PRELIMINARY DRILLING IN THE POWDER RIVER BASIN, CONVERSE, CAMPBELL, AND JOHNSON COUNTIES, WYOMING

By
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June 1957

Division of Raw Materials, AEC
Denver Area Office
Denver, Colorado
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ABSTRACT

On July 16, 1953, a diamond core-drilling program was begun in the Pumpkin Buttes area to secure geologic information. Drilling was terminated March 11, 1954, after 12 holes had been completed for a total of 5,813 feet.

An investigational rotary noncore-drilling project was conducted from June 14, to September 17, 1954, in the southern part of the Powder River Basin, Campbell, Johnson, and Converse Counties, Wyoming. Drilling was done in the Pumpkin Buttes area and the Converse County area. A total of 52,267 feet was drilled and the average depth of hole was 75.3 feet.

Forty-one anomalous areas in the Powder River Basin were drilled; of these, three in Converse County were found to contain possible commercial ore bodies. All of the drilling was done in the Wasatch formation of Eocene age except one locality, which was in the Fort Union formation of Paleocene age.

INTRODUCTION

Purpose and scope

A core-drilling program for the U. S. Atomic Energy Commission was begun July 16, 1953, in the Pumpkin Buttes area, (fig. 1). Six vertical holes were drilled to obtain stratigraphic information on the Wasatch formation. After completion of drilling in the Pumpkin Buttes area, the drill was moved to Converse County where an additional six holes were drilled, also for stratigraphic information, in the Wasatch formation. This program was terminated March 11, 1954, after a total of 5,813 feet had been drilled. Drilling was done for the Commission by the Special Minerals Investigations Branch of the U. S. Bureau of Mines.

On June 14, 1954, two rotary noncore drills under U. S. Atomic Energy Commission contracts began drilling in the southern part of the Powder River Basin, Campbell, Johnson, and Converse Counties, Wyoming. A total of 52,267 feet was drilled on 41 selected anomalies scattered throughout the Pumpkin Buttes and Converse County areas. (figs. 2 and 3).
LOCATION MAP OF DRILL SITES IN PUMPKIN BUTTES AREA, WYOMING

LEGEND

- Tw
  - White River Formation
- Tw
  - Wasatch Formation
- Tw
  - Fort Union Formation
- KI
  - Lance Formation
- O
  - Rotary Noncore Drill Area
- Diamond Core Drill Site

Based on USGS Map OM 122

FIG-2
FIG. 3 - LOCATION MAP OF DRILL SITES IN SOUTHERN PART OF DRILLED AREA
CAMPBELL AND CONVERSE COUNTIES, WYO.
This program was designed to explore the subsurface extent of as many favorable anomalies in the Powder River Basin as possible. The normal drilling grid was set up with holes 200 feet apart, some holes being spaced as much as 1,000 feet apart in reconnaissance areas. Offsetting of mineralized holes was done on 50- to 100-foot centers. The average depth of drill holes was 75.3 feet, and the maximum depth drilled was 220 feet.

**Location and access**

The regions investigated are designated for the purpose of this report as the Pumpkin Buttes and Converse County areas. They are located in parts of Campbell, Johnson, and Converse Counties, in the southern part of the Powder River Basin. No rotary drilling was done on lands in the Pumpkin Buttes Withdrawn Area (restored to prospecting November 17, 1955) which covers over 63,000 acres in and around the Pumpkin Buttes.

**Pumpkin Buttes area** - This area of known uranium deposits is approximately 45 miles southwest of Gillette, Wyoming, and constitutes an area of about 200 square miles centering around the Pumpkin Buttes (fig. 2).

The area is best reached from Gillette by graded State Route 109; graded county roads and unimproved private ranch roads provide access to the individual deposits and anomalies. Travel on roads other than the State Route is uncertain during wet weather and the area is generally inaccessible from December 15 to April 15, due to snows. Gillette is served by U. S. Highways No. 14 and 16, Wyoming Highway No. 59 and a main line of the Chicago, Burlington and Quincy Railroad.

