (Hanley *et al.*, 1950), long famous for its rose quartz and for many years an important source of microcline and beryl and lesser amounts of other pegmatite minerals. It is presently being quarried for rose quartz. Most of the large pegmatites are very irregular in shape, with a general northeasterly trend. They appear to be related to a body of Pikes Peak granite that lies several miles to the southwest of Devils Hole (Vian, 1965). The north wall of Devils Hole is capped by a series of Tertiary volcanic rocks which extend from the widespread South Park volcanic field down to the north rim of the Arkansas River Valley.

THE CHIEF PEGMATITE

General. The Chief pegmatite has been explored by means of two open cuts. The eastern cut, from which the feldspar was mined, is approximately 100 feet long with a generally east-west axis, about 25 feet across, and as much as 35 feet deep at the face. The western cut, in which the lithium pegmatite is exposed, is about 25 feet across and has a maximum depth of about 12 feet (Fig. 2). There are, in addition, several small prospect pits and trenches.

The entire pegmatite is much larger than the part that has been mapped. The mapped section is the thick, arcuate, western end of a generally northeasterly trending dike (Fig. 2). Beyond the mapped area to the northeast the pegmatite continues for at least another 300 feet, but is neither commercially nor mineralogically interesting.

The mapped part of the pegmatite, which is the thickest section of the dike and the only part that is distinctly zoned, has the form of a letter "C", open to the south (Fig. 2). The eastern half of this arcuate segment trends south of east and dips northeast (*i.e.*, into the slope of the hill) at moderate angles. The western "tail" trends at right angles to this quarried part, striking just east of north and dipping generally westward. East of the area mapped the dike strikes northeast, dips moderately northwest and is not zoned.

Internal structure. Within the pegmatite, five main rock types are represented (Fig. 2):

1. Wall zone rock which consists of fine-to-medium-grained pegmatite containing quartz, microcline, plagioclase, muscovite and minor amounts of biotite, garnet and tourmaline.
2. Quartz-feldspar core. This is exposed only in the eastern cut and represents the feldspar ore body previously mined.
3. Irregular small units of black tourmaline and muscovite. Some of the tourmaline crystals are several inches across and some of the books of muscovite are as much as $1\frac{1}{2}$ feet across. This unit, which is exposed only in the eastern cut, is too small and too irregular to be shown on the scale of the map (Fig. 2).
4. Cleavelandite-tourmaline rock
5. Cleavelandite-lepidolite rock

Units 4 and 5 are found only in the western "tail" of the pegmatite, and Unit 5 is exposed chiefly in and near the western open cut.

