Distribution of Leached Radioactive Material in the Legin Group Area, San Miguel County, Colorado

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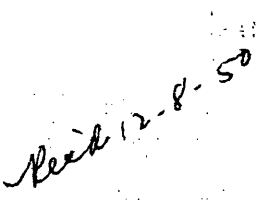
Trace Elements Memorandum Report 171

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY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UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WASHINGTON 25, D. C.

DEC 1 1950

AEC-268/1

Dr. Phillip L. Merritt, Assistant Manager
Raw Materials Operations
U. S. Atomic Energy Commission
P. O. Box 30, Ansonia Station
New York 23, New York

Dear Phil:

Transmitted herewith for your information and distribution are eight copies of Trace Elements Memorandum Report 171, "Distribution of leached radioactive material in the Legin group area, San Miguel County, Colorado," by Allen S. Rogers, November 1950.

This report presents the first substantiated evidence of a long-range radioactivity effect that may be useful in the search for carnotite ore bodies. The work on this effect is continuing.

Other copies of the report are being distributed as shown on the attached distribution sheet.

Sincerely yours,

/s/ W H Bradley

W. H. Bradley
Chief Geologist

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

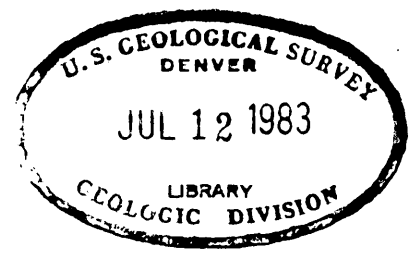
DISTRIBUTION OF LEACHED RADIOACTIVE MATERIAL IN THE LEGIN GROUP AREA, SAN MIGUEL COUNTY, COLORADO

by

Allen S. Rogers

November 1950

Trace Elements Memorandum Report 171



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CONTENTS

ILLUSTRATIONS

DISTRIBUTION OF LEACHED RADIOACTIVE MATERIAL IN THE LEGIN GROUP AREA, SAN MIGUEL COUNTY, COLORADO

by

Allen S. Rogers

Abstract

Radioactivity anomalies, which are small in magnitude, and probably are not caused by extensions of known uranium-vanadium ore bodies, were detected during the gamma-ray logging of diamond-drill holes in the Legin group of claims, southwest San Miguel County, Colo. The positions of these anomalies are at the top surfaces of mudstone strata within, and at the base of, the ore-bearing sandstone of the Salt Wash member of the Morrison formation.

The distribution of these anomalies suggests that ground water has leached radioactive material from the ore bodies and has carried it down dip and laterally along the top surfaces of underlying impermeable mudstone strata for distances as great as 300 feet.

The anomalies are probably caused by radon and its daughter elements. Preliminary tests indicate that radon in quantities up to 10^{-7} curies per liter may be present in ground water flowing along sandstone-mudstone contacts under carnotite ore bodies. In comparison, the radium content of the same water is less than 10^{-10} curies per liter.