**Converse County area** - The center of this area of uranium deposits is located about 40 miles north of Douglas, Wyoming (fig. 3). It is best reached via the graded "Ross road". This road extends from Douglas along the southwestern margin of the district and terminates at State Highway No. 287, 79 miles north of Douglas and at the southern end of the Pumpkin Buttes area. Douglas is served by U. S. Highways No. 20 and 87, and the main lines of the Chicago, Burlington and Quincy and the Chicago and Northwestern Railroads. Mines Development, Inc. operates a mill at Edgemont, South Dakota, 140 miles eastward from Douglas and Gillette. Favorable rail rates for shipping car loads of uranium ore have been granted from Douglas and Gillette to Edgemont.

**Topography**

The area covered by this report is located near the center of a topographic and structural basin, and exhibits topography of the semiarid and eroded high plains regions. Most of the area has
relatively mature topography of low rolling hills and wide gentle drainages; however, the northwestern part shows badland topography consisting of steep-sided ridges and narrow valleys. The most prominent features are the flat-topped Pumpkin Buttes at the northern end of the area covered by this report.

Elevations range from 4,500 to more than 6,000 feet at the Pumpkin Buttes; the average elevation is about 5,000 feet.

Major streams are the Dry Fork of the Cheyenne River to the east, the Belle Fouche River to the northeast and the Powder River to the north. Intermittent tributaries to these main streams are found throughout the area. The climate of the area is semiarid with infrequent torrential rains in the summer and snow in the winter.

History

Uranium was first detected in the Pumpkin Buttes area by an airborne radiometric survey conducted by the U. S. Geological Survey in the summer of 1951; J. D. Love of the U. S. Geological Survey did limited reconnaissance later that same year (Love, 1952). As a result of this work, 101 sections surrounding the Buttes were withdrawn from mineral entry. Field parties of the U. S. Geological Survey did additional reconnaissance and geologic mapping.

Uranium was first detected in the Converse County area as a result of airborne radiometric surveying by the U. S. Atomic Energy Commission in the fall of 1952. Extensive ground reconnaissance was carried out by the U. S. Atomic Energy Commission in both areas and, in the summer and fall of 1953, a diamond drilling program for obtaining stratigraphic information was conducted by the U. S. Bureau of Mines on behalf of the U. S. Atomic Energy Commission.

Private activity, from 1952 to 1955, included extensive airborne and ground reconnaissance, exploratory drilling and mining of some of the deposits. This work was done by two or three major companies and several smaller ones.

Acknowledgments

The writers were assisted by ranchers of the area and the personnel of Kerr-McGee Oil Industries, Loma Uranium Company, American Uranium Company and the U. S. Geological Survey.

GENERAL GEOLOGY

Stratigraphy

All the rocks exposed within the described areas range in age from Paleocene through Oligocene. The combined maximum thickness
of these Tertiary sedimentary rocks is approximately 4,500 feet along the northward-trending basin axis which is 10 miles west of the Pumpkin Buttes. The Wasatch formation of Eocene age covers most of the central basin and is thought to contain all of the known commercial uranium.

Following is a detailed description of the stratigraphic characteristics of each formation.

**Fort Union formation** - The Fort Union formation of Paleocene age is exposed along the steeply dipping Great Pine Ridge on the western margin of the basin, and as a more gently dipping sequence around the southern and eastern margins of the basin. The formation overlies the older Cretaceous rocks with only minor unconformity. The sedimentary rocks of the Fort Union were derived from the surrounding highlands, and deposited as fluvial, lacustrine and swamp deposits. The formation, as described by Wegemen (1928), consists of about 2,000 feet of fine-grained sandstones, bluish-white shales, and coal beds. The coarse-grained crossbedded ferruginous sandstone in the upper part of the formation is responsible for the topographic feature known as the Great Pine Ridge. Above this sandstone is coal bed "H" or the Roland Coal bed, which Wegeman regards as the top of the formation. There is some evidence that a series of fine-grained sediments ranging in thickness from 0 to 500 feet and lying on top of this coal may belong to this formation.

