Diamond-drilling Exploration of the Beecher No. 3–Black Diamond Pegmatite Custer County, South Dakota

GEOLOGICAL SURVEY BULLETIN 1162-E

Diamond-drilling Exploration of the Beecher No. 3–Black Diamond Pegmatite Custer County, South Dakota

By J. A. REDDEN

CONTRIBUTIONS TO ECONOMIC GEOLOGY

GEOLOGICAL SURVEY BULLETIN 1162-E

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1963

UNITED STATES DEPARTMENT OF THE INTERIOR

STEWART L. UDALL, *Secretary*

GEOLOGICAL SURVEY

Thomas B. Nolan, *Director*

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington 25, D.C.

CONTENTS

ILLUSTRATION

TABLE

CONTRIBUTIONS TO ECONOMIC GEOLOGY

DIAMOND-DRILLING EXPLORATION OF THE BEECHER NO. 3–BLACK DIAMOND PEGMATITE, CUSTER COUNTY, SOUTH DAKOTA

By J. A. REDDEN

ABSTRACT

Diamond-drilling at the Beecher No. 3–Black Diamond pegmatite, Custer County, S. Dak., has provided information that modifies and supplements findings reported previously (Redden, 1959). Two zones not exposed at the surface were found during the drilling: a quartz-albite-perthite-muscovite-pegmatite zone and a quartz-albite-perthite-spodumene pegmatite zone. Previous concepts of the structure near the surface require no significant change, but the new data make possible a greatly improved interpretation of the structure at depth. The most notable change is the recognition of a narrow constriction in the pegmatite at a depth of 60 to 100 feet.

The drilling results are not encouraging in an economic sense. The beryl-rich deposit exposed at the surface was not recognized in the drill core, but the quartz-albite-perthite-muscovite pegmatite zone is the most favorable for further exploration. The known beryl deposits are all above the newly discovered constriction and along a low-plunging roll on the east side of the deposit. Some zones containing spodumene were cored, but they are either low in grade or altered and iron stained.

INTRODUCTION

A report on the Beecher No. 3—Black Diamond pegmatite, Custer County, S. Dak., including a map and inferred cross sections, was published in 1959 (Redden, 1959). In the fall of 1960, the pegmatite was core-drilled by the Lithium Corp. of America under Office of Minerals Exploration contract 6,083. This core-drilling provided a partial test of the previously interpreted structure and the inferred distribution of beryl; it also supplied added detail on the subsurface character of the deposit.

Six BX core holes, totaling 1,740.9 feet, were drilled in the deposit. One split of each core was logged by the writer (table 1), although the first part of the core from hole 2 was unfortunately ground to a minus 0.5 inch and the textures destroyed before it was examined.

Core recovery in pegmatite was generally good. The drill core of the country rock was not available for logging.

These data permit the construction of new cross sections of the pegmatite, as shown in plate 1.

The writer wishes to thank the Lithium Corp., of America and its representatives, especially J. N. McClure and F. F. Clarke, for permission to publish the results of this work and to examine chemical assays.

DESCRIPTION OF PEGMATITE UNITS

At the surface, the Beecher No. 3—Black Diamond pegmatite contains five distinguishable zones (Redden, 1959, p. 543–548). From the contact inward they are (1) quartz-muscovite-albite pegmatite (border zone), (2) albite-quartz-muscovite pegmatite (wall zone), (3) quartz-albite-muscovite-perthite-beryl pegmatite, (4) perthite-quartz-albite pegmatite, and (5) perthite-quartz pegmatite. Accessory minerals include beryl, tourmaline, spodumene, and apatite. In general, the muscovite content decreases and perthite increases inward from the contact. Zone 3 is discontinuous, and zone 5 occurs only in the thickest parts of the pegmatite. Fracture fillings containing spodumene and quartz cut across all zones. Details of the mineral character and distribution of these zones, and the general geologic setting of the pegmatite, are included in the published account (Redden, 1959).

All zones except zone 3 were cut by one or more of the drill holes (table 1). In addition, two new zones were noted. One of these, which apparently is the downward extension of zone 3 consists of quartz-albite-perthite-muscovite pegmatite; the other, which lies in the center of the pegmatite body consists of quartz-albite-perthite-spodumene pegmatite. The distribution of all zones, and their inferred relation to the surface exposures, are shown in the cross sections.

