KANSAS GEOLOGICAL SURVEY
OPEN-FILE REPORT 1959-4

Data on Silver City Mining & Processing Company
and on Goldite, Inc.

compiled by

P.C. Franks

Data and Report on Rose Dome-Silver City Area

Disclaimer

Kansas Geological Survey
1930 Constant Avenue
University of Kansas
Lawrence, KS 66047-3726

Kansas Geological Survey
Open-file Report

Disclaimer

Kansas Geological Survey

Open-File Report 59-4

Data on Silver City Mining & Processing Co. and on Goldite Inc.

P. C. Franks data and report on Rose Dome--Silver City area.

COPY:

1)Engineer's report by F.C.Clute

2)A radioactivity survey over Rose Dome, Woodson Co., KS, by R.H. Hartenberger

3)Silver City Meta area cores

4)Report on Kansas thin-sections for Prof. K.K. Landes

5)Report on Silvercity peridotite and contact aureole in southwestern Woodson Co

6)Reprints

7)Prospectus for the Silver City Mining and processing

8)Silvercity Geologic and assay logs

9)Rose Dome corelogs by P.C. Franks

"EXHIBIT 22"

ENGINEER'S REPORT

by

FRANCIS H. CLUTE

Research Engineer

Rocky Ford, Colorado

for

Glen Chilton
Columbus, Nebraska

and

Alden McAbee
Emporia, Kansas

June 19, 1959

PROPOSED ENGINEERING REPORT

for a

Fifty Ton Vermiculite Mill

for

Glen Chilton
and
Alden McAboo

EXPLANATION

After running the samples that I brought back from Toronto, Kansas with me I found it necessary to change the flow-sheet which was originally proposed for the processing of vermiculite ore which was found on the property described in our geological report and to describe this procedure I will endeavor to cover each part of the mill, describe its use and purpose in the processing of this ore, and have a finished product that will be marketable in three different grades. In our drawing that we are submitting with this report we have merely tried to show the machinery used and the steps necessary to make the finished product herein described. In as much as this ore is free and can be mined from the surface at very little cost we propose the following equipment:-

col rpt ?

ORE BIN

The ore bin to this mill will be a steel constructed bin of quarter inch plate 8x8x8 feet deep, reinforced with 2x2x¼ inch angle iron at intersections of every two feet. This will be necessary as this bin will be mounted above the ground and it will be necessary that it hold approximately 100 cubic yards of raw ore. This bin will be mounted on 4x4x⅜" angles which should be mounted in cement pillars. The ore can be mined with an open shovel on the front of the tractor which will scoop the ore from the ground, carry it up and dump it into the ore bin.

VIBRATING FEED

A vibrating feeder will be mounted directly below the ore bin which will contain the volume of ore fed to the remainder of the processing plant. It is very necessary to have a vibrating feed at this point so that the ore can be delivered to the screens in capacities that they will handle. This vibrating feed is a standard made product made by Syntron people and a very durable piece of equipment. The volume from the screen is controlled by the amont of vibration given the feeder and can be set only by trial and error until the screens of the processing plant have been fed to their capacity. The vibrating feeder then remains as a permanent set feeder until such time as the feed to the mill needs to be varied.

ELEVATOR #1

We recommend that this ore be picked up from the vibrating bin with suction-air elevators. The purpose of this is to remove the moisture from the ore before it is fed onto the screens. The air-elevator will have a tendency to break up the lumps and have less returned to the system. The elevator we recommend is a number three elevator having a 8 inch suction line, a 48 inch collector, and a 42 inch collector, and a 42 inch fan powered with a 15 horse-power electric motor.

SCREEN #1

This air elevator will feed directly onto a two screen vibrating shoe of mineral type. The purpose of this shoe is to remove on the top screen all the particles too large to exfoliate as well as the rock which will be classified as tails. The second screen of this shoe will deliver its plus products to an exfoliator. The minus of the second screen will be too fine for commercial products and therefore will be discharged as tails. Two screens we recommend for this stage of operation is a little screen having two decks with interchangeable screens. These screens are 48 inches wide and 60 inches long. The top screen will be perforated with ¼ inch round hole perforated metal. The bottom will be supported with number 50 mesh woven wire screen. The screen is mounted on 4x4x½ inch angle iron frame and powered with a 1½ horse-power motor.

TAILING CONVEYOR #1

There will be a tailing conveyor mounted under this shoe to remove the tails separated by the screens to the outside of the plant. This tailing conveyor will be a 12 inch belt conveyor. The price which we have quoted will be for a conveyor 15 inches long with a one horse-power motor.

ELEVATOR # 2

Elevator #2 is a suction air elevator with the same specifications as #1 and will deliver the ore from the screen to the exfoliator. This elevator will be powered with a separate fan and motor the same as #1.

EXFOLIATOR

The exfoliator that we propose for this plant is a 16 inch cylinder 15 feet long. This cylinder ore exfoliator is insulated on the outside with 3 inches of vermiculite insulation and travels on trommel wheels which cause the cylinder to rotate. The cylinder of this exfoliator is mounted on a fram of 6 inch "I" beam and so constructed that the pitch of the cylinder may be varied either up or down to suit the purpose needed. The exfoliator tube is to be equipped with a gas burner of sufficient size to exfoliate the material by heat that is put into it. This gas equipment is not furnished by us but size and capacity will be recommended to the gas company supplying this equipment. The exfoliator is driven with a chain wheih extends around the cylinder and to a jack-shaft which is geared to give it the proper speed. The jack-shaft is driven with a three horse-power electric motor and is belt driven from the motor to the jack-shaft.

ELEVATOR #3

This is a machine the same as elevator #1. Its purpose is to move the vermiculite from the exfoliator and deliver it to the second set of screens. It is most important at this stage to use a low velocity air-elevator to remove the product from the exfoliator to the screens as it is necessary to coll this product as soon as possible and to separate the particles one from another so that the second stage of screens might perform its functions more efficiently. It is also well to mention at this time that air under suction does not damage the exfoliated crystals while they are hot.

SCREEN #2

Screen #2 is a sizing unit similar to screen #1 being constructed so this unit is equipped with two screens with 1/25 inch perforations on the top screen and 100 mesh on the bottom. The purpose of these screens is to grade and size the exfoliated vermiculite. The plus of the screen will be materials that are larger than 1/25 inch. The minus of the screen will be materials smaller than 1/25 inch, which classifies the exfoliated vermiculite into two grades, a coarse and a medium. There will also be discharged from this shoe any vermiculite that has not been exfoliated and it will be returned to the exfoliator and classed as return product.

0.15 mm

Will it ensure rejection?

TAILING CONVEYOR # 2

Tailing conveyor#2 has the same specifications as conveyor #1 and its purpose is to take the unexfoliated vermiculite from the second screen and return it to the exfoliator.

ELEVATOR 3 and 4

Elevators 3 and 4 are similar units to 1 and 3, having air under suction to move the sized vermiculite to their respective bins. The two elevators are powered by one motor and one fan. Their purpose is to take the coarse and medium to their respective bins for further processing.

TWO FINISHING BINS AND A BOND BIN

There are a set of three bins constructed of 16 guage iron, 4 feet wquare and 10 feet high. Constructed with tapered bottoms they are provided with manual cutoff. The purpose of these bins are as follows: Bin #1 is a reservoir into which the coarse vermiculite is held until further processing is done. The second bin is a bin of the same size which holds the bond which is applied to the exfoliated materials so that it might be used as a plaster. Bin #3 is a reservoir for the fine exfoliated materials and holds them for further processing. These three bins are equipped with individual outlets which hads its product to a blender or to a common draw-off. This draw-off is provided so that if it is necessary to bag material as straight vermiculite not combined with the bond it may be done on both the coarse and medium materials.

BLENDER

The blender for this plant is an augor type blender into which certain materials are delivered and by the use of an augor the materials are metered together certain proportions which are then completely blended before it is delivered to the sacking stage. This unit consists of one 6 inch auger and one 8 inch broken-flight augor which blends the products together and produces a finished product.

SACKING BIN

The sacking bin is a 4x4x8 foot steal bin constructed of 16 gague black iron into which the finished product is delivered for sacking. This bin is equipped with an outlet spout that handles a certain number of cubic feet of material to the bag. This delivery spout is adjustable so that the cubic feet may be varied as desired so that a certain weight can be delivered to the bag. This type is very satisfactory in bagging bulky material where absolute accurate weight is not essential. The outlet spout is equipped with two cut-off gates that are conjuncted with each other, that is, when the bottom gate is closed the top gate is open allowing the delivery tube to fill with a certain number of cubic feet of material. When the bottom slide is open the top slide will close, cutting off any materials from entering into the delivery chamber which allows a definite amount of cubic feet to enter into the bag. The first bag is removed, another bag is placed on the tube and the procedure is repeated.

SUMMARY

I have given the engineering of this processing plant considerable thought and while I recommended a 25 ton unit for the plant I believe that it is doubtful that you will operate 24 hours a day only under extreme conditions. A 25 ton mill will produce 8 ton of finished product in 8 hours and I believe this capacity too small for this operation and in figuring prices I find that for less then double the money, a 50 ton mill can be put in which will handle 16 tons of product in 8 hours. It would be my advise to the users to take the advantage of the lesser cost of the equipment and to keep in mind that it costs no more to install a 50 ton mill than it does to install a 25 ton mill, neither does it require a great deal more space. In selecting apoint for this operation I advise that you keep in mind that this 50 ton mill will require a floor space of approximately 25 feet square and when a building is purchased it would be advisable to get one with adequate storage for at least one carload of bagged, finished product. I also believe there should be an open shed under which the raw ore can be stored prior to processing. This will avoid delays in waiting for materials to dry before processing after a rain or snow as the material will not process wet. It might even be possible that a sheet dryer will have to be installed. I do hope that you find all in order in this engineer's report on a processing plant for your vermiculite. We are enclosing an itemized price list on the equipment required for this installation. This price includes complete instructions both for installing and operation. Any further questions that you might have in reguard to construction or cost we would be pleased to give you further details.

SIGNED [signature]
Research Engineer

PRICE LIST

A-1	Primary Ore Bin ½" plate 8x8x8'		$ 982.00
B-1	Syntron Vibrating Feed		1,276.00
C-1	Clute Elevator (No. 1) Includes Motor-fan and piping		1,540.00
D-1	Clute Separating Screen With Changeable Screens and Motor		1,660.00
C-2	Clute Elevator (No. 2) Same as Item No. C-1		1,540.00
E-1	Exfoliator Propelled		1,784.00
C-3	Clute Elevator (No. 3) Same as Items C-1, C-2		1,540.00
D-2	Clute Separating Screen Same as Item D-1		1,660.00
C-4 C-5	Clute Elevators 2 Elevators 1 Fan Unit		2,187.00
F-1	Combining Bins (3)		1,284.00
G-1	Blender		1,140.00
H-1	Sacking Bin		735.00
I-1	Bond Auger		245.00
	TOTAL		$17,563.00

Price Does Not Include Installation

FOB Rocky Ford, Colorado

Quotation VALID for 90 Days

FRANCIS H. CLUTE AND SON

ENGINEERING AND GEOLOGICAL REPORT

This report is to cover the area affected by the periodite dyke intrusion known geologically as the Silver City Dome and stratigraphy as the Hill Pond periodites in Sections 29, 30, 31, and 32, Township 26 S., Range 15 E., Woodson County, Kansas and Section 5 and 6, Township 27 S., Range 15 E. and Section 1, Township 27 S., Range 14 E., Wilson County, Kansas. I personally am aquainted with this area and did my first work here in 1921 when I surveyed the surface structure for oil exploration. The area of the dome is about eight square miles with a fairly flat irregular elongated top and the sides that dip as high as 200 feet to the mile. There is a closure of 200 feet. One peculiararity of this dome is the fact that the 200 feet closure on the top of the Lansing Lime does not carry thru only to the Fort Scott Lime at 800 feet, and there is practically no reflection in the Mississippi Lime at 1200 feet. Therefore, we came to the conclusion that the warping was caused by intrusive lacoliths which are the ore bodies. In fact, the thickness of the ore bodies is nearly the same as the up warp. In 1941, the Santa Fe Railroad and Alf F. Landon did some core drilling along the north edge of Section 32 and the south edge of Section 29. They were searching for ballast rock, due to the fact of a surface exposure of metalmorposed sand stone that had been transformed by magma waters to quartzite. There was not sufficient of this rock to warrant quarrying and running spur to same.

Mr. George Hill, the land owner, took some of the weathered ore to Denver, for testing and there was only tested for vermiculite. At that time vermiculite was worthless and no chemical analysis was run on ore. So the project was abandonded.

The Kansas State Geological Survey and United States Geological Survey had representatives on the ground during this work and published a folio known as the Fredonia Quandrangle with special emphasis on the metalmorpose area known as the Silver City Dome. They report two ores that we found later and had chemical analysis made. We find that both ores are very similiar in chemical composition and the chemical composition of these ores are fairly constant over the entire area of all six horizons. They average: Magnesium Oxide...20%, Silicon Dioxide...46%, Aluminum Oxide...7%, Iron Oxide...6.56%, Titanium Oxide...3.5%, Potassium Oxide...5.5%, Sodium Oxide... .75%, and Calsium Oxide...3%. These chemical analysis were arrived at by the Kansas State Geological Survey, Geo. Chemistry Division, Lawrence, Kansas and the Bruce Williams Laboratory at Joplin Missouri. The summary of these analysis will not vary to any extent to be noticeable. So we conclude that they are right and the ore body has the same source.

THE ORE BODY

In the core drilling by Alf Landon and others, it shows in the logs of these wells, along the south half of Section 29 and the north side of Section 32, there is an ore body laying on the surface approximently 1,000 feet wide and 5400 feet long with an average thickness of 40 feet of the weathered periodite and an average thickness of 30 feet of the unweathered periodite. This makes, using an average of 80 pounds per cubic foot for the ore, 8,448,000 tons of weathered ore and 6,336,000 tons of unweathered periodite ore making a total of nearly 15 million tons of ore that can be mined entirely by strip mining.

It appears that his surface body of ore is in two lenses or bodies. That both connect to the dyke. We have a body of weathered ore, laying near the center of the west half of Section 32 and possibly extending over to Section 31. This body of ore lays very close to the surface of the ground and is approximently 2500 feet long, 500 feet wide, and has an average thickness of 20 feet and in this one deposit only the weathered ore there is over one million ton of ore that can be strip mined. Under laying this and covering a lot larger area possibly 3600 feet long and 1500 feet wide and averages over 20 feet in thickness is a bed of ore of the solid periodite type. This ore body possibly extends and definitely must extend to the dyke which is 1500 feet farther north, as it dips Down at about 3600 feet north of the south line of Section 32 so we really know of no amount, or thickness of it but we do know in coring wells from south to north that it increased in thickness. This known part of this ore body represents 54 million tons of ore that can be strip mined and mined from an addit taking off from the strip mine pits. It has, when undergroung, a strong ceiling and this can be mined and hauled from the mine in trucks same as if an open pit. It's chemical composition is the same as the upper strip in the north end of the section. Deep coring in this section near the south end of Section 32 also shows an ore body, 20 feet thick at 300 feet. It also shows another ore body beginning at 490 feet and running to 525 feet, a thickness of 35 feet. It also shows another bed of ore at 705 feet to 760 feet and another bed that beging at 770 feet and we were still in it when we lost the hole at 801 feet. Chemical tests on all these lower beds show an equal or increased mineral content that corresponds with the chemical analysis of the two surface beds. In fact, in quoting Mr. Paul Franks of the Kansas State Geological Survey and referring to the map of the United States Geological Survey of the Fredonia Quandrangly by Hollis D. Wagner, he shows, and Mr. Franks states that these lower lacoliths or beds of ore are from the same source as the surface beds and should show and Mr. Franks says will show the same mineral content as the upper beds as to make his expression as a quote, "these beds are similiar to a grain bin of which the grain bin is the dyke and if you drew off the bin that has been filled with the same kind of grain you will get the same kind of grain from the top of the bin to the bottom of the bin." Taking the logs of the six wells drilled for ore tests in the area under discussion show that these lower four beds extend and can be correlated as continous lacoliths in their horizons. A cross section map will show the same. As we know that these beds will extend to the "Mother Dyke". In these four beds there is definitely ten times more of this ore than is exposed on the surface, but as they are deeper, will be more costly to produce and it is not economical to hold these beds on present leases. I would recommend that the company drop the leases in Section 6 and 1 as the lease will not run long enough to be perputated by production and it is a economical waste to pey rental on these leases that will run out in four more years. As there is sufficient ore in Sections 29, 30, 31, and 32 to furnish an adequate reserve of ore produced at a high rate five times as mush as contemplated by you for over a hundred years and beside you still have the huge reserve of the four lower beds. Also in checking the logs and the cuttings of a well drilled near the north line of the northeast quarter of Section 31 at 1,000 feet this well logged a 50 foot vein of coal that the drill cutting taken from the slush pond show that this coal is definietely antricite and according to the Bureau of Mines at Denver and also at Rolla, Missouri, this is the only deposit of antricite coal west of the Appalachian Mountains. It stands to reason that this coal should be antricite because it lays within the scope of the metalmorpism from this dyke and that is the only known way that antricite coal can be formed. No other antricite coal beds have been found anywhere in the world unless it is a metalmorphic area. It is claimed by the Bureau of Mines that the known supply of antricite coal in Pennsylvania and Virginia will not last at the present rate of extraction over fifty years. So this is an asset to this project and should be core drilled to find it's extent which I think is very large. I could go into the reasons for the extremely thick bed of coal but it would take an exhaustive amount of detail to do so.

There is another peculiar thing around this upper ore bed whixh is a fairly thick deposit of serpentine igneous rock which is directly related chemically to the ore body. Part of this rock is a dark, brownish-black mottled in color and is very rare and is in demand from "rock hounds", rock houses, and lapadarists. As several rock experts have told me recently that there is no deposits that they know of where they can get supplies of these two types of serpentine and want samples of same. This is on the surface and can be economically quarryed and prepared for their consumption. This will be a nice little side-line for your project.

The area under discussion lies 14 miles southeast of Toronto, 14 miles southwest of Yates Center, 13 miles north and a little east of Fredonia and approximently 5 miles from Buffalo, Kansas. All of these areas are on State and U. S. Highways and there are county roads, hard surfaced, to the project site. The area is drained by the Little Sandy Creek, which flows into the Verdigris River. It lays approximently 1,000 feet above mean sea level. There is ample water supply within reasonable distance of the plant site. There are two electric power lines that can supply power for this size plant. There is an adequate gas main that can furnish heat for heating buildings and necessary processing and there is sufficient housing in the immediate area of good abandoned farm homes and in the four cities mention, where modern facilities are available.

MARKETING PRODUCTS

Your vermiculite has a ready demand as exfoliated insulation and your rare earths are increasing in demand daily and you should not anticipate the disposal of these as they are and can be produced in large enough quantity and can be attractive to buyers of these products. The slimes need some more research to develop high temperature refractory brick which are in great demand and other dense clay products. The magnesium, aluminum, and silicon can be processed into a form that are salable to industry and are also in increasing demand as the atomica age develops. In your dark ores you will have all the same products except slimes and the phlogopite mica which cannot be exfoliated can be processed to produce pure silicon which is a very scarce, hard to get metal that is in very scarce supply. The fact there is no other large supply of phlogopite in the world except in Madagrascar, increases the value of this mica. Of all the sixteen types of mica, phlogopite mica is the only one that can be converted into pure silicon, hance you have a supply of a very scarce articale.

CONCLUSION

I am and have been for years very muchly impressed with this unique metal deposits and am satified that this can be developed into a very paying project.

Respectfully submitted,

Cecil T. Welch

Cecil T. Welch
Geologist and Engineer

CTW;dls

A RADIOACTIVITY SURVEY OVER ROSE DOME, WOODSON COUNTY, KANSAS

By

R.A. Hartenberger

CONTENTS

Abstract

Introduction

Geology

Basis For Survey

Results

Conclusions

References

ABSTRACT

A radioactivity survey was made over Rose Dome, Woodson County, Kansas, to attempt to locate any igneous body which might be present.

Two traverses across the dome appear to indicate the presence of the granite on the dome.

INTRODUCTION

Rose Dome is located in Eminence Township, Woodson County, Kansas, approximately 8½ miles south of Yates Center, or 1 mile west and ½ mile south of Rose, Kansas. The NE¼ of the SE¼ of S13, T26S, R15E is partially covered by the granite boulders. This constitutes an area of about 40 acres. Most of the granite exposures are directly associated with the 5 prominent hills of the area. These hills have no definite alignment.

This radioactivity survey was made to determine whether or not radioactive anomalies were present in the area, and if so, the relation of the anomalies to the occurrence of igneous rocks.

Previous Work

Twenhofel, (1917, p. 363) believed the hills owed their origin to the resistance of the boulders as compared with the resistance of the surrounding rock. He concluded that the boulders reached their positions through the agency of ice.

Powers (1917, p. 150) suggested that the boulders were derived from a local granite elevation which was undergoing erosion during the deposition of the Weston shales.

Darton (1918) believed that the parent rock for the granite in Woodson County, Kansas, was to be found on the northern end of the buried mountain ridge of central Kansas.

In a later paper, Twenhofel (1926, p. 412) discarded the idea of glacial origin for the boulders. He recorded the presence of contact metamorphic minerals in the shale. He concluded that the blocks are surface exposures of a granite mass which intruded into Pennsylvanian strata; that this intrusion arched the strata intruded, and developed contact metamorphic minerals.

Twenhofel and Bremer (1928, p. 758) recorded the fact that a well drilled 3 miles southeast of the Rose Dome penetrated a black rock for a thickness of 102 feet. The black rock was identified as peridotite. They suggested that the peridotite is a dike or intrusive sheet which is connected in some way with the Rose Dome intrusive.

Knight and Landes (1932, p. 15) suggested that "a parent body of magma first intruded the crystalline shell underlying Woodson and adjacent counties. Cupolas on the top of this deep-seated igneous body broke through the pre-Cambrian rocks and arched the overlying sedimentary strata at the same time sending out dike offshoots. With crystallization of the magma in the cupola, hydrothermal solutions were expelled which worked upward through the rocks causing metamorphism of the shales, sandstones, limestones, and some of the dikes".

Radioactivity Survey

This radioactivity survey was made during the month of March, 1948, using a Geiger counter. The instrument was checked for cosmic radiation during the course of the survey.

and the checks averaged 11.5 counts per minute. A Brunton compass was used to lay out the traverses. Two traverses were used, one trending N20W, and the other trending N55E. On each traverse stations were placed at 30 foot intervals across the dome for a distance of 600 feet, and at 300 foot intervals for a distance of 3000 feet on either side of the dome. The traverses crossed in the center of the dome.

Acknowledgments

The writer wishes to thank Dr. R.M. Dreyer of the University of Kansas, who supervised the work and who made many helpful suggestions to the author. The writer wishes also to thank Dr. Mark Jewett of the Kansas Geological Survey, who gave helpful advice and information on the survey area.

GEOLOGY

The Weston shale in the Pedee group of the Missouri series, crops out over most of the area. The Weston contains local beds of limestone and beds of shaly and even-bedded sandstone. Beneath the Weston are several hundred feet of lower Pennsylvanian sediments which are in turn underlain by Mississippian sediments, mostly limestone. Marine limestones, and some sandstones of Cambrian and Ordovician age lie beneath the Mississippian sediments and overlie the pre-Cambrian granite.

In the survey area the Paleozoic sediments are intruded by a granite mass. This intrusion intersects the Missouri sediments and is therefore probably post-Missouri in age.

BASIS FOR THE SURVEY

Most igneous rocks are more radioactive than any of the sediments. The sedimentary rocks of the earth's crust are radioactive in different degrees. Generally, dark-colored shales are more radioactive than are sandstones, and sandstones are usually more radioactive than pure limestones. Therefore, it should be possible to detect the presence of igneous rock in sedimentary strata.

RESULTS

This survey shows a high radioactivity anomaly in the center of the dome (Figures 1 and 2). This anomaly is of the magnitude of 19 counts per minute, and is present on both of the traverses. No other counts on either traverse were as great as the count at the center of the dome; rather, all other counts were approximately average for cosmic radiation.

CONCLUSIONS

The high radioactivity anomaly at the center of the dome appears to be caused by the granite and not by the surrounding sediments.

REFERENCES

Twenhofel, W.H., "Granite boulders in the Pennsylvanian strata of Kansas," Amer. Jour. of Sc., vol. 193, pp. 363-380, 1917.

Powers, S., "Granite in Kansas", Amer. Jour. of Sc., vol. 44, pp. 146-150, 1917.

Darton, N.H., "Structure of parts of the central Great Plains", U.S. Geological Survey Bull. 691-A, p. 5, 1918.

Twenhofel, W.H., "Intrusive granite of the Rose Dome, Woodson County, Kansas", Bull. Geological Society of Amer., vol. 37, pp. 403-412, 1926.

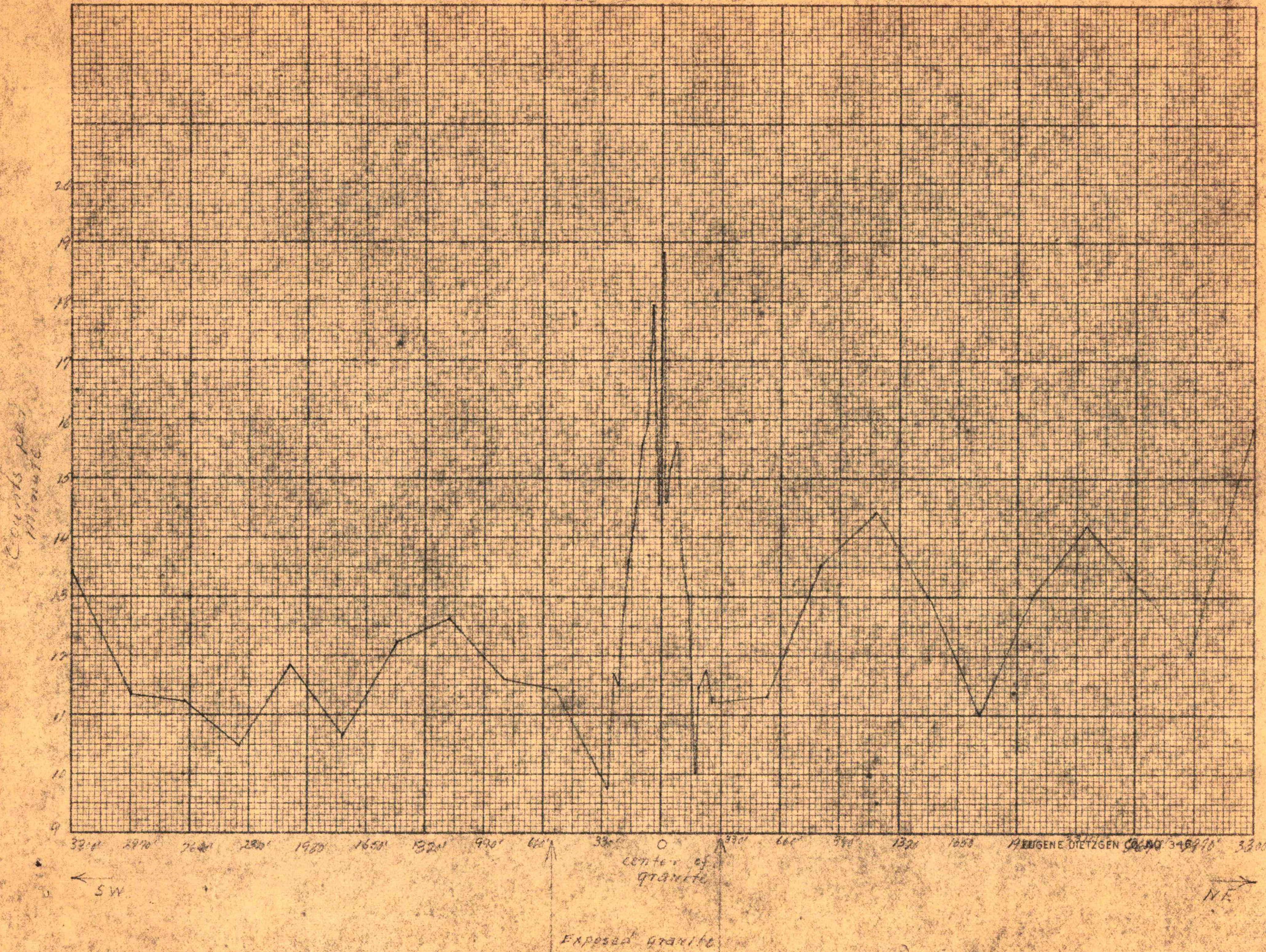
Twenhofel, W.H. and Bremer, B., "An extension of the Rose Dome intrusives, Kansas", Bull. Amer. Assoc. Pet. Geol., vol. 12, pp. 758, 1928.