**Wasatch formation** - Conformably overlying the Fort Union formation is the Wasatch formation of early Eocene age. This formation of fluvial origin is composed of sediments derived largely from crystalline rocks of the Laramie Mountains, and exhibits a general decrease in grain size from south to north. Near the Pumpkin Buttes, where the formation reaches its maximum thickness of greater than 1,500 feet, it is comprised of interbedded mudstones, siltstones, coals, carbonaceous shales and fine- to coarse-grained sandstones. Because the fluviatile and lensing nature of interbedded sediments cause rapid facies changes both laterally and vertically, correlation is possible only over limited distances. No correlation between areas was attempted. A series of thick, poorly sorted, crossbedded, lensing, medium- to coarse-grained sandstones, west of the Pumpkin Buttes and in the mineralized zone of Converse County, indicate extensive aggraded channels. Southward from the Pumpkin Buttes, the Wasatch formation thins and is more deeply eroded, exposing the Fort Union rocks in the Dry Fork of the Cheyenne River. The formation in this part of the basin consists of variegated siltstones and mudstones, relatively thin coal beds, carbonaceous shale and thick coarse-grained to conglomeratic sandstone beds. In general, the Wasatch formation in Converse County is a sandstone sequence interbedded with siltstone and mudstone lenses.
White River formation - The only exposure of the White River formation in this area is the 40- to 60-foot thick caprock on the Pumpkin Buttes. This resistant caprock is comprised of light-gray sandstone and pebble conglomerate cemented by siliceous material. The conglomerate consists of subangular to subrounded stream-worn pebbles of dolomite and igneous rock, which were probably derived from the Big Horn Mountains to the west. The White River formation unconformably overlies the Wasatch formation with local channel scours which cut into the old Wasatch erosion surface.

Structure

The Powder River Basin is a topographic as well as a structural basin that occupies most of northeastern Wyoming and southeastern Montana. This basin is bounded on the east by the Black Hills and the line of folding extending northward, on the west by the Big Horn Mountains, on the southwest by the Pine Mountain line of folding, on the south by the Laramie Mountains and on the southeast by the Hartville uplift.

The basin is asymmetrical and the longitudinal axis is near the western edge. The deepest part of the structural basin is about 10 miles west of the Pumpkin Buttes, where the Precambrian rocks lie at an estimated depth of 16,000 feet.

Near the Pumpkin Buttes and the central Converse County area the Wasatch formation generally dips to the northwest at about 25 feet to the mile.

GEOLOGY OF THE ORE DEPOSITS

Sedimentary and structural characteristics

The principal uranium deposits in the southern Powder River Basin occur in a medium-grained to conglomeratic sandstone; the coarser-grained rocks are found in the southern part of the area. These sandstones are predominantly buff to light gray, but some are various shades of red and brown. The sandstone accumulated in discontinuous layers and has frequent textural variations. The discontinuous layers are abundantly crossbedded and are poorly sorted. The sediment appears to have been deposited principally in stream channels. Fragments of plant material, both carbonized and replaced by silica or calcium carbonate, and clay galls ranging from a few to 10 inches in diameter are locally abundant. Iron sulfides are rarely associated with carbonized wood. Calcium-carbonate-cemented concretions, both in irregular and elongated masses, are common. The elongated concretions are roughly cylindrical, and range from a few inches to 5 feet in diameter and from 1 foot to several hundred feet in length. Fossilized wood is often
found as the nucleus of these concretions. The long axis of most of the concretions is oriented in a northerly direction and may coincide with the direction of paleostream drainage.

Poor rock exposures make it difficult to work out structural relationship to ore deposition. However, it is believed that some small anticlinal flexures and fractures are present in the mineralized zone, particularly in the Converse County area.

The uranium deposits in the Wasatch formation trend in a discontinuous northwesterly belt. This belt, which is about 70 miles long and as much as 15 miles wide, extends from T. 35 N., R. 72 W., in Converse County to T. 45 N., R. 76 W., in the Pumpkin Buttes area. Between 200 and 300 radioactive anomalies are known in this zone. In both the northern and southern part of this belt, the uranium deposits are of two types, disseminations in sandstone and small podlike or irregularly shaped concretions. The disseminated deposits, which are the principal ore producers of the area, are more extensive than the pod type but are generally of much lower grade. The uranium in the unique podlike concretions is associated with a black manganese mineral and iron oxide. These pods are usually small, ranging from 6 inches to 10 feet in diameter, and tend to occur in groups. The pod-type deposit is more common in the Pumpkin Buttes area than to the south. Uranium content of these concretions is often very high. Because of their small size and erratic occurrence, they have been less important as ore producers than the disseminated deposits.