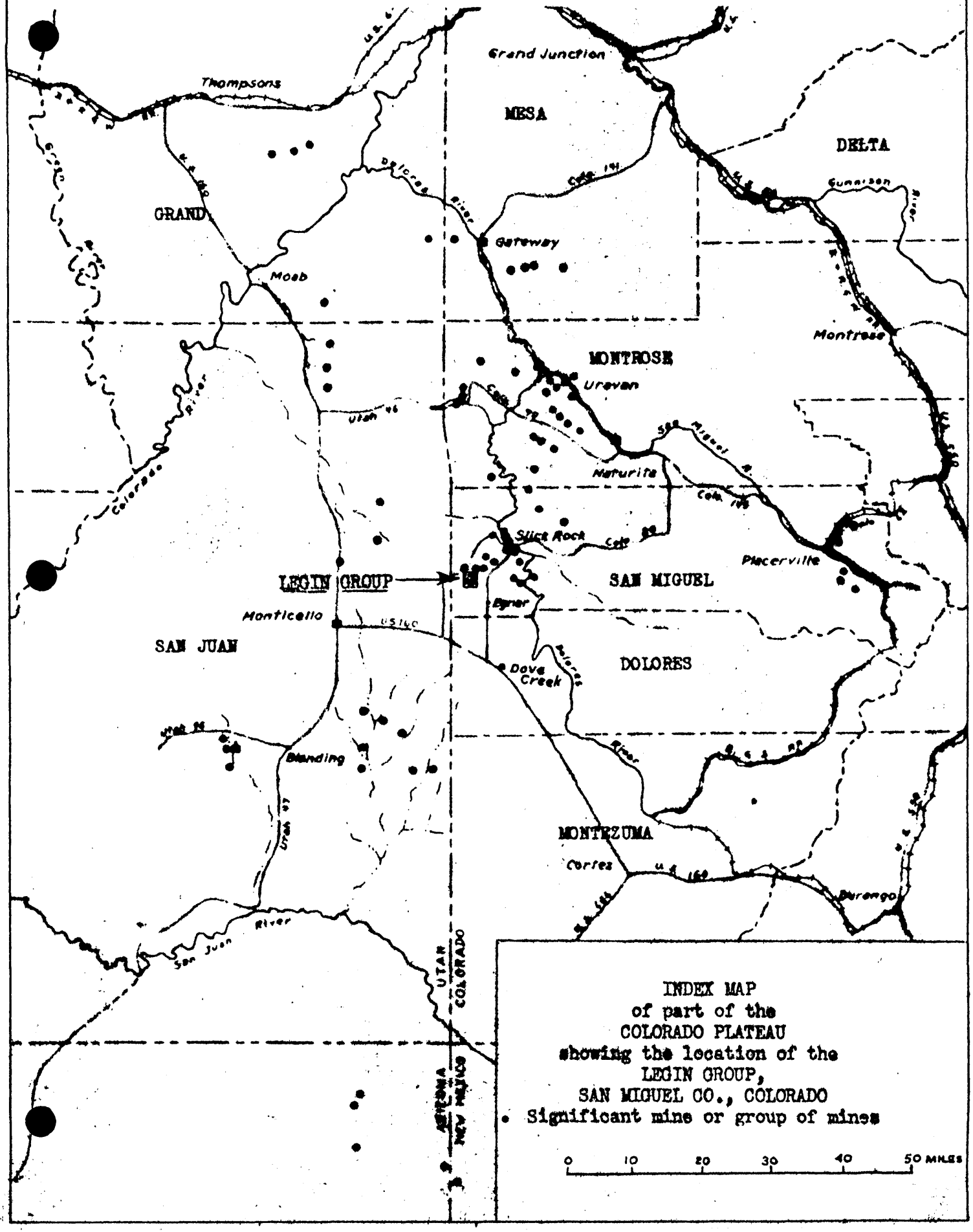
Further substantiation of the relationship between ore bodies, the movement of water, and the radon-caused anomalies may greatly increase the scope of gamma-ray logs of drill holes as an aid to prospecting.

Introduction

During the routine gamma-ray logging of holes drilled in the search for carnotite deposits in the Colorado Plateau area by the U. S. Geological Survey, radioactivity anomalies of small magnitude were detected at the upper surfaces of mudstone strata in the ore-bearing sandstone of the Salt Wash member and at its base. Preliminary evaluation of the available data suggested that the radioactive materials causing the anomalies were not thin seams of carnotite or other uranium-bearing minerals but were possibly disintegration products such as radium, radon, or other radioisotopes transported by ground water from nearby ore bodies.

A detailed study of the distribution of such radioactivity anomalies was undertaken for the Legin group of claims in southwest San Miguel County, Colo. (fig. 1). The objectives of the study were the determination of (1) the relationship between the radioactivity anomalies and the ore bodies in the area, (2) the relationship between the distribution of the radioactive materials at the upper surfaces of mudstone strata and the movement of ground water, and (3) the radioactive materials causing the anomalies. Should a definite relationship be found between the radioactivity anomalies, ore bodies, and ground-water movement, the value of gamma-ray logs of drill holes as an aid to prospecting would be greatly increased.