Knight, G.L. and Landes, K.K., "Kansas laccoliths", Jour. of Geol., vol. 40, pp. 1-15, 1932.

Fig. 2 Traverse II N20W

Fig II

Traverse II N55E



Abbreviations used on core logs

//	interlaminated or interbedded
A	abundant
Bl	[illegible]
C	[illegible]
Calc	calcitic or calcareous
cm	centimeter(s)
D	dark
diam	diameter
F	fine-grained
fks	flakes
[illegible]	fractures
[illegible]g(s)	[illegible]nt(s)
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]red
int-l	interlaminated
Ki	[illegible]
lam	[illegible] laminated
Lim	limonite
M	moderate
MS	mudstone
Musc	muscovite
N	none
S	sparse
ss	sandstone
ST	siltstone
Tr	trace
V	very
VF	very fine
Wh	white
xtl(s)	crystal(s)

Silver City Meta Area Cores

Described by Holly C. Wagner
7/14/52 & 7/15/52

Core Hole # 1

0-7.5' about 60% recovery	Quartzite, moderate grayish green (5G 4/2), very fine sand grains cemented with silica. Mica sparingly present on bedding planes. Locally speckled with 1/8 inch bleb-like areas of darker green color.
to 7.5-13' 50%	Shale, yellowish-gray (5Y 7/2), fissile, slightly silty, apparently entirely unaltered. Grades downward into
to 13.2' 100%	Siltstone, very light gray (N8), very finely micaceous no apparent alteration. Grades downward into
to 13.5' 100%	Shale, light olive gray (5Y 6/1), very slightly silty, slightly micaceous, a few wood fragments along bedding. Grades downward through a siltstone (about 3/4" thick) into
to 22.0' 100%	Sandstone, very pale orange (10YR 8/2) to grayish orange (10YR 7/4), very fine grained, well-sorted, slightly micaceous, many very small blebs of iron oxide throughout. Generally fairly well-bedded and thin bedded (1/16" to 1/4"). Basal 8" is cross bedded and contains very many small fragments of carbonaceous matter on the bedding planes.
to 28.5' 100%	Sandstone, very light gray (N8), very fine grained, thin bedded, the beds being about 1/4" thick, separated by 1/16" beds of carbonaceous matter that contains a few mica plates. Locally the carbonaceous beds are lenticles that feather out laterally. Small-scale intraformational folding is present at the top.
to 51.8' Ireland ss to here	Sandstone, very light gray (N8), very fine grained, massive, relatively porous, slightly micaceous. Strongly cross-bedded locally and when cross bedded, the bedding is brought out by the thin carbonaceous layers. Lower 8" is gradational to the underlying
to 84' TD Robbins sh	Siltstone, medium light gray (N6), carbonaceous, very finely micaceous. Brownish lenticular units throughout at intervals of a foot or slightly less.

Core Hole # 2		250' SW of Shaft
	0-10'	Quartzite, light bluish gray (5B 7/1), very slightly micaceous, much chlorite (?)
Ireland ss	25'	Sandstone, light olive gray (5Y 6/1), slightly micaceous, cross bedded toward base.
Robbins sh	to 63' T.D.	Claystone, medium light gray (N6), contains a little carbonaceous matter and very fine Mica. Slightly silty. Many moderate yellowish brown (10YR 5/4) lenses. (Ironstone concretions (?) throughout. Actually is fairly well bedded and breaks along bedding planes.

Core Hole # 3	350' SE of Shaft
0-11' Ireland	Quartzite, pale yellowish brown (10YR 6/2) to moderate yellowish brown (10YR 5/4), locally only poorly silicified. Many greenish blebs (chlorite?) locally.
to 16'	Shale, silty, yellowish gray (5Y 7/2) to light olive gray (5Y 5/2). No alteration apparent micaceous.
to 40' T.D. Robbins sh.	Shale, medium gray (N5), very slightly silty, a little chlorite along joint planes in upper part. Lower part contains many reddish ironstone concretions.

Core Hole # 4

0-7' 6" T.D. Ireland	Sandstone, grayish orange (10YR 7/4), very micaceous, very fine grained, well sorted, well bedded but locally cross bedded, many dark bleb-like areas in lower part.

Core Hole # 5 300' W of Shaft

0-18' Ireland	Quartzite, very light gray (N8) with distinct greenish cast or bluish cast locally. About 1' above the base is a greenish body that appears to be almost entirely olivine (?) near which are vugs filled with small tetrahedral crystals, tentatively identified as
to 26' T.D. Robbins	Shale, light olive gray (5Y 6/1) in the upper foot and medium light gray (N6) below that. One ironstone concretion (?) noted.

Core Hole # 6 600' W of Shaft

0-19' Ireland	Quartzite, yellowish gray (5Y 8/1) to grayish orange pink (5YR 7/2). Locally pale green (5G 7/2). Generally very fine grained, well sorted sandstone cemented with silica. Cementation less complete at base. Slightly to moderately micaceous silty lenses common near base.
to 23' T.D. Robbins	Siltstone, light gray (N7) much finely divided carbonaceous matter. Slightly micaceous.

Core Hole # 7

0-12.5' Ireland	Sandstone, grayish orange (10YR 7/4) to very pale orange (10YR 8/2), very fine grained, well sorted, locally cross bedded, slightly to moderately micaceous.
to 17'	Shale, very pale orange (10YR 8/2) at top to light olive gray (5Y 6/1) at base. Very finely micaceous and silty. Carbonaceous.
to 21' T.D.	Sandstone, grayish orange (10YR 7/4), very fine grained, finely micaceous. Locally cross bedded.

Core Hole # 8 200' S of # 7

0-11'	Quartzite, very light gray (N8) with a distinct greenish cast. Very fine grained, cemented with silica. Bedding thin and regular, but locally cross bedded. Slightly micaceous
to 15'	Sandstone, very fine grained, light grayish orange (10YR 8/4), locally cross bedded and irregularly bedded, but generally thin, well bedded carbonaceous fragments and mica flakes present but not common.
to 16'	Siltstone, light olive gray (5Y 6/1), finely micaceous, sandy at base.
to 18.5'	Sandstone, yellowish gray (5Y 8/1) to light olive gray (5Y 6/1), harder than that directly above the slst and probably has some added silica, poorly bedded, very fine frained, well sorted, some mica.
to 21' T.D.	Shale, medium light gray (N6), very slightly silty, ironstone concretions (?) present.

Core Hole # 9 — 300' E of Shaft

0-30.9'	Quartzite, yellowish gray (5Y 8/1) with distinct pinkish cast locally, to very light gray (N8) with greenish cast. Very fine grained moderately micaceous and many small carbonaceous fragments locally. Locally cross-bedded and swirly-bedded. Silicification generally complete but is locally incomplete where bedding is most evident. This bedding is due to thin siltstone bands which were apparently not as readily permeated by the silicifying solution.
to 35' T.D.	Shale, medium light gray (N6), very slightly silty. Some ironstone concretions.

Core Hole # 10 800' E of Shaft

0-22'	Quartzite, light gray (n7) with greenish cast in upper 14 ft and yellowish gray (5Y 8/1) in lower 8 ft. Upper part completely silicified. Lower part only partially silicified. Well bedded, locally cross-bedded. Very fine grained, well sorted, slightly micaceous.
to 26' T.D.	Shale, medium light gray (N6), unaltered. Some ironstone at top.

Core Hole # 11

0-2' 90% recovery Haskell Ls.	SiO_2 dark dray (N3), seamed with white veinlets of quartz. The uppermost 5 inches contains many small, roundish to irregularly shaped white quartz which may represent fossils. At the outcrop I have found meta Haskell ls. that looked just like this and didn't react to acid either.
to 3.8' Vinland sh.	SiO_2, dark gray (N3) with some greenish areas. This I believe represents the upper, calcareous (fossiliferous) part of the Vinland shale.
to 9' Vinland sh.	Shale, medium light gray (N6), slightly micaceous altered to quartzite practically throughout, excepting basal 3 inches, which is soft and unaltered.
to 12' Westphalia Ls.	SiO_2, between very pale blue (5B 8/2) and light blue (5B 7/6). Has many darker blue or greenish areas, oval shaped to circular, that look as though they might originally have been Osagia Algae or fusulinids. I think this is the altered Westphalia.
to 15' Tonganoxie ss	Quartzite, light brownish gray (5YR 6/1) very thin bedded, the interlaminations being white. Softer greenish material occurs locally at 13.4 ft.
to 26' T.D.	Mica rock grayish yellow (5Y 8/4) to yellowish gray (5Y 7/2). Cuttings only. No Core.

Core Hole # 12

0-6"	Shale, grayish orange (10YR 7/4), punky. No silicification.
27.9'	Sandstone, grayish orange (10YR 7/4) slightly silicified, very fine grained, well sorted, well bedded but locally cross bedded. Silty with carbonaceous fragments toward base.
to 28' T.D.	Shale, light gray (N7), very slightly silty.

Core Hole # 13

0-20'	Quartzite, very light gray (N8) to light gray (N7), locally with distinct greenish cast. Many small dark blebs throughout. Well bedded, locally cross bedded. Silicified completely throughout.
to 22' T.D.	Shale, medium light gray (N6), slightly silty, micaceous.

Core Hole # 14

Geo. Hills' record shows this hole as all mica rock. No. core or depth given.

Geo. told me later that they got about 3 feet of Quartzite at the top and then all mica rock.

Core Hole # 15

0-7.3' Tonganoxie	Quartzite, very light gray (N8). Has distinct greenish and bluish casts locally. The colors are due to addition of greenish to bluish quartz in the interstices and as partial replacement of limonitic blebs (?). Generally massive and unbedded except near the center. Very micaceous.
to 8.8'	Quartzite, dark gray (N3) to very light gray (N8) consisting of alternating beds (about 4") of silicified sandstone and shale, the shale being the dark gray. The shale is only partly silicified near the base. Micaceous.
to 12.3'	Quartzite, very light gray (N8) with many very thin lenticular partings of black siltstone. Micaceous. Very fine grained.
to 18'	Siltstone and Sandstone, alternating in i/8" (ss) and 1/16" (slst) beds. The slst is nearly black and very micaceous and occurs as very thin lenticles interlaminated in the sandstone. Relatively unaltered.
to 21' T.D.	Slst, medium dark gray (N4), very micaceous. A few beds of very fine grained very light gray (N8) sandstone included. Soft, relatively unaltered.

Core Hole # 16

Igneous Rock, highly altered, approximately light olive gray (5Y 6/1) with yellowish spots in it. Very micaceous. One part of the sample had a quartzite (looked like a fragment of a core) embedded in the igneous material. Practically no core.

No depth given.

Core Hole # 17

0-4' Tonganoxie	Quartzite, very light gray (N8), very micaceous. Very fine grained. Some pistachio green alteration.
to 4.8'	Siltstone, light olive gray (5Y 6/1) very micaceous. Soft unaltered. Grade downward into
to 13' T.D. Weston	Shale, silty, medium gray (N5), well bedded, micaceous.

Core Hole # 18

0-41.6'	No Core - Geo. Hill's record shows this as mica rock.
41.6-66'	Igneous Rock - General color is moderate olive brown (5Y 4/4) to olive gray (5Y 3/2). Relatively coarse grained, large amber colored mica books, black nearly equidimensional fe mag; light green or pistachio green mineral as blebs (olivine?). A few calcite (it fizzed) veinlets cut the cores.
to 72' T.D. Robbins or Weston sh	Shale, dark gray (N3), fissile, no mica or silt or ironstone.

Core Hole # 19

0-3' Robbins sh	Quartzite, greenish gray (5G 6/1), absolutely solid SiO_2, very thin bedded. Very poor recovery. A few fragments are dark pinkish gray (5YR 7/1) with many iron blebs.
to 5' Haskell	Quartzite, medium dark gray (N4), brecciated. I think this is Haskell. Poor recovery.
to 16' Vinland	Quartzite, dark gray (N3) unbedded to well bedded.
to 21' Westphalia	Limestone, generally light gray (N7), considerably altered locally but Osagia Algae and calcareous nature still quite obvious.
to 25'	Siltstone, medium gray (N5) very micaceous and thin bedded. Interlaminae are light colored very fine grained ss. This is silicified in local areas.
to 41' T.D.	Sandstone, light gray (N7) and siltstone, light olive gray (5Y 6/1) interlaminated in very thin laminae. Sandstone most prevalent in upper 4 ft. Very micaceous. Seamed with a few calcite veinlets. Only locally silicified and then only slightly.

Tonganoxie

Core Hole # 20 -

0-8.5'	Quartzite, very light gray (N8) locally with a distinct greenish cast. Very micaceous, much added greenish (chloritic?) silica.
to 10'	Clay, yellowish gray (5Y 8/1), may be alteration product of something but seems to fill this interval. Very poor recovery.
to 31'	Sandstone, very light gray (N8) and siltstone, light olive gray (5Y 6/1), both very micaceous, interlaminated, the sandstone generally predominating. ss locally silificied.
to 34.8'	Siltstone, light olive gray (5Y 6/1) with a few ss interbeds. Very micaceous.
to 41' Weston	Shale, medium light gray (N6), very slightly silty, fissile, locally micaceous and silty or very fine sandy.

REPORT ON KANSAS THIN SECTIONS

For Professor K. K. Landes

By E. W. Heinrich

Thin Sections 1-4, 10-12, and 1-25

These sections are of sandstone that contains, in addition to quartz, varying amounts of kaolinite, sericite, and limonite. Chlorite is very abundant in section 1-4, in which it occurs as dark green shreds and fibers. In the same section apatite occurs as inclusions in quartz, and a few rounded grains of zircon were also noted. Sericite is a distinctly minor constituent in this section.

Section 10-12 is somewhat coarser-grained than 1-4. Both zircon and sericite are more abundant, particularly the latter. Likewise, limonite is very common; chlorite is not nearly as abundant as in section 1-4. Kaolinite after feldspar is also present. Feldspar, some of which is still unaltered, appears; it is plagioclase from the indices.

Section 1-25 has a somewhat different texture than the other two sections. The grain size is approximately the same as that of 1-4, but the quartz grains are more rounded, and, whereas in the other two sections quartz grains are in contact with one another, in this section the subrounded grains are separated from one another by much fine-grained, interstitial kaolinite. In addition, there are thin layers rich in magnetite and sericite. There are also layers rich in sericite without magnetite, and there is also much sericite disseminated throughout the quartz-rich parts of the rock. Kaolinite is more abundant in this specimen than in the other two.

Section 21-66

This is a very fine-grained, dark brown shale whose chief components are sericite, kaolinite, calcite, and limonite. Locally lenses of material somewhat richer in fine-grained quartz occur. Some layers contain abundant calcite. Scattered throughout the rock are "eyes" of chloritic material. Some of these show a concentric structure with central parts rich in calcite. The chlorite is dark green in color and is generally characterized by a low birefringence, but some of the material of a similar color shows high birefringence, and may be slightly altered biotite.

Sections 21-24, 18-41, 21-10, and 18-66

These four sections are apparently of the same rock unit--a mica peridotite. The first three sections are similar in texture, being very coarse-grained. Mineral constituents are reddish brown to amber phlogopite, olivine, augite(?), hypersthene, magnetite, and apatite. The olivine and pyroxene have been strongly altered to antigorite, secondary magnetite, magnesite, and tremolite-actinolite. Very little of the olivine or of the pyroxene remains unaltered. Carbonate is particularly abundant in section 21-10.

Section 18-66 is characterized by a distinctive texture.

The rock is somewhat finer-grained, and corona structure is conspicuous. The central parts of the orbs consist of serpentine obviously replacing original olivine, and the rim consists of phlogopite blades arranged normal to the contacts of the core. These orbs are set in a fine-grained matrix which has been completely altered to serpentine, tremolite-actinolite, limonite, magnetite, and possibly some talc.

REPORT ON THE SILVER CITY PERIDOTITE
AND CONTACT AUREOLE
IN SOUTHWESTERN WOODSON COUNTY,
KANSAS

Paul C. Franks
11 June 1953

INTRODUCTION

The Silver City area is one of three areas of known igneous outcrop in the state of Kansas. (Moore and others, 1951, p. 30) At Silver City, serpentinized peridotite has been intruded into the surrounding Pennsylvanian sandstones, shales and limestones with the development of a contact metamorphic aureole.

The igneous body and the metamorphic aureole are located in sec. 32, T. 26 S., R. 15 E., southwestern Woodson County, Kansas. The area acquired the name of Silver City when it was thought that a silver strike had been made in the vicinity of the igneous body. Although no silver was found, the numerous prospect pits are an indication of the high hopes once held for the area.

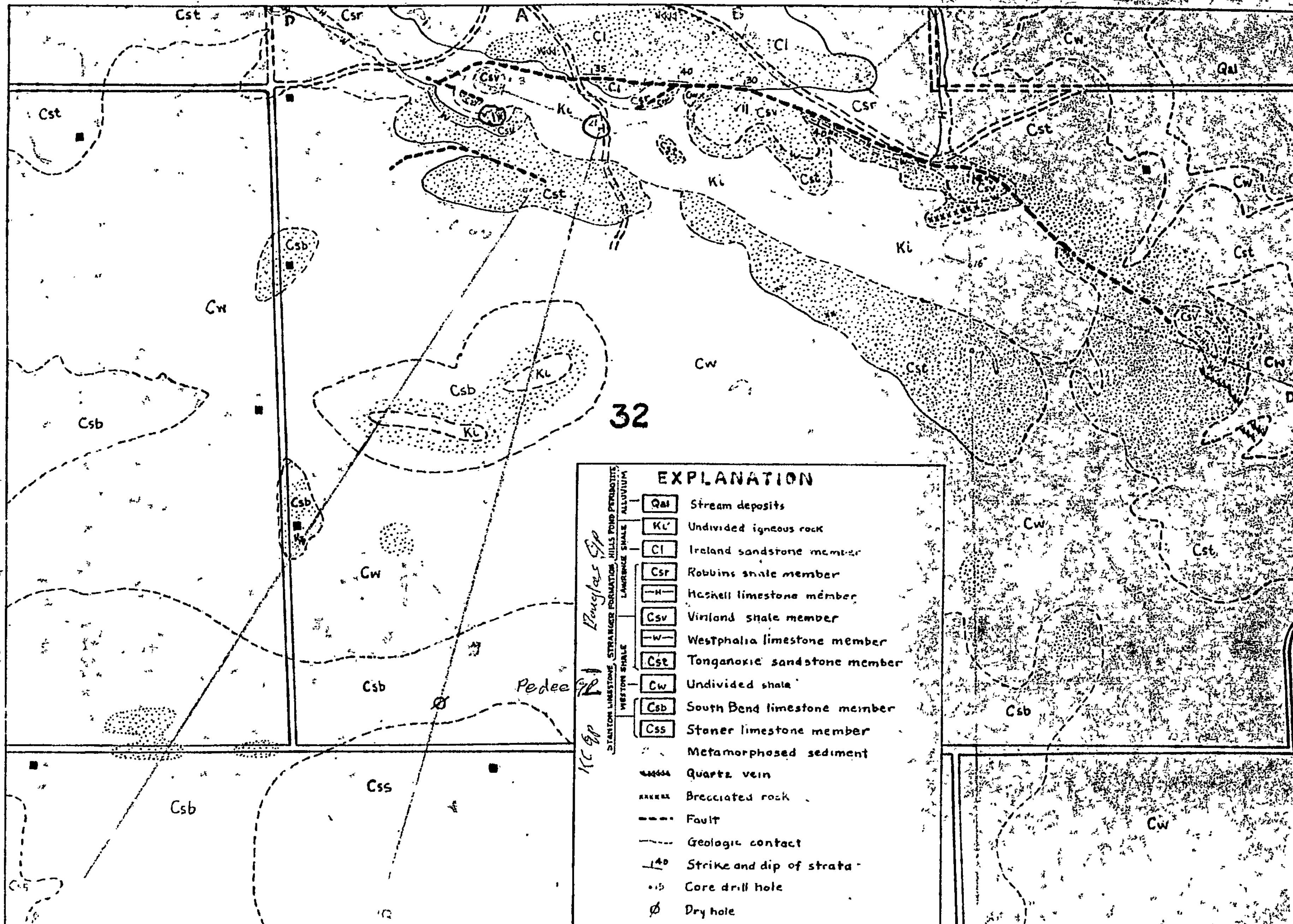
In more recent years (1946), attention has been drawn to the area as a possible source of vermiculite, bauxite, chromite, and road ballast. There are, however, no commercial amounts of vermiculite present. Nor is there any bauxite. Chromite has been reported from mechanical analyses made by the U. S. Bureau of Mines, but none was observed in the thin sections studied in this report. The dome which is associated with the intrusive has been drilled as a possible petroleum reservoir, but with negative results.

There is insufficient data to relate the Silver City peridotite to other igneous bodies in Kansas, even the nearby Rose Dome granite. The peridotite is unusual because of the well developed contact aureole, and the later hydrothermal activity. The intrusion of the igneous mass into an anorogenic region is also anomalous.

Some conclusions concerning the mode of emplacement and the contact effects are discussed in this report, as is the petrography of the igneous rock and a description of several thin sections cut from it and the metamorphosed sediments.

PREVIOUS WORK

The area attracted the attention of Twenhofel in 1921. In 1938, Schaffner published a paper on the metamorphic rocks of south Woodson County. Since that time, no information has been published on the Silver City intrusive. At the


32
EXPLANATION
ALLUVIUM
HILLS POND PERIDOTITE
LAWRENCE SHALE
STRANGER FORMATION
WESTON SHALE
STANTON LIMESTONE
Qal Stream deposits
Ki Undivided igneous rock
Cl Ireland sandstone member
Csr Robbins shale member
H Haskell limestone member
Csv Vinland shale member
W Westphalia limestone member
Cst Tonganoxie sandstone member
Cw Undivided shale
Csb South Bend limestone member
Css Stoner limestone member
Metamorphosed sediment
Quartz vein
Brecciated rock
Fault
Geologic contact
Strike and dip of strata
Core drill hole
Dry hole
Douglas Gp
Pedee Gp
KC Gp
Cst
Csr
Cl
Cw
Qal
Ki
Csb
Css

present time, the U. S. Geological Survey is sponsoring a study of the Fredonia Quadrangle which includes the Silver City area. The report, now in preparation, is by Holly Wagner, who is also writing a report on Woodson County for the Kansas Geological Survey. The field relations presented in this report are those determined by Mr. Wagner.

ACKNOWLEDGEMENTS

The writer is indebted to Prof. W. W. Hambleton (The University of Kansas) for his help in the study of the thin sections and the preparation of this report. Holly Wagner of the U. S. Geological Survey has been of great assistance. Through his effort, the cores taken from the area, those thin sections already cut, and certain reports concerning the area were made available for study.

GENERAL GEOLOGY

The geology of the area is shown in Fig. 1, which was prepared by Holly Wagner. Regionally, the Pennsylvanian sediments dip gently to the west-northwest, but here they are upturned on the flanks of the elongate, eroded Silver City dome which trends roughly west-northwest. The limited outcrops of the igneous and metamorphic rocks are exposed in the center of the dome. The igneous body is flanked on the north side by a fault downthrown to the north. The rocks adjacent to the fault are drag-folded and brecciated. Dips as steep as 80° are found along the fault, but they flatten rapidly away from it.

The stratigraphic section, as shown in the map legend ranges from the Stanton limestone of the Missourian series to the Lawrence shale of the Virgilian series. In general, the section consists of alternating sandstones, shales, and limestones.

The youngest rock cut by the intrusive body is the Ireland sandstone member of the Lawrence shale. On this basis, the peridotite can be dated as late post-Pennsylvanian.

The igneous body is sill-like in form. Core holes drilled into the igneous rock have passed through it into metasediments. Likewise, wells drilled in the area have passed through the igneous rock into sediments.

DESCRIPTIONS OF THIN SECTIONS

The thin sections described below were all cut from cores drilled on the Silver City dome. Certain sections had been prepared before this work was undertaken and others were cut at that time. The first number for a given thin section indicates the core hole from which the core was taken, and the second number indicates the depth on the core at which the section was cut. The core hole locations are shown in Fig. 1.

Whenever possible, it was attempted to identify the stratigraphic units from which the thin sections of metamorphic rock were cut. Samples to be sectioned were selected after megascopic examination of the cores with the intention of sampling as many different rock types as possible.

Section 1 - 4:

Section 1 - 4 is a fine-grained quartzite, probably metamorphosed Ireland sandstone. It shows a quartz mosaic made up of grains with a subangular habit, and in close contact with one another. The quartz grains show ~~no signs of secondary growth~~. There are no indications of siliceous or other cement binding the grains, except for minor amounts of clay minerals.

Minor amounts of feldspar, probably plagioclase, has developed in the rock. The feldspar is optically positive, and the indices are less than those of the quartz, indicating that it is either oligoclase or andesine. The grains of plagioclase show porphyroblastic tendencies with respect to the quartz, apparently having developed at the expense of the quartz. Sutured outlines indicative of replacement, however, are absent.

The section contains abundant chlorite which is largely interstitial to the quartz. Interstitial sericite is present in parts of the section. It probably formed after the chlorite since it transects the chlorite flakes. Some sericite may have developed through the alteration of the feldspar.

Limonite is common in the section. Much of it appears to be an alteration product of the chlorite. Minor amounts of clay materials are closely associated with the limonite. Small, rounded grains of zircon are present in the section as inclusions in the quartz.

Minor amounts of euhedral apatite are present. It is probable that they are grains of hydroxyl apatite which has been identified in the metasediments of the area through X-ray studies. (Ada Swineford, Kansas Geological Survey, personal communication)

In general, there is no strong alignment of the mineral grains in the section, except for a tendency toward preferred orientation of the chlorite and sericite flakes parallel to the traces of former bedding. Most quartz grains show no undulatory extinction, indicating that the rock was not under appreciable strain during recrystallization.

The percentage composition of the section has been estimated as follows:

Quartz	70%
Chlorite	20%
Clay minerals	4%
Feldspar	3%
Limonite	2%
Sericite	1%
Apatite	trace
Zircon	trace
	100%

Section 1 - 25:

Section 1 - 25 probably has been cut from metamorphosed Ireland sandstone on the basis of its location and depth. It consists of fine, subrounded quartz grains seperated from one another by clay matter and/or limonite as welllas sericite. Some of the clay material in the section appears to be derived from feldspars, probably plagioclase as described in 1 - 4.

Well developed flakes of sericite are segregated into zones and aligned subparallel to the bedding. Stringers of magnetite and pyrite are also found parallel to the bedding. They are best developed in those zones rich in sericite.

Traces of leucoxene after ilmenite may be present in close association with the magnetite. Rounded grains of zircon and euhedral grains of apatite are also present in the section.

Percentage composition:

Quartz	60%
Clay minerals	20%
Magnetite	8%
Limonite	5%
Sericite	4%
Pyrite	2%
Feldspar	1%
Apatite	trace
Zircon	trace
Leucoxene (?)	trace
	100%

Section 10 - 12:

The rock in this section is metamorphosed Ireland sandstone showing a quartz mosaic of medium grain size. The quartz grains are subangular to subrounded, and some show faint signs of secondary growth and suturing. Some quartz seems to be present as a cementing material, although most of the interstitial material is clay, limonite and chlorite. Many of the quartz grains are in direct contact with neighboring grains.

The interstitial chlorite is brown in color because of partial alteration. There is little tendency of the chlorite toward preferred orientation parallel to the traces of former bedding. Minor amounts of fine-grained sericite are also present.

Zircon is relatively abundant in this section. The grains are generally well rounded and are probably of sedimentary origin. Well developed, but altered plagioclase without twinning is present.

Anhedral magnetite is present associated with the sericitic layers, as is what may be leucoxene.

Percentage composition:

Quartz	65%
Chlorite	18%
Clay minerals	8%
Limonite	5%
Sericite	2%
Magnetite	1%
Feldspar	1%
Leucoxene (?)	trace
Zircon	trace
	100%

Section 11 - 2:

The section is a hornfels derived from the Vinland shale. The rock is composed of clay minerals, chlorite, and limonite. Two veinlets of what may be hydroxyl apatite are present. There is no preferred orientation of any of the minerals found in the slide.