The cleavelandite-rich units grade into each other and show diffuse and

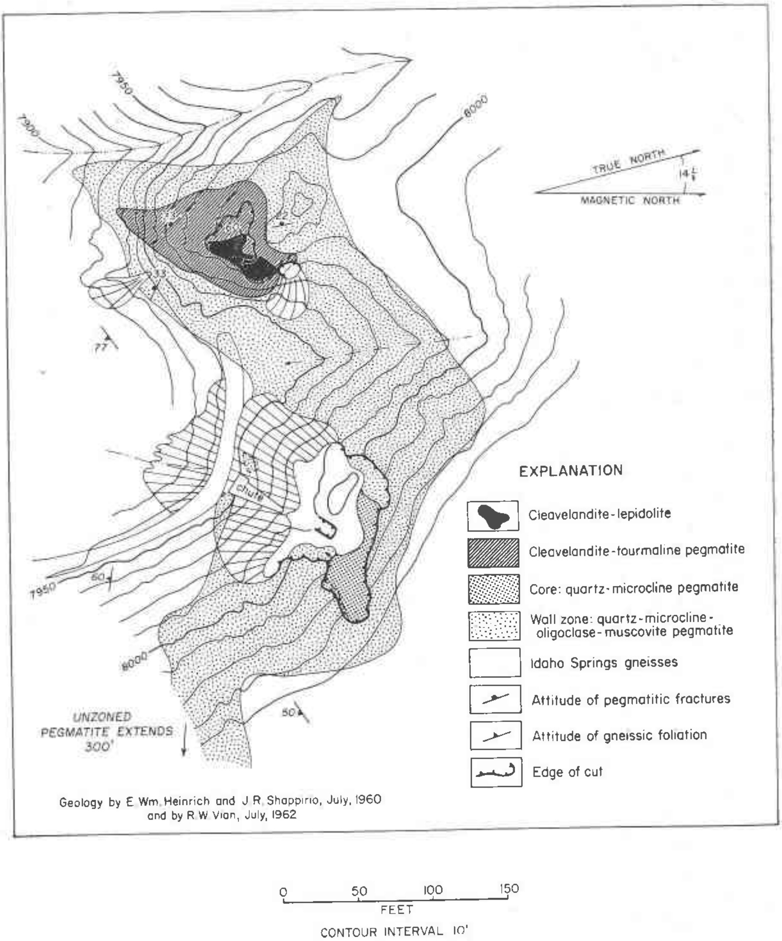

FIG. 2. Geologic map of the Chief pegmatite, Devils Hole, Colorado.

gradational contacts with wall-zone rock. In the marginal parts of the cleavelandite-tourmaline unit corroded microcline remnants are common. It is noteworthy, however, that the albitization is not localized along a zone contact, as is so commonly the case in albitized pegmatites of some other districts (see, for example, Heinrich, 1948B; Jahns, 1946).

Within the westward dipping "tail" of the pegmatite there is developed a conspicuous planar structure consisting of a series of parallel fractures that also strike northerly and dip westward. Such fractures are absent elsewhere in the dike. The cleavelandite units are believed to have been formed as replacement units of wall-zone pegmatite, localized along this multiple fracture system.

Mineralogy

Wall zone. Most of the wall zone consists of anhedral granular microcline, quartz, and subordinate sodic plagioclase. Books of muscovite several inches across are clustered in some places. Some of these include needles of schorl. Locally the rock is peppered with rounded spessartite grains, as much as ½ inch in diameter, set in a conspicuous dark halo. This halo consists of a rim of granular blue tourmaline and a fine-grained flaky aggregate of a bronze mica which optical and chemical tests indicate is zinnwaldite ($\gamma = 1.564 - 1.570 \pm 0.002$). No lepidolite appears in the wall zone other than a very narrow outer rim overgrown on some of the larger muscovite books.

Cleavelandite-tourmaline pegmatite. The larger of the two cleavelandite-rich units contains chiefly cleavelandite, quartz, microcline, muscovite, black tourmaline and green tourmaline. Green tourmaline, which is very abundant locally, appears as:

1. Rims and outer shells on schorl crystals
2. Slender prisms, 6 inches or less in length, or prismatic clusters
3. Veinlets of very fine anhedral grains (called "epidote" locally)

The microcline and muscovite and much of the quartz are relict from wall-zone rock.

Cleavelandite-lepidolite pegmatite. Within the cleavelandite-tourmaline unit, near its northeastern corner, is a small, irregular, tabular mass which, at this spot, appears to underlie the main body of cleavelandite-tourmaline pegmatite, although to the south, cleavelandite-tourmaline rock appears beneath it. Thus originally it was probably enclosed in cleavelandite-tourmaline pegmatite.

This body measures 55 by 20 ft in plan. It is as much as 15 feet thick at its northern end but is very poorly exposed along the south side of the western cut. It appears to dip about 60° to the west, and its long axis may plunge at a somewhat more shallow angle to the southwest.