FIGURE 1


Grand Junction
MESA
DELTA
Thompsons
GRAND
Gateway
Moab
Montrose
MONTROSE
Uravan
Naturita
Slick Rock
Placerville
LEGIN GROUP
SAN MIGUEL
Egnar
Monticello
SAN JUAN
Dove Creek
DOLORES
Blanding
MONTEZUMA
Cortez
Durango
UTAH
COLORADO
ARIZONA
NEW MEXICO
INDEX MAP
of part of the
COLORADO PLATEAU
showing the location of the
LEGIN GROUP,
SAN MIGUEL CO., COLORADO
• Significant mine or group of mines
0 10 20 30 40 50 MILES

General geologic features

The rocks exposed on the Legin group of claims are the Brushy Basin and Salt Wash members of the Morrison formation. The Salt Wash member consists mostly of sandstones and subordinately of mudstones. At this locality, the upper sandstone stratum of the Salt Wash member has been extensively mineralized with uranium and vanadium minerals, including carnotite, in several rather distinct horizons. The ore-bearing sandstone stratum includes many thin discontinuous lenticular mudstone seams. The basal and, in part, altered mudstone, which underlies the ore-bearing sandstone, is a thick continuous stratum and has a general dip of about 1° - 2° SW. The sandstones form a rim in the west part of the area and are overlain by mudstones of the Brushy Basin member in the east and south parts of the area.

Radioactivity anomalies discrete from carnotite deposits

Many radioactivity anomalies were found at the top surface of the thick basal mudstone, and at the top surfaces of other thin lenticular mudstone seams located in the ore-bearing sandstone. These anomalies usually can be distinguished from those caused by extensions of known carnotite ore bodies and are the only radioactivity anomalies discussed in this report. They represent thin zones not more than 2 or 3 inches thick which usually contain less than 0.05 percent equivalent U_3O_8; all the anomalies are at the upper surfaces of mudstone strata.

The identity of the radioactive material causing the anomalies is only partly known. The radiometric core scanning laboratory in Grand

Junction, Colo., which makes a rough quantitative estimate of equivalent U_3O_8 in the core recovered from the diamond-drill holes, has searched for but not detected radioactive material in core samples from the zones producing the anomalies. This circumstance may be the result of: (1) minor core loss at the contact of sandstone and underlying mudstone strata, or (2) radioactive material of short half-life that decays prior to measurement in the radiometric scanning laboratory. The fact that the anomalies are rarely found more than 300 feet from ore bodies suggests a radioisotope of short half-life. Preliminary tests of some water samples have indicated that radon is present in quantities up to 1×10^{-7} curies per liter in ground water flowing along the upper surfaces of mudstone strata which lie below carnotite ore bodies. The radium content of the same water appears to be extremely low, usually less than 1×10^{-10} curies per liter. It is probable that the daughter elements of radon are the radioisotopes producing the anomalies found at the sandstone-mudstone contacts.

The relationship of the radioactivity anomalies to the ore bodies is shown on a map of the Legin group and on five cross sections (figs. 2-7). The map (fig. 2) shows the contour of the top surface of the basal mudstone which is a continuous stratum at the base of the ore-bearing sandstone. It also shows the location of all diamond-drill holes.

On figure 2 the ore bodies are outlined in three colors, orange, red, and purple, shaded on the inside. Each color does not represent the same stratigraphic horizon in all places but indicates the rela-

tive positions of ore bodies situated one above the other. Weakly mineralized rock is indicated by a dashed line of appropriate color. The positions of the ore bodies were determined from gamma-ray logs, except for caved holes where the geologists' field logs were used. The term "ore" is considered in this report to represent rock that has an equivalent uranium content greater than 0.10 percent. "Weakly mineralized rock" represents a probable range of 0.05 to 0.10 percent equivalent U_3O_8, and may not be recognized by the geologists' visual inspection of the core.

The approximate lateral extent of each known radioactivity anomaly is outlined on figure 2 by one of three colors: light blue, olive green, and dark green, shaded on the inside. Areas delimited by these colors include the holes in which radioactivity anomalies have been found.

Areas within which radioactivity anomalies are found on the top surface of the basal mudstone are outline on figure 2 in light blue. The light-green color outlines anomalies on thin, moderately persistent, mudstone seams lying 10 to 40 feet above the basal mudstone. The double-shaded dark-green color outlines anomalies on a thin continuous mudstone stratum near the top of the ore-bearing sandstone, and also includes some radioactivity anomalies stratigraphically above all known ore bodies (figs. 4, 7).

Some shading has been omitted to suggest overlapping. The omitted shading represents the lower, overlapped, horizons.

On the cross sections (figs. 3-7), the anomalies are represented by a small diamond (◇) at their correct position in the drill hole, and are connected by lines.

All geologic data for the contour map of the basal mudstone and for the cross sections were obtained from the geologists' logs of the core recovered from the diamond-drill holes.