Section 11 - 5:

In this section, the Vinland hornfels is composed primarily of chlorite, clay minerals and limonite. Coronas of chlorite which grade into the argillaceous, chloritic and limonitic groundmass are present. Finely divided quartz is erratically disseminated through the groundmass.

Section 11 - 13.4:

Section 11 - 13.4 is metamorphosed Vinland shale which is now a chlorite-sericite hornfels. The groundmass of the rock is fine chlorite and sericite with some tendency toward orientation parallel to the traces of the former bedding. Limonite and clays are concentrated in zones parallel to the bedding. Radiate knots of chlorite and sericite in such zones have resulted in lighter colored coronas. Some talc may be present in the light-colored coronas.

Blebs of calcite and other blebs of clay minerals are scattered randomly through the rock.

Section 11 - 14.8:

This section was probably cut from metamorphosed ~~Vinland~~ shale in which the bedding is still apparent. Chlorite and sericite are the major constituents of the fine-grained groundmass and they show a tendency toward preferred orientation parallel to the bedding. Small blebs of calcite are disseminated through the rock.

Section 18 - 41:

Section 18 - 41 shows intensely altered igneous rock. There are no traces of the original olivine and augite of the peridotite. The only primary igneous mineral still present is an amphibole of uncertain affinities described under section 21 - 24. The major constituents of the rock are serpentine, limonite and clay. X-ray and D.T.A. studies of surface clays from the igneous rock indicate that they are montmorillonoid, probably nontronite. It is probable that the clays from more deeply buried portions of the igneous body are also nontronite (?). Also present in the section is phlogopite, some of which has been bleached, and minor quantities of a carbonate, probably magnesite.

The rock in the section is located only 14.5 ft. above a zone of brecciated chert. It is quite possible that the intense alteration of the rock is due to the more active circulation of hydrothermal and phreatic waters along the zone of brecciation.

Section 18 - 55.6:

Section 18 - 55.6 is of a chert breccia which is cut by quartz veins containing pyrite and penninite in places. Robbins Replacement

Similar chert is found at the surface. The surface chert is a replacement of the metamorphosed Tongonoxie sandstone and/or Vinland shale and appears to be of hydrothermal origin, particularly since considerable chlorite is found in the groundmass of the chert.

After brecciation of the chert, quartz veins containing pyrite and penninite were formed. Along with the hydrothermal introduction of the quartz, penninite and pyrite, some recrystallization of the chert may have taken place as is evidenced by its coarse character and the sutured habit of many of the grains of quartz in the breccia filling bordering the chert.

Provided that the chert in this section is of hydrothermal origin, indications are that there were at least two stages of hydrothermal activity following the intrusion of the peridotite. Both these stages involved the introduction of silica.

Section 18 - 66:

The section shows a relatively fine-grained and highly altered sample of the igneous rock. Of particular interest in the section is a well developed corona structure involving a serpentine core rimmed by phlogopite blades arrange normal to the contact with the serpentine. The serpentine core of the coronas appears to have formed through the alteration of primary olivine. The corona structure lends support to the idea that the phlogopite is not a primary igneous mineral in the rock, but that it is more likely a product of deuteric alteration.

The groundmass of the rock is composed of serpentine, clays, and limonite as in other sections of the igneous rock. However, some talc as well as tremolite-actinolite may be present.

Section 21 - 10:

The section was cut from the altered igneous rock. It contains serpentine, both chrysotile (in minor amounts) and antigorite, olivine, augite, the unknown amphibole, phlogopite, nontronite (?), limonite, leucoxene (?), apatite, and carbonates, probably magnesite.

The amount of the carbonate minerals in this section is relatively high (10%). The magnesite (?) appears to be a replacment after serpentine, although much of it transects and replaces the phlogopite.

The near-surface location of the rock in this section may account for the relatively intense alteration observed in this slide.

Section 21 - 24:

Section 21 - 24 was cut from the igneous body. In this section, the rock is of medium to fine grain size. The primary minerals of the peridotite were olivine, augite, and the amphibole of uncertain identity. There may have been minor amounts of primary magnetite and ilmenite, but most of the magnetite appears to have formed during the alteration of the olivine and augite to serpentine.

Much of the rock is now composed of clay minerals which X-ray and D.T.A. curves on surface samples have shown to be a montmorillonoid clay (nontronite (?)). Limonite has formed as another weathering product in the igneous rock, as has a carbonate (magnesite (?)).

The phlogopite remains relatively unaltered, except at surface exposures where it has been converted to a vermiculite type of mica. In the subsurface, the phlogopite occurs in well-developed euhedral books. Inclusions found within the phlogopite are euhedral grains of hydroxyl (?) apatite, remnants of olivine, augite, and the unknown amphibole. Because of this and the coronas described under section 18 - 66, it is thought that the phlogopite formed as a product of deuteric alteration of the original peridotite.

Likewise, the serpentine now found in the rock, including the antigorite and the minor amounts of chrysotile, may have formed through deuteric alteration, but it is likely that some of the serpentine is the result of later alteration through hydrothermal activity and weathering. The later hydrothermal activity probably resulted in the introduction of the pyrite found in the igneous body.

Chromite has been reported in mechanical analyses of the peridotite, but none has been observed in the thin sections.

The minerals found in this and other sections show no tendency toward preferred orientation, including the chrysotile veinlets. It is probable, therefore, that the peridotite crystallized in situ and that solid state intrusion did not take place. The later hydrothermal activity may be closely related to the fluids necessary to keep the olivine rich magma fluid during intrusion at low temperatures.

The percentage composition of the section is estimated as follows:

Serpentine	42%
Phlogopite	25%
Nontronite (?)	10%
Limonite	8%
Olivine	7%
Augite	4%
Magnetite and other opaques	3%
Amphibole unknown	2%
Magnesite (?)	trace
Apatite	trace
	100%

The amphibole unknown has the following characteristics: it is bi-axial negative with a 2V of about 45°; it is length-slow. Given proper orientation, it shows good amphibole cleavage and pleochroism with X and/or Y pinkish, and Z clear; interference figures show dispersion with r greater than v; interference colors range up to first order yellow; z angle c = 14°±.

Section 21 - 65.3:

The rock in the section is highly altered peridotite with corona structures developed in places. The coronas involve serpentine cores after olivine and rims of phlogopite with the blades oriented normal to the contact with the serpentine. In som e of the coronas, the phlogopite appears to have replaced the olivine in the centers contemporaneously with or prior to the development of the serpentine.

There are no traces of the original igneous minerals in the slide. Instead, serpentine, talc, clay, magnesite (?), and phlogopite are present.

~~A feldspar, probably plagioclase,~~ Optically (+) length fast Zoolite is relatively abundant in the section. The grains are anhedral, without twinning, and hold remnant inclusions of the above minerals except for the clay and magnesite (?).

The whole rock is cut by the magnesite (?) veinlets which are generally parallel and of a sub-horisomtal nature. Minor amounts of magnetite are present in the section.

Percentage composition:

Phlogopite	30%
Serpentine	20%
Talc	16%
Feldspar	15%
Nontronite (?)	7%
Limonite	6%
Magnesite (?)	5%
Magnetite	trace
	100%

Section 21 - 66:

The section was cut from an argillaceous hornfels. The rock still shows prominent bedding. The groundmass is composed largely of clay minerals and limonite with finely disseminated chlorite, sericite, calcite and quartz. Segregated layers rich in calcite and/or quartz have developed parallel to the bedding. The sericite of the groundmass shows a tendency toward preferred orientation sub-parallel to the bedding.

An unusual corona structure is also found in the section. The coronas show centers of calcite, with or without serpentine, and they are rimmed by concentric rings of chlorite. Veinlets of calcite are also present in the section.

The rock may be metamorphosed Vinland shale.

Sections 21 - 69.5A, B, and C:

These three sections are all from the same piece of core, taken at successively lower intervals, and spaced approximately 1 in. apart.

A is of an aragonite vein which cuts through the country rock. The aragonite fibers are oriented normal to the walls of the vein and show signs of partial inversion to calcite. Small fragments of chloritized country rock are found as inclusions in the aragonite.

B is a quartzite with a mosaic of fine, subangular and sutured quartz grains. Interstitial to the quartz is considerable chlorite, sericite, penninite, clay and limonite. Minor amounts of plagioclase feldspar showing albite twinning have developed in the mosaic. Pyrite has been introduced as a replacement after quartz. Much of the chlorite and sericite shows a general tendency for the flakes to be aligned sub-parallel to the bedding, but some larger and well developed flakes of chlorite showing no preferred orientation are present.

C is essentially the same as B except that some of the chlorite and sericite occur in segregated bands aligned parallel to the bedding. Along with the pyrite, there are indications of minor amounts of leucoxene (?).

The percentage analysis of the sandstone is approximately as follows:

Quartz	55%
Sericite	17%
Chlorite	10%
Clay minerals	10%
Limonite	5%
Penninite	1%
Plagioclase	1%
Pyrite	trace
Leucoxene (?)	trace
	100%

Section 21 - 71:

The section is cut along a contact between a metamorphosed shale and either a limestone or a calcite vein.

The shale side of the section shows well developed knots of radiate penninite in a groundmass of finely divided chlorite, clay minerals and limonite. Also present are small blebs and disseminations of fine quartz grains. Veinlets of calcite penetrate the argillaceous hornfels from the calcareous side of the section.

The calcareous portion of the section shows finely crystallized calcite which may be a metamorphosed limestone. Magnetite is present in anhedral blebs. Pyrite, partially altered to limonite, is present in cubes. Stringers of finely divided quartz are present in the calcite.

Section 21 - 80:

The section is an argillaceous hornfels. It may have been a shale member in the Tongonoxie sandstone.

The shale has been converted to a finely divided chloritic rock containing a high percentage of clay minerals. Calcite veinlets are common, but sericite is scarce in the rock. Much of the chlorite has been segregated into "eyelets" in which the chlorite shows random orientation. In the groundmass, the chlorite is aligned sub-parallel to the traces of former bedding.

Blebs of cryptocrystalline quartz are found in the calcite veinlets.

PETROLOGY OF THE PERIDOTITE

The igneous intrusive is a sill-like body with very definite upper and lower limits. Cores drilled through the igneous rock passed into metasediments at depths of 66 ft. in holes 21 and 18. Drillers logs of nearby wells have also indicated a sill-like form for the intrusive.

The exact horizontal extent of the body is indeterminate on the basis of present information, but areas of slight thermal metamorphism are found at considerable distances (See map.) from the known igneous outcrops. It is probable that such areas are underlain by igneous rock.

There are no textures or structures within the fine-grained igneous rock that indicate the intrusion of the peridotite as a serpentinite in the solid state or the intrusion of a very viscous liquid. The random orientation of grains indicates rather that intrusion took place while the rock was still quite mobile. This is in contrast to the concept of solid-state or viscous intrusion which is held to be the mechanism of emplacement for most peridotites. (Turner and Verhoogen, 1951, pp. 246, 252)

The original igneous rock contained olivine, augite, and an amphibole of uncertain identity as essential constituents. Remnants of the minerals show fair euhedral habits. Also present in the original rock may have been magnetite, ilmenite, and chromite. No chromite was observed in the thin sections studied, but it has been reported in mechanical analyses conducted by the U. S. Bureau of Mines. Much of the magnetite now found in the rock is probably the result of alteration of the original igneous minerals to serpentine. Part of it may also be related to later hydrothermal activity.

The unidentified amphibole shows the following characteristics: given proper orientation, it shows good amphibole cleavage and pleochroism with X and/or Y pinkish in color and Z clear; it is biaxial negative and length slow; 2V is about 45°; dispersion is r greater than v; interference colors range up to first order yellow; z angle c is about 18°.

Prior to serpentinization of concurrently with it, the phlogopite developed in the rock. It is believed to be a product of deuteric alteration of the olivine as described on pages 7 and 8. Serpentinization of the igneous rock has resulted in the formation of magnetite along with the antigorite, scarce chrysotile veinlets, and magnesite (?). Further alteration has led to the formation of a montmorillonoid clay (nontronite (?)), and limonite. Hydrothermal activity has resulted in the formation of some feldspar in the peridotite as described under section 21 - 65.3 as well as pyrite and perhaps some of the magnetite, but the latter cannot be stated with any degree of certainty. The late hydrothermal activity may be responsible for much of the intense alteration of the rock.

The extent of the contact aureole and the grade of metamorphism in the aureole indicates that the temperature of the intrusion was quite low. Since intrusion did not probably take place in the solid or viscous state, it is likely that there was considerable water associated with the magma. Experimental evidence, however, indicates that a high water content is not possible in a peridotite magma. (Turner and Verhoogen, 1951, p. 246) The author, however, is of the opinion that mineralizers in some form must have been present to account for a highly fluid intrusion of magma and the later hydrothermal activity.

The contact aureole extends up to 1,000 ft. from the area of igneous outcrops. How much of the metamorphosed area is underlain by shallow igneous rock is not known. It is probable that certain metamorphic areas removed from the igneous outcrop are underlain by igneous material. (See Fig. 1.)

It is difficult to determine which effects are due to contact metamorphism and which are due to the later hydrothermal activity. The time element of the two factors is likewise difficult to determine, but it seems probable that the hydrothermal activity followed very closely after the contact metamorphism.

The major products of the contact metamorphism are the quartzites and chlorite-sericite hornfelses of the area. There has been no high grade metamorphism resulting from the intrusion of the peridotite. All the metamorphic minerals are of low rank and relatively fine grain size. The sandstones have been recrystallized into quartzites whereas clay minerals and limonite present have been converted to chlorite, sericite, and magnetite. The zircon in the quartzites has remained relatively unchanged. The feldspars in the quartzites are probably of metamorphic origin. It is unlikely that any detrital feldspar would be found in sediments such as the Ireland and Tonganoxie sandstones which are so far removed from areas of igneous outcrops. The pyrite may be a product of metamorphism, but in certain sections, it is closely associated with hydrothermal quartz and calcite. It is, therefore, probably of hydrothermal origin. The origin of the leucoxene (?) remains uncertain.

The hornfelses are composed largely of chlorite and sericite. The origin of the quartz and calcite found in the hornfelses is uncertain, but it is possible that they are in part metamorphic segregates.

Indications of strain during metamorphism are practically absent. Some of the quartz does show slight undulose extinction. Any of the preferred orientation of the micaceous minerals is subparallel to the bedding. These effects are more likely due to load rather than tectonic forces.

No limestones were found in the cores drilled through the igneous rock. What accounts for their absence is uncertain. Perhaps the peridotite was emplaced by means of assimilation of the limestone country rock. Perhaps the cores did not penetrate to the limestones in the section. Metamorphic affects on the limestone, therefore, remain indeterminate.

Hydrothermal activity following intrusion of the original peridotite magma probably resulted in the further serpentinization of the peridotite and the development of some feldspar in the body. It is thought that the source of the anomalous hydrothermal fluids lies in the mineralizers necessary for the low-temperature, liquid-state intrusion of the peridotite.

The major effects of the hydrothermal activity were the development of hydrothermal (?) chert (See under section 18 - 55.6) in brecciated zones, and the development of quartz calcite veins cutting both the metasediments and the igneous intrusive. In those veins cutting the peridotite, the quartz is amethystine. Veins containing quartz and hydroxyl apatite have been found cutting surface exposures of the Haskell limestone. Veins of hydroxyl (?) apatite have been found cutting the hornfelses in the cores. One vein of fibrous aragonite was found in the thin sections. Pyrite and some penninite has been found in the quartz veins.

The paragenetic sequence as far as can be determined was first the development of the chert followed by the introduction of the vein quartz and calcite. The exact position of the other minerals in the sequence remains uncertain.

The degree of hydrothermal silicification of the country fock is uncertain, but it is probably very slight. Very little evidence for secondary growth of quartz grains in the quartzites has been found. Some of the quartz found in the hornfelses may be of hydrothermal origin, but it seems more likely that it is a metamorphic segregate.

The hydrothermal activity, besides furthering the alteration of the peridotite, may be responsible for some of the alteration of the hornfelses back to clay and the redevelopment of clay minerals in the quartzites.

CONCLUSIONS

The Silver City peridotite is a low-temperature sill-like body. Intrusion was probably in the liquid state, the mineralizers being responsible for later hydrothermal activity. Deuteric alteration was probably responsible for the development 66 the phlogopite in the rock. Following intrusion, the rock suffered intense alteration during which the original olivine and other primary minerals were converted largely to serpentine.

The small size of the contact aureole is indicative of the low temperature of the intrusion. The thermal metamorphism of the country rock in the aureole has resulted in the development of quartzites and chlorite-sericite hornfelses indicative of the lower grades of thermal metamorphism. Tendencies toward preferred orientation of the minerals in the metasediments is generally parallel to the traces of former bedding. This may be partly due to the influence of load during thermal metamorphism. The influence of tectonic forces is thought to be practically nil.

Later hydrothermal activity is thought to be responsible for the formation of cherts in certain portions of the contact aureole, as well as the formation of quartz-calcite veins and quartz-hydroxyl apatite veins. The later hydrothermal activity is not thought to be responsible for the silicified nature of the country rock. It is more likely due to recrystallization during thermal metamorphism. Nonetheless, hydrothermal quartz derived from a peridotite magma is recognized as anomalous.

BIBLIOGRAPHY

Moore, R. C. and others (1951) The Kansas rock column: Kans. Geol. Survey Bull. 89, 132 pp.

Schaffner, D. C. (1938) Metamorphic rocks in south Woodson County, a preliminary paper: Kansas Acad. Sci. Trans., Vol. 41, pp. 223 - 224.

Turner, F. J. and Verhoogen, J. (1951) Igneous and metamorphic petrology: New York, McGraw Hill, 602 pp.

Twenhofel, W. H. (1917) The Silver City quartzites, a Kansas metamorphic area: Geol. Soc. Am. Bull., Vol. 28, pp. 419 - 430.

Twenhofel, W. H. and Edwards, E. C. (1921) The metamorphic rocks of Woodson County, Kansas: A. A. P. G. Bull., Vol. 5, pp. 64 - 74.

Addenda

Report on Silver City Peridotite

The section cut by Prof. Kinney and described as typical of certain veinlets cutting the main body of the igneous rock was found to contain the following minerals in the percentages listed:

Mineral	Percentage
Quartz	37
Calcite	23
Phlogopite	15
Clay material and limonite	11
Pyrite	9
Magnetite	4
Apatite	1
Penninite	trace
	100%

Remnant inclusions as well as mineral boundaries indicate that the phlogopite was present prior to the development of the quartz and calcite which replace it. The magnetite appears to have formed prior to the quartz, but its relation with the phlogopite seems indeterminate. The pyrite and the quartz are probably syngenetic, both of them having developed prior to the calcite.

It seems probable that the magnetite, clay minerals and limonite (except that derived from the alteration of pyrite) were developed through the silicification of the original peridotite. The penninite, also, probably falls in this same category.

READINGS ON SILVER CITY

Twenhofel (1917) The Silver City quartzites, etc.:

Did not believe the metamorphics to be related to intrusion.

Twenhofel (1928) The metamorphic rocks of Woodson County, Kansas:

Debated presence of an intrusion.

Moore (1920) An outcrop of basic igneous rock in Kansas: Bala Intrusive

Rock described as a kimberlite or porphyritic peridotite. Brucite and chromite described in the thin sections. Chromite present as blobs with brown transluscent borders.

Microscopic Character:

"Groundmass. Primary minerals: Chromite, black and opaque, in irregular grains, usually showing a limonitic stain about the borders, and in a number of cases surrounded by kaolin stained reddish brown by the weathering of the chromite, 5 to 10 per cent of groundmass. No biotite was recognized in the sections.

"Secondary minerals. The groundmass is chiefly composed of serpentine and calcite. The serpentine is in pale greenish-yellow masses and stringers, and the calcite in irregular grains. These two secondary minerals break up the outline of the original minerals and produce a heterogeneous mass which is very difficult to identify. The striking features of the groundmass are the phenocrysts and the inclusions.

"Phenocrysts. (a) Some of the phenocrysts show fairly sharp angylar outlines which are recognizable as original pyroxene crystals now changed to pale yellowish green serpentine, green chlorite and calcite; (b) some are rounded grains, which show irregular cracks and coloration varying from pale yellowish-green to darker green, these are regarded as altered olivine crystals; (c) a considerable portion of the apparent phenocrysts vary from irregularly angular to rounded forms, are of extremely variable sizes, generally larger than (a) and (b), and show zonal bands about the margins. In plane polarized light the colors are pale yellowish-green with a border zone of darker tone which is distinctly granular. Under crossed nicols these masses are seen to be composed of an aggregate of very fine grains, chiefly quartz and kaolin and some feldspar. These pseudophenocrysts therefore are regarded as inclusions of shale in a more or less altered condition.

..." studied by Mr. W. Harold Tomlinson, of Swarthmore, Pa.: 'Samples 2 and 3 are metamorphosed basic igneous rocks, probably dikes. Section of Sample 2 shows serpentine and calcite to be the principal minerals, apatite and a black (brown by tansmitted light when very thin), metallic mineral of the isometric system, probably chromite, are accessory. The rock is thickly porphyritic. The phenocrysts which form about half the rock are rounded and consist of serpentine and calcite replacing olivine. A few have the form of augite, but as the angles have been rounded in alteration it is impossible to say what proportion. The apatite occurs rather thickly in small rounded crystal grains. There is a little chlorite with the serpentine. Sample 3 is a very similar rock, but does not have the apatite. Some of the phenocrysts in this sample are altered biotite, some probably augite, but the great majority altered olivine. There is relatively more calcite and less serpentine. Brucite was found with the serpentine in an altered phenocryst of olivine. Metamorphism by carbonation andhydration is extreme in both samples. I would classify 2 and3 as kimberlite or porphyritic peridotite.'

...

"It will be noted that Mr. Tomlinson makes no mention of the type (c) psuedo phenocrysts or shale inclusions. It is possible that his samples may not have contained them, though this seems unlikely in view of their widespread occurrence through the igneous rock in all parts."

presently in any particular segment of such an imbricate complex; that it must be free of subsequent deformation; and that a specific rock of advanced tectonic transport must be exposed as roots at any given level of erosional truncation of the complex. Regarding the involvement of pre-Cambrian rocks, and in addition to the foregoing, can it be categorically denied that the structures involving pre-Cambrian rocks in the Arbuckle Mountains, for example, do not relate directly to Ouachita tectonics?

7. The lack of evidence over large areas is normal for occurrences of isolated klippen, for all klippen exist only as a consequence of removal elsewhere of the thrust plate.

The comment on the St. Francois felsite-granite-diabase relations is a complete irrelation ignoring that part of the paper which mentions the undeniably autochthonous pre-Cambrian crystallines in the eastern part of the area. It is these rocks that are the subject of Robertson's abstract (1965).

This reply is not a defense of the St. Francois thrust interpretation, for such is not called for by the preceding discussion. It is merely to point out that none of the discussion disqualifies or weakens that interpretation. The St. Francois thrust will be demonstrated or disproved in the St. Francois Mountains of Missouri and neighboring areas. If the interpretation should prevail, the Ouachita belt will remain the most likely source for the reasons stated in the paper, at least until a seemingly improbable and more distant source may be shown to have equal potential.

Finally, it would be remiss not to take this occasion to credit Bretz (1965) for his recognition of the *geomorphic* anomalies involving the "... curious ... survival of Precambrian [St. Francois] mountains [which] have remained without any notable modification through the vicissitudes of all subsequent erosion" (p. 21); and for pointing out that the "complex" drainage pattern "... fits no textbook classification." In his review of the Bretz paper, Holmes (1965) seems equally discontent in his notation that "... by far the most enigmatic, are the [pre-Cambrian] St. Francois Mountains which ... have stood as topographic eminences through much of subsequent time; yet their partially exhumed valleys carry no record of peneplanations that have repeatedly beveled the surrounding Paleozoic formations" (p. 823). At this point it seems more than mere coincidence that most of the glaring drainage incongruities, which Bretz has ingeniously attempted to explain (but with somewhat less than complete self-assurance), actually should be anticipated if one were to envisage that the principal streams may have been let down through a wasting plate of resistant pre-Cambrian rocks—a condition requiring continuously varied adjustment of tributaries to the ever-changing terrane.

References

Bretz, J. H., 1965, Geomorphic history of the Ozarks of Missouri: Missouri Geol. Survey and Water Resources, v. 41, 2d ser., 147 p.

Holmes, C. D., 1965, Review of Geomorphic history of the Ozarks of Missouri: Am. Jour. Sci., v. 263, p. 823–824.

Robertson, Forbes F., 1965, Petrology of St. Francois batholith (abs.): Geol. Soc. America Program, 1965 Annual Meeting, Kansas City, Mo.

Wheeler, Harry E., 1965, Ozark pre-Cambrian-Paleozoic relations: Am. Assoc. Petroleum Geologists Bull., v. 49, no. 10, p. 1647–1665.

Ozark Precambrian–Paleozoic Relations: Discussion of Igneous Rocks Exposed in Eastern Kansas[4]

PAUL C. FRANKS[5]
Lawrence, Kansas

Introduction

In a provocative article on "Ozark Pre-Cambrian-Paleozoic Relations," that was published in the October, 1965, issue of this *Bulletin*, Harry E. Wheeler proposes (p. 1655–1657) that the igneous and contact-metamorphic rocks exposed in Kansas may be klippen derived from his so-called St. Francois thrust. Field and petrographic evidence, much of it already published, negates Wheeler's thesis.

[4] Release for publication authorized by the director of the State Geological Survey of Kansas. Manuscript received, December 2, 1965.

[5] State Geological Survey of Kansas, The University of Kansas.

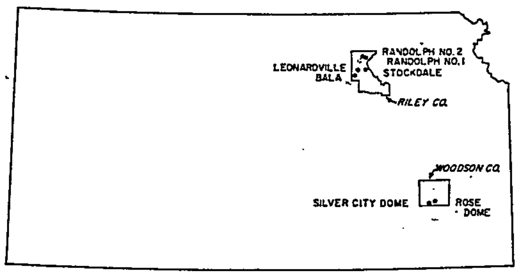


FIG. 1.—Outline map of Kansas showing locations of exposures of igneous rocks.

ALKALINE ULTRAMAFIC ROCKS NOT EVIDENCE OF THRUSTING

Harry E. Wheeler (p. 1656, 1658, 1659) stresses that the alkaline ultramafic rocks of Kansas (Fig. 1) are not part of a normal cratonic association. Concerning the peridotite intrusions of Riley County, Kansas, he states (p. 1656) ". . . that they may represent parts of a body whose more appropriate original emplacement was geosynclinal rather than cratonic." However, it is important to note that peridotites can be divided conveniently into three classes: (1) those whose association is geosynclinal, (2) those associated with stratified mafic plutons, and (3) those whose association is cratonic (*cf.* Turner and Verhoogen, 1951, p. 225, 239; Davidson, 1964; Bailey, 1964). Peridotites of geosynclinal and plutonic associations differ markedly in chemistry and mineralogy from those of cratonic association. The geosynclinal and plutonic peridotites are composed largely of olivine, enstatite, and diopsidic augite. Chromite and picotite commonly are the main accessory minerals. Alteration of olivine to serpentine ranges from incipient to complete in peridotites of orogenic regions. Concentrations of alkalies are low.

In contrast, the alkaline ultramafics of cratonic regions show considerable variation in mineralogy. Serpentinization of olivine seems to be nearly complete in most alkaline ultramafics. Phlogopite or biotite, together with diopsidic augite, alkali or other types of amphibole, and calcite or dolomite are common components. Relatively exotic minerals (as melilite, perovskite, chromite, and pyrope) are common accessories in some alkaline ultramafics; locally, pectolite, magnetite, ilmenite, diamond, and other minerals may be important accessories. The rocks range from alnöite through kimberlite to mica peridotite (*cf.* Kidwell, 194?; Martens, 1924; Singewald and Milton, 1930; Tarr and Keller, 1933), but most contain appreciable K_2O or Na_2O (for example, as much as 6 per cent K_2O and 1.5 per cent Na_2O in mica peridotite at Rose and Silver City domes in Kansas).

Brock and Heyl (1961) have summarized data on the widespread occurrence of alkaline ultramafic rocks in the cratonic interior of the United States. More recently, Davidson (1964) has noted the cratonic association of alkaline ultramafics in Russia, and Bailey (1964) has stressed the same relationship in Africa. Thus it seems that the mica peridotite that has intruded Rose and Silver City domes, and the kimberlites of Riley County, Kansas, are in their proper cratonic association. Hence, there is no need to postulate a major overthrust involving displacements of the order of 330 miles (Wheeler, 1965, p. 1662) to account for the emplacement of alkaline ultramafic rock in eastern Kansas.