Pumpkin Buttes - The sandstone is buff to light gray to pink, fine to coarse grained, and contains a few thin conglomeratic layers. Grains are rounded and usually exhibit fair to good sorting. Abundant quartz, semidecomposed feldspars and interstitial clays are present. The sandstones are friable, generally massive to thin bedded, and contain calcium-carbonate concretions, and abundant oxidized and a few unoxidized iron concretions. A few thin layers are composed of clay galls and conglomerate, and carbonaceous material is found intermittently dispersed throughout the sandstones. These sandstones are often lenticular, and the lithology is extremely variable over short vertical and horizontal distances.

Core drilling in the Pumpkin Buttes area established the thickness of the Wasatch formation to be greater than 1500 feet. Drilling did not reach coal bed "H" but intersected what has been proposed to be the Wasatch-Fort Union formational contact, about 500 feet above coal bed "H" in this area (Troyer et al. 1954).

The stratigraphic range of mineralization in the Pumpkin Buttes is about 450 feet and ranges from 450 to 900 feet above the base of Wasatch formation. No correlation has yet been established between widely spaced deposits in the area.
Converse County - The buff to light-gray coarse-grained to conglomeratic sandstone contains angular to subrounded, poorly sorted grains, which range in size from small pebbles to a few granite boulders having a maximum diameter of 12 inches. The massive crossbedded strata are friable and contain a few chert pebbles, clay galls from a few inches to 10 inches in diameter, abundant carbonaceous trash and calcium-carbonate-cemented concretions consisting mostly of feldspar and some quartz grains.

Diamond core drilling in the Monument Hill area in Converse County (sec. 3, T. 37 N., R. 73 W.) established the thickness of the Wasatch at this point as about 330 feet. The top of coal bed "H", as mapped by Wegeman (1928), was used as the Wasatch-Fort Union formation contact. This coal bed outcrops 3 miles to the east in the Dry Fork of the Cheyenne River. The stratigraphic range of uranium mineralization in this area is about 150 feet. The stratigraphic relationship between the Monument Hill uranium deposits and the deposits to the southeast (sec. 1, T. 35 N., R. 72 W.) is not understood. No correlation could be established between the core holes drilled in each of these localities.

Mineralogy

As previously described, uranium deposits in the Powder River Basin are of two types, podlike concretions and disseminations. Uranophane is the principal uranium mineral found in pod-type deposits. The uranium replaces peripheral calcite in and surrounding these pods. Although these high-grade uranophane deposits usually are not found in the absence of iron and manganese oxides, the uranium does not replace these minerals and the relationship to them is not known.

Tyuyamunite and carnotite are the most common uranium minerals in disseminated deposits. In these deposits, the uranium minerals fill interstices and coat grains in the sandstones. Often the highest concentrations of uranium are present as halos surrounding carbonaceous trash and concentrations of calcium carbonate. Uranium enrichment is often concentrated in buff-colored sandstones along contacts with pink-stained sandstones. This contact indicates a difference between the ferric and ferrous states of oxidation within the sandstone (Sharp, oral communication, 1954). A small amount of uraninite has been found in close association with carbonaceous material in one and possibly two of the deposits in the Pumpkin Buttes area.

The disseminated deposits in the Pumpkin Buttes are almost always underlain by an impervious shale, whereas, in the Converse County area, the mineralized zone is usually within a sandstone section.
Core drilling

On July 16, 1953, a diamond core-drilling project for the Atomic Energy Commission was commenced in the Powder River Basin. This drilling was done with one drill by the Special Minerals Investigation Branch of the U. S. Bureau of Mines. The project was terminated on March 11, 1954, after 12 vertical holes were drilled for a total of 5,813.5 feet.

The drilling project was set up specifically to obtain geologic information in the Wasatch formation within the Powder River Basin. Drilling was carried on in two general areas known to contain uranium deposits: Pumpkin Buttes and Converse County.

Six core holes were drilled in each area and spaced from 4½ miles to 11 miles between holes. A distance of 26 miles separates the extreme southern hole of the Pumpkin Buttes area from the most northerly hole in the Converse County area. (figs. 2 and 3).