The wide spacing of holes, numerous plugged holes, and holes plugged at depths above the basal mudstone have made the information incomplete, particularly in the east and south parts of the group.

Discussion

The radioactivity anomalies found by gamma-ray logging at sandstone-mudstone contacts in the Salt Wash member of the Morrison formation appear to show a systematic relationship to the larger ore bodies. The material causing the radioactivity anomalies is believed to have been leached by ground water from nearby carnotite ore bodies and to have been carried along the top surfaces of impermeable mudstone strata. The exact outline of the areas of the anomalies is not fully known, but it generally extends down dip and laterally from the ore bodies as would be expected from ground water movement in this area.

In some places where a lenticular mudstone seam lies between an ore body and the basal mudstone, a cascade effect has been produced. The ground water travels through the ore body downward to the first mudstone seam, spreads out, and cascades downward ultimately to be accumulated on the basal mudstone. The basal mudstone is shielded

from the radioactive fluid by the small mudstone seam above it (figs. 3, 5, 6).

The radioactive fluid does not necessarily move directly downward from ore bodies. Some of the fluid has travelled somewhat down dip. The results of this lateral movement are most noticeable where the dip is greatest.

The grouping of anomalies near large ore bodies, cascading, and the general down-dip direction or movement of the radioactive fluid, suggests that ground water has been responsible for the distribution of these radioactivity anomalies.

Investigation of the distribution of radioactivity anomalies will be continued. As additional data become available, further effort will be made to establish the true relationship between the anomalies and the uranium-vanadium ores.

Conclusions

In summary, the evaluation of the data from the Legin group of claims shows that:

1. The general distribution of radioactivity anomalies in the Legin group area, although not fully known, is down dip and laterally away from carnotite ore bodies.

2. The radioactive material causing the anomalies has been tentatively identified as radon and its disintegration products that have been leached by ground water from carnotite ore bodies.

3. The basal mudstone is shielded from the leached radioactive fluid, in some places, where a mudstone seam lies between the basal mudstone and the carnotite ore-body source.

4. In this area the maximum extension of detectable radioactive material is about 300 feet from an ore body.

5. It is possible that further study of the movement of the radioactive fluid and the manner in which it effectively increases the target of the drill may lead to a new method of evaluating gamma-ray logs of drill holes that did not penetrate mineralized ground. The potentialities of such a technique remain to be tested in practice.

USBM DRILL HOLES

MINE

MINE

MINE

MINE

MINE

APPROX. POSITION OF ALTERED MUDSTONE OUTCROP

LEGEND

VERTICAL HORIZONTAL

RADIOACTIVE ANOMALY ABOVE ALL KNOWN ORE BODIES — SANDSTONE / MUDSTONE

HIGHEST STRATIGRAPHIC POSITION OF ORE

INTERMEDIATE STRATIGRAPHIC POSITION OF ORE — SANDSTONE

RADIOACTIVE ANOMALY ON MUDSTONE STRATUM — MUDSTONE

LOWEST STRATIGRAPHIC POSITION OF ORE — SANDSTONE

RADIOACTIVE ANOMALY ON ALTERED MUDSTONE — MUDSTONE

THE ORE BODIES, REPRESENTED BY PURPLE, RED, AND ORANGE, ARE SEPARATED BY VARYING THICKNESSES OF SANDSTONE AND MUDSTONE. EACH COLOR DOES NOT REPRESENT THE SAME STRATIGRAPHIC HORIZON IN ALL PLACES, BUT INDICATES ORE BODIES SITUATED ONE ABOVE THE OTHER.

WEAK MINERALIZATION IS INDICATED BY A DOTTED LINE OF APPRORIATE COLOR.

THE ORE AND MINERALIZATION INDICATED ON THE MAP AND CROSS SECTIONS ARE BASED ON GAMMA RAY LOGS EXCEPT IN PLUGGED HOLES.