ROSE DOME

Granitoid igneous rock is found at the surface on Rose dome partly as rounded blocks scattered in the SE. ¼, sec. 13, T. 26 S., R. 15 E., Woodson County, Kansas, and in nearby parts of adjacent sections. Wheeler (p. 1655–1656) has cited this enigmatic occurrence of "granite"[6] as supporting evidence for his proposed St. Francois thrust.

By use of quotation marks in referring to Rose dome (Wheeler, p. 1648, Fig. 1; p. 1655, 1656) and by direct statement (p. 1655), Wheeler seems to imply that Rose dome is not a structural dome, but rather a topographic high; hence, part of a klippe. The "granite" actually is found near the apex of a breached domal structure. Structural contour maps, using the base of the Plattsburg Limestone (Pennsylvanian) and the top of the Mississippian as datum, show more than 50 feet of closure on the crudely ovoid dome (Hambleton and Merriam, 1955, Pl. 2).

Wheeler (p. 1656) also uses a quotation from Twenhofel (1926, p. 403) to support the idea

[6] The term "granite" is used in quotation marks here to emphasize that the rock on Rose dome differs from most granite in that it shows amazing textural heterogeneity and because much of the contained feldspar has optical and X-ray characteristics indicative of high-temperature or volcanic feldspar (Franks, 1965). Except for these peculiarities, the rock might be described as a leucogranite.

f. Kidwell, 1947;
Iilton, 1930; Tarr
ontain appreciable
nuch as 6 per cent
mica peridotite at
Kansas).
summarized data
of alkaline ultra-
rior of the United
dson (1964) has
of alkaline ultra-
1964) has stressed
ca. Thus it seems
has intruded Rose
the kimberlites of
heir proper craton-
no need to postu-
ving displacements
eeler, 1965, p. 1662)
nt of alkaline ultra-

ound at the surface
led blocks scattered
R. 15 E., Woodson
y parts of adjacent
656) has cited this
nite"[6] as supporting
Francois thrust.
in referring to Rose
. 1; p. 1655, 1656)
p. 1655), Wheeler
me is not a structur-
graphic high; hence,
te" actually is found
ed domal structure.
ing the base of the
nsylvanian) and the
datum, show more
n the crudely ovoid
iam, 1955, Pl. 2).
ses a quotation from
to support the idea

ed in quotation marks
rock on Rose dome
that it shows amazing
because much of the
al and X-ray charac-
emperature or volcanic
ept for these peculiar-
ribed as a leucogranite

that the "granite" on Rose dome is allochthonous; hence, part of a klippe. Actually, the quotation from Twenhofel seems to have been taken out of context, for it comes from the introduction of the paper in which Twenhofel, after referring to his earlier considerations (1917, 1919), finally concluded that the "granite" on Rose dome had been intruded into the associated Pennsylvanian sedimentary rocks. Because Wheeler's statement that ". . . Twenhofel found it difficult to envisage an intrusive relationship. . . ." follows the quotation, Wheeler implies that Twenhofel did not believe in 1926 that the "granite" had intruded the sedimentary section.

In his 1926 paper, however, Twenhofel actually described a contact that he found between the "granite" and metamorphosed Pennsylvanian Weston Shale in the grader ditch on the east side of sec. 13, T. 26 S., R. 15 E. (p. 404-405). On page 407 he showed a photograph of a sample that he collected from the grader ditch; the "granite" is in direct contact with metamorphosed shale in the sample. On page 406 he stated:

"The theory of glacial origin for the granite blocks is discarded, as the facts indicate that they are the surface exposures of a granite mass intrusive in the Pennsylvanian and lower strata."

In the same article (p. 411) he stated:

". . . it is concluded that the granite blocks which are strewn over the surface of the Rose dome are the surface exposures of a granite mass that was intruded into the Pennsylvanian and lower strata."

Wheeler (p. 1656) also credits me with a personal communication to Merriam (1963, p. 152) whereby I relayed information to Merriam on the Rb/Sr age determination of 1,220 million years calculated for Rose "granite" by the U. S. Geological Survey. Actually, E. G. Lidiak passed that information on to Merriam, and Wheeler's reference should be to the footnote on page 154 of Merriam's report. To add to the confusion, Merriam (1963, p. 152–154) did attribute a personal communication to me. That communication could be taken to mean that I have doubted the presence of contact-metamorphic country rock on Rose dome. Although others may have doubted the occurrence of metamorphosed country rock on Rose dome, I have not. Be that as it may, the idea expressed by Franks (1965) that emplacement of the "granite" probably was as young as Cretaceous should not be taken as casting doubt on the validity of the age determination made by the U. S. Geological Survey, but rather as indicating the most likely time of emplacement of the "granite" on Rose dome.

Franks (1965) cited the presence of hornfels, composed largely of sanidine, included in and adhering to the faces of a boulder of Rose "granite," as evidence of the intrusive character of the "granite"—*not* as evidence ". . . that the granitic and associated igneous and *metamorphic* rocks at Rose dome *were intruded* into the Pennsylvanian strata . . ." [italics mine], as stated by Wheeler (1965, p. 1656). In many ways the information cited by Franks does not differ appreciably from that offered by Twenhofel (1926); both workers have found metamorphosed country rock in direct contact with Rose "granite." Moreover, it was because of the drilling by the State Geological Survey of Kansas on Rose dome, not "despite" that drilling (Wheeler, 1965, p. 1656), that I continued to think that the "granite" showed intrusive relations with the enclosing Pennsylvanian section.

For purposes of this discussion, the written communication, furnished to H. E. Wheeler as part of a letter dated December 2, 1964, will help assess the state of knowledge of the igneous and metamorphic rocks on Rose dome:

"Kansas Geological Survey put down five shallow drill holes in the vicinity of the 'granite' boulders near the apex of Rose dome in August and September of 1964. All five holes were bottomed in unmetamorphosed or mildly metamorphosed Pennsylvanian country rock. Two holes were collared in metamorphosed shale, pierced 'granite,' and penetrated subjacent Pennsylvanian shale. One hole was collared in granitoid rubble and penetrated weathered or altered 'granite' and then subjacent Pennsylvanian shale. The two remaining holes pierced 'granite' and then passed into subjacent ultramafic rock, both peridotite and a mica-rock differentiate of the peridotite that is composed mainly of phlogopite, before being bottomed in Pennsylvanian country rock."

Because the deepest hole drilled by the State

Geological Survey of Kansas was only 90.1 feet deep, and inasmuch as both the metamorphosed country rock and the ultramafic rocks are very fine-grained almost without exception, the term "crystalline complex" employed by Wheeler (1965, p. 1656) may be misleading.

Inasmuch as dikes or sills of alkaline ultramafic rock similar to that which is found at Silver City dome have been penetrated in the subsurface of Rose dome (*cf.* Twenhofel and Bremer, 1928; Knight and Landes, 1932, p. 6–8) at various depths (the greatest of which is 1,675 feet below the land surface), and because of the intrusive characteristics displayed by both the "granite" and the alkaline ultramafic rocks of Rose dome, it seems unwarranted to call upon large-scale thrusting to account for the emplacement of the igneous rocks found near the apex of Rose dome.

SILVER CITY DOME

The Hills Pond Peridotite (Wagner, 1954), a mica peridotite, is exposed in the N. ½, sec. 32, and NW. ¼, sec. 33, T. 26 S., R. 15 E., on the north flank of Silver City dome. Wheeler (1965, p. 1656, 1659), in a series of statements similar to those referring to Rose dome, seems to conclude that the ultramafic igneous rock, which is intrusive into Silver City dome, and the associated contact-metamorphic rocks not only are allochthonous, but also are in their present geologic and topographic position as a result of large-scale thrusting.

Again, by use of quotation marks, Wheeler (p. 1648, Fig. 1; p. 1655, 1656) seems to imply that Silver City dome is only a topographic high. The geologic map published by Wagner (1954) and the structural contour maps published by Hambleton and Merriam (1955, Pl. 2) show the fallibility of that implication.

Although metamorphic effects had been recognized in the Pennsylvanian sedimentary rocks on the north flank of Silver City dome in N. ½, sec. 32 and W. ½, sec. 33, T. 26 S., R. 15 E., for nearly 50 years (Mudge, 1880), it was not until 1928 (Twenhofel and Bremer) that it was suggested that the metamorphism was caused by intrusion of mica peridotite into the Pennsylvanian strata. Hay (1883, p. 16–17) noted the occurrence of yellowish micaceous dirt associated with the metamorphosed sedimentary rocks, but failed to recognize that it was weathered mica peridotite. Rather, he described the weathered peridotite as "perhaps altered shale." He also noted "seams of dark blue (or purplish) stone of great hardness" transecting the micaceous soil and ranging in thickness from 1 to 12 inches. He interpreted the dark blue rock to be igneous; it probably is a derivative of the mica peridotite magma that locally is found as seams or dikes in the main body of the peridotite.

Twenhofel and Edwards (1921) re-examined the area, but found no sign of igneous rock associated with the metamorphosed sediments. Nor did Knight and Landes (1932) report the occurrence of mica peridotite at the surface of Silver City dome. Although Weidman (1933) thought that he had found samples of igneous rock on the surface of the dome, the first published description of the mica peridotite itself seems to be that by Wagner (1954). Subsequently, Franks (1956) published a generalized petrographic description of the rock and made note of some variations in its mineralogic composition.

By study of surface exposures, records, and cores from 22 diamond-drill holes (*cf.* Wheeler, 1965, p. 1659, end of section on Diagnostic Criterional Associations), and of samples and records of nearby oil and gas tests, Wagner (1954) found that sills of mica peridotite finger from a dike-like feeder southward into Pennsylvanian limestone and shale. Moreover, Wagner indicated sills of peridotite that are as much as 1,000 feet or more below the land surface on Silver City dome. Subsequent logging by Franks of seven additional rotary and core-holes drilled by private interests testing the ultramafic rock for phlogopite and vermiculite does little to modify Wagner's cross section.

Contact-metamorphic effects at Silver City dome are extensive and varied. Contact-metamorphic rocks form an aureole as wide as 1,000 feet around the surface exposures of the main mass of mica peridotite (Wagner, 1954). The Ireland Sandstone and Tonganoxie Sandstone Members of the Lawrence and Stranger Formations, respectively, have been converted from relatively friable argillaceous rocks to dark green or gray quartzite containing appreciable chlorite and in which traces of original bedding as well as other sedimentary structures are well preserved. The various Pennsylvanian shales in the contact au rocks have been converted to dense hornfels composed largely of feldspar, mica, and amphibole near the main mass of peridotite. Locally, Pennsylvanian limestone is transected by veinlets of apatite (Wagner, 1954).

Citing Hay (1883, p. 17) on the causes of contact metamorphism at Silver City, Wheeler (1955, p. 1656) attempts to discredit Twenhofel's suggestion (1926, p. 406–407, 410) that the metamorphism was produced by intrusion from below. Moreover, Wheeler (p. 1656) exaggerates the importance of brecciation noted by Hay (1883) and Wagner (1954), among others. Brecciated country rock (mainly brecciated hornfels) is largely restricted to the vicinity of the ultramafic body exposed at the surface of Silver City dome. Moreover, areas of brecciated country rock probably do not amount to more than a few per cent of the total area of country rock showing signs of contact metamorphism. Wheeler's statement (p. 1656) also can be taken to mean that the mica peridotite shows considerable brecciation. Brecciation of the mica peridotite has not been reported by Wagner (1954) or by Franks (1959). I have examined more than 40 core samples and thin sections of the peridotite and have seen no sign of brecciation of the ultramafic rocks.

Thus, Wheeler (p. 1656) attempts to portray the alkaline ultramafic rock and contact-metamorphosed country rock as being something other than an ". . . altogether cryptic feature on the Kansas prairie" and to attribute their occurrence to large-scale thrusting. The conclusion seems inescapable that the alkaline mica peridotite has been intruded into the sedimentary section on Silver City dome and is responsible for conversion of Pennsylvanian sandstone to quartzite and for conversion of Pennsylvanian shale to hornfels.

ULTRAMAFIC ROCKS IN RILEY COUNTY

Alkaline ultramafic rock now seen as serpentinized peridotite containing numerous xenoliths of various types and showing signs of partial brecciation is exposed at five localities near the crest of the Abilene arch in the Permian terrane of Riley County, Kansas (Fig. 1). The rocks have been described briefly by Moore and Haynes (1920) and Byrne, Parish, and Crumpton (1956). Dreyer (1947) has published the results of drilling and magnetometer investigations of one of them (Bala intrusive). Cook (1955) reported on magnetometer studies of the remaining four bodies.

Two of the five bodies of igneous rock, Stockdale intrusive in sec. 23, T. 8 S., R. 6 E., and Leonardville intrusive in sec. 22, T. 8 S., R. 5 E., are remarkably similar in lithology and mineralogy. Thin-section examinations by myself and data published by Byrne, Parish, and Crumpton (1956) and Bagrowski (1941) indicate that these two bodies are kimberlite containing numerous xenoliths of chloritized, serpentinized, and otherwise altered limestone and shale. They also contain phenocrysts of ilmenite, some of which has a peculiar glassy luster, phenocrysts of chloritized phlogopite, abundant grains of pyrope, disseminated grains of chromite, and sparse magnetite in the serpentinized matrix. The structure of much of the serpentine is suggestive of the former presence of phenocrysts of olivine and pyroxene. The rock also holds numerous veinlets and patches of calcite. In addition to inclusions of altered sedimentary rocks, inclusions of various igneous and metamorphic rocks have been found. These include gabbro, gabbroic gneiss, pyroxenite, and schist (Bridge, 1953).

The Randolph No. 1 body in sec. 35, T. 6 S., R. 6 E., and Bala serpentinite in sec. 6, T. 9 S., R. 5 E., also show signs of brecciation and contain numerous fragments of altered limestone and shale. The writer also has seen a well-preserved crinoid columnal entrapped in the serpentine matrix of the Bala intrusive. Both serpentinites are cut by calcite veinlets, some of which contain euhedral to subhedral crystals of magnetite as long as 2 mm. in the *a*-axis direction. Irregular patches of calcite also have replaced parts of the serpentinized matrix. Small amounts of apatite, chromite, and chloritized phlogopite or biotite are present in the serpentine matrix. The former presence of phenocrysts of olivine and perhaps also of pyroxene can be inferred from the texture of much of the serpentine. The Randolph No. 2 serpentinite in sec. 27, T. 6 S., R. 6 E., is similar to the Bala and Randolph No. 1 intrusives except that it holds far fewer inclusions of altered sedimentary rock. Although the degree of brecciation, abundance of inclusions, and diversity of mineralogy are much less in the Bala and Randolph bodies than in the Stockdale and Leonardville serpentinites, they, too, can be classed as kimberlitic on the basis of their mineralogy, texture, and structure.

Wheeler (p. 1656) maintains that the mere presence of the Riley County serpentinites in northeastern Kansas is *"prima facie"* evidence of their allochthonous nature. He also stresses that their origin more likely was geosynclinal rather than cratonic, and then reasons (p. 1662) that they too are klippen or remnants of his St. Francois thrust. The cratonic association of intrusive rocks of the type found in Riley County already has been stressed in this discussion under Alkaline Ultramafic Rocks Not Evidence of Thrusting.

Wheeler (p. 1656) suggests that the xenoliths entrapped in the serpentinites most likely are tectonic breccia, inasmuch as the literature available to him indicated that the fragments were derived only from Permian country rock. My own observations and those of Bridge (1953) not only indicate considerable diversity in the types of inclusions, but also indicate development of reaction rims and extensive chloritization or serpentinization of the inclusions of sedimentary rock that might be difficult to explain by tectonic activity; hence, the suggestion (Wheeler, p. 1656) that the serpentinites or kimberlites did not pass through the entire Paleozoic section of the region loses strength.

Although Wheeler (p. 1659) stresses the importance of drill-hole information from the various intrusives in Kansas, he (p. 1656-1657) suggests that drilling information on the Bala intrusive shown in Dreyer's cross section (1947, p. 26, Fig. 4) might have been in error because of caving, or that the igneous mass might have been "... driven down into weaker rocks beneath." Dreyer's crosss section shows that one of eight drill holes penetrated about 148 feet of serpentinite without penetrating sedimentary rock, and it is difficult to visualize exactly how caving from above might have completely masked penetration of Permian country rock. Dreyer's cross section indicates, even allowing for its vertical exaggeration of 10×, a shape for the Bala intrusive that would be difficult to achieve by driving it "... down into weaker rocks beneath."

Wheeler also cites the supposed absence of contact-metamorphic effects (p. 1656) of the Riley County igneous rocks on Permian country rock as indicative that they were not intruded from below. As noted by Clark and Fyfe (19 emplacement of ultramafic rocks commonly not induce appreciable metamorphism of cou rock. The description by Parham (1963) of tact-metamorphic effects produced by intrusio peridotite dikes in the Absher area of Illi demonstrates how mild they can be. Moreo contacs of the igneous rocks of Riley Co with their Permian host rocks are masked al completely by surficial deposits. Cook (1955 484) reported that the contact of the Rand No. 1 serpentinite was exposed by trenchin two locations, that the exposed contacts appar ly were vertical, and that the Permian cou rock dipped away from the igneous materia angles as great as 45°. Moreover, the cou rock exposed by the trenching does show signs mild thermal alteration as well as fractures fi by veins of calcite adjacent to the intrusive. G. Brookins (Kans. State Univ.) reports (communication, 1965) that he also exposed country rock-intrusive contact at the Stock body and that the Permian sedimentary ro show signs of mild contact metamorphism.

Although Cook (1955, p. 485) concluded fr his magnetic surveys that the main mass of Randolph No. 2 serpentinite may not extend great depth, he noted that "... magnetic data not preclude the possibility that a small igne feeder may extend to great depth." Thus, bulk of the evidence from the igneous rocks Riley County verifies their intrusive origin a precludes their emplacement by large-scale thru ing that had its root in the Ouachita geosync (*cf.* Wheeler, p. 1662).

SUMMARY

The widespread occurrence of alkaline ult mafic rocks in the cratonic interior of the Uni States and in other parts of the world indica that large-scale thrusting is unnecessary to a count for emplacement of alkaline ultram rocks at Rose and Silver City domes, Wood County, Kansas, and near the crest of the A lene arch in Riley County, Kansas.

The sill-like form of ultramafic rock interca ed with Pennsylvanian country rock on Rose a Silver City domes and the presence of horn and other contact-metamorphosed country r demonstrate that the mica peridotite has intru the Pennsylvanian section. Although the Pre

ınd Fyfe (1961),
; commonly does
hism of country
n (1963) of con-
d by intrusion of
area of Illinois
in be. Moreover,
of Riley County
re masked almost
. Cook (1955, p.
of the Randolph
l by trenching at
contacts apparent-
Permian country
neous material at
over, the country
loes show signs of
as fractures filled
the intrusive. D.
iv.) reports (oral
e also exposed a
at the Stockdale
sedimentary rocks
metamorphism.
5) concluded from
main mass of the
nay not extend to
. magnetic data do
at a small igneous
depth." Thus, the
e igneous rocks of
trusive origin and
y large-scale thrust-
uachita geosyncline

of alkaline ultra-
erior of the United
the world indicates
unnecessary to ac-
alkaline ultramafic
y domes, Woodson
e crest of the Abi-
nsas.
afic rock intercalat-
y rock on Rose and
resence of hornfels
nosed country rock
ridotite has intruded
though the Precam-

brian age calculated for the "granite" found on Rose dome introduces problems in accounting for the intrusive relationships shown by the "granite," the information given by Twenhofel (1926), together with the contact effects and inclusions noted by Franks (1965), and the intercalation of the "granite" with, or penetration of the "granite" into, Pennsylvanian Weston Shale on Rose dome determined from holes drilled by the State Geological Survey of Kansas, indicate that part of the "granite" also has intrusive relationships with Pennsylvanian country rock.

Similarly, drill-hole information and magnetometer surveys of the Bala kimberlite in Riley County, Kansas, indicate that it has intruded Permian country rock. Magnetometer surveys of the Randolph, Leonardville, and Stockdale kimberlites also indicate an intrusive relationship with Permian country rock. Moreover, exposure of contacts between kimberlite and Permian country rock at the Randolph No. 1 body shows that the country rock dips away from the igneous material and that the country rock has been affected by mild contact metamorphism compatible with the low-temperature emplacement commonly noted for kimberlite. Similar contact effects are reported for the Stockdale kimberlite. Poor exposures prevent direct observation of kimberlite-country rock contacts at the Bala, Leonardville, and Randolph No. 1 kimberlites, but the absence of exposures of the contacts is not justification for calling on large-scale thrusting to account for their emplacement. Moreover, the diverse types of inclusions found in the Stockdale kimberlite, and the reaction rims and other alteration effects seen in inclusions in all of the Riley County kimberlites, not only indicate that the igneous material passed upward through more than just the Permian section found at the surface in Riley County, but also that whatever fluids were present within the kimberlite mush when it was emplaced reacted with the xenoliths.

Field and petrographic evidence, therefore, demonstrates that the igneous rocks in eastern Kansas were intruded into the Paleozoic sequence and that these rocks are not evidence supporting existence of the so-called St. Francois thrust proposed by Wheeler (1965).

References

Bagrowski, B. P., 1941, Pyrope garnet vs. ruby spinel in Kansas: Am. Mineralogist, v. 26, p. 675–676.

Bailey, D. K., 1964, Crustal warping—a possible tectonic control of alkaline magmatism: Jour. Geophys. Research, v. 69, p. 1103–1111.

Bridge, T. E., 1953, The petrology and petrography of the igneous rocks of Riley County, Kansas: unpub. M.S. thesis, Kans. State Univ.

Brock, M. R., and A. V. Heyl, Jr., 1961, Post-Cambrian igneous rocks of the central craton, western Appalachian Mountains, and Gulf coastal plain of the United States: U. S. Geol. Survey Prof. Paper 424-D, p. D33-D35.

Byrne, F. E., K. L. Parish, and C. F. Crumpton, 1956, Igneous intrusions in Riley County, Kansas: Am. Assoc. Petroleum Geologists Bull., v. 40, p. 377–380.

Clark, R. H., and W. S. Fyfe, 1961, Ultrabasic liquids: Nature, v. 191, p. 158–159.

Cook, K. L., 1955, Magnetic surveys over serpentine masses, Riley County, Kansas: Min. Engineering, v. 7, p. 481–488.

Davidson, C. F., 1964, On diamantiferous diatremes: Econ. Geology, v. 59, p. 1368–1380.

Dreyer, R. M., 1947, Magnetic survey of the Bala intrusive, Riley County, Kansas: Kans. Geol. Survey Bull. 70, pt. 2, p. 21–28.

Franks, P. C., 1959, Pectolite in mica peridotite, Woodson County, Kansas: Am. Mineralogist, v. 44, p. 1082–1086.

——— 1965, Intrusive character of "granite," Rose Dome, Woodson County, Kansas (abs.): Geol. Soc. America Special Paper 82, p. 65–66.

Hambleton, W. W., and D. F. Merriam, 1955, Magnetic anomalies in Wilson and Woodson Counties, Kansas: Kans. Geol. Survey Bull. 114, pt. 3, p. 113–128.

Hay, Robert, 1883, The igneous rocks of Kansas: Kans. Acad. Sci. Trans., v. 8, p. 14–18.

Kidwell, A. L., 1947, Post-Devonian igneous activity in southeastern Missouri: Mo. Geol. Survey and Water Res. Rept. Inv. 4, 83 p.

Knight, G. L., and K. K. Landes, 1932, Kansas laccoliths: Jour. Geology, v. 40, p. 1–15.

Martens, J. H. C., 1924, Igneous rocks of Ithaca, New York, and vicinity: Geol. Soc. America Bull., v. 35, p. 305–320.

Merriam, D. F., 1963, The geologic history of Kansas: Kans. Geol. Survey Bull. 162, 317 p.

Moore, R. C., and W. P. Haynes, 1920, An outcrop of basic igneous rock in Kansas: Am. Assoc. Petroleum Geologists Bull., v. 4, p. 183–187.

Mudge, B. F., 1880, Metamorphic deposit in Woodson County: Kans. Acad. Sci. Trans., v. 7, p. 11–13.

Parham, W. E., 1963, Contact temperature of peridotite dike with Pennsylvanian shale determined by clay mineral alterations: Ill. State Acad. Sci. Trans., v. 56, p. 59–67.

Singewald, J. T., Jr., and Charles Milton, 1930, An alnöite pipe, its contact phenomena, and ore deposition near Avon, Missouri: Jour. Geology, v. 38, p. 54–66.

Tarr, W. A., and W. D. Keller, 1933, Post-Devonian igneous intrusions in southeastern Missouri: Jour. Geology, v. 41, p. 815–823.

Turner, F. J., and J. Verhoogen, 1951, Igneous and metamorphic petrology, 1st ed.: New York, McGraw-Hill, 602 p.

Twenhofel, W. H., 1917, Granite boulders in (?) the Pennsylvanian strata of Kansas: Am. Jour. Sci., v. 43, 4th ser., p. 368–380.

——— 1919, Additional facts relating to the granite boulders of southeastern Kansas: Am. Jour. Sci., v. 48, 4th ser., p. 132–135.

——— 1926, Intrusive granite of the Rose dome, Woodson County, Kansas: Geol. Soc. America Bull., v. 37, p. 403–412.

——— and B. H. Bremer, 1928, An extension of the Rose dome intrusives, Kansas: Am. Assoc. Petroleum Geologists Bull., v. 12, p. 757–762.

——— and E. C. Edwards, 1922, The metamorphic rocks of Woodson County, Kansas: Am. As troleum Geologists Bull., v. 5, p. 64–74.

Wagner, H. C., 1954, Geology of the Fredoni rangle, Kansas: U. S. Geol. Survey Map G

Weidman, Samuel, 1933, Igneous intrusives ver City area, Kansas: Am. Assoc. Petroleu ogists Bull., v. 17, p. 1268–1270.

Wheeler, H. E., 1965, Ozark pre-Cambrian-P relations: Am. Assoc. Petroleum Geologists 49, p. 1647–1665.

Reply to Paul C. Franks[7]

HARRY E. WHEELER

Despite his discourse on ultramafic rocks, Franks' cited references either fail to demonstrate or do not support his contention that alkaline ultramafics are typically cratonic. Regarding the Turner and Verhoogen reference, in terms of cases, the ultrabasic rocks of Uganda are confined to the great rifts, a tectonic environment which differs radically from that envisaged for northeastern Kansas.

The Bailey reference contains no mention of ultrabasic rocks. The Davidson discussion concerns ultramafics in the geosynclinal-cratonic border region of eastern Siberia, involving diamantiferous breccia, whose relations are both anomalous and admittedly highly speculative. Finally, contrary to Franks, the Brock and Heyl reference does not summarize the data on ultramafics as such in the cratonic interior of the United States because these are lumped with rocks of lesser mafic content.

Regarding alkaline ultramafics, there may indeed be good bases for a generalization that such rocks are most characteristic of the geosynclinal-cratonic border regions, but Franks' implication that they are typically cratonic has no properly objective foundation.

Franks implies that the magnetometer data are among those demonstrating the intrusive character of the northeastern Kansas ultrabasic rocks; whereas Cook's own evaluation of these data is that they may not extend at depth. The fact that these data ". . . do not preclude the possibility . . ." of a small feeder is without weight in the discussion.

Franks implies that there are breccia fragments in addition to those derived from the Permian sediments. However, he indicates neithe character nor their significance with regard possible involvement of sub-Permian Pa strata.

Although the northeastern Kansas bre ultrabasic rocks were cited in the Ozark pa incongruous, it was clearly stated that add critical data are needed before their inte tion can be established beyond doubt. Fran view of the literature and his statement judgment do not fill that need, and the sam be said for the exposure at Silver City d southeastern Kansas.

Rose dome is another matter. Here crys rocks of pre-Cambrian age rest on Pennsyl strata belonging to a normal, almost undef Paleozoic succession. Unless one can invok plausibly demonstrate) some phenomenon unknown to geology, the Rose dome pre brian body must be interpreted as allochth The geometry of this simple relationship ha demonstrated by five drill holes. Franks' tedly disputed judgment as to "contact met phism" of the Pennsylvanian is not plausi terms of the overwhelming evidence of th ometry.

The fact that the strata may be slightly in the areas of such klippen is not surprisin cause differential solution of the carbonat stituents of underlying sediments should be pated where the klippen, though now dimin have served as local watersheds.