Within it are exposed two distinctly different types of pegmatite. The upper part of the exposure, which forms a very pronounced erosional knob, consists almost entirely of cleavelandite and flakes of lepidolite that range in diameter from ¼ to 1 inch, the mica being rather uniformly distributed through the cleavelandite. Beneath this rock the unit consists chiefly of cleavelandite with scattered larger books of lepidolite, a few of which are as much as 10 inches across, although most measure 2 to 6 inches.

The two lepidolites compare as follows:

	γ	Li_2O
Flakes, ¼–1″	1.561±0.002	2.4%
Coarse, thick books	1.560±0.002	5.3%

Other minerals present as accessories in the cleavelandite-lepidolite unit are:

beryl, a few scattered prisms, very pale blue, up to 3 inches long;
topaz, white to pale buff (subhedra up to 6 inches long) rimmed by a film of fine-grained rose *muscovite;*
apatite, pale blue to gray, anhedral masses several inches or less across;
columbite, thin plates as large as ¼×½ inch, and
bismuth carbonate (bismutite?), interstitial patches a fraction of an inch long.

Paragenetic note. Both the micas and the tourmalines appear in several species and varieties, which may be paired paragenetically as follows:

	Position	Mica	Tourmaline
Oldest	1. Wall zone (rare)	biotite	—
	1. Wall zone	muscovite	schorl
	2. Wall zone, altered	zinnwaldite	blue tourmaline
	3a. Cleavelandite tourmaline unit	—	green tourmaline
	b. Cleavelandite lepidolite unit	lepidolite (flakes)	—
↓	c. do.	lepidolite (books)	—
Youngest	4. do. , altered	rose muscovite	—

Lithium concentration. In the Montgary pegmatite of Manitoba, Wright (1963) has shown that lithium has been concentrated toward the hanging wall and up the dip of the pegmatite. In the Chief pegmatite lithium mineralization is restricted to the *lowest* part of the pegmatite, close to its keel. The lithium is confined:

1. To the thickest section of the dike
2. To that part of the thickest section that lies at right angles to the main trend of the dike
3. To the strongly fractured part of this "tail."

Other Lithium Pegmatites of the Region

Lithium pegmatites are rare in Colorado, indeed in the entire Rocky Mountain belt from Montana through New Mexico. The mineral assemblages of the lithium pegmatites of Colorado and New Mexico are compared in Table 1 (see also Fig. 3). There are striking similarities among those of the Brown Derby group, of the Harding, of the Pidlite. and of the Chief. The similarity of the Chief assemblage with that of the Brown Derby is further emphasized by the occurrence of one of their lepidolites in large, thick books—an unusual form for this species. These similarities also have been noted by Jahns (1953). These assemblages differ markedly from that of the Meyers Quarry. Moreover, the Chief lithium assemblage is totally different from that of any other pegmatite in the Devils Hole and in all the pegmatite districts of Colorado east of the Continental Divide (Heinrich, 1948A, B, 1957).

The lithium pegmatites of Table 1 (except the Meyers Quarry) have albitic replacement units that are mineralogically and geochemically similar, being characterized by the elements: B, Be, Bi, F, Li, Mn, Nb and P. It is interesting to speculate if these similarities arise from a fundamental relationship such as magmatic consanguinity or origin or whether

Table 1. Comparison of the Accessory Mineral Assemblages of Colorado and New Mexico Lithium Pegmatites

	Chief	Brown Derby	Meyers Quarry	Harding	Pidlite
amblygonite	—	—	X	—	—
apatite	X	X	—	X	X
beryl	X	X	X	X	X
bi-carbonate	X	X	—	X	X
columbite	X	X	—	X	X
fluorite	—	X	—	X	X
gahnite	—	X	—	X	X
lepidolite	X	X	X	—	—
magnetite	X	X	—	X	X
microlite	—	X	—	X	X
monazite	—	X	—	X	X
rose muscovite	X	X	—	X	X
spessartite	X	X	—	X	X
spodumene	—	—	—	X	X
sulfides	—	—	—	X	X
topaz	X	X	—	X	X
tourmalines					
schorl	X	X	—	X	X
blue	X	X	X	—	—
green	X	X	X	—	—
elbaite	—	X	X	—	X
zinnwaldite	X	X	—	—	—