P PLUGGED HOLES
X NOT LOGGED TO DEPTH OF ALTERED MUDSTONE
N NOT LOGGED
RADIOACTIVE ANOMALY -- SYMBOL USED ONLY ON VERTICAL SECTIONS

? - QUESTIONABLE CONTOURS

N

MAP OF
LEGIN GROUP
SHOWING
CONTOUR OF ALTERED MUDSTONE
DATA FROM GEOLOGISTS LOGS

DRILL HOLES :
● ORE BEARING
Ø WEAKLY MINERALIZED
O BARREN
(FROM GEOLOGISTS LOGS)

CONTOUR INTERVAL - 5'
CONTOUR DATUM - 6800'
SCALE 1" - 200'

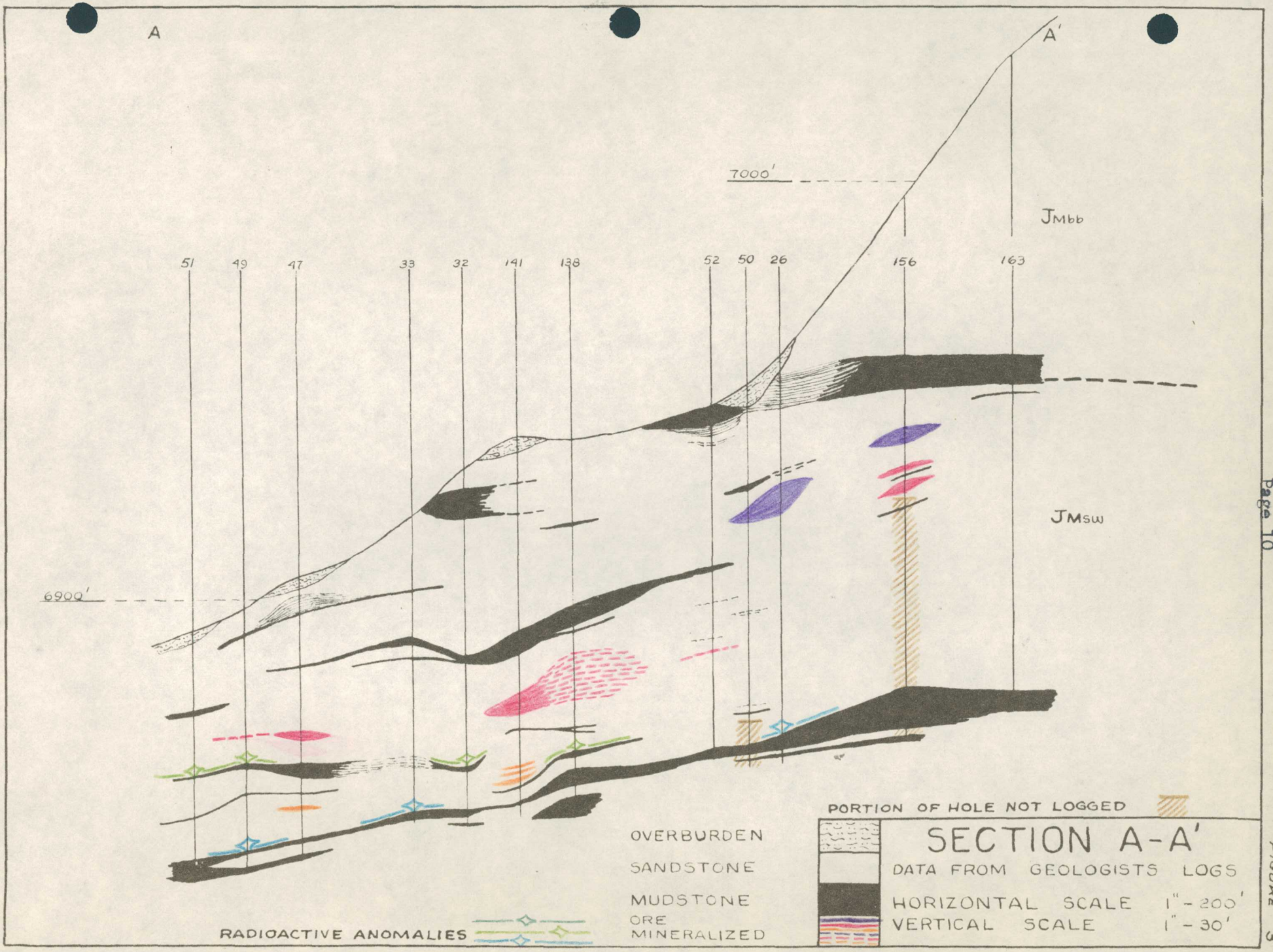

A
A'
7000'
6900'
JMbb
JMsw
51
49
47
33
32
141
138
52
50
26
156
163
PORTION OF HOLE NOT LOGGED
OVERBURDEN
SANDSTONE
MUDSTONE
ORE MINERALIZED
RADIOACTIVE ANOMALIES
SECTION A-A'
DATA FROM GEOLOGISTS LOGS
HORIZONTAL SCALE 1" - 200'
VERTICAL SCALE 1" - 30'