Thus, as stated in the paper under disc the Rose dome pre-Cambrian rocks appe comprise one of the many klippen in the region as a whole. In view of its proximit certain similarities, the Silver City dome *likely* candidate for that same interpretati

[7] Reply received, December 25, 1965.

KGS OF 59-4

Acknowledgments

The work outlined in this note is admittedly a side line. We have experimented with these devices from time to time for several years, and many individuals have helped us with valuable suggestions. It is difficult to recall them all by name. We are grateful to M. R. Forrer and M. H. Maeschler of the Institute of Physics, University of Strasbourg, and to Profs. F. Houtermans and E. Niggli of the University of Bern. Faul acknowledges the support of the U. S. Educational Commission for France (Fulbright program) during the early mineral separation experiments in Strasbourg. The assistance of the Syntron Company, Homer City, Pa., and the W. Flämrich Co., Recklinghausen, Germany, is also acknowledged.

References

Fairbairn, H. W. (1955), Concentration of Heavy Accessories from Large Rock Samples: *Am. Mineral.*, 40, 458–468.

Gaudin, A. M. and Spedden, H. Rush (1943), Magnetic Separation of Suiphide Minerals: *Am. Inst. Met. Eng. Trans.*, 153, 563–575.

McAndrew, John (1957), Calibration of a Frantz Isodynamic Separator and its Application to Mineral Separation: *Australian Inst. Min. Met., Proc.* No. 181, 59–73.

Rosenblum, Sam (1958), Magnetic Susceptibilities of Minerals in the Frantz Isodynamic Magnetic Separator: *Am. Mineral.*, 43, 170–173.

Rubinstein, M. M., Grigoriev, I. G., Gellman, O. Ia., Kutzaidze, A. L. and Chikvaidze, B. G. (1958): [Production of Monomineralic Fractions for the Measurement of the Absolute Age of Rocks by the Argon Method]. *Izv. Akad. Nauk, Ser. Geol.*, No. 6, 95–100 [In Russian].

THE AMERICAN MINERALOGIST, VOL. 44, SEPTEMBER–OCTOBER, 1959

Pyroxene

$Ca_2NaH(SiO_3)_3$

PECTOLITE IN MICA PERIDOTITE, WOODSON COUNTY, KANSAS*

Paul C. Franks

State Geological Survey, University of Kansas, Lawrence, Kansas

Pectolite has been identified by optical and *x*-ray diffraction techniques as a major constituent in the groundmass of one facies of the Hills Pond peridotite, section 32, T. 26 S., R. 15 E., Woodson County, Kansas. The occurrence of pectolite as a major component of the groundmass of a facies of peridotite seemingly is unique. Pectolite has been recognized as a secondary mineral in cavities and seams in mafic eruptive rocks as at Weehawken and Patterson, New Jersey, and as a minor component in syenitic rocks as at Hot Springs, Arkansas and in the Kola Peninsula, U.S.S.R. (Dana and Ford, 1932, p. 567). Some pectolite has been found

* Publication authorized by Director, State Geological Survey, University of Kansas, Lawrence, Kansas.

where serpentinized ultramafic rocks have been intruded by younger, less mafic rocks (Bloxam, 1954, p. 527; Parsons, 1924, p. 55–57). Further, pectolite has been reported in South African kimberlite (Mountain, 1931, p. 70–74) as encrustation on less mafic foreign inclusions, on slickenside surfaces bounding the kimberlite pipes, and locally as isolated spheres and tufts in the kimberlite.

The Hills Pond peridotite has been mapped by Wagner (1954). It crops out in the center of a gentle dome and is bounded on the north by a fault. Sills of the peridotite finger from the main body of peridotite along the fault southward into Pennsylvanian shale, limestone, and sandstone. Thin-section studies of samples of the peridotite taken from both the outcrop and diamond-drill core show that, in most places, the rock is a serpentinized mica peridotite containing about 25 per cent phlogopite and less than 10 per cent each of olivine remnants, diopsidic augite, and pleochroic, light-red-brown amphibole as phenocrysts in the serpentine groundmass. Minor constituents include apatite, magnetite, and perovskite. Locally in the subsurface, the rock has a groundmass that is composed almost completely of fine-grained phlogopite and contains phenocrysts of the major constituents given above. At the surface, the serpentine groundmass has weathered in large part to nontronite (?), and the phlogopite has weathered to a mixed-layer vermiculite mineral.

The pectolite was found in a thin-section of peridotite core samples from a sill that is at least 30 feet thick and whose top is at a depth of 765 feet. The upper 10 feet of the sill, which intrudes dark-gray Galesburg shale (Pennsylvanian), contains pectolite as a major component of the groundmass. Directly below the pectolitic rock, the sill holds phenocrysts of amphibole, augite, and olivine in a groundmass composed mainly of very fine grained phlogopite. The groundmass of the sill gradually becomes serpentinitic with depth.

The rock containing the pectolite is light gray and speckled with light-brown phlogopite. In thin section it is seen that the rock contains about 40 per cent phlogopite as subhedral books measuring as much as 2 mm. in length and as smaller fragments in the groundmass that measure as little as 0.025 mm. in length. The phlogopite has reversed absorption ($X>Y>Z$) and the books commonly have frayed ends that are intergrown with pectolite in the groundmass. The groundmass includes 1 or 2 per cent perovskite as anhedral patches or blebs as large as 0.1 mm. in diameter. The perovskite grains are surrounded by subcircular patches of a brown, radially fibrous carbonate (dolomite(?)) as much as 0.3 mm. in diameter that is clouded by leucoxene. The patches of dolomite(?) approximate 8 per cent of the rock, and seemingly have replaced other components of the groundmass. Trace amounts of magnetite as anhedral grains measuring less than 0.03 mm. in diameter are scattered through

TABLE 1. *d*-VALUES IN ANGSTROMS OF *X*-RAY REFLECTIONS FROM PECTOLITE SAMPLES FROM HILLS POND PERIDOTITE, SECTION 32, T. 26 S., R. 15 E., WOODSON COUNTY, KANSAS, AND FROM PATTERSON, NEW JERSEY. DATA OBTAINED USING GENERAL ELECTRIC DEBYE-SCHERER CAMERA (14.32 CM. DIAMETER) AND CuKα RADIATION

d Å	Relative intensity estimated	*d* Å	Relative intensity estimated	*d* Å	Relative intensity estimated
7.82	<1–1	1.94	<1–1	1.35	<1–1
7.02	<1–1	1.92	<1–1	1.29	<1–1
5.50	1	1.88	1	1.28	<1
3.90	3	1.83	1	1.24	<1–1
3.50	2	1.77	<1–1	1.166	<1–1
3.31	5	1.75	3	1.133	<1–1
3.28	2	1.71	3	1.101	<1–1
3.08	6*	1.67	<1–1	1.089	<1–1
2.92	10	1.66	1	1.080	<1
2.74	3	1.60	1	1.062	<1
2.59	3	1.56	<1–1	1.040	<1
2.43	1	1.55	2	0.995	<1–1
2.33	1	1.52	<1–1	0.921	<1
2.31	1	1.49	1	0.884	<1
2.17	3**	1.47	2	0.866	<1
2.09	<1–1	1.39	<1–1	0.852	<1
2.00	1	1.37	1		

* Skewed to 3.15A.
** Doublet (?)

parts of the groundmass and as inclusions in the phlogopite books. About 3 per cent of the rock is nontronite(?) (identification as a montmorillonite confirmed by *x*-ray diffraction), which occurs as green patches measuring as much as 2 mm. in length and in which minute, strongly birefringent flakes are discernible. Melilite, which constitutes not more than 1 per cent of the rock, is present in the groundmass as 0.8-mm. patches of squarish uniaxial negative grains and as disseminated individuals measuring 0.01 to 0.25 mm. across. The birefringence (about 0.007) and negative sign indicate that the melilite may have a composition near that of gehlenite. Much of the groundmass (about 20 per cent of the rock) is composed of a very fine grained, turbid aggregate showing low birefringence; it contains a montmorillonite mineral (confirmed by *x*-ray diffraction), and locally has structure suggestive of the former presence of melilite. The turbid groundmass locally grades into pectolite.

Pectolite, which approximates 25 per cent of the rock, is the major component of the groundmass. It occurs as sheaflike and radial aggregates of fibers and blades that locally penetrate into the phlogopite

FIG. 1. Photomicrographs of pectolite-bearing rock, section 32, T. 26 S., R. 15 E., Woodson County, Kansas. A, plane-polarized light; B, crossed nicols. D, dolomite (?) clouded by leucoxene; P, pectolite; Ph, phlogopite.

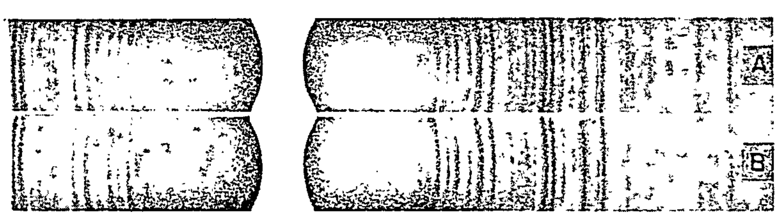


FIG. 2. *X*-ray powder films of pectolite. A, sample from section 32, T. 26 S., R. 15 E., Woodson County, Kansas; B, sample from Patterson, New Jersey.

books along cleavage traces and that grade into the turbid argillic part of the groundmass (Fig. 1). The blades and fibers range in length from nearly submicroscopic sizes to as much as 2 mm. Maximum width of the blades is about 0.1 mm. The blades and fibers have positive elongation, imperfect nearly parallel extinction, and strong birefringence (about 0.04), and are optically positive with moderate 2V. Locally they show cleavage that is both nearly parallel to and nearly normal to the length of the fibers. N_x is about 1.60, N_z about 1.64.

Comparison of x-ray powder films (Fig. 2) of pectolite from the peridotite with films of pectolite from Patterson, New Jersey, confirmed optical identification. d- values and intensities of the x-ray reflections (Table 1) for both the pectolite from the Hills Pond peridotite and the New Jersey sample proved identical.

Thanks are due Mr. Cecil T. Welch of Toronto, Kansas, who gave the writer permission to log drill core taken under Mr. Welch's supervision and to collect samples from the core.

References

Bloxam, T. W. (1954), Rodingite from Girvan-Ballantrae complex, Ayrshire: *Min. Mag.*, **30**, 525–528.

Dana, E. S., and Ford, W. E., (1932) A Textbook of Mineralogy, 4th ed. John Wiley and Sons, Inc., New York.

Mountain, E. D. (1931), Crystals from the Kimberley mines. *Trans. Royal Soc. South Africa*, **20**, 65–78.

Parsons, A. L. (1924), Pectolite and apophyllite from Thetford Mines, Quebec. *Univ. of Toronto Studies, Geol. Ser.*, **17**, 55–57.

Wagner, H. C. (1954), Geology of the Fredonia quadrangle, Kansas. U. S. Geological Survey Map GQ49.

THE AMERICAN MINERALOGIST, VOL. 44, SEPTEMBER–OCTOBER, 1959

A PENETRATION-TWIN IN OLIVINE

R. N. Brothers
Department of Geology, University of Auckland, New Zealand.

A porphyritic alkali basalt (A.U. thin-section 3560) from Khyber Pass, Auckland, contains numerous euhedra of olivine set in a finely felted groundmass of plagioclase, pyroxene, magnetite and glass. The olivine phenocrysts range in size up to 0.9 by 0.5 mm. and vary in composition from Fo_{84} to Fo_{90}. Their habit is fairly constant, the commonest combination of forms being $\{010\}+\{110\}\pm\{120\}$, together with $\{101\}+\{021\}$. True twinning was observed only in the one grain herein described, but the thin-section also contains euhedral olivine with "translation lamellae" oriented parallel to (100).

PROSPECTUS

FOR THE

SILVER CITY MINING

AND PROCESSING

TORONTO

WOODSON COUNTY

KANSAS

EXHIBIT NO. 1
STATE CORPORATION COMMISSION

MAY 27 1959

DOCKET NO.
REPORTER, HAZEL FARMER

Potassium . . . K.
Sodium . . . na.
Flake Mica

Telephone 112

Magnesium
Small Amounts of
14 Other Minerals.

MICA

SILVER CITY MINING and PROCESSING
TORONTO, KANSAS

May 22, 1959.

GEOLOGIC HISTORY AND STRUCTURE

The area under discussion lies in Sections 29, 30, 31, and 32, Township 26S., Range 15E., Woodson County, Kansas and consists of low dome shaped plain, surrounded by a halo of low hills. Drainage is to the southwest by Little Sandy Creek. Elevation averages 990 feet above mean sea level. Farming and cattle raising are the principal industry.

The formations exposed here are Middle Pennsylvanian, the Lansing Lime group, and the lower part of Douglas group, consisting of mostly heavy bedded lime stone and argalaßious shales, and an intrusion of periodite, a type of granite rock that penetrated upward thru all the sedimentary rocks from the crystalline basement. This intrusion spread outward to the south of the main dyke as lacoliths or sills and forced it's way thru the sedimentary rocks causing an upwarp in the Pennsylvanian rock to form a 200 feet closed dome. There is no evidence that this warp carries to the Mississippian of lower beds.

In the vicinity of the intrusion, all the sedimentary rocks are either highly meta-morphosed sandstone into quartzite, some shales into slates, and limestones into a solid bed of limestone from which all bedding planes are obliterated. Coal has been changed from Bituminous to antricite and beds so altered they can hardly be identified as to their original stratification. This type of intrusion is rare, according to the United States Geological Survey, and is possibly the only one in North American continent that is now known.

THE ORE BODIES

There are six definite ore bodies or lacoliths in Section 29, 31, and 32, originationg from the common source of the dyke, which is in evidence on south side of Section 29 and Section 32 where it is exposed on the surface and lacoliths have been encountered by deeper drilling in the south half of Section 32 at location Hill #1, where ore was encountered at 81.2-108.3 or 27.3 feet in thickness, at 295-325 or 30 feet thick, at 490-525 or 35 feet thick, at 690-760, 70 feet of ore, and 770-800/, 30 feet of ore, and still in ore. At the north side of Section 32 and south side of Section 29 there is the sixth lacolith is present that shows a thickness of 67 feet and an average thickness of 70 feet. These logs conform to Hollis Wagner of the United States Geological Survey Fredonia Quadrangle sheet where he shows the locoliths on cross section of his report. Study map of Fredonia Quadrangle attached.

TYPE OF ORES

There are two types of ores in this deposit. First a yellowish-brown granular soft ore that can be spaded and is classed as weathered periodite. Second, a hard, bluish-black ore, hardness of 4.5 that lies under the weathered ore of the first lacoliths, and in five other lacoliths.

The chemical content of these ores are practically the same, so they should be, coming from the same source of supply when deposited by magma waters that were highly mineralized.

Following are some laboratory reports.

Laboratory analysis of five veins of ore in Hill #1, center south line, west half of Section 32.

	#1 95-100	#2 301-306	#3 515-517	#4 750-760	#5 790-795
Total Magnesium as magnesium	19.88	19.25	19.33	18.40	26.98
Oxide	4.00	7.88	5.75	6.25	3.75
Total Calcium as Calcium Oxide					
Silica	43.40	40.17	42.85	42.36	39.15
Iron and Alumina Oxides	16.50	14.52	17.50	17.75	15.00
Total Potassium Oxide that is not water soluble.	1.86	2.71	4.54	4.39	1.53
Water Soluble Potash	1.44	1.81	2.08	2.77	1.60
Sodium Oxide	1.42	0.85	1.52	1.92	0.56
Ignition loss, carbon dioxide and chemically combined water	11.20	12.60	8.10	5.90	11.20
Undetermined oxides of phosphorus, titania, manganese, etc.	0.30	0.21	0.33	0.26	0.23

Bruce Williams Laboratory, Joplin, Missouri.

Laboratory analysis, Hill #21, drilled by Alf Landon. This well is exactly one mile north of above analysis.

Silicon Dioxide	44.33	Magnesium Oxide	19.88
Alumina	5.45	Phosphorus Pentoxide	0.23
Iron Oxide	8.11	Sulfur Trioxide	trace
Titanium Oxide	2.72	Potassium Oxide	5.45
Calcium Oxide	3.60	Sodium Oxide	0.48

Diff. Loss on Ignition:		Loss on ignition at:	
Air/140°C.	4.95	600-1000°C.	2.92
140/550°C.	1.56		
550/600°C.	0.41	Total	100.09
$CaCO_3$, calculated	5.89		
$MgCO_3$, calculated (maximum)	0.63		

Kansas State Geological Survey, Geo. Chemistry Divison.

Laboratory report on Well #3, one-fourth mile north Hill #1, 80-100 feet

Total Potassium as K_2O	3.90%	Total Sodium as Na_2O	0.46%
Water Soluble Potash as K_2O	0.61%	Acid Soluble Magnesium as MgO	22.06%

Laboratory report Well #6, one-half mile north, Hill #1. 23-31

Total Potassium as K_2O	4.70%
Total Sodium as Na_2O	0.50%
Acid Soluble Magnesium as MgO	20.26%

Laboratory analysis close to Hill #21, grab sample of weathered ore by kansas State geological Survey, Geo. Chemistry Division.

Silicon Dioxide	46.24	Sulfur Trioxide	trace
Alumina	6.83	Potassium Oxide	3.00
Iron Oxide	8.35	Sodium Oxide	0.33
Titanium Oxide	3.13	Loss on ignition at:	
Calcium Oxide	2.48	1000°C.	7.90
Magnesium Oxide	20.91		
Phosphorus Pentoxide	0.29	Total	99.46

On April 1, 1959, a 250 pound sample of weathered ore taken from the exact spot of grab sample by the Kansas State Geological Survey was taken by me to Denver Equipment Company of Denver for a pilot plant test for ore dressing and to determine the type and size of equipment. This is a flow sheet. Ore was dried with 6.67% moisture, a specific gravity of 2.75%, weight per cubic foot, 80 pounds, and a Ph of 7.6.

The ore mixes readily with water and a weighed amount was mixed one to one in a mixer for twenty minutes and screened thru a 35 mesh screen and ≠35 vermiculite was removed. The slimes were removed by decantation and left to settle. The residue was then run over a Wilfley gravity table and rare earths cut, ore middlings cut and fine vermiculite cut were made the results as follows:

	%	Pounds Per Ton	Daily Run Tons in 100 tons
Coarse Vermiculite	14%	280	14 Tons
Total Slimes	27.15	543	27.75 Tons
Table Rare Earths	.49	9.8	980 Pounds
Non-magnetic rare earths	.384	7.68	768 Pounds
Vermiculite table middlings	38.70	774	38.7 Tons
Table Middlings	19.66	393.2	19.66 Tons

Re-classifying Table Middlings and Vermiculite Table Middling 58.33 from which by Clue Extractor 22% pure fine vermiculite was extracted makes a total of

36% Vermiculite or 720 pounds per ton or 36 ton per 100 ton daily run. With a 6% loss in ignition when exfoliated or 2.16 tons from 36 tons leaves 33,84 tons of pure exfoliated vermiculite per 100 tons of ore.

OTHER VALUABLE MATERIALS

There is a large amount, ten thousand tons or more a rare type of serpentine rock highly prized by "rock hounds" and lapaderists all over the country. The dark mottled type will bring in rough sawed blocks $1.50 per pound and the light striped will bring .75¢ per pound. It will not cost over $25,00 per ton to process this. There is over 160 acres of this lease that has an over-burden of eight feet and fifty feet of good hard lime suitable for crushed rock and other limestone products. When a railroad spur is placed in, it will be valuable for ballast and construction purposes.

EXTENT OF ORE BODIES

In all the core drilling and testing by myself, Alf Landon and others, it shows in the logs of these wells and from soundings taken by post augors, the weathered ore lies in two distinct bodies. One approximently 1,000 feet wide and 5,400 feet long, lying in a slightly northwest-southeast axis along the south half of Section 29 and the north half of Section 32, Township 26S , Range 15 E., with an average of 40 feet in thickness. This ore in this body lies very near the surface in fact in some places with only a one foot of over-burden and weighs 80 pounds per cubic feet in figuring this the figure of 8,448,000 tons of weathered ore is blocked out. See Figure 1 of the United States Geological Survey of Fredonia Quadrangle. I carried out a more intensive investigation and find that this ore body is a little wider than shown on the United States government map. The second ore body lies in the west half of Section 32 and two small surface exposures of this ore are marked on Figure 1 of the same map, and they cross the center line, north and south, and are from 0-10 feet in depth under the surface and are about 500 feet wide and 2,500 feet long and has an average thickness of 20 feet and has a volume of over one million tons. These can easily be striped and mined with trucks and high loaders.

The dark unweathered periodite ore lies directly underneath of this weathered ore and in the upper lens at the north end of the section has a thickness of approximently 20 feet and this lens have a volmme of 6,336,000 tons. This second lens extends under all of this lease. Will have an average thickness of 20 feet and will have a volume of close to 50,000,000 tons which can all be mined by strip mine and adits from the strip pits. See cross section of line B-B in Figure 1 of the map. Also not on the same figure cross section that the 300 feet vein is not shown but has been developed by me in core drilling. There are four, as you will note, of these lacoliths extending over the area of this lease which will have an average of 50,000,000 per each. These will have to be mined in later years from shafts.

VALUE OF ORE

In the two known products the rare earths concentrate and the vermiculite in the weathered ore as established by pilot runs by the Denver Equipment Company and further runs by myself and others. The rare earths will at present market prices are worth $10.00 per ton of raw ore and the vermiculite unexfoliated at the present market price as shown by the E. and MJ mineral and metal markets will have a value of 1½¢ a pound of $10.80 a ton for vermiculite content per ton of ore. By exfoliating this can be raised to the market price of $21.60 per ton of vermiculite content in one ton of ore with an exfoliating costs of $2.00 makes the net value of this vermiculite $19.60 per ton of raw ore content. Totaling the rare earths and raw ores values and subtracting $3.50 for mining and processing and $2.00 per ton royalty makes a net value of the ore after processing of $23.70 per ton of ore after processing or the total value of the weathered ore $223,967,600.00. Of the unweathered ore as there will be a little more processing costs which is still unknown as to its exact figure. This unweathered ore will not drop below $15.00 per ton after processing and as there are 56,336,000 tons of hard ore in these first two lenses with a processed value of $840,040,000.00 makes this upper ore deposts in mineral values worth over a billion dollars of ore in place on this lease. This is figuring only the two known and accurately estimated surface veins.

FUTURE POSSIBILITIES

In the weathered ore as before stated there is an appreciable amount of slimes which will make either a hard tile or brick or, I believe will make a refractory brick either of which will make a profit. In the metallic content there are both magnesium and silicon which, I believe, can be produced as magnesium metal which has a quotation of 36¢ per pound and ferro-silicon which sells from 12-14¢ per pound and is in demand and in the unweathered ore, we, from laboratory tests and from government bulletins and chemists, can produce from the fhlogopite mica flakes, by dissolution in hot sulphuric acid, pure or transitor grade silicon of which there is a critical shortage of this metal and sells on the open market from $100-$360 per pound as quoted in the E and MJ mineral and metal markets. We can produce this more economically from phlogopite mica than any other method of extraction from other silicon bearing minerals and as we have the only major deposit that is workable in the United States we feel sure that producing this metal is well worth looking into. In the unweathered ore we will have no slimes, but will have extractable potassium, magnesium and material for making ferro-silicon. All these can be producted at a profit. The development of these products are a part of the research that must be carried on when plant is in operation.

MARKETS

On the rare earths we have quoted price tentatively from the rare earths processers which they have quoted $1.25 per pound based on percentage of metallic content which they specify and to which we can conform. On the exfoliated vermiculite we have personal contact with a large manufacturing company who wish an insulation material that can be sprayed on metal buildings, grain bins, and industrial and commercial metal buildings which we can produce in this plant in quanitites which they will requires and to the specification for this material, so that we are assured of the two products we will produce of a ready market that will be of vital value to the United States in time of war as we have the only known reserve of these materials in large quanitites in the United States and depend largely on imports to supply the demand.

UTILITIES

We have on the lease a power line for electricity and another within one mile, so adequate current is available.

We have ample water supply of good pure lake water in three places from one-fourth to one mile from the plant site.

We have natural gas available that will be piped to the plant site by the gas company and can be purchased at prevailing manufacturing rates making a very cheap fuel source.

We also have an unexplored supply of antricite coal on our leases at a depth of 950 feet and an indicated thickness of 50 feet as logged in a well drilled 20 years ago. Core drilling will, possibly show from known surface geology, a production area of 2,000 acres or more. Shaft conditions are good, stable to fairly water free.

TRANSPORTATION AND ACCESSABILITY

The area is accessable and no deep gullies or rough steep hillsides are present. No trucking obstacles are present and only roads needed are from strip pit to plant, about one-fourth of a mile. Plant site is fairly level, with no great grading to be done for leveling. A good hard surfaced all weather county road lies along the west side of the plant site and runs both to Toronto and Buffalo where railroads and U. S. highways are present.

The Missouri Pacific runs thru both towns, with Buffalo five miles away and the road to Buffalo is capable of carrying any and all weights of trucks.

The Vice President of the Missouri Pacific was in the office some time ago and said if production reached 100 tons per day, they would build a spur to the plant and that they are also interested in good ballast rock.

Unlike most mining ventures, the transportation problems are minor.

CLIMATE

The climate is mild and work can be carried on twelve months a year.

ORGANIZATION

The venture is organized on basis of $1,000,000.00 or one million units and will operate as a leasehold for one year and then by majority vote change to corporation basis or continue as a leasehold, which ever shall be better for tax purposes.

Units are $1.00 each with direct assignment made and no assignment shall be made for not less then 1/24th of the orginal lease, and these assignments shall be a working interest with each one paying his full income tax on said assignment as no income tax will be deducted.

This lease covers the East half (½) of the West half (½); the Northwest quarter (¼) of the Northwest quarter (¼); the Southwest quarter (¼) of the Southwest quarter (¼); the West half (½) of the East half (½); and also beginning on the Northwest corner of Section 32, thence South 40 rods thence in a Southwest direction to the Southwest corner of the Northeast quarter (¼) of the Northeast quarter (¼); then North 80 rods thence East 80 rods to the point of beginning, containing 30 acres, all the foregoing land being in Section 32; also the South 40 rods of Section 29, all in Township 26S, Range 15E, in Woodson County, Kansas and containing 510 acres more or less. Filed for record this 20th day of May, 1959 at 11:30 A. M. and duly recorded in Book 33, of miscellanous on Page 579.

3/8th of units are retained and income from them shall be placed as a sinking fund for plant expansion and repairs and when a surplus exists it can, by the Advisory Board, be distributed pro-ratio to working interests holders above the regular dividend.

Dividends shall be declared as follows: 1st dividend, six months after plant go on production and every three months afterwards.

The management shall consists of and Operator, Assistant Operator, and an eight member Advisory Board.

At a meeting of all existing interest holders, on May 17, 1959, which was attended by or represented by 95% of interested parites, leasehold plan was adopted, Operator's Agreement accepted and wage scale to be set by Advisory Board. Operator and Assistant Operator and three board members were elected. The other five members are, Operator, Assistant Operator, Office Manager and Auditor, and two plant superintendants. Each hold office for one year unless removed by special meeting by majority vote. All checks or funds issued by leasehold shall be signed by Operator and

Auditor. Operator is limited to $2,000.00 expenditure unless authorized by concurcurence of majority of board members.

Board will meet once a month or oftener, when problems arise that need their decision.

An auditor's report will be issued every six months as to the status of operations.

CONCLUSION

All facts and figures are taken from my personal observations and tests and checked with the United States Geological Survey reports and maps, chemical analysis from the Bruce Williams Laboratory at Joplin, Missouri; the Kansas State Geological Survey, Geo. Chemistry Division; Charles Parker Company, chemists and assayers, Denver, Colorado; Ochs Laboratories, Denver Colorado; Denver Equipment Company, Ore Testing Division; E and MJ mineral and metal markets, New York; Rare Earths Manual Zonalite Company, Wichita, Kansas; and Lindsay Chemical Company, Chicago, Illinois; and vermiculite insulation prices set by organization as they will be sole producers.

In all it is a good clean operation, muchly needed in Kansas and especially Woodson County as it is a low income area and needs industry.

Signed,

SILVER CITY MINING & PROCESSING

By [signature]
Cecil T. Welch
Operator.