Zone 1 (border zone) was recognized in cores from holes 1, 3, and 4. At the surface it occurs along most contacts between pegmatite and country rock, but it is absent at about half of the subsurface contacts. The zone is normally 0.1 to 0.2 foot thick, and because it is so narrow, it is combined with zone 2 in some of the logs (table 1). The chief minerals are quartz, muscovite, and albite.

Zone 2 (wall zone), cut by all six drill holes, ranges in thickness from 1 to 7 feet. The mineral character is similar to that at the surface. The zone consists dominantly of albite and quartz, which occur in nearly equal amounts, and it also carries about 10 percent muscovite. In holes 4, 5, and 6, the wall zone (as well as parts of adjacent inner zones) has as much as 10 to 15 percent of arsenopyrite(?) in veinlets or disseminated throughout the core.

TABLE 1.—*Diamond-drill logs, Black Diamond pegmatite*

[Tr, trace]

Interval (feet)	Zone	Mode (percent)				Other minerals		Additional data
		Quartz	Perthite	Albite	Muscovite			
Hole 1								
							Volume percent	
0–50.0								Overburden and schist. No core.
50.0–245.1								Country rock. Not logged.
245.1–245.2	1	45		45	10			Grain size less than 0.1 in.
245.2–252.0	2	30	Tr	62	8	Blue phosphate at 251 ft.		Grain size about 0.5 in.
252.0–267.7	3a	40	5	50	5	Beryl Spodumene Apatite Tourmaline	Tr	Muscovite is in 0.5-in. books except at 266 ft where books are larger than 2 in. Fresh and altered spodumene is in crystals 1 in. long. One sq in. of white beryl at 262 ft. Arsenopyrite(?) is present along fractures.
267.7–279.0	4	25	50	25	Tr	Spodumene	Tr	Perthite crystals as much as 3 ft long. Quartz and albite average 0.8 in. grain size.
279.0–295.0	4	40	7	50	3	Spodumene Apatite Tourmaline Beryl	Tr	Some of albite is sugary textured. Log of other core split reports a ⅜-in. crystal of beryl at 290 ft.
295.0–310.5	6	70	15	5	5	Spodumene Unidentified phosphate mineral.	5 Tr	Perthite is only slightly perthitic and could more aptly be called microcline. Fresh and altered spodumene crystals as much as 2.4 in. long. Part of albite is sugary textured.
310.5–329.0	4	35	7	55	3	Spodumene Tourmaline	Tr	Most of interval is fine grained.
329.0–331.6	4	20	60	20				Medium grained. Perthite is graphically intergrown with quartz.
331.6–333.1	2	30		60	10			Fine grained. Thin border zone at end. Schist contact is at 25° to core.
333.1–387.0								Mica shist. Not logged. Hole end 387.0 ft.

TABLE 1.—*Diamond-drill logs, Black Diamond pegmatite*—Continued

Interval (feet)	Zone	Mode (percent)				Other minerals		Additional data
		Quartz	Perthite	Albite	Muscovite			
Hole 2								
							Volume percent	
0–50.0								Overburden and schist. No core.
50.0–104.0								Country rock. Not logged.
104.0–110.5	2	40		50	10	Tourmaline	Tr	Core ground to minus ½ in. before logging. Very poor core recovery.
110.5–127.0	3a	40	5	50	5	Tourmaline	Tr	Core ground as in 104–110 ft. interval. Mineral character resembles that in surface exposures of zone 4 in southeast part of pegmatite except core has more muscovite and less perthite. Core recovery, 50 percent.
127.0–128.0	3a	65	5		30			Core ground as above. Possibly represents outer part of a fracture filling.
128.0–131.6	[1] FF(?)	60		30		Spodumene	10	Core ground as above.
131.6–150.0	3a	30	5	60	5			Core ground as above.
150.0–155.5	3a(?)	10	80	10				Core ground as above.
155.5–156.6	2	30		65	5			Core ground as above.
156.6–157.7								Altered country rock.
157.7–161.0	2	25		70	5			Core ground as above.
161.0–162.0	FF(?)	50		30		Spodumene	20	Core ground as above. Presumably a fracture filling.
162.0–190.0	3a(?)	30		65	5	Beryl Spodumene Tourmaline	Tr	Fine grained. Two beryl crystals, with 1 sq in. area each, occur at 173.7 and 173.9 ft. Small rounded grain of beryl between 183 and 186 ft where core recovery is only 50 percent.
190.0–196.0	6(?)	50(?)		25(?)		Spodumene	25	Very poor core recovery. Spodumene is fine grained. Could be a fracture filling.
196.0–216	3a	25		65	8	Tourmaline Apatite Spodumene Garnet	Tr	Fine grained. Gneissose structure in some of core. Core brecciated near 209 ft. Only 5-percent recovery between 209.5–216.0 ft.
216.0–225.0	6(?)	40		25	10	Spodumene Beryl	15 Tr	Spodumene both fresh and altered. Only 66-percent core recovery. Presumably spodumene ground up and lost. One beryl crystal measuring 1.5 by 2 in. at 225 ft. Could be a series of spodumene-bearing fracture fillings.
225.0–234.0	3a(?)	40		20	40			Fine to medium grained.
234.0–236.6	2	15		65	15	Tourmaline	5	Fine grained. A muscovite-rich border zone 2.4 in. thick at end. Schist contact is at 63° to core.
236.6–239.0								Schist country rock.
239.0–240.1	2							Pegmatite. Same as 234–236.6 interval. No contact angles available.
240.1–241.1								Schist country rock.
241.1–241.8								Pegmatite. Same as 234–236.6 interval.
241.8–255.0								Schist country rock. Hole ends 255.0 ft.