FIGURE 3

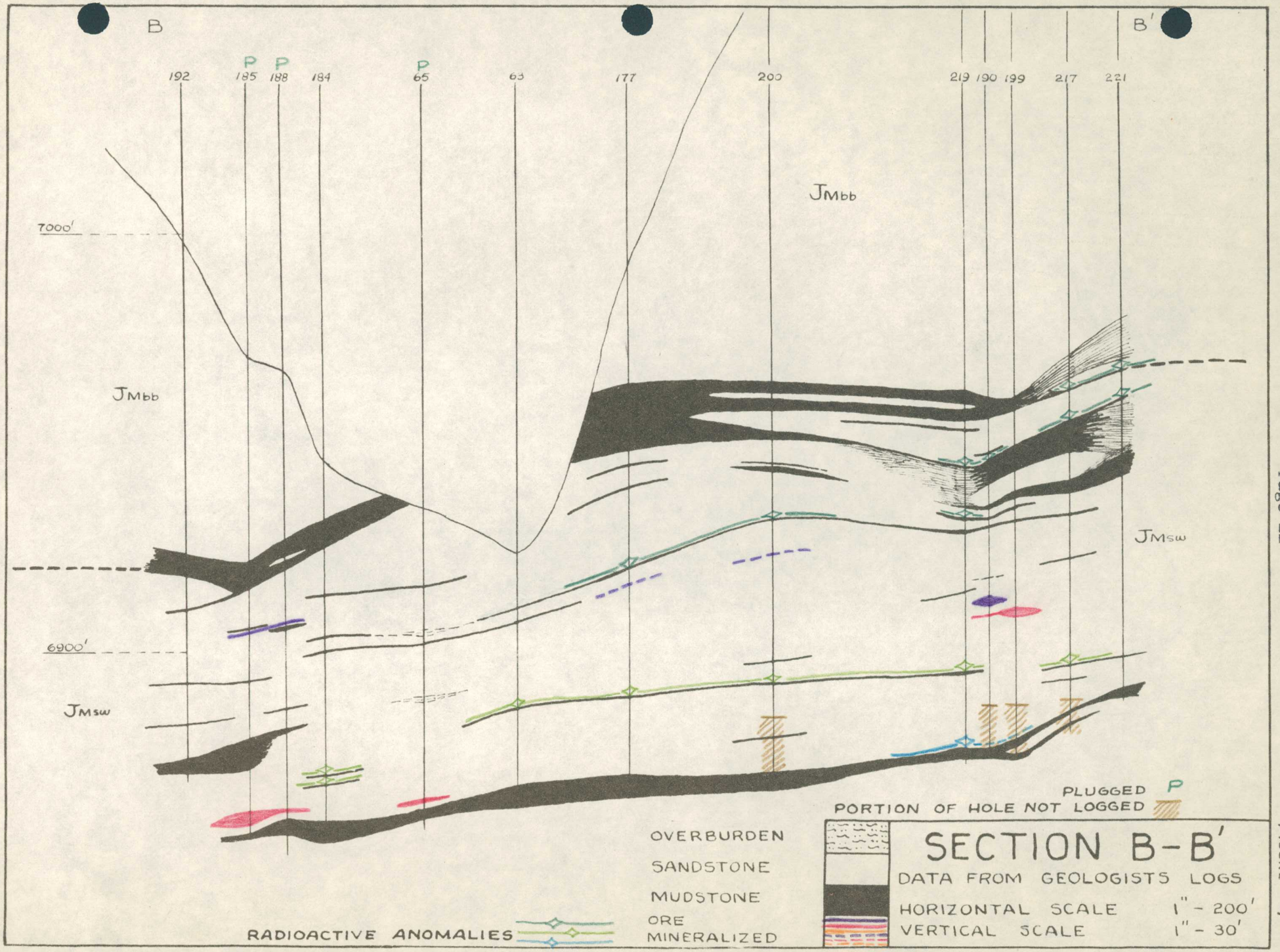

B
B'
192
185
188
184
65
63
177
200
219
190
199
217
221
P
P
P
7000'
6900'
JMbb
JMbb
JMsw
JMsw
PLUGGED P
PORTION OF HOLE NOT LOGGED
OVERBURDEN
SANDSTONE
MUDSTONE
ORE
MINERALIZED
RADIOACTIVE ANOMALIES
SECTION B-B'
DATA FROM GEOLOGISTS LOGS
HORIZONTAL SCALE 1" - 200'
VERTICAL SCALE 1" - 30'