AGENDA

The following spectrographic analysis were run on rare earths non-magnetic concentrates and are as follows:

HERBERT M. OCHS
DENVER, COLORADO
SPECTROGRAPHER

Aluminum	5%	Nickel	.01%
Boron	.001%	Phosphorus	5%
Barium	1%	Potassium	1%
Calcium	Major	Praseodymium	1%
Columbium	1%	Scandium	.01%
Cerium	5%	Samarium	1%
Chromium	.1%	Silicon	Major
Copper	.05%	Silver	Trace
Iron	5%	Sodium	1%
Lanthanum	5%	Thorium	.02%
Lead	1%	Tin	1%
Magnesium	Major	Titanium	Major
Manganese	1%	Tungsten	.01%
Neodymium	1%	Vanadium	.01%

Yttrium	.01%	
Zinc	.01%	
Zirconium	1%	

A geiger counter tests shows weak radioactivity.

Charles Parker Chemist, Denver, Colorado. Fluorescent X-ray spectrographic examination.

Table Conct: Fluorescent X-ray spectrographic examination shows the following: Cerium, 5.0; Lanthanum, 3.0; Barium, 4.0; Tin, 0.01; Nickel, 0.03; Neodymium, 1.0; Chromium, 0.1; Columbium, 0.2; Yttrium, 0.01; Strontium, 2.0; Rubidium, 0.01; Iron, 3; Manganese, 0.06; Praseodymium, 0.07; Thorium, 0.04; Lead, 0.05; Zinc, 0.04; Tantalum, 0.01; Samarium, 0.2; Gadolinium, 0.3; Titanium, 10; all figures represent a semi-quantitative estimate of the content in the repesative oxides of the metals.

X-ray flurescope is acknowledged to be the only accurate check on rare earths and is more reliable than any chemical analysis.

The Lindsay Chemical Company reports these few ways: Carbon-arc lighting, motion picture projection, lighter flints, alloy steels, medium and low carbon steels, stainless steels, rare earth-zirconium-magnesium alloys, glass coloring, glass decolorizing, ingredient in color TV tubes, textile waterproofing, scavenger in explosives manufacture, ceramic opacifiers, ceramic coloring, catalysts, activators for fluorescent lighting phosphors, photosensitive glass, glass windows for radiation protection, capacitor for electronic equipment, aluminum alloys, paint driers, sunglasses, glass blower's goggles, welder's goggles, neutron absorbers in nuclear reactors, nausea preventive, reagent chemicals, flame-sprayed ceramic coatings.

GEOLOGIC AND ASSAY LOGS

Drill-hole No. No. 1 M (Hill) ( )
Inclination 5° Bearing W
Total depth 795
Collar elev. 989.9 T P
Area Silver City

Map coord (T) 1200' E, 200' N of SW Cor
Map coord (P)
Sec. 32 T 26S R 15E
Co. State Woodson, Kansas

Claim Cecil T. Welch
Date completed 14 May 58
Date logged 26 May 58
Logged by PCF

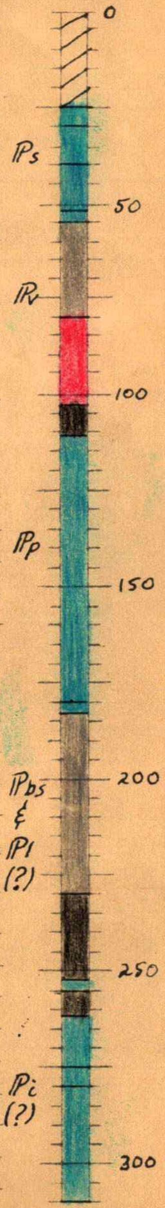
Rev		-
Ed		.

Summary of log Peridotite from 80 to 103 thick 23 color DGnGy
731 ? 64+, MYBr, Gy Pink, Gn Bk Sltbd Sh

DRILL LOG			LITHOLOGIC LOG									
Depth	Rec ft.		Base	Thick	Rec %	Rock	Color	Grain	Access. Min's	Cbn	MS in SS	Remarks
0.0		Stanton Ls	25	25								Rock Bit; No Samples.
No	Rock		30	5		Ls	Lt Yw Gy-	F				5Y8.5/1.
Core	Bit		—				Lt Gy					
765			40	10		Ls	Lt Pink Gy	F-C				5YR 8/1.
			52	12		Ls	V Lt BrGy	F-M				5YR 7/1; S fossil frags.
	2.7		55	3		Ls	M Gy	F				N5; shaley partings; argillaceous.
775		Sh	80	25		Sh	M Lt Gy		S Musc fks; TR			N6; shaley; non-Calc.
			—						Py			
			103	23		Perido-	DGn Gy	F-C	A Br phlogopite			5 GY 4/1; similar to dug well,
785	8.3	Vilas	—			tite			fks			Santa Fe core; S Wh Calcite
			—									rhombs, 95-100 ft.
			111	8		Sh	DGy - M					N3-N4; TR Bk Sh, baked (?).
795			—				DGy					
	TD	Plattsburg Ls	180	69		Ls	M Lt Gy-	F-M				N6 - 5 YR 6/1; Fenestellid frags,
			—				Lt BrGy					115-120', 125-130'; lighter color
			—									below 120', N7-6 YR 7/1; A fossil
			—									frags, bryozoans, brach, 145-
			—									150'; grades to M Gy (N5.5) at
			—									175'.
			183	3(?)		Ls	M Gy	F				N5.5; argillaceous.
		Bachelor	230	47		Sh	M Gy		S Mica fks			N 5.5; Calc.
		Springs &	252	22		Sh	M D Gy					N 4.5; S Calc.

Sample		Lab assay (%)			Sample		Lab assay (%)			Interval						
Base	Thick			$CaCO_3$	Base	Thick			$CaCO_3$	Base	Thick		Base	Thick		

Graphic log



GEOLOGIC AND ASSAY LOGS

Drill-hole No. No 1 M (Hill) (   )
Inclination 5° Bearing W
Total depth 795
Collar elev. 989.9 T ____ P
Area Silver City

Map coord (T) 1200'E, 200'N of SW Cor
Map coord (P) ____
Sec. 32 T. 26S R. 15E
Co., State Woodson, Kansas

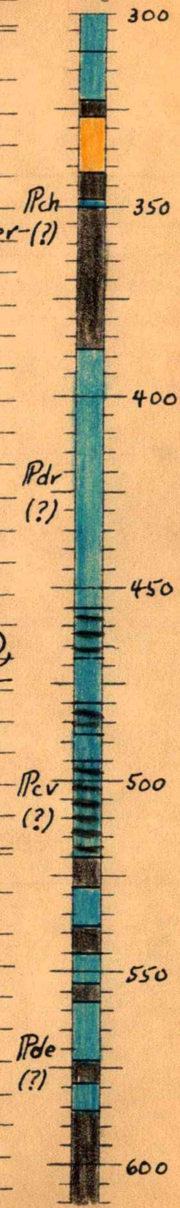
Claim Cecil T. Welch
Date completed 14 May 58
Date logged 26 May 58
Logged by PCF

Rev		
Ed		

Summary of log Peridotite ; from 80 to 103 thick 23 ; color D Gn Gy ; ____ ; ____
731 ? 64+ M Y Br, Gy Pink, Gn Bk Sitbd Sh

DRILL LOG		LITHOLOGIC LOG								
Depth	Rec ft.	Base	Thick	Rec %	Rock	Color	Grain	Access. Min's.	Cbn	MS in SS	Remarks
	Lane Sh (?)	255	3(?)		Ls	M Gy —	F				N5 - 5Y 5/1.
		—				M Dl Gy					
	Iola Ls (?)	262	7		Sh	M D Gy		5 Mica fks			N4; Calc.
		275	13		Ls	M D Gy;	F-M				N4; argillaceous; 30%(?) inter-
		—				5 Lt Gy					lam Sh, 270-275'.
		280	5		Ls	V Lt Gy -	F				N8-N5.
		—				M Gy, Mot					
		310	30		Ls	V Lt Gy	F-M				N8; chalky in top 5'.
		323	13		Ls	Lt Gy	F				N7.
	Chanute Sh (?)	327	5		Sh	M D Gy					N4; Calc.
		342	15		ST-SS	M Lt Gy	ST-VF	A Mica fks	S;	20-30%, M	N6; Calc.
		—							fks	Gy; inter lam	
		348	6		Sh	M D Gy					N4; Silty; Calc.
		350	2(?)		Ls	Lt Gy	F				N7.
		388	38		Sh	M D Gy					N4; Non-Calc
	Drum Ls (?)	400	12		Ls	Lt Gy -	F				N7 - 5YR 7/1; oolitic; top has M
		—				Lt Br Gy					Gy Or Calc clay frags (10YR 7/1),
		—									388 - 390'; oolite fillings com-
		—									monly leached out; 5 brach
		—									frags.
		455	55		Ls	Lt Gy - Lt	F-M	TR chert; TR			As above; no oolites; N7-
		—				Br Gy; Mot		lim specks			-5YR 7/1; Mot N8; TR fossil
		—									frags.

Graphic log



Sample		Lab assay (%)			Sample		Lab assay (%)			Interval				Base	Thick		
Base	Thick			$CaCO_3$	Base	Thick			$CaCO_3$	Base	Thick			Base	Thick		

GEOLOGIC AND ASSAY LOGS

Drill-hole No. No 1 M (Hill) (   )
Inclination 5° Bearing W
Total depth 795
Collar elev. 989.9 T ______ P
Area Silver City

Map coord (T) 1200'E, 200'N of SW Cor
Map coord (P) ______
Sec. 32 T. 26S R. 15E
Co., State Woodson, Kansas

Claim Cecil T. Welch
Date completed 14 May 58
Date logged 26 May 58
Logged by PCF

Rev		
Ed		

Summary of log Peridotite ; from 80 to 103 thick 23 ; color DGn Gy ; ______ ; ______
731 ? 64+ MYBr, Gy Pink, GnBk Sitbd Sh

Graphic log

DRILL LOG / LITHOLOGIC LOG

Cherryvale Sh (?)

Depth	Rec ft.	Base	Thick	Rec %	Rock	Color	Grain	Access. Min's.	Cbn	MS in SS	Remarks
		468	13		Ls, Sh	Lt Gy –	F				N7 – 5YR 7/1, N3; Sh, Calc;
		—				Lt Br Gy,					brittle.
		—				MDGy					
		480	12		Ls	V Lt Gy –	F-M				N8 – 5YR 6/1; coarse chips.
		—				Lt BrGy					
		488	8		Ls, Sh	Lt Gy –	F-M, SC				N7-N4, N4; Sh non-Calc;
		—				MDGy,					Fossils, Composita sp; 30% Sh.
		—				MDGy					
		495	7		Ls	V Lt Gy –	F-M, SC				N8 – N6, 5YR 7/1.
		—				M Lt Gy,					
		—				V Lt BrGy					
		520	25		Ls, Sh	V Lt Gy –	F	TR Chert; TR Py;			N8-N4, N4; 40% Sh; Sh Calc.
		—				MDGy,		TR Musc fks in			
		—				MDGy		Sh			
		528	8		Sh	MGy –					N5-N3; MGy Calc; Silty.
		—				DGy					
		538	10		Ls	Lt Gy –	F				N7 – 5YR 7/1; Brach frags.
		—				Lt Br Gy					
		545	7		Sh	MDGy					N4.
		553	8		Ls	Lt Gy,	F-C				N7-N6, S 5YR 7/1; VS 10YR 7/4.
		—				S Lt BrGy					
		558	5		Sh	MDGy					N4; S Calc.
		573	15		Ls	Lt Gy	F				N7-N6.

Sample		Lab assay (%)			Sample		Lab assay (%)			Interval						
Base	Thick			$CaCO_3$	Base	Thick			$CaCO_3$	Base	Thick		Base	Thick		

GPO 837381 Hole No. ______

GEOLOGIC AND ASSAY LOGS

Drill-hole No. No 1 M (Hill) (   )
Inclination 5° Bearing W
Total depth 795
Collar elev. 989.9 T ______ P
Area Silver City

Map coord (T) 1200'E, 200'N of SW Cor
Map coord (P) ______
Sec. 32 T. 26 S R. 15 E
Co., State Woodson, Kansas

Claim Cecil T. Welch
Date completed 14 May 58
Date logged 26 May 58
Logged by PCF

Rev		
Ed		

Summary of log Peridotite ; from 80 to 103 thick 23 ; color D Gn Gy ; ______ ; ______ Graphic log
731 ? 64+ M Y Br, Gy Pink, Gn Bk Sitbd Sh

DRILL LOG		LITHOLOGIC LOG									
Depth	Rec ft.	Base	Thick	Rec %	Rock	Color	Grain	Access. Min's.	Cbn	MS in SS	Remarks
	Dennis Ls (?)	579 —	6		Sh	M D Gy					N4; silty; S Calc; S itbd Ls, Lt Gy - Lt Br Gy.
		586	7		Ls	M D Gy	F				N4; V hard, cuttings VF.
	Galesburg Sh - Pleasanton Gp undif (?)	633 — —	47		Sh	M D Gy		TR Musc fks			N4; Silty; Calc; thin Ls bed between 610-615; V Lt Gy, Mot Br; TR Coal.
		645 —	12		Sh	M Gy		lim nods			N5; V Calc; Silty; Br lim nods near top; S gas reported.
		731 —	86		Sh	M D Gy - M Gy		TR Musc fks			N4 - N5; locally Calc; S itbd Ls at 663'±.
		735 —	4(?)		Perido-tite	M Y Br	F - C	VA phlogopite fks			10 YR 4/4; S GnGy groundmass; phlogopite fks ≤ 3mm in diam.
		743 —	8		Sh	D Gy					N3; silicified (?); S V Lt Gy, N8, interlam ST.
		748 — —	5		Perido-tite	M Yw Br - M Br, V Lt Gy	F - C	VA phlogopite fks			10 YR 4/4 - 5 YR 3/4, N8; V Lt Gy groundmass; phlogopite fks ≤ 3mm in diam.
		756	8		Sh	M D Gy					N4.
		760 — —	4(?)		Perido-tite	M Yw Br - M Br, V Lt Gy	F - C	VA phlogopite fks			10 YR 4/4 - 5 YR 3/4, N8; V Lt Gy groundmass; phlogopite fks ≤ 2mm in diam.
		765	5		Sh	M D Gy - M Y Br					N4 - 10 YR 5/4; locally silicified (?).

Sample		Lab assay (%)			Sample		Lab assay (%)			Interval						
Base	Thick			$CaCO_3$	Base	Thick			$CaCO_3$	Base	Thick		Base	Thick		

GPO 837381 Hole No. ______

GEOLOGIC AND ASSAY LOGS

Drill-hole No. No 1 M (Hill) ( )
Inclination 5° Bearing W
Total depth 795
Collar elev. 989.9 T P
Area Silver City

Map coord (T) 1200'E, 200'N of SW Cor
Map coord (P)
Sec. 32 T. 26 S R. 15 E
Co., State Woodson, Kansas

Claim Cecil T. Welch
Date completed 14 May 58
Date logged 26 May 58
Logged by PCF

Rev		
Ed		

Summary of log Peridotite ; from 80 to 103 thick 23 ; color DGn Gy ; ;
731 ? 64+ M YBr, Gy Pink, Gn BK S itbd Sh

Graphic log

DRILL LOG		LITHOLOGIC LOG								
Depth	Rec ft.	Base	Thick	Rec %	Rock	Color	Grain	Access. Min's.	Cbn	MS in SS	Remarks
		774	9	25	Perido-tite	Gy Pink, S Mot Gn	F-C	A phlogopite fks			5YR 7/2; V soft Gy Pink groundmass, ~~talcose (?)~~; phlogopite fks ≤ 2 mm in diam. Pectolite matrix
		775	1(?)	30	Perido-tite	Gy, Mot Br	F-C	VA phlogopite fks; S serpentine (?) blebs			V Lt Gy groundmass, N8; phlogopite fks ≤ 3 mm in diam.
		795+	20+	42	Perido-tite	Gn Bk; S BrGy Mot	F-C	30% ± phlogopite fks; S talcose (?) fms; S Aragonite (?) veinlets			5GY 2/1 – 5YR 4/1; phlogopite fks ≤ 4mm.

Sample		Lab assay (%)			Sample		Lab assay (%)			Interval			Base	Thick	
Base	Thick			$CaCO_3$	Base	Thick			$CaCO_3$	Base	Thick				

GEOLOGIC AND ASSAY LOGS

1/1

Drill-hole No. No. 1 A (Hill) (   )
Inclination Vertical Bearing ____
Total depth 110.8
Collar elev. 990 T ____ P
Area Silver City

Map coord (T) 1200'E, 200'N of SW Cor
Map coord (P) ____
Sec. 32 T. 26 S. R. 15 E.
Co., State Woodson, Kansas

Claim Cecil T. Welch
Date completed Nov, 58
Date logged Nov 8, 58
Logged by PCF

Rev		
Ed		

Summary of log Peridotite; from 81.2 to 108.3 thick 27.1+; color D Gn Gy, M Lt Gy

DRILL LOG

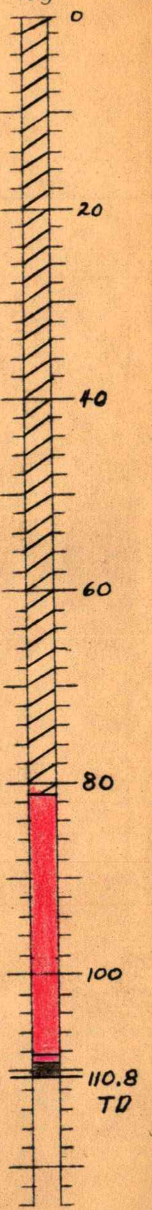
Depth	Rec ft.
0.0	
Rock Bit	No Core
81.2	
	4.3
86.5	
	5.7
96.5	
	4.8
101.5	
	3.7
108.3	
	2.4
110.8	TD

LITHOLOGIC LOG

Base	Thick	Rec %	Rock	Color	Grain	Access. Min's.	Cbn	MS in SS	Remarks
81.2	81.2								Rock Bit; No Core; No Samples.
107.4	26.2	70	Peridotite	D Gn Gy	F	A phlogopite fks, blebs; S aragonite veinlets			5G 4/1; phlogopite fks ≤ 1 mm in diam.
—									
—									
108.3	0.9	70	Peridotite	M Lt Gy	F	A int Calcite; A phlogopite fks, blebs			N6; phlogopite fks ≤ 1 mm in diam.
—									
—									
109.3	1.0	96	Sh	M D Gy		S musc fks			N4; top 0.3 ft baked (?).
110.8+	1.5+	96	Sh	M D Gy		A calcite as algae-like contorted layers 1-2 mm thick			N4.
—									
—									
—									

Sample Base	Sample Thick	Lab assay (%)		$CaCO_3$	Sample Base	Sample Thick	Lab assay (%)		$CaCO_3$	Interval Base	Interval Thick		Base	Thick

Graphic log



GPO 837381

Hole No. ____

GEOLOGIC AND ASSAY LOGS

1/4

Drill-hole No. No. 2 M (Hill) ( )
Inclination Vertical Bearing
Total depth 524.5
Collar elev. 973.6 T P
Area Silver City

Map coord (T) Center SW 1/4, SE 1/4
Map coord (P)
Sec. 32 T. 26 S. R. 15 E.
Co., State Woodson Co., Kansas

Claim Cecil T. Welch
Date completed 5 June 58, approx.
Date logged 8 Nov 58
Logged by PCF

Rev		
Ed		

Summary of log Peridotite ; from 61 / 300 to 68 / 320 thick 7 / 20 ; color Gn Bk / Gy Pink, Gn Bk ; from 509? ; color Lt Br-Gn Bk

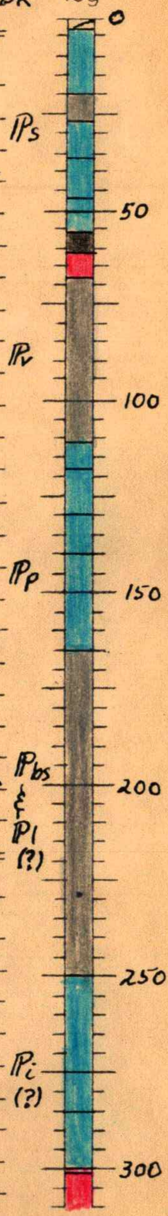
DRILL LOG

Depth	Rec ft.	Formation
0.0		Stanton Ls
No Core	Rock Bit	
300.0		
	0.2	
306.0		
No Core	Rock Bit	
501.0		
	0.0	Vilas Sh
510.0		
	5.0	
517.0		
	6.3	Plattsburg Ls
524.5	TD	
		Bachelor Springs & Lane Sh (?)

LITHOLOGIC LOG

Base	Thick	Rec %	Rock	Color	Grain	Access. Min's.	Cbn	MS in SS	Remarks
3(?)	3(?)		Soil						Rotary Bit; No Samples.
20	17(?)		Ls	Lt Yw Br/	F; SC				10YR 6/2/N7; N7 comes in com-
—				Lt Gy					pletely at 17± feet.
27	7		Sh	MGy					N5; Calc.
36	9		Ls	Lt Gy	F				N7; shaly partings (?).
47	11		Ls	V Lt Gy	F-M				N8.
50	3		Ls	V Lt Gy-	F				N8-10YR 8/4; mottled.
—				Lt Gy Or					
56	6		Ls	Lt Gy -	F				N8-10YR 6/4; mottled.
—				Lt Yw Br					
61	5		Sh	MDGy					N4; non-Calc.
68	7		Perido-	Gn Bk	F-VF	S phlogopite fks			5G 2/1.
—			tite						
111	43		Sh	MGy					N5; locally Calc. near base.
118	7		Ls	V Lt Gy-	F-M				N8-10YR 6/2; mottled; fossil
—				Lt Yw Br					frags, brach, bryozoan.
130	12		Ls	M Lt Gy	F				N6; S Lt Yw Br (10YR 6/2) be-
—									tween 125-130 feet.
140	10		Ls	M Lt Gy-	F-C				N6-5YR 6/1.
—				Lt Br Gy					
165	15		Ls	Lt Gy	F				N6; argillaceous below 160 feet.
250	85		Sh	MGy					N5; V Calc to 195 feet; M Calc 195-
—									225 feet; V Calc 225-250 feet;

Graphic log



Sample		Lab assay (%)			Sample		Lab assay (%)			Interval				Base	Thick		
Base	Thick			$CaCO_3$	Base	Thick			$CaCO_3$	Base	Thick						

GPO 837381

Hole No.

GEOLOGIC AND ASSAY LOGS

Drill-hole No. No. 2 M (Hill) ( )
Inclination Vertical Bearing
Total depth 524.5
Collar elev. 973.6 T P
Area Silver City

Map coord (T) Center SW¼, SE¼
Map coord (P)
Sec. 32 T. 26S. R. 15E.
Co., State Woodson, Kansas

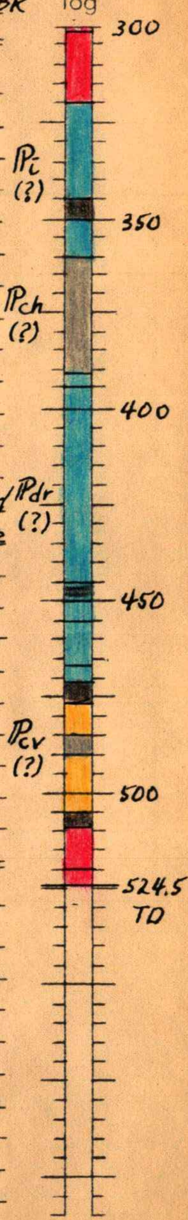
Claim Cecil T. Welch
Date completed 5 June 58, approx.
Date logged 8 Nov 58
Logged by PCF

Rev		
Ed		

Summary of log Peridotite; from 61 / 300 to 68 / 320 thick 7 / 20 color GnBk / GyPink, GnBk ; from 509? ; color LtBr-GnBk

DRILL LOG		LITHOLOGIC LOG									
Depth	Rec ft.	Base	Thick	Rec %	Rock	Color	Grain	Access. Min's.	Cbn	MS in SS	Remarks
		—									5 D Yw Or 215-220 feet.
		275	25		Ls	DGy/M Gy	F	TR Py			N4/N5; argillaceous.
		285	10		Ls	VLtGy-VLtBrGy	F				N8-5YR 7/1.
		300	15		Ls	VLt BrGy	F				5YR 7/1; V soft, powdery cuttings.
Iola Ls (?)		301	1	20	Peridotite	GyPink	F	VA phlogopite fks			Calc groundmass; talcose (?); 5YR 7/2; similar to core from 765-774 feet in hole No. 1 M.
Iola Ls (?)		320	19	0.0	Peridotite	GnBk	F	30% phlogopite fks			5G 2/1; identical to unweathered Hills Pond peridotite; phlogopite fks ≤ 1mm in diam; wh Calc cuttings (Aragonite (?)) from 315-320 feet.
Iola Ls (?)		345	25		Ls	MGy-MDGy	F				N5-N4
		350	5		Sh	M DGy					N4; S Calc.
		360	10		Ls	PinkGy	F	TR phlogopite fks			5YR 6/4; soft, powdery cuttings.
Chanute Sh(?)		391	31		Sh	MGy					N5; locally Calc; VS itbd Ls (?).

Graphic log



Sample		Lab assay (%)			Sample		Lab assay (%)			Interval			Base	Thick		
Base	Thick			$CaCO_3$	Base	Thick			$CaCO_3$	Base	Thick		Base	Thick		

GPO 837381 Hole No.

GEOLOGIC AND ASSAY LOGS

Drill-hole No. No. 2 M (Hill) ( )
Inclination Vertical Bearing
Total depth 524.5
Collar elev. 973.6 T P
Area Silver City

Map coord (T) Center SW 1/4, SE 1/4
Map coord (P)
Sec. 32 T. 26 S. R. 15 E.
Co., State Woodson, Kansas

Claim Cecil T. Welch
Date completed 5 June 58, approx.
Date logged 8 Nov 58
Logged by PCF

Rev		
Ed		

Summary of log Peridotite; from 61 to 68 thick 7; color Gn Bk; from 509?; color Lt Br-Gn Bk
from 300 to 320 thick 20; color Gy Pink, Gn Bk

Graphic log

DRILL LOG: Depth	Rec ft.	Base	Thick	Rec %	Rock	Color	Grain	Access. Min's.	Cbn	MS in SS	Remarks
	Drum Ls (?)	395	4		Ls	MGy	F				N5; cuttings VF, similar to Ls
		–									from 579-586 feet in No. 1 M;
		–									V hard.
		445	50		Ls	M Lt Gy-	F-M				N6-5Y7/1 / N7-5YR8/1; S
		–				V Lt Ol					itbd M Gy Sh in top 5 feet.
		–				Gy / Lt					
		–				Gy - Lt					
		–				Pink Gy					
		450	5		Ls, Sh	MGy - M	F				N5-N6, N3.
		–				Lt Gy, D					
		–				Gy					
		455	5		Ls	V Lt Gy-	F-M	S hem, lim nods			N8-5YR 6/1.
		–				Lt Br Gy					
		467	12		Ls	Lt Ol Gy	F	S hem, lim nods			5Y6/1.
		471	4		Ls	Lt Br Gy-	F				5YR6/1 - N4.
		–				M D Gy					
	Cherryvale Sh (?)	477	6		Sh	D Gy					N3; non-Calc.
		485	8		ST	Lt Gy	ST-VF	S Musc fks		S interlam (?)	N7; M Calc.
		–								M Gy Sh	
		490	5		Sh	M Gy		S Musc fks			N5; S Calc.
		505	15		ST	Lt Gy	ST	S Musc fks		S interlam (?)	N7; M Calc.
		–								M Gy Sh	

Sample: Base	Thick	Lab assay (%)		CaCO3	Sample: Base	Thick	Lab assay (%)		CaCO3	Interval: Base	Thick		Base	Thick		

GEOLOGIC AND ASSAY LOGS

Drill-hole No. No. 2 M (Hill) ( )
Inclination Vertical Bearing
Total depth 524.5
Collar elev. 973.6 T P
Area Silver City

Map coord (T) Center SW 1/4, SE 1/4
Map coord (P)
Sec. 32 T. 26 S. R. 15 E.
Co., State Woodson, Kansas

Claim Cecil T. Welch
Date completed 5 June 58, approx.
Date logged 8 Nov 58
Logged by PCF

Rev		
Ed		

Summary of log Peridotite ; from 61 to 68 thick 7 ; color GnBk ; from 509? color Lt Br - Gn Bk
from 300 to 320 thick 20 ; color Gy Pink, Gn Bk

Graphic log

DRILL LOG		LITHOLOGIC LOG									
Depth	Rec ft.	Base	Thick	Rec %	Rock	Color	Grain	Access. Min's.	Cbn	MS in SS	Remarks
		509(?)	4(?)	0.0	Sh	Gy Bk					N2; non-Calc; Baked (?)
		520.0	16(?)	50	Peridotite	Lt Br - Gn Bk	F - M	S/M Gn Bk serpentine "eyes"; A phlogopite fks			5 YR 5/2 - 5 GY 2/1; phlogopite is major constituent, fks ≤ 1 mm in diam; "eyes" ≤ 3 mm in diam.
		524.5 +	4.5 +	70	Peridotite	Lt Br - Gn Bk	F - M	A Gn Bk serpentine "eyes"; S wh talcose fms (?) on fracs; S wh aragonite (?) veinlets; A phlogopite fks.			5 YR 5/2 - 5 GY 2/1; phlogopite is major constituent, fks ≤ 2 mm in diam; "eyes" ≤ 3 mm in diam.