Hole 3

0–104.6								Country rock. Not logged.
104.6–105.0	1	65			35			Average grain size about 0.1 in. Schist contact is at 80° to core.
105.0–110.9	2	55		30	15			Muscovite books as much as 2 in. in diameter.
110.9–111.1	1	40		40	20			Very fine grained. Schist contact is at 79° to core.
111.1–123.9								*Country rock.* Not logged.
123.9–124.0	1	60			40			Schist contact is at 80° to core.
124.0–129.0	2	50		40	10			Average grain size is less than 1 in. Muscovite books are as much as 3 in. in diameter.
129.0–132.3	3a	40		40	20			
132.3–141.1	5	15	80		5			
141.1–142.6	[1] FF(?)			95(?)		Spodumene	5(?)	Probably a fracture-filling unit. Albite is sugary. Low core recovery.
142.6–186.9	5	10	85	5		Tourmaline	Tr	The hole was in the same crystal of perthite for at least 15 ft. and perhaps 30 ft.
186.9–187.7	2	35	30	35				Border zone not recovered.
187.7–206.6								Country rock. Not logged.

Hole 4

0–75.0								Overburden and schist. No core.
75.0–110.0								Schist country rock. Not logged.
110.0–139.4	2	45		40	15			Core heavily iron stained, poor recovery. First 13 ft has only 9-percent recovery. Core veined and replaced by sulfide (arsenopyrite ?). Contact at 139.4 ft is about 40° to core. Large muscovite books in bottom half of interval.
139.4–141.8								Tourmalinized schist *country rock.*
141.8–145.0	2	45(?)		45(?)	10(?)			Very poor core recovery. Mineral character in doubt.
145.0–148.5	3a	35	25	35	5			Muscovite, about 1 mm in diameter.
148.5–163.0	4	23	55	20	2			Perthite crystals as much as 2 ft long. Quartz and albite are less than 1 in. in size. First 5.5 ft of interval is 85 percent perthite.
163.0–167.0	3a	35	5	55	5			Fine to medium grained. May not be zone 3a but resembles inner part of zone 2.
167.0–196.0	4	35	40	25				Perthite mainly in crystals less than 2 ft in diameter. Graphically intergrown with quartz.
196.0–223.0	3a	35	4	55	5	Spodumene	Tr.	Fine grained, although muscovite may average 1.0 in. *in* grain size. Small spodumene crystal at 212 ft.
223.0–234.8	2	50	10	40		Beryl	Tr.	Fine grained, although perthite crystals may be several inches across. White beryl in 2 small crystals of 1 sq in. and 0.4 sq in. area at 224.5 ft. Last 6 ft of core is about 80 percent quartz and 10–15 percent muscovite.
234.8–235.2	1	60			35	Tourmaline	5	Very fine grained border zone. Schist contact is about 45° to the core.
235.2–254.3								Schist country rock. Not logged. Hole end, 254.3 ft.

[1] FF, fracture filling.