FIGURE 4

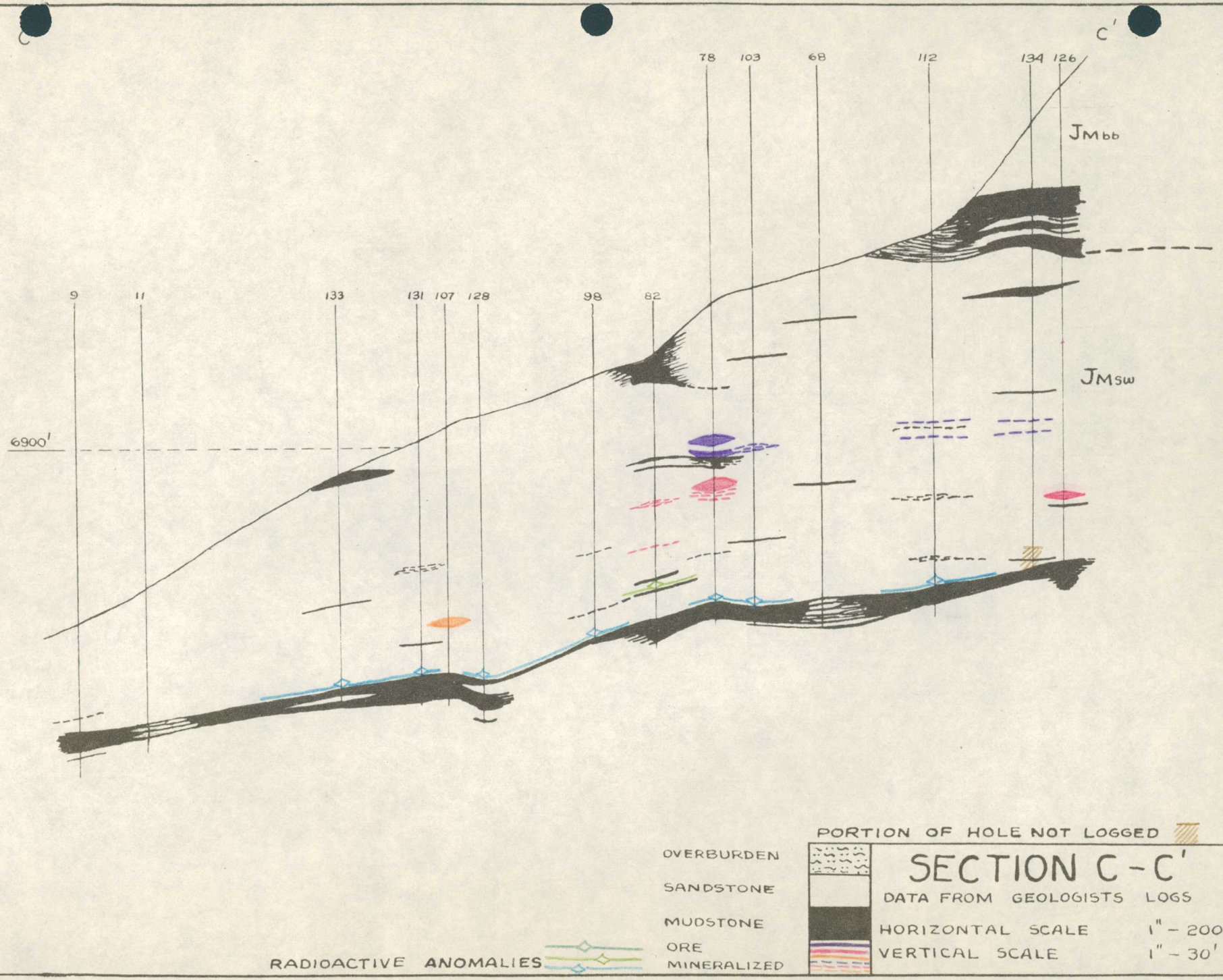

C
C'
78
103
68
112
134
126
9
11
133
131
107
128
98
82
JMbb
JMsw
6900'
PORTION OF HOLE NOT LOGGED
OVERBURDEN
SANDSTONE
MUDSTONE
ORE MINERALIZED
RADIOACTIVE ANOMALIES
SECTION C-C'
DATA FROM GEOLOGISTS LOGS
HORIZONTAL SCALE 1" - 200'
VERTICAL SCALE 1" - 30'