Others: Harding, lithiophilite; Pidlite, cyrtolite; Brown Derby, stibiotantalite, euxenite

References: *Brown Derby*, Hanley *et al.* (1950), Heinrich and Levinson (1953), Staatz and Trites (1955), Heinrich (1960)
Meyers Quarry, Heinrich (1948B)
Harding, Jahns (1953)
Pidlite, Jahns (1953)

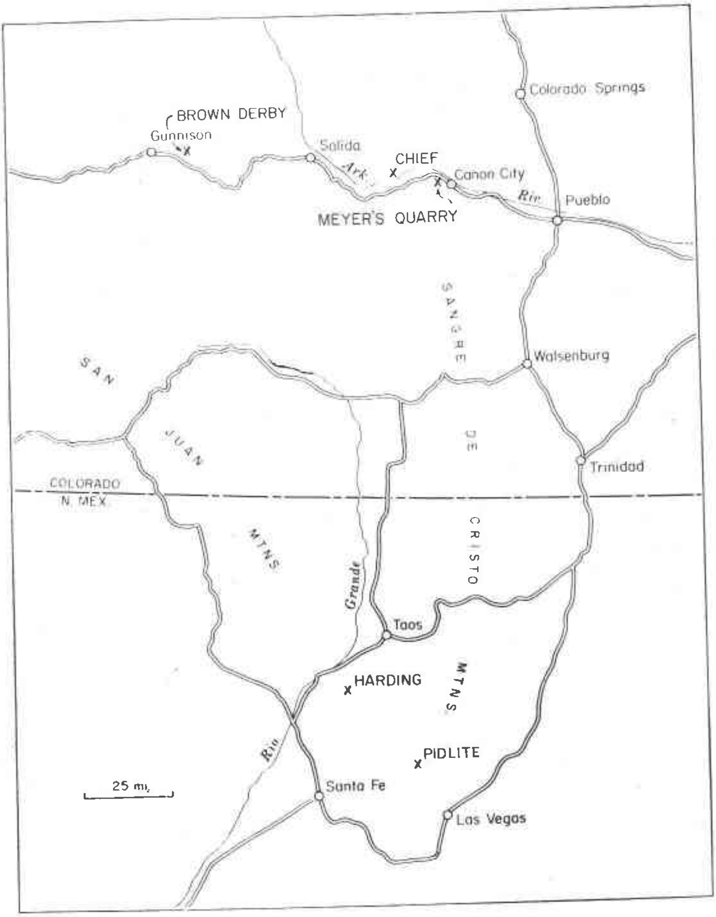

FIG. 3. Index map of southern Colorado and northern New Mexico, showing location of Li pegmatites.

it is entirely fortuitous that these characteristic mineralogical and elemental assemblages have appeared within a large region at just a few such widely separated deposits (Fig. 3). A relationship in age is certainly indicated by the work of Aldrich *et al.* (1958), whose results by the K-A method are:

Brown Derby,	lepidolite	1300 my
Harding,	muscovite c	1250
	muscovite d	1260

Age determinations on Chief and Pidlite micas would be very desirable. Furthermore, these investigators obtained age determinations on 12 granites and pegmatites in Arizona, New Mexico, Colorado and Wyoming " . . . the value of whose ages is close to 1350 my." They conclude (Aldrich *et al.*, 1958, p. 1130) that "The close agreement of these ages is believed to be an indication of some large scale process of granitic rock formation which occurred 1300 to 1400 my ago, one which has not been eradicated by any subsequent geological event such as the Laramide orogeny. Before these measurements there was no basis for associating these rocks." It is a thesis of this study that mineralogical and geochemical assemblages of derivative pegmatites *do* afford such a basis.

Acknowledgements

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