TABLE 1.—*Diamond-drill logs, Black Diamond pegmatite*—Continued

Interval (feet)	Zone	Mode (percent)				Other minerals		Additional data
		Quartz	Perthite	Albite	Muscovite		Volume percent	
Hole 5								
0–34.0								Overburden and schist. No core.
34.0–95.0								Schist country rock with small stringers of pegmatite. Not logged.
95.0–100.0	2(?)							No core. Drillers log says contact at 95.0. Presumably zone 2.
100.0–104.0	4(?)	?	?	?				Only small fragment of core recovered. Contains quartz, albite, and perthite.
104.0–123.8	4	?	?	?		Spodumene	Tr	Only 50-percent core recovery. Core consists largely of heavily hematite-stained and veined fragments of perthite.
123.8–155.0	3a	40	5	50	5	Spodumene Tourmaline	Tr	Core recovery poor, especially in 124–128 and in 151–155 ft. intervals where there are traces of spodumene. Average grain size of quartz and albite is less than 1 in. Muscovite is in books larger than 3 in. in interval near 146 ft. Some coarser grained albite and quartz associated with large muscovite books.
155.0–163.0	4	30(?)	50(?)	20(?)	Tr			Only 50 percent core recovery, largely perthite.
163.0–170.0	2	30		60	10	Tourmaline	Tr	Fine grained.
170.0–170.5								Intensely altered country rock. Probably an inclusion.
170.5–171.2	2	30		60	10			Same as 163.0–170.0 interval above.
171.2–171.7								Altered country rock.
171.7–176.5	2	30		60	10			Same as 163.0–170.0 interval.
176.5–229.0	4	25	50	23	Tr	Spodumene Tourmaline	Tr	Perthite crystals hematite stained and most are less than 2 ft. across. Perthite is graphically intergrown with quartz near end of interval. Trace of altered spodumene at 204.6 ft. Mainly albite and quartz between 194 and 197 ft. and 217.3–219.3 ft.
229.0–230.5	2	60		30	10	Tourmaline	Tr	Includes thin muscovite-rich border zone. Contact not recovered, but mineral orientation suggests it may be nearly parallel to core.
230.5–244.4								Schist country rock. Core not logged. Hole end, 244.4 ft.
Hole 6								
0–40.0								Overburden and schist. No core.
40.0–187.0								Country rock. Not logged.
187.0–197.8	2	30		60	10	Tourmaline	Tr	Average grain size 0.2 in. Garnet occurs in thin border zone. Almost 10 percent sulfide (arsenopyrite ?) in veinlets and cavities. Sulfide is all introduced and is not part of pegmatite.

197.8–229.0	3a	40	15	40	5	Beryl Spodumene Apatite Tourmaline	Tr	Mainly fine grained, although perthite crystals are as much as 1 ft across. Spodumene occurs as small soft altered crystals at 198 ft. First part of interval has faint banded structure. One sq in. of white beryl at 211 ft. Core is stained by a greenish phosphate(?).
229.0–272.0	4	35	25	38	2	Spodumene	Tr	Spodumene forms small crystals at 254, 261, and 270.5 ft depths. Core richer in perthite near end of interval.
272.0–279.5	3a(?)	80		5	15	Spodumene Tourmaline	Tr	Muscovite in large books thicker than 3 in. Spodumene and muscovite could be part of a fracture filling.
279.5–283.8	4		100					A single crystal of perthite.
283.8–302.7	6	40	40	10	tr	Spodumene	10	Poor core recovery in soft altered spodumene. Perthite crystals average about 1 ft in diameter.
302.7–316.6	4	35	40	25	3	Tourmaline	Tr	Perthite crystals average 1 ft and muscovite 1 in. across.
316.6–319.8	3a	55	25	Tr	20			Muscovite is in books larger than 3 in.
319.8–325.8	2	25	5	65	5			Fine grained, less than 1 in. average grain size.
325.8–326.9	2	60		25	15	Tourmaline	Tr	Includes thin border zone at end. Fine grained. Driller's log says drill went out of pegmatite at 328.8 ft, but core footage disagrees. No contact angle available.
326.9–391.4								Schist country rock. Not logged. Hole end, 391.4 ft.

A zone consisting of quartz-albite-perthite-muscovite pegmatite (zone 3a) follows the wall zone in all but one of the holes. This zone is approximately equivalent to zone 3. It consists of nearly equal amounts of albite and quartz, and about 5 percent each of perthite and muscovite. Accessory minerals are beryl, apatite, tourmaline, and spodumene. Zone 3, as mapped at the surface, has this same suite of minerals, but also carries about 5 percent beryl. Zone 3a is found on both sides of the pegmatite in most drill holes, but appears to be thickest and more continuous along the east side and south end of the pegmatite. The thickest section cut in the drill holes is west of the thin country-rock screen in hole 2. Here zone 3a encloses the quartz-albite-perthite-spodumene pegmatite of zone 6 rather than the perthite-quartz-albite pegmatite of zone 4 that was enclosed elsewhere. In hole 2, some of zone 3a lacks perthite and may not be equivalent to zone 3a as logged in other holes. The core recovered from the segment east of the screen was ground up prior to logging, but it appeared that the rock was exceptionally fine grained.