All diamond drill holes were radiometrically logged. In the Pumpkin Buttes area a portable bore-hole Geiger counter was used, whereas in the Converse area a recording scintillator probe was used. Several months after completion of the drilling an attempt was made in the Pumpkin Buttes area to log some of the holes with a jeep-mounted recording scintillation unit; but, because of hole collapse, radiometric logging was prevented below a depth of 150 feet. No abnormal radioactivity was encountered in any of the holes.

In each area, one hole was designed to intersect the contact of the Wasatch formation and the Fort Union formation. In Converse County, coal bed "H" (Wegeman, 1928) was used as the formation contact. In the Pumpkin Buttes area, a contact proposed by the U. S. Geological Survey (Troyer et al., 1954) on paleontological evidence, some 300 to 500 feet above coal bed "H", was used. Coal bed "H" was too deep to be reached by drilling in the Pumpkin Buttes.

Probable stratigraphic correlation between 3 or 4 holes within each area was tentatively established on coal beds and similar lithologic sequences (figs. 4 and 5). Correlation between the two areas has not been made.

Surface stratigraphic sections between holes should be measured to give more positive correlation. The lack of outcrops, however, will make such mapping difficult.
Noncore drilling

Under U. S. Atomic Energy contract, operations were begun with two drills on June 10, 1954. Drilling was completed September 17, 1954. One drill was assigned to the Pumpkin Buttes area and the other to the southern part of the area in Converse County. Near the end of the project, both drills operated in the Converse County area.

Drilling was done with "Failing 1500" rotary drills. Air, furnished by Ingersol-Rand Gyro-Flo 600 cu. ft./min. capacity air compressors, was used as a circulating medium. Cuttings were blown from the hole into an SD, size 3, Ducon-type sampler. Cuttings from each 2-foot interval were collected in containers and checked with Geiger counters for radioactivity.

All samples were then logged lithologically. Samples that exhibited radioactivity of more than twice background were divided by a Jones sample splitter, and a part of each sample was submitted for chemical assay.

In the Pumpkin Buttes area, during the first week of the drilling project, all holes were radiometrically probed with a portable Geiger hole-probe unit. Thereafter, the only holes probed were those in which abnormally radioactive samples were noted. As a hole probe was not available at all times during the drilling in the Converse County area, only a few holes were radiometrically probed. The hole probing was unreliable in determining mineralized zones. In most instances, the radioactive or mineralized zone was in disequilibrium favoring equivalent percent uranium. This is believed to be due to excessive amounts of radon in these sandstone strata.

Exploratory drilling was done on grid spacings ranging from 200 to 1,000 feet. Fifty-foot centers were used surrounding mineralized holes in an attempt to determine the size and shape of the mineralized area.

At 41 selected localities, 694 holes comprising 52,267 feet were completed. The holes ranged in depth from 12 to 220 feet and in diameter from 3 to 6 inches. The average depth was 75.3 feet.

Cost of the project was $33,819.37, averaging $0.646 per foot.

INDIVIDUAL DEPOSITS

Uranium was discovered in drill holes at 11 of the 41 anomalous localities drilled in the Powder River Basin. Six of these 11 localities, 2 in the Pumpkin Buttes and 4 in Converse County, yielded one or more drill-hole samples of ore-grade material. Only three of these localities, all of them in Converse County, appear to contain ore of sufficiently high grade and tonnage to be minable.
FIG. 5
DIAMOND-DRILL CORE SECTIONS, CONVERSE COUNTY, WYOMING
Following is a discussion of the localities in which ore-grade mineralization was found:

**K-M Ray or "channel" claims**

These claims are in sec. 28, T. 45 N., R. 76 W., 3½ miles northwest of the North Butte. Three holes contained ore-grade uranium. Two of the holes were 200 feet apart and one hole was more than 1,000 feet from the other two (figs. 6, 7 and 8). Only one 2-foot sample assaying ore grade was found in each of these 3 holes. More closely spaced drilling around these holes failed to reveal any extension of ore.

**Anomaly 119, Archibald Fee Land**

This locality is in sec. 11, T. 45 N., R. 75 W., 3 miles west of Sageston, Wyoming. Drilling was done on the western margin of the largest known ore body in the area. However, the only ore-grade sample was recovered from a near-surface pod.