Sample		Lab assay (%)			Sample		Lab assay (%)			Interval			Base	Thick		
Base	Thick			$CaCO_3$	Base	Thick			$CaCO_3$	Base	Thick					

GPO 837381

Hole No.

GEOLOGIC AND ASSAY LOGS

Drill-hole No. No. 2 A (Hill) ( )
Inclination Vertical Bearing
Total depth 70.5
Collar elev. 794 T P
Area Silver City

Map coord (T) 30' SW of No. 2M
Map coord (P) Center SW 1/4, SE 1/4
Sec. 32 T. 26 S. R. 15 E.
Co., State Woodson, Kansas

Claim Cecil T. Welch
Date completed Nov, 58
Date logged Nov 8, 58
Logged by PCF

Rev		
Ed		

Summary of log Peridotite ; from 61.5 to 69.0 thick 7.5 ; color MGnGy - LtBrGy ; ;

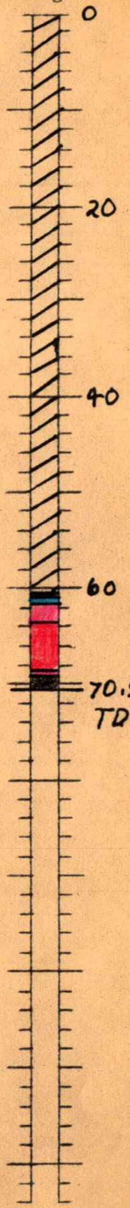
DRILL LOG

Depth	Rec ft.
0.0 Rock Bit	No Core
60.5	1.3
61.5	1.4
63.6	
67.6	3.6
68.8	1.3
70.5	1.8 TD

LITHOLOGIC LOG

Base	Thick	Rec %	Rock	Color	Grain	Access. Min's.	Cbn	MS in SS	Remarks
60.5	60.5								Rock Bit; No Core; No Samples.
60.9	0.4	87	Sh	MDGy		S Musc fks			Calc; S ST grains; N4.
61.5 —	0.6	87	Ls	Lt Gy, DGy, Mot	F				N7, N4, mottled; oolitic.
63.7 — —	2.2	67	Peridotite	M Gn Gy	F	A phlogopite fks; A calcite blebs			5 GY 5/1; phlogopite fks ≤ 1 mm in diam; calcite blebs 1-2 mm in diam.
68.4 —	4.7	95	Peridotite	M Gn Gy	F	A phlogopite fks			5 G 5/1; phlogopite fks ≤ 1 mm in diam; aragonite vein at 68.4.
69.0 —	0.6	100	Peridotite	Lt BrGy - Lt GnGy	F	A phlogopite fks, blebs.			5 YR 6/1 - 5 GY 6/1; Calc.
70.5+	0.5+	100	Sh	MDGy		S musc fks			N4; baked for top 0.3 ft (?).

Graphic log



Sample		Lab assay (%)			Sample		Lab assay (%)			Interval					
Base	Thick			$CaCO_3$	Base	Thick			$CaCO_3$	Base	Thick		Base	Thick	

GEOLOGIC AND ASSAY LOGS

1/1

Drill-hole No. No. 3 M (Hill) (   )
Inclination Vertical Bearing
Total depth 106.8
Collar elev. 983.5 T P
Area Silver City

Map coord (T) 50 ft N, 50 ft W NE Cor
Map coord (P) SW¼ SW¼
Sec. 32 T. 26 S. R. 15 E.
Co., State Woodson, Kansas

Claim Cecil T. Welch
Date completed Nov 14, 58
Date logged Nov 22, 58
Logged by PCF

Rev		
Ed		

Summary of log Peridotite ; from ~73.5 to 106.8+ thick 33.3+ ; color Ol Gy/Br Gy ; ;

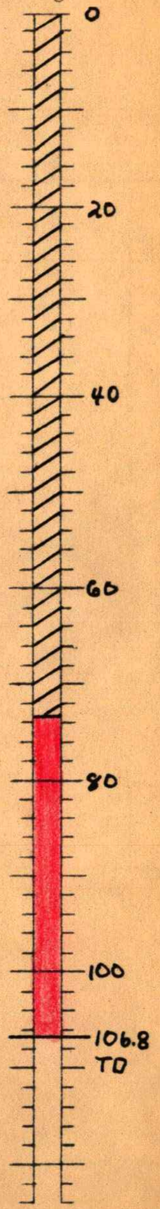
DRILL LOG

Depth	Rec ft.
0.0	
Rock Bit	No Core
73.5	
No Record of Runs	24.4
106.8	TD

LITHOLOGIC LOG

Base	Thick	Rec %	Rock	Color	Grain	Access. Min's.	Cbn	MS in SS	Remarks
73.5	73.5								Rock Bit; No Core; No Samples.
106.8	33.3	73	Peridotite	Ol Gy/Br Gy	F-M	A phlogopite fks; A GnBk serpentine, pyroxene "eyes"			5Y 4/1/5YR 4/1; phlogopite fks ≤ 1 mm in diam; "eyes" 3-5 mm in diam; slightly weathered in upper 10 ft (?); basal 3 ft hard; phlogopite fks give groundmass GyR col (10 R 4/2) locally.

Graphic log



Sample		Lab assay (%)			Sample		Lab assay (%)			Interval					
Base	Thick			$CaCO_3$	Base	Thick			$CaCO_3$	Base	Thick	Base	Thick		

GPO 837381 Hole No.

GEOLOGIC AND ASSAY LOGS

1/1

Drill-hole No. No. 4M (Hill) ( )
Inclination Vertical Bearing
Total depth 100.0
Collar elev. 978.5 T P
Area Silver City

Map coord (T) 100 ft E, 100 ft N SW
Map coord (P) Cor
Sec. 32 T. 26S. R. 15E.
Co., State Woodson, Kansas

Claim Cecil T. Welch
Date completed Nov 20, 58
Date logged Nov 22, 58
Logged by PCF

Rev		
Ed		

Summary of log Peridotite ; from 30.7 to 42.7 thick 12.0+ ; color Lt Bl Gy/M Gn Gy/D Gn Gy ;

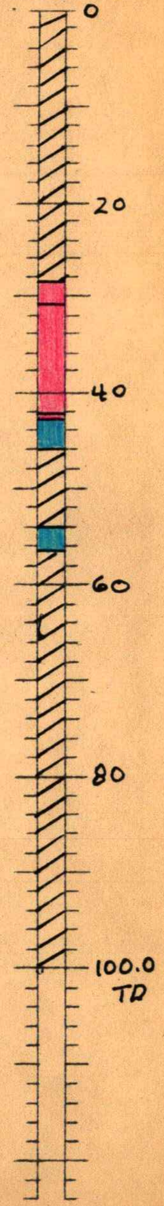
DRILL LOG

Depth	Rec ft.
0.0	
Rock Bit	No Core
28.4	3.0
31.5	4.5
37.0	2.0
40.0	5.4
46.0	
Rock Bit	No Core
54.0	1.2
56.5	
Rock Bit	No Core
100.0	TD

LITHOLOGIC LOG

Base	Thick	Rec %	Rock	Color	Grain	Access. Min's.	Cbn	MS in SS	Remarks
28.4	28.4								Rock Bit; No Core; No Samples.
30.7	2.3	97	Peridotite	Lt Bl Gy/ M Gn Gy	F	A phlogopite fks			5B 7/1 / 5GY 6/1; V Calc; phlogopite fks ≤ 1 mm in diam; grades into peridotite next below.
42.1	11.4	76	Peridotite	D Gn Gy	F	A phlogopite fks			5GY 4/1; locally M Calc; S incl-horiz aragonite veinlets; phlogopite fks ≤ 1 mm in diam.
42.7	0.6	100	Peridotite	D Gn Gy	F	S phlogopite fks; M Pink Or calcite gns (?)			5GY 4/1; V Calc; phlogopite fks < 0.5 mm in diam; basal 0.1 ft VF; basal contact wavy.
46.0+	3.3+	100	Ls	M Gy	F-C				N5; dense; fossiliferous.
54.0	8.0								Rock Bit; No Core; No Samples
56.5+	2.5+	48	Ls	Pink Gy	F				5YR 8/1; chalky; A sol pits; A wavy clay (?) fms.
100.0	43.5								Rock Bit; No Core; No Samples.

Graphic log



Sample Base	Sample Thick	Lab assay (%)		$CaCO_3$	Sample Base	Sample Thick	Lab assay (%)		$CaCO_3$	Interval Base	Interval Thick		Base	Thick	

GPO 837381

Hole No.

GEOLOGIC AND ASSAY LOGS

Drill-hole No. No. 5 M (Hill) ( )
Inclination Vertical Bearing
Total depth 37.5
Collar elev. 976.0 T P
Area Silver City

Map coord (T) 100 ft E, 1275 ft N of SW
Map coord (P) Cor
Sec. 32 T. 26S. R. 15E.
Co., State Woodson, Kansas

Claim Cecil T. Welch
Date completed 5 Dec 58
Date logged 8 Dec 58
Logged by PCF

Rev		
Ed		

Summary of log Peridotite ; from ? to 33.8 thick ? ; color DGnGy - BrGy ;

DRILL LOG

Depth	Rec ft.
0.0	
No Core	Rock Bit
26.0	
29.0	1.4
	3.1
34.7	1.8
37.5	TD

LITHOLOGIC LOG

Base	Thick	Rec %	Rock	Color	Grain	Access. Min's.	Cbn	MS in SS	Remarks
26.0	26.0								Rock Bit; No Core; No Samples.
29.3	3.3	47	Peridotite	DGnGy-BrGy	F-M	A phlogopite fks; A GnBk serpentine "eyes"			5GY 4/1 - 5YR 4/1; partly weathered; phlogopite fks ≤ 1 mm in diam; serpentine "eyes" ≤ 3 mm in diam.
33.8	4.5	54	Peridotite	VDGnGy	F-M	A phlogopite fks; A GnBk serpentine "eyes"; S aragonite veinlets; S Py in veinlets			5G 3/1; phlogopite fks ≤ 1 mm in diam; serpentine "eyes" ≤ 4 mm in diam; aragonite at 32-33 ± ft; veinlets ≤ 0.1 ft thick, contain 1 mm Py xstals.
34.1	0.3	64	Sh	DGy					N3; non-Calc; thin-lam; grades into Ls next below.
37.5+	3.4+	64	Ls	MDGy-MLtGy, Mot	F-C/C				N4-N6; fossiliferous; A int-lam Sh in top 0.3 ft.

Graphic log: 0; 37.5 T.D.

Sample Base	Sample Thick	Lab assay (%)		CaCO3	Sample Base	Sample Thick	Lab assay (%)		CaCO3	Interval Base	Interval Thick		Base	Thick		

*Assays marked "e" are from lab gamma-ray readings

GPO 837381

Hole No.

GEOLOGIC AND ASSAY LOGS

Drill-hole No. No. 6 M (Hill) ( )
Inclination Vertical Bearing
Total depth 52.0
Collar elev. 970 T P
Area Silver City

Map coord (T) 1330'E, 2745'N of SW Cor
Map coord (P)
Sec. 32 T. 26 S. R 15 E.
Co., State Woodson Co., Kan.

Claim Cecil T. Welch
Date completed 11 Dec 58
Date logged 8 March 59
Logged by PCF
Rev
Ed

Summary of log Peridotite; from ? to 51.5 thick ?28.5; color Lt Gy – Lt Br Gy – D Gn Gy;

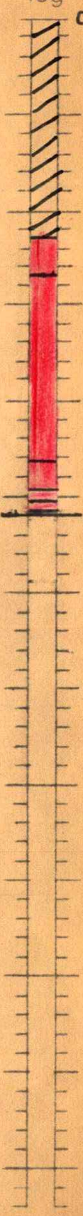
DRILL LOG

Depth	Rec ft.
0.0	
No Core	Rock Bit
23.0	
27.0	2.1
31.5	1.8
35.0	2.5
37.2	2.0
42.0	4.0
43.0	0.9
	6.6
52.0	T.D.

LITHOLOGIC LOG

Base	Thick	Rec %	Rock	Color	Grain	Access. Min's.	Cbn	MS in SS	Remarks
23.0	23.0								Rock Bit; No Samples
27.0	4.0	53	Peridotite	Lt Br Gy - Lt Gn Gy	F	A phlogopite fks; A Yw Gn serpentine eyes			5YR 6/1 – 5G 8/1; phlogopite fks ≤ 1 mm in diam; eyes ≤ 5 mm in diam, 10 GY 3/2; rock is V soft.
46.3	19.3	57	Peridotite	D Gn Gy	F	A phlogopite fks; S Lt Yw Gn "talcose" fms; S wh Aragonite veinlets			10 G 5/2; phlogopite fks ≤ 2mm; fms 10 GY 7/2; veinlets ≤ 1mm thick; 30-40% serpentine blebs ≤ 5mm in diam, Gy Ol Gn (5 GY 3/2) – M Bl GY (5 B 5/1).
49.4	3.1	81	Peridotite	Dusky Yw Gn – Lt Gn	F	M phlogopite fks; A serpentine in ground mass			5GY 5/2 – 10G 6/2; phlogopite fks ≤ 1mm in diam.
50.3	0.9	81	Peridotite	Lt Br Gy	VF	M Gy Ol Gn serpentine eyes.			5YR 5/1; groundmass of VF phlogopite fks; eyes 5GY 3/2, ≤ 7mm in diam; hard but non-Calc; grades into next below.
51.5	1.2	81	Peridotite	Lt Br Gy - V Lt Gy	VF	S phlogopite fks; S serpentine blebs			5YR 6/1 – N8; phlogopite fks ≤ 0.5mm in diam; blebs ≤ 2mm in diam, GY Ol Gn (5 GY 3/2); groundmass may

Graphic log



Sample		Lab assay (%)			Sample		Lab assay (%)			Interval				
Base	Thick			$CaCO_3$	Base	Thick			$CaCO_3$	Base	Thick		Base	Thick

GEOLOGIC AND ASSAY LOGS

Drill-hole No. No 6 M (Hill) ( )
Inclination Vertical Bearing
Total depth 52.0
Collar elev. 970 T P
Area Silver City

Map coord (T) 1330'E, 2745'N of SW cor
Map coord (P)
Sec. 32 T. 26 S. R 15 E.
Co., State Woodson Co., Kan.

Claim Cecil T. Welch
Date completed 11 Dec. 58
Date logged 8 March 59
Logged by PCF

Rev		
Ed		

Summary of log Peridotite ; from ? to 51.5 thick >28.5 ; color Lt Gy - Lt Br Gy - D Gn Gy ;

Graphic log

DRILL LOG		LITHOLOGIC LOG									
Depth	Rec ft.	Base	Thick	Rec %	Rock	Color	Grain	Access. Min's.	Cbn	MS in SS	Remarks
		—									be zeolitic; contact w/ Sh
		—									below inclined 70°±; rock
		—									is VVF w/ VF grained mica
		—									0.5" from contact.
		52.0	0.5+	100	Sh	M Lt Gy		A Dusky Yw Gn,			N6; silicified (?); chlori-
		—						wh fms			tized (?); hard.

Sample		Lab assay (%)			Sample		Lab assay (%)			Interval						
Base	Thick			CaCO3	Base	Thick			CaCO3	Base	Thick		Base	Thick		

GPO 837381

Hole No.

GEOLOGIC AND ASSAY LOGS

1/1

Drill-hole No. No 7 M (Hill) ( )
Inclination Vertical Bearing ____
Total depth 52.5
Collar elev. 990 T ____ P
Area Silver City

Map coord (T) 2650'E, 2745'N SW Cor
Map coord (P) ____
Sec. 32 T. 26S. R. 15E.
Co., State Woodson

Claim Cecil T. Welch
Date completed 14 Dec 58
Date logged 8 March 59
Logged by PCF

Rev		
Ed		

Summary of log Peridotite ; from ? to ? thick ≥21.0' ; color V Lt Gy – Lt Br Gy – Gy Ol Gn

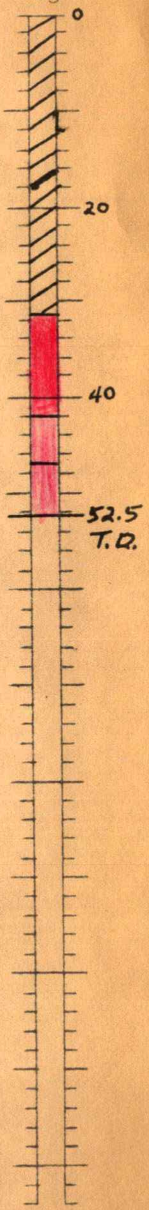
DRILL LOG

Depth	Rec ft.
0.0	
No Core	Rock Bit
31.5	
	2.5
34.5	
	2.3
37.0	
	2.1
39.5	
	2.4
42.0	
	1.5
43.5	
	1.5
45.0	
	1.9
50.0	
	1.7
52.5	T.D.

LITHOLOGIC LOG

Base	Thick	Rec %	Rock	Color	Grain	Access. Min's.	Cbn	MS in SS	Remarks
31.5	31.5								Rock Bit; No Samples.
42.0	10.5	89	Peridotite	Gy Ol Gn – Lt Br Gy, Mot	F	A phlogopite fks; A serpentine eyes; S wh clay (?) specks			5 GY 3/2 – 5 YR 6/1; phlogopite fks ≤ 1 mm in diam; eyes Dusky Yw Gn (5 GY 5/2), ≤ 4 mm in diam, have phlogopite haloes from 32 – 33± feet.
47.0	5.0	78	Peridotite	V Lt Gy – Lt Br Gy	F	M phlogopite fks; M serpentine eyes			N8 – 5 YR 6/1; phlogopite fks ≤ 1 mm in diam; eyes Gy Gn (10 GY 5/2), ≤ 3 mm in diam, have phlogopite haloes.
52.5	5.5	49	Peridotite	Lt Br Gy	F	A phlogopite fks; A serpentine eyes, blebs			5 YR 6/1; phlogopite fks ≤ 2 mm in diam; eyes, blebs Dk Gn Gy (5 G 4/1), ≤ 3 mm in diam.

Graphic log



Sample		Lab assay (%)			Sample		Lab assay (%)			Interval					
Base	Thick			$CaCO_3$	Base	Thick			$CaCO_3$	Base	Thick		Base	Thick	

*Assays marked "e" are from lab gamma-ray readings

GPO 837381

Hole No. ____

Abbreviations used in Rose Dome core logs by Paul C. Franks

// --- interbedded, interlaminated, or intercalated
A --- abundant
Bl --- blue
Bk --- black
Br --- brown
C --- coarse-grained
Calc --- calcareous or calcite
cm --- centimeters
Cs ---claystone
Dk --- dark
diam --- diameter
dimen --- dimension
dissem --- disseminated
F --- fine-grained
Fe --- iron
fks --- flakes
fldspr --- feldspar
frac --- fractures, fractured
frag --- fragments
Gn --- green
"Gran" --- "granite"
Gy --- gray
Lam --- laminae or laminated
hem --- hematite
hnfls --- hornfels
Kgr --- Cretaceous (?) "granite"
Kmr --- Cretaceous mica rock
Kp --- Cretaceous peridotite
lim --- limonite or limonitic
ls --- limestone
Lt --- light
M --- moderate, medium
min --- mineral
mm --- millimeters
musc --- muscovite
Ol --- olive
Or --- orange
peg --- pegmatitic in granin size
Py --- pyrite
R --- red
S --- sparse
TD --- total depth
Tr --- trace
V --- very
Wh --- white
xls --- crystals
Yw --- yellow
w/ --- with

GEOLOGIC AND A[illegible]AY LOGS

Drill-hole No. RD DDH-1 ( )
Inclination Vert. Bearing
Total depth 22.0
Collar elev. 1053.38' T P
Area Rose Dome

Map coord (T) 1876'N 1157' W SE cor sec 13
Map coord (P)
Sec. 13 T. 26S R. 15E
Co., State Woodson Co., Kan

~~Claim~~ Farm Maynard Stockebrand
Date completed 25 Aug 64
Date logged 26 Aug 64
Logged by Paul C. Franks

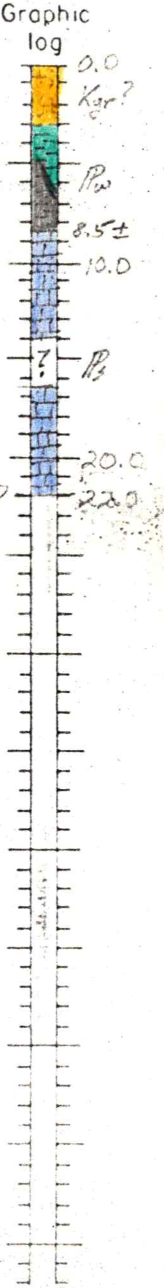
Rev		
Ed		

DRILL LOG

Depth	Rec ft
0.0 – 18.0 Rotary Bit	No Core
18.0 – 20.0	0.2
20.0 – 22.0	1.8
22.0	TD

LITHOLOGIC LOG

Base	Thick	Rec %	Rock	Color	Grain	Access. Min's.	Cbn	MS in SS	Remarks
3±	3±	—	gran.	M Yw — Lt Gy	F — peg	[illegible]			largely rubble; not necessarily in place; highly weathered
8.5±	5.5±	—	hrfls & sh	Ol Gy	Cs — VF	Calc			Slightly metamorphosed Sh: Pw; less metamorphosed w/ depth?
14'	6.5±	—	ls	Dk Gy (N3) — Lt Gy	VF	Tr — S dissem Py; possibly S chert			Brittle; breaks w/ hackly to chonchoidal frac; sugary texture in part; slightly metamorphosed?
16.5	2.5	—	?			A soft RBr — Yw Gy frags, Cs & Fe-oxide?			Bit dropped suddenly & drilling rate increased markedly; S metamorphosed Sh (hrfls) present?; either altered min. rock or "Gran"?
18.0	1.5	—	ls	Dk Gy (N3)	VF	S Py, dissem & in veinlets			as from 9-14'?
20.0	2.0	10	ls	Dk Gy — V Lt Gy	VF	Dolomitic in [illegible] [illegible]?; [illegible] ? in Lt Gy — [illegible] Gy [illegible]; S calcite [illegible] lets w/ Fe-oxide stain & Py frags			as above; argillaceous; basically no different than ls above & below; possibly less cherty, but bit plugged at start of run due to [illegible] core catcher; brittle; [illegible] to chonchoidal fra[illegible]
22.0	2.0	80	ls	Dk Gy — V Lt Gy	VF	Argillaceous [illegible] S silica [illegible]			S [illegible] lamy; [illegible] filling along [illegible]; not obviously recrystallized or metamorphosed.



Sample		Sample		Sample		Sample		Sample		Sample		Sample		Sample		Sample		Sample	
Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick

GEOLOGIC AND ASSAY LOGS

Drill-hole No. DDH-2 ( )
Inclination Vert Bearing
Total depth 55.9
Collar elev. 1056.46 T P
Area Rose Dome

Map coord (T) 1868N 1202W SE cor Sec 13
Map coord (P)
Sec. 13 T. 26S R. 15E
Co., State Woodson Co., Ks

Farm Claim Maynard Stockebrand
Date completed 28 Aug '64
Date logged 2 Sept '64
Logged by Paul C. Franks

Rev		
Ed		

DRILL LOG

Depth	Rec ft.
0.0	
Rotary Bit (0.0–10.3)	No Core
10.3	
10.3–13.9	1.0
13.9	
cuttings saved (13.9–23.7)	0.0
23.7	
Rotary Bit (23.7–29.8)	No Core
29.8	
29.8–33.3	2.7
33.3	
33.3–39.3	4.9
39.3	
39.3–43.4	3.5
43.4	
44.7	
44.7–49.7	3.8
49.7	
Rotary Bit (49.7–55.9)	No Core
55.9	TD

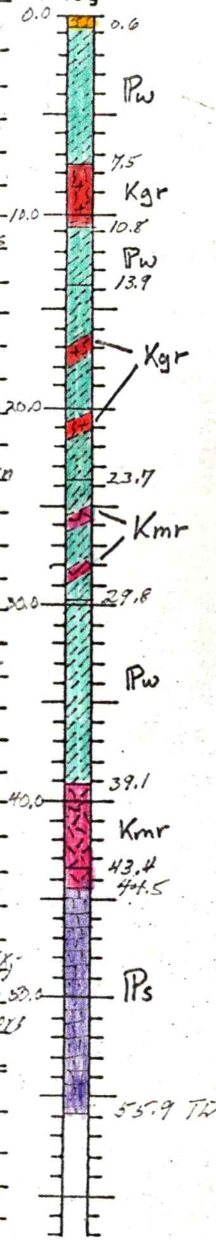
Rotary Bit / No Core (43.4–44.7)

LITHOLOGIC LOG

Base	Thick	Rec %	Rock	Color	Grain	Access. Min's.	Cbn	MS in SS	Remarks
0.6	0.6	—	Soil						derived from hnfls
7.5	6.9	—	hnfls	Lt Ol Gy – D Yw Or	VF	A lim stain on fracs			highly fractured; bedding of hnfls seems inclined 30–45° WSW in sump pit
10.8±	3.3	20	Cs & "Gran"/"Gran"	Yw Or & V Lt Gy	F – C	S Biotite			A "gran" frags drilled up; seems to be highly altered "gran"; "Gran" is F w/ S C gns & S amphibole (?) needles & has A small voids filled w/ Yw Or lim – Cs; many frags show flow structure; "Gran" is V Lt Gy; Core badly washed & worn
13.9	3.1	19	hnfls	Dk Gy – Gn Bk	VF	Tr Py on fracs			A lim & Fe-oxide stain along fracs; cherty texture
23.7	9.8	0.0-	hnfls & "Gran" & Cs	Dk Gy – M Gy & V Lt Gy – Yw Or	VF	Tr Py & Calcite on fracs			Cherty texture; used sawtooth bit in this interval; no core, but cuttings saved; Seems to be decomposed gran in this interval; fine cuttings include Yw Or Cs, sericitic material, & "gran", qtz, & feldspar frags; a few gran frags in C cuttings
29.8	6.1	—	hnfls; S mica rock selvage or stringers	Dk Gy – Gn Bk – Gn Or; Dk Gy R – Br Gy	VF	S Py & Calcite, probably in veinlets in hnfls; M mica (phlogopite (?)) on some surfaces of hnfls judging by core next			S qtz, feldspar, & "Gran" frags from this interval may or may not be cavings; Mica rock is Br Gy – Yw Or; Yw Or is from altered phases; Calc matrix; S Gy Gn blebs & circs; probably present as veinlets & stringers cutting the hnfls.