The grain size of the minerals that constitute zone 3a generally averages 1 inch or less, but perthite crystals are several inches to a foot across. In most of the holes, muscovite books are locally more than 3 inches in diameter, and beryl is commonly associated with this coarser grained muscovite. The highest concentration of beryl actually seen in zone 3a is about 1.4 percent over a 10-foot interval, but some of the assays of holes 2 and 5 suggest a beryl content of as much as 3 percent.

Zone 4 carries abundant albite and perthite, less quartz, and traces of beryl, spodumene, and muscovite. Core recovery was commonly low where spodumene is present. The perthite crystals are generally a few feet across, and the quartz and albite crystals less than an inch across. Some parts of this zone are notably stained by hematite. Thick sections of zone 4 are noted in holes 1, 4, 5, and 6, but not in holes 2 and 3 in the south part of the pegmatite. Though present at the surface above these two holes, the zone apparently pinches out above the depths penetrated by the drill.

Zone 5 is characterized by extremely large crystals of perthite. It also has quartz and a trace of tourmaline. More than 50 feet of this zone was penetrated in hole 3, but it was not found in the other five holes. In this hole a single perthite crystal was found in the core over a length of 15 feet, possibly 30 feet. Some of the perthite is graphically intergrown with quartz, and nearly all is iron stained or cut by hematite veinlets.

A quartz-albite-perthite-spodumene zone was penetrated in holes 1, 2, and 6. It succeeds zone 4, and its position is such that it may be structurally equivalent to zone 5 or may follow that zone; it is desig-

nated zone 6 in the core logs (table 1) and cross sections. This zone is assigned an innermost position in the zonal sequence because of its central location and also because it locally contains about 15 percent microcline and almost no albite lamellae, as in the innermost zones of large lithium-bearing pegmatites in the Black Hills (Page and others, 1953, table 3).

The maximum thickness of zone 6 may be as much as 30 feet, but probably thicknesses of more than 20 feet are rare. The spodumene is fine to medium grained. Some crystals are fresh, but others are altered to a soft claylike substance. Core recovery through this zone is generally low and the mineral character is poorly known. Spodumene may be more abundant than indicated by the estimates in the drill logs (table 1) because it breaks easily and much of it may enter the sludge during drilling. Muscovite is moderately abundant, and one crystal of beryl was found in the zone in hole 2. Perthite was not found in the core from hole 2, and possibly the spodumene-bearing interval from that hole should be separated as a distinct zone.

The narrow spodumene-bearing intervals in holes 2 and 3 consist largely of quartz and albite, and seem best interpreted as fracture fillings. This spodumene is both fresh and altered; it is notably fine grained, the largest crystals being only a few inches long. Quartz and albite make up the remainder of these fracture fillings, but core recovery is generally low and the details of the mineral character are not known. The spodumene of zones 2 and 5 may also be in parts of fracture fillings.

STRUCTURAL GEOLOGY

The pegmatite was originally interpreted (Redden, 1959, p. 549–552) as a gently south plunging, nearly horizontal pipe, whose southern part consists of two segments. Some of the rolls exposed in the top of the pegmatite were projected into structurally low areas so that the inferred width of the pegmatite was nearly constant even where the surface exposures are narrow. The results of the drilling generally confirm this interpretation, but some changes and additions to the previous concepts can now be made.

The crest of the pegmatite probably still has a gentle south plunge with local reversals. Drill holes 1 and 6 confirm that the northern part of the pegmatite has a dip to the west of about 80°, as predicted in the original cross sections. Drill holes 4 and 5, near the middle of the pegmatite, indicate average dips that are nearly vertical; this also is in accord with the previous interpretation. Drill holes 2 and 3, near the south end, indicate east dips of about 60°; this is somewhat less steep than predicted in the earlier cross sections.