**Box Creek, (sec. 1, T. 35 N., R. 72 W.)**

Although highly radioactive samples were collected from many holes, chemical assay revealed that only a very small number contained significant amounts of uranium. Generally, the grade was below 0.05 percent U₃O₈. The occurrences were in a discontinuous northward-trending belt about 2,500 feet long and 1,000 feet wide. Most of the mineralized area is underlain by impervious shale beds; however, in a few holes uranium minerals occur within a sandstone section.

**Monument Hill (sec. 3, T. 37 N., R. 73 W.)**

The most important and largest ore bodies were found here. Six separate deposits at four stratigraphic horizons were discovered. These deposits occur within a north-trending zone about 1,300 feet long and up to 500 feet wide. The ore bodies lie from 45 feet to 100 feet below the surface and have a stratigraphic range of 55 feet. All mineralized zones encountered were within the sandstone section (figs. 9 and 10).

**K-M-D-15 or Red claims (sec. 27, T. 38 N., R. 73 W.)**

This area is located 2½ miles north of the Monument Hill area. In this locality, as in the Monument Hill area, the deposits lie on several stratigraphic levels and trend in a northerly direction. This zone is about 1,300 feet long and up to 250 feet wide. The ore bodies occur from 35 feet to 110 feet below the surface and have a stratigraphic range of about 35 feet. One of the deposits is underlain by an impervious shale bed. The other occurs within a sandstone unit.
FIG-6
PLAN MAP RAY CLAIMS (EAST & WEST)
SEC.28, T45N, R76W
-20-
Western Portion of Drilling Area

**Legend**
- Medium-To Very Coarse-Crystallized Sandstone.
- Very Fine-To Medium-Grained Sandstone.
- Silty Sandstone
- Silty Mudstone
- Ore Sample
- Mineralized Sample

(E) East (W) West represent two separate grids at some anomaly. (Figure 6)

Eastern Portion of Drilling Area

**Figure 7**
Sections across channel trend, Ray Claims, Sec. 28, T45N, R76W
Pumpkin Buttes Area, Johnson and Campbell Counties, Wyoming
LEGEND

- Medium-to Very Coarse-Grained Sandstone
- Very Fine-To Medium-Grained Sandstone
- Silty Sandstone
- Silty Mudstone

(E) East (W) West Represent Two Separate Grids At Some Anomaly, (Figure 6)

SECTIONS ACROSS CHANNEL TREND, RAY CLAIMS, SEC. 28, T45N, R 76W
PUMPKIN BUTTES AREA, JOHNSON AND CAMPBELL COUNTIES, WYOMING

FIG.-8
NOTES

- Sandstone
- Siltstone

SCALE
0 FEET
50
100
Vertical Scale

FIG-9
DRILL-HOLE CROSS SECTIONS
MONUMENT HILL AREA, CONVERSE COUNTY, WYOMING

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FIG. 10
DRILL-HOLE CROSS SECTIONS MONUMENT HILL AREA, CONVERSE COUNTY, WYOMING
K-M Pete claims (sec. 19, T. 41 N., R. 73 W.)

Drilling located three ore holes in this locality. Supplementary auger drilling in January 1955 was done in order to determine the extent and geologic control of the ore. Two small ore bodies underlain by impervious shale and ranging from 4 to 20 feet below the surface were delineated.

ORE CONTROLS AND GUIDES

Uranium deposition seems to be influenced by carbonaceous material and abnormal concretions of calcium carbonate. Color changes are a guide, as the deposits are found near contacts where buff to gray sandstone changes color to lavendar. This color boundary usually is not related to sedimentary features. Small irregular lavendar zones and clay galls are found within ore deposits. These zones and galls are not mineralized.

Other possible controls that are believed to influence the deposition of uranium are listed below:

(1) channeling
(2) facies changes
(3) faulting and/or flexing
(4) possible chemical control by increased amounts of clay material and feldspar.

There is definite evidence that some of the ore deposits were partly controlled by channeling. However, only a very detailed study of the deposits would determine if any of the above listed controls are applicable.

In the Pumpkin Buttes, the most significant ore deposits have been found on the flanks of channel scours, often associated with carbonaceous material. An unexplained control here is the presence of uranium in a buff-colored sandstone, at the buff and lavendar contact.

It is probable that more than one control determines the localization of an ore body, and that ore deposition undoubtedly depends upon a combination of the above factors.
REFERENCES


Sharp, W., 1954, Oral Communication.