Sample		Sample		Sample		Sample		Sample		Sample		Sample		Sample		Sample		Sample	
Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick
39.0±	Ts																		
49.0±	Ts																		

Graphic log



Hole No. DDH-2, RD

GEOLOGIC AND ASSAY LOGS

Drill-hole No. DDH-2 ( )
Inclination Vert Bearing —
Total depth 55.9
Collar elev. 1056.46 T P
Area Rose Dome

Map coord (T)
Map coord (P)
Sec. 13 T. 26 S R. 15 E
Co., State [illegible]

~~Claim~~ Farm: Maynard Stockebrand
Date completed 28 Aug 64
Date logged 2 Sept '64
Logged by Paul C. Franks

Rev		
Ed		

Graphic log

DRILL LOG / LITHOLOGIC LOG

Depth	Rec ft.	Base	Thick	Rec %	Rock	Color	Grain	Access. Min's.	Cbn	MS in SS	Remarks
								[illegible], Calcite & [illegible] are on fracs			
		39.1	9.2	[illegible]	[illegible]	[illegible] Gy [illegible] [illegible] Rcor [illegible]tact of mica-rock next below	VF	[illegible] like on [illegible] surfaces			apparently as above; highly fractured & locally traversed by veinlets of calcite, Py & Fe oxide that parallel fracs; bedding inclined as much as 60°±, or what looks like bedding might be slaty cleavage; fracs commonly parallel this direction as do color changes
		43.4	4.3	85	Micro-[illegible]	Br Gy — Gy R	VF	Calc matrix; & Py veinlets & stringers; & calcite patches, veinlets, stringers & masses; & M [illegible] Bl Gy Calc — serpentinitic "blebs" < 4 mm in diam & ≤ 15% of rock enclosed in calc [illegible] matrix; & Py stringers & veinlets in calc [illegible] for ls inclusions)			Contact w/ bedded ls above may be present in interval from 39.1 – 39.5; if so, highly irreg locally near vertical & w/ distinct sign of brecciation & calcification of country rock; & corroded ls frags ≤ 1.5 cm diam in breccia along contact(?); some of the calc patches & stringers are as much as 1" long & may be inclusions of recrystallized ls [illegible] rock; & angular — rounded frags of K-spar (Rose "gran." type) as well as a few inclusions of calcified & "softened" rounded inclusions of Rose (?) "gran".

Sample		Sample		Sample		Sample		Sample		Sample		Sample		Sample		Sample		Sample	
Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick

GEOLOGIC AND ASSAY LOGS

Drill-hole No. DDH-2 ( )
Inclination Vert Bearing —
Total depth 55.9
Collar elev. 1056.46 T P
Area Rose Dome

Map coord (T)
Map coord (P)
Sec. 13 T 26S R 15E
Co., State

~~Claim~~ Farm Maynard Stockebrand
Date completed 28 Aug 64
Date logged 2 Sept '64
Logged by Paul C. Franks

Rev		
Ed		

Graphic log

DRILL LOG		LITHOLOGIC LOG									
Depth	Rec ft	Base	Thick	Rec %	Rock	Color	Grain	Access Min's	Cbn	MS in SS	Remarks
		44.5±	1.1±	—	mica-rock						As above in cored interval
		55.9	11.4±	78	ls — Marble	V Lt Gy - M Gy w/ Br over-tones; S Lt Gn Gy	F-M	A Py in mica-rock [illegible] & along argillaceous fms, both GnGy & Lt BrGy, & Py blebs; A Py also dissem; S Qtz xls in vugs; S dissem phlogopite fks in whole sequence			At least partly rexlized; upper 1.5'± cut by irregular veins of mica rock, some of which hold inclusions of pyritized hnfls; generally vuggy; vugs commonly lined w/ M-C calcite xls; mica-rock veinlets have M GnGy pyritic fringes composed largely of clay(?); vugs may be stained w/ oil; bedding seems inclined 60°± as are argillaceous fms & most vuggy stringers; loss of circulation in rotary bit interval from 49.7 - 55.9' indicates porosity or cavities may be extensive; hole bottomed because of repeated loss of circulation; Some vugs & fracs may show oil stain

Sample		Sample		Sample		Sample		Sample		Sample		Sample		Sample		Sample		Sample	
Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick

Hole No. DDH-2, RD

GEOLOGIC AND ASSAY LOGS

Drill-hole No. DDH-3 ( )
Inclination Vert Bearing
Total depth 90.1
Collar elev. 1058.0? T P
Area Rose Dome

Map coord (T) 1866 N 1240 W SE Cor Sec 13
Map coord (P)
Sec. 13 T [illegible] R [illegible]
Co., State [illegible]

Farm ~~Claim~~ Maynard Stukebrand
Date completed 4 Sept '64
Date logged 17 Sept '64
Logged by Paul C. [illegible]

Rev		
Ed		

DRILL LOG

Depth	Rec ft.
0.0	
Rotary Bit	No Core
20.8	
23.6	1.0
	2.6
29.0	2.1
31.5	0.8
33.0	
Rotary Bit	No Core
41.5	
43.5	1.6
46.3	1.3
Rotary Bit	No Core
50.4	
53.6	1.6
54.6	1.1
Rotary Bit	No Core
76.6	1.3
78.2	
Rotary Bit	No Core
90.1	TD

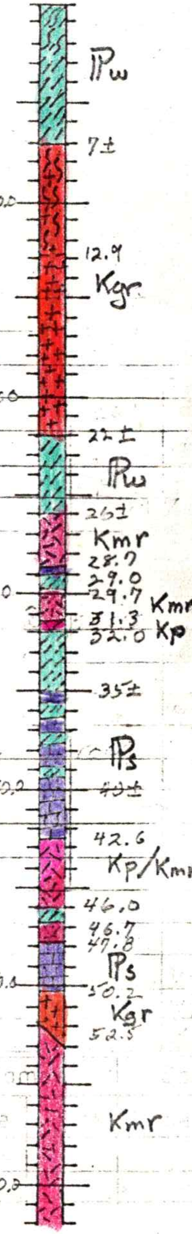
LITHOLOGIC LOG

Base	Thick	Rec %	Rock	Color	Grain	Access. Min's	Cbn	MS in SS	Remarks
5'	5	—	Sil/hnfls	DK Br Gy - Dk Gy					largely from weathered hnfls; sump pit actually dug in hnfls
7(?)	2(?)	—	hnfls	Rk Br Gy	VF				Shaly bedding still seems to persist
19.9	12.9(?)	—	Cs	V Dk Yw Or – M Yw Br	Cs	A VF mica fks, Qtz gns, & feldspar frags			Contains residuum of relatively fresh "granite"; seems to be weathered "gran" or otherwise altered "gran"
22±	2.1±	49	"Gran"	M Lt Gy	VF – Peg	A calcite frags in cuttings from 19.9 – 20.8'; Tr dissem magnetite; Py, veinlets & dissem; a few % dissem biotite books ≤ 2mm across.			Calcite & phlogopite probably from Mica rock veins; locally highly fragmented w/ Qtz & spar blended by M Gy sericitic Qtz-feldspathic VF matrix; Qtz has typical opalescent character; "Gran" is porphyritic, allotriomorphic inequigranular; S subhedral phenocrysts
26±	4±	2	hnfls	Lt Gy – Dk Gy	VF	S VF mica fks; S Fe-oxide stain			Shaly bedding persists; Tr Py on fracs
28.7	2.7±	90±	Mica rock	M Br Gy	VF-F	A Calcite in matrix; A Calc-chloritic veinlets, pods & masses; masses ≤ 7cm in long dimen			Phlogopite is major min component; many of the Calc patches ≤ 1cm across as well as larger ones may be either inclusions or replacement patches; A frags spar as inclusions & S rounded frags "gran" & A hnfls ≤ 10cm long as inclusions.
29.0	0.3	100	Carbonate	V Lt Gy – M Lt Gy – M Or Pk	F – VC	A dissem VF Py; S mica flks dissem & as			Composed mainly of Calcite; interpenetrates w/ mica rock above w/ irregular contact; M Or Pk

Samples

Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick
24.0±	TS	41.5±	TS	52.3±	TS														
27.0±	TS	42.0±	TS	77.0±	TS														
30.5±	TS	43.0±	TS																

Graphic log



Hole No. DDH-3, R.D.

2 — 5

GEOLOGIC AND ASSAY LOGS

Drill-hole No. DDH-3 ( )
Inclination Vert Bearing
Total depth 90.1
Collar elev. 105[illegible] T P
Area Rose Dome

Map coord (T)
Map coord (P)
Sec. 13 T. 26 S R. 15 E
Co., State Woodson Co, Kan

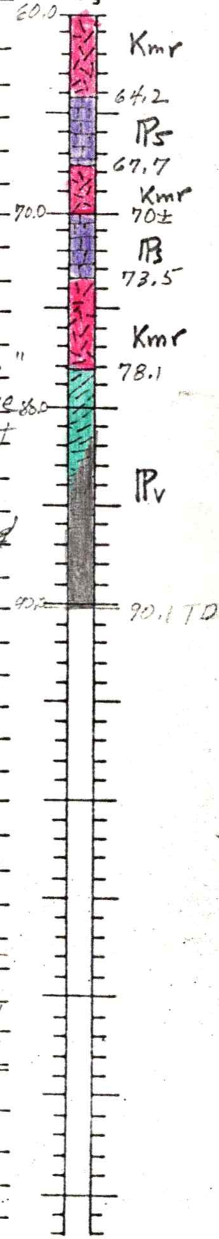
Farm ~~Claim~~ Maynard Stockebrand
Date completed 4 Sept '64
Date logged 17 Sept '64
Logged by Paul C. Franks

Rev		
Ed		

DRILL LOG		LITHOLOGIC LOG									
Depth	Rec ft.	Base	Thick	Rec %	Rock	Color	Grain	Access. Min's.	Cbn	MS in SS	Remarks
		— —						as aggregates			is in irregular VF patches ≤ 2 cm in long dimen
		29.7 — —	0.7	50	hnfls	Lt Gy — DK Gy	VF	S Py & Fe-oxide on fracs; S VF mica fks			Bedding poorly preserved; cherty texture; Worn granite frags recovered from this interval
		31.3 — — — — — — — —	1.6	100	Mica rock	M Br Gy	VF — F	A Gn Gy CO_3^{2-} — chloritic eyes ≤ 1cm in diam; S calcite [illegible]; Tr Py as replacements even in "Gran" inclusions			Grades into next below; as mica rock above, but "gran" inclusions larger & more A than hnfls inclusions; "Gran" inclusions saussuritized & have DK Gn Gy reaction rims against mica rock
		32.0 — — — —	0.7	85±	Peridotite	Mottled DK Br Gy — DK Bl Gy	VF — F	A mica (phlogopite); Tr Py replacements; Tr $CaCO_3$ in matrix			Grades into next above; M fdsprd S "Gran" inclusions ≤ 2cm long; selvage against hnfls next below is composed almost wholly of mica.
		35 ± —	3 ±	30 ±	hnfls	M Lt Gy — Dk Gy	VF	S Fe-oxide stain on fracs			Bedding preserved locally; fractured; Cherty texture
		40.0 ± — — — —	5.0 ±	—	Calc mica rock or marble // hnfls	V Lt Gy — P R[illegible] M Lt Gy — DK Gy & DK Bl Gy	F — M // VF	A C calcite; A phlogopite; Tr Py in Calc mica rock			Sequence could be altered ls or marble // hnfls; M feldspar & qtz frags brought up in this interval, possibly inclusions from mica rock veins or stringers.
		42.6 — — — —	2.6	90 ±	Marble	Lt Gy — M Gy & Br Gy / Wh — Lt Gy	VF — M / F — VC	[illegible] in upper [illegible] dissem [illegible] in lower Lt C part; Qtz (?)			A mica rock [illegible] & inclusions or stringers ≤ 5cm long in Lt C part; S vugs in C part; relict bedding (?) seams: steeply inclined (60°±?); Py concentrated in

Sample		Sample		Sample		Sample		Sample		Sample		Sample		Sample		Sample		Sample	
Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick

Graphic log



Hole No. DDH-3, R.D.

GEOLOGIC AND ASSAY LOGS

Drill-hole No. DDH-3 (   )
Inclination Vert Bearing
Total depth 90.1
Collar elev. 1058.01 T P
Area Rose Dome

Map coord (T)
Map coord (P)
Sec. 13 T 26S R 15E
Co., State [illegible]

Farm Claim Maynard Stockebrand
Date completed 4 Sept '64
Date logged 17 Sept '64
Logged by Paul C. Franks

Rev		
Ed		

DRILL LOG		LITHOLOGIC LOG										Graphic log
Depth	Rec ft.	Base	Thick	Rec %	Rock	Color	Grain	Access. Min's	Cbn	MS in SS	Remarks	
								concentrated in [illegible] adjacent to mica rock inclusions			in veinlets & along metamorphosed sh partings in Lt lower part.	
		46.0	3.4	50	Peridotite / Mica rock	M GnGy / M BrGy	VF	[illegible] calc; S phlogopite in peridotite; A phlogopite in mica rock & mica rock veins			A "gran" inclusions; S hnfls inclusions near base; Cut by veinlets of calc M BrGy mica rock that hold A inclusions of hnfls, gran, & fldspr; "gran" inclusions in both perid & mica rock veins highly saussuritized	
		46.7	0.7	60	hnfls	Dk Gy w/ Gn & Bl overtones	VF	S Py along fracs			highly fractured; slaty to cherty texture	
		47.8	1.1	—	Mica rock	M BrGy	F	Tr dissem Py			Calc matrix; perhaps actually marble impregnated w/ phlogopite	
		50.2	2.4	—	Marble	Wh-Lt Gy	F	Tr dissem Py & Phlogopite			Sugary texture; probably contains blebs or stringers of M BrGy mica rock judging by abundance of frags in cuttings	
		52.5	2.3	28	"Gran"	V Lt Gy - M GnGy	M-Peg	≤ 5% Br Bk Biotite books, probably chloritized			Highly saussuritized, particularly along contact w/ mica rock next below; contact w/ next below inclined 60°±; porphyritic, allotriomorphic inequigranular; Qtz is opalescent in character but not abundant near contact w/ mica rock next below	
		64.2	11.7	99	Mica rock	M-Dk Br Gy	F	Calc matrix, M Calcite blebs, Lt [illegible]			Phlogopite is major component; A inclusions of "gran", fldspar, &	

Sample		Sample		Sample		Sample		Sample		Sample		Sample		Sample		Sample		Sample	
Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick

Hole No. DDH-3, R.D.

7-5

GEOLOGIC AND ASSAY LOGS

Drill-hole No. DDH-3 ( )
Inclination Vert Bearing
Total depth 90.1
Collar elev. 1058.01 T P
Area Rose Dome

Map coord (T)
Map coord (P)
Sec. 13 T. 26 S R. 15 E
Co., State Woodson Co, Kan

Farm Claim Maynard Stockebrand
Date completed 4 Sept '64
Date logged 17 Sept '64
Logged by Paul C. Franks

Rev		
Ed		

DRILL LOG Depth	DRILL LOG Rec ft.	Base	Thick	Rec %	Rock	Color	Grain	Access. Min's.	Cbn	MS in SS	Remarks
								Gn-P Gy Org & Gn Gy - Dk Gn Gy blebs; S dissem Py blebs & pinlets; Py most A near bnfls inclusions & where calcite is most A			contorted bnfls frags; fldspr & "gran" inclusions highly saussuritized; inclusions ≤ 10 cm long; Series of bnfls inclusions between 53.6 & 54.6' show parallel arrangement of relict bedding inclined 80°± from vertical & might be edge of a zone of interfingering of mica rock w/ sh; "Gran" inclusions VA from 52.5-53.5±' & 59-63±'; Calcite content of matrix is low from 53.6'-55' & increases sharply near base.
		67.7	3.5	—	Marble	V Lt Gy - Lt Br Gy & Dk Gn Gy	F, VS C	S Phlogopite lks & dissem Py & blebs of Py			Sugary texture; may contain blebs of Calc mica rock.
		70±	2.3±	—	Mica Rock	M-Dk Br Gy	F-VF	Calc matrix; S dissem Py; Calcite blebs?			Generally as from 52.5-64.2' but no obvious inclusions seen in cuttings
		73.5	3.5±	—	Marble	Wh - Lt Gy & Br Gy - Dk Gn Gy	F, VS C	S dissem Py & phlogopite			Sugary texture; may contain blebs & stringers of Calc mica rock
		78.1	4.6±	81	Mica Rock	M-Dk Br Gy	F-VF	Calc matrix; Calc veinlets & blebs?; S Gn Gy blebs & eyes; Tr dissem Py; V Calc locally in basal 2'			"Gran" & bnfls inclusions; Py seems most A where calcite is most A; bnfls inclusions become VA from 76±-78.1; locally may even be intercalated w/ bnfls in this interval; bnfls inclusions or veinlets cut by calcite veins

Sample Base	Sample Thick	Sample Base	Sample Thick	Sample Base	Sample Thick	Sample Base	Sample Thick	Sample Base	Sample Thick	Sample Base	Sample Thick	Sample Base	Sample Thick	Sample Base	Sample Thick	Sample Base	Sample Thick	Sample Base	Sample Thick

Graphic log

Hole No. DDH-3, R.D.

GEOLOGIC AND ASSAY LOGS

Drill-hole No. DDH-3 ( )
Inclination Vert Bearing
Total depth 90.1
Collar elev. 1058.01 T P
Area Rose Dome

Map coord (T)
Map coord (P)
Sec. 13 T. 26s R. 15E
Co., State Woodson Co., [illegible]

Farm Claim Maynard Stockebrand
Date completed 4 Sept '64
Date logged 17 Sept '64
Logged by Paul C. Franks

Rev		
Ed		

Graphic log

DRILL LOG / LITHOLOGIC LOG

Depth	Rec ft.	Base	Thick	Rec %	Rock	Color	Grain	Access. Min's.	Cbn	MS in SS	Remarks
		90.1	12.0+	—	hnfls/	M Dk Gy	VF	[illegible] & Py			P Yw Br stringers & zones of
		—			Sh	→ M Lt Gy		veinlets fill			hnfls near contact w/ mica
		—				M Lt Gy		fracs; locally			rock above may be impreg-
		—				→ M Gy		Calc; S dissem			nated w/ phlogopite; cherty
		—						Py; A VF mica			fabric; thin lam where
		—						(musc?) fks			not overly metamorphosed;
		—						dissem along			change from hnfls to sh is
		—						laminae			in interval from 80-86'

Sample		Sample		Sample		Sample		Sample		Sample		Sample		Sample		Sample		Sample	
Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick

Hole No. DDH-3, R.D.

GEOLOGIC AND ASSAY LOGS

Drill-hole No. DDH-4 ( )
Inclination Vert Bearing
Total depth 49.3
Collar elev. 1050.97 T P
Area Rose Dome

Map coord (T) 1827N 1125W SE Cor Sec 13
Map coord (P)
Sec. 13 T. 26S R. 15E
Co., State [illegible]

Farm Claim Maynard Stockeland
Date completed 9 Sept '64
Date logged 22 Sept '64
Logged by Paul C. Franks

Rev		
Ed		

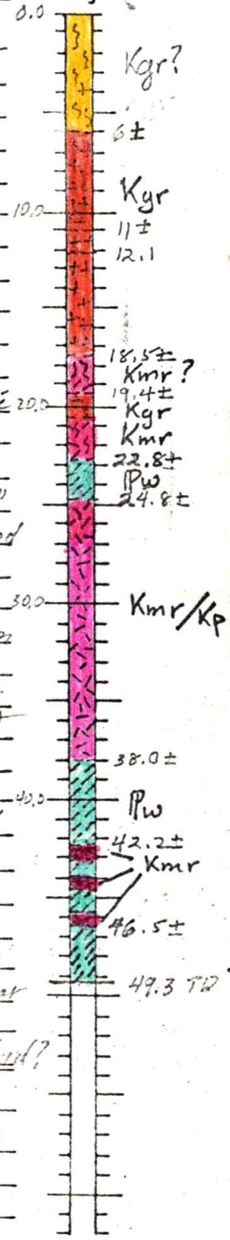
DRILL LOG

Depth	Rec ft
0.0	
Rotary Bit	No Core
12.1	0.8
15.4	1.2
19.5	0.2
23.0	1.3
28.4	0.6
32.7	
49.3	TD

LITHOLOGIC LOG

Base	Thick	Rec %	Rock	Color	Grain	Access. Min's.	Cbn	MS in SS	Remarks
6±	6±	—	Soil	[illegible] Yw Br / M Yw Br	Cs – C	VS [illegible] lim			A Qtz, fldspar, & "gran" frags; S hnfls frags; A sericitic mica in Yw Br clay base of soil; sandy – gravelly clay residuum is best description; hnfls frags seem to increase in abundance downward
11±	5±	—	"Gran" residuum	Dk Yw Br	Cs – VC	A lim stain			VA Qtz, fldspar, & "gran" frags in Dk Yw Br M sericitic clay matrix.
12.1	1.1±	—	"Gran" residuum	Dk Gy Or – Yw Or	F – M	M weathered biotite or vermiculite [illegible]; S [illegible]; Tr opaques			A Cs, Gy Or – Yw Or; A Qtz & feldspar gns; could be "gran" cut by stringer of weathered mica rock.
18.5±	6.1±	26	"Gran"	V Lt Gy – Lt Gy	F – M / C – Peg in S F–M matrix	≤ 2% Biotite; Tr magnetite ?; Tr dissem Py; S hnfls (?) inclusions; Tr hem after magnetite (?)			Has numerous small vugs ≤ 3 mm in long dimen that are filled w/ a late generation of xline Qtz; early Qtz has bluish opalescent character; texture generally allotriomorphic inequigranular to subequigranular; upper F–M phase may show faint flow structure & plag feldspar partly altered & shows Gn Gy tones; whole sequence shows some sign of weathering; much feldspar shows sign of graphic – vermicular intergrowths w/ Qtz – altered feldspar?

Graphic log



Sample		Sample		Sample		Sample		Sample		Sample		Sample		Sample		Sample		Sample	
Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick
14.0±																			
16.5±																			
27.0±																			

2-3

GEOLOGIC AND ASSAY LOGS

Drill-hole No. RDH-4 ( )
Inclination Vert Bearing
Total depth 49.3
Collar elev. 1057.99 T P
Area Rose Dome

Map coord (T) 1820'N 1125'W SE Cor Sec 13
Map coord (P)
Sec. 13 T. 26S R. 15E
Co., State Woodson Co, Kan

Farm ~~Claim~~ Maynard Stockebrand
Date completed 9 Sept '64
Date logged 22 Sept '64
Logged by Paul C. Franks

Rev		
Ed		

Graphic log

DRILL LOG		LITHOLOGIC LOG									
Depth	Rec ft	Base	Thick	Rec %	Rock	Color	Grain	Access. Min's.	Cbn	MS in SS	Remarks
		19.4±	0.9±	24	Cs	Dusky Yw	VF - F	A mica (bleached - vermiculite); S BK opaques, Qtz, fldspar; S Calc			Most likely highly weathered & altered mica rock.
		20.5±	1.0±	20	"Gran"	V Lt Gy - Lt Gy	F - C	≤ 10% Biotite; Tr hem after magnetite (?)			Generally as from 12.1-18.5'; S hnfls (?) inclusions; core badly worn; altered & weathered?
		22.8±	2.3±	0	Weathered Mica Rock	Dusky Yw	VF - F	A Qtz & fldspar fracs, possibly inclusions; S Calc; VA bleached biotite or phlogopite			
		24.8±	2.0±	10	hnfls	M Dk Gy w/ Gn overtones; commonly Br Gy along fracs	VF	S Calcite as frac filling; Tr Py on fracs & also lim - jarosite stain			Cherty texture; highly fractured
		38.0±	14.2±	24	Mica rock/ peridotite	Lt Br Gy/ M Gn Gy	VF - F	S-M Calc matrix; peridotite has A accessory phlogopite & S BK opaque grns; Tr Py concentrated on hnfls inclusions along calcite veinlets			A inclusions of altered fldspar ≤ 1 cm in long diam; S-M hnfls inclusions ≤ 3 cm in long diam; some hnfls inclusions cut by A calcite veinlets; A "zeolitic" eyes ≤ 2 mm in diam in mica rock; Peridotite is cut by steeply inclined veins of mica rock ≤ 2 cm thick; S Qtz inclusions in mica rock & peridotite; S "gran" & hnfls inclusions in basal 4' of peridotite

Sample		Sample		Sample		Sample		Sample		Sample		Sample		Sample		Sample		Sample	
Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick

GEOLOGIC AND ASSAY LOGS

Drill-hole No. DDH-4 (   )
Inclination Vert Bearing
Total depth 49.3
Collar elev. 1057.99 T   P
Area Rose Dome

Map coord (T) 1827'N 1125'W SE Cor Sec 13
Map coord (P)
Sec. 13 T. 26S R. 15E
Co., State [illegible] Kan

Farm ~~Claim~~ Maynard Stockebrand
Date completed 9 Sept '64
Date logged 22 Sept '64
Logged by Paul G. Franks

Rev		
Ed		

Graphic log

DRILL LOG		LITHOLOGIC LOG									
Depth	Rec ft.	Base	Thick	Rec %	Rock	Color	Grain	Access. Min's.	Cbn	MS in SS	Remarks
		42.2±	4.2±	[illegible]	hnfls	M Dk Gy - Dk Gy	VF	Tr-S Py on fracs; S CaCO₃, some as minute vein-lets associated w/ Py			Cherty texture; fractured;
		46.5±	4.3±	—	hnfls // Mica Rock	M Dk Gy - Dk Gy // BrGy	VF, VF - F				hnfls & mica rock as above; seems to be intercalated hnfls & Calc Mica Rock; about 40% Mica Rock.
		49.3	2.8±	—	hnfls	M Dk Gy - Dk Gy	VF	Tr-S Py on fracs; S CaCO₃, partly as veins			Cherty texture; fractured

Sample		Sample		Sample		Sample		Sample		Sample		Sample		Sample		Sample		Sample	
Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick

GEOLOGIC AND ASSAY LOGS

Drill-hole No. DDH-5 ( )
Inclination Vert Bearing
Total depth 24.0
Collar elev. 1062.25 T P
Area Rose Dome

Map coord (T) 1720' N 820' W SE Cor Sec 13
Map coord (P)
Sec 13 T 26S R 5W
Co., State [illegible] Co., Kan

Farm ~~Claim~~ Maynard Stockebrand
Date completed 10 Sept '64
Date logged 22 Sept '64
Logged by Paul C. Franks

Rev		
Ed		

DRILL LOG

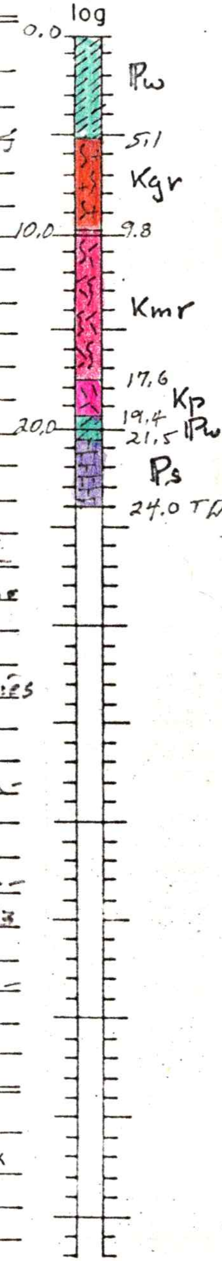
Depth	Rec ft.
0.0	
Rotary Bit	No Core
24.0	TD

LITHOLOGIC LOG

Base	Thick	Rec %	Rock	Color	Grain	Access. Min's	Cbn	MS in SS	Remarks
5.1	5.1			VLt Gn-M Gy	VF	A Fe-oxide-stain; Tr mica fks on some frac surfaces along w/ A Fe-oxide			Cherty textures; relict laminae; hole collared in hnfls & soil derived from same
9.8±	4.7±	–	"Gran residuum"	M Yw Br	VF-Peg	S-M sericite fks; A Fe-oxide stain; VS biotite & bleached biotite			Qtz & fldspar frags in M Yw Br sericitic Cs matrix; highly weathered "Gran"; A "Gran" frags
17.6±	7.8±	–	Cs	Dusky Yw		Calc; A F bleached biotite or phlogopite fks			M hnfls, qtz, fldspar frags w/ A phlogopite - bleached phlogopite fks in Calc Cs matrix; weathered Mica Rock or peridot
19.4	1.8±	–	Peridotite	M Gn Gy	VF-F	A phlogopite phenocrysts ≤ 1mm diam; Calc matrix; S Bk opaques; Tr dissem Py; S Calc veinlets			Cuttings of Br Gy Mica Rock probably from veins cutting perid; matrix probably carries both clay & serpentine as well as calcite; S "Gran", Qtz, fldspar, & hnfls inclusions
21.5±	1.1±	–	hnfls	M-Dk Gy	VF	A Py as veinlet fillings; S Calcite in veinlets			Cherty text; fractured; Grades into Ls next below by interlamination of increasing $CaCO_3$ content
24.0	2.5	–	ls or marble	Lt-M Gy	F	M-A dissem Py & Py in veinlets; S dissem VF phlogopite fks			At least partly re-xlized; conchoidal to hackly fracture; S Qtz xls in small vugs; TD; rig broke down!

Sample		Sample		Sample		Sample		Sample		Sample		Sample		Sample		Sample		Sample	
Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick	Base	Thick

Graphic log



Hole No. DDH-5, R.12.