The zones penetrated in drill holes 4 and 5 indicate that the main pegmatite has a constriction 60 to 100 feet below the surface. The

exact shape of this constriction is difficult to reconstruct, but it is inferred to be related to the junction of the main pegmatite and its parallel offshoot to the west exposed at the surface. This constriction is shown in all the geologic sections, though the main evidence for it is only from holes 4 and 5; it is presumed to have a nearly flat plunge, parallel to the plunge of rolls exposed at the surface. It is possible that this constriction is so tight that it separates the pegmatite locally, or even completely, into an upper and lower segment.

ECONOMIC APPRAISAL OF THE EXPLORATION

The drilling indicates that the pegmatite extends to depths of more than 200 feet. There is evidence from the drill holes of a general thinning of the north part of the pegmatite at depth. The central and probably the southern parts have a constriction 60 to 100 ft below the surface, but may have a considerable "bulge" below this constriction. Nevertheless, the thickness of the pegmatite is somewhat less at depth than that predicted in the previously published geologic sections, which were based solely on surface maps.

The beryl-rich zone (zone 3) exposed at the surface apparently does not continue downward to the depth of the drill holes. However, the beryl crystals of zone 3 average about 6 in. in diameter and normally occur in aggregates (Redden, 1959, p. 546); as they constitute only 5 to 10 percent of the pegmatite in the richest surface exposures, it would be relatively easy to drill through such a zone without encountering any large crystals. The general mineral character and position of zone 3a show it to be the most likely downward extension of the beryl-rich zone 3. A tabulated summary of beryl occurrences in the drill cores is given below.

Beryl occurrences in the drill cores

	Depth (feet)	Approximate cross-sectional area of beryl crystal (sq in)	Zone
Hole 1	262. 0	1. 0	3a
Hole 2	173. 7	1. 0	3a
	173. 9	1. 0	3a
	185(?)	1. 0	3a
	225. 0	3. 2	[1] 6(?)
Hole 4	224. 5	[2] 1. 4	2
Hole 6	211. 0	1. 0	3a
Total number of crystals			8
Total area of beryl crystals			sq in 9. 6

[1] Zone 6 or a fracture filling. [2] 2 crystals.

The richest concentration of visible beryl in the drill core is in hole 2 where there is approximately 1.4 volume percent beryl in the interval between 173 and 185 feet. Five of the seven noted occurrences of beryl are in zone 3a. All the beryl crystals in the drill core were relatively small; the largest crystal had an area of only a little more that 3 square inches.

Chemical assays for BeO, obtained by the Lithium Corp. of America, indicate that holes 2, 4, and 5 contain the most beryl, and that most of it is in zone 3a. Hole 2, which is below good surface exposures of the beryl-rich zone 3, has the most observed occurrences of beryl and the highest single assay value for BeO. Though most of the beryl actually seen is in zone 3a, the highest assay was from zone 6, between 216.5 and 221.5 feet in hole 2, where the core has 0.375 percent BeO, which is equivalent to about 3.7 percent beryl.

Assays indicate that the richest beryl concentrations in holes 4 and 5 are localized along the east side of the pegmatite, in the roll above the constriction shown in the cross sections. Coarse-grained muscovite is prominent in the drill cores from this zone and also in the prospect pits at the surface of this particular part of the pegmatite. Zone 3a in this area appears to be favorable as a place to explore for rich pockets of beryl inasmuch as some of the richest beryl ore that has been mined was associated with abundant coarse-grained muscovite.

Surface mapping and the drill cores indicate that zones 4 and 5 are the least favorable for beryl, although it is possible that large scattered crystals can be found.

The drilling makes it clear that this pegmatite is a large one, and doubtless the tonnage of beryl is also large. However, the grade is difficult to establish, and much of the beryl is as crystals too small for conventional hand-sorting methods.

There is little hope for any substantial deposit of spodumene in this pegmatite between the surface and the depths at which the drill holes cut it. Spodumene-bearing zones in the drill core are not exceptionally large nor rich, and much of the spodumene is fine grained and altered.

The promise of commercial feldspar is also poor because most of the perthite in the drill cores is either iron stained or graphically intergrown with quartz.

REFERENCES

Page, L. R., and others, 1953, Pegmatite investigations, 1942–45, Black Hills, South Dakota: U.S. Geol. Survey Prof. Paper 247, 228 p.

Redden, J. A., 1959, Beryl deposits of the Beecher No. 3–Black Diamond pegmatite, Custer County, South Dakota: U.S. Geol. Survey Bull. 1072–I, 537–559.

○