FIGURE 5

FIGURE 6

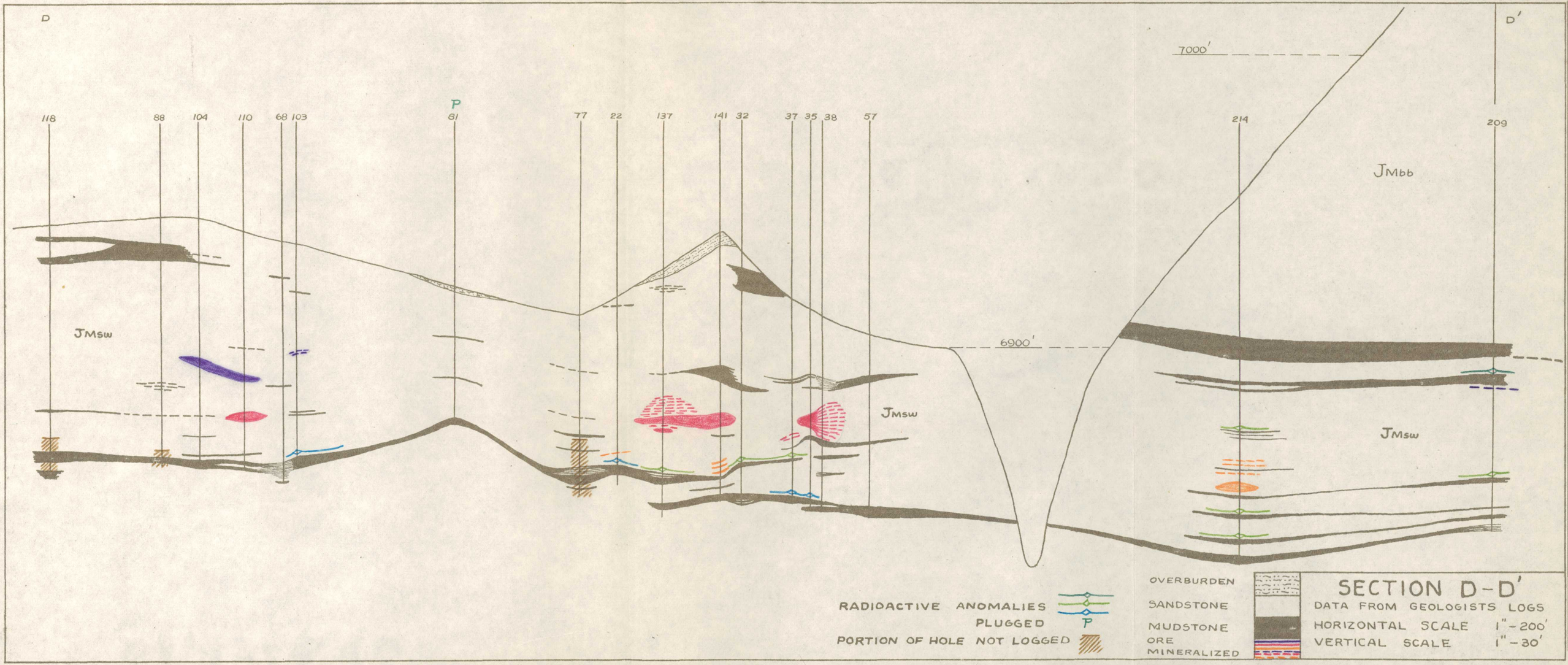

D
D'
7000'
6900'
118
88
104
110
68
103
P
81
77
22
137
141
32
37
35
38
57
214
209
JMbb
JMsw
JMsw
JMsw
RADIOACTIVE ANOMALIES
PLUGGED P
PORTION OF HOLE NOT LOGGED
OVERBURDEN
SANDSTONE
MUDSTONE
ORE MINERALIZED
SECTION D-D'
DATA FROM GEOLOGISTS LOGS
HORIZONTAL SCALE 1"-200'
VERTICAL SCALE 1"-30'

FIGURE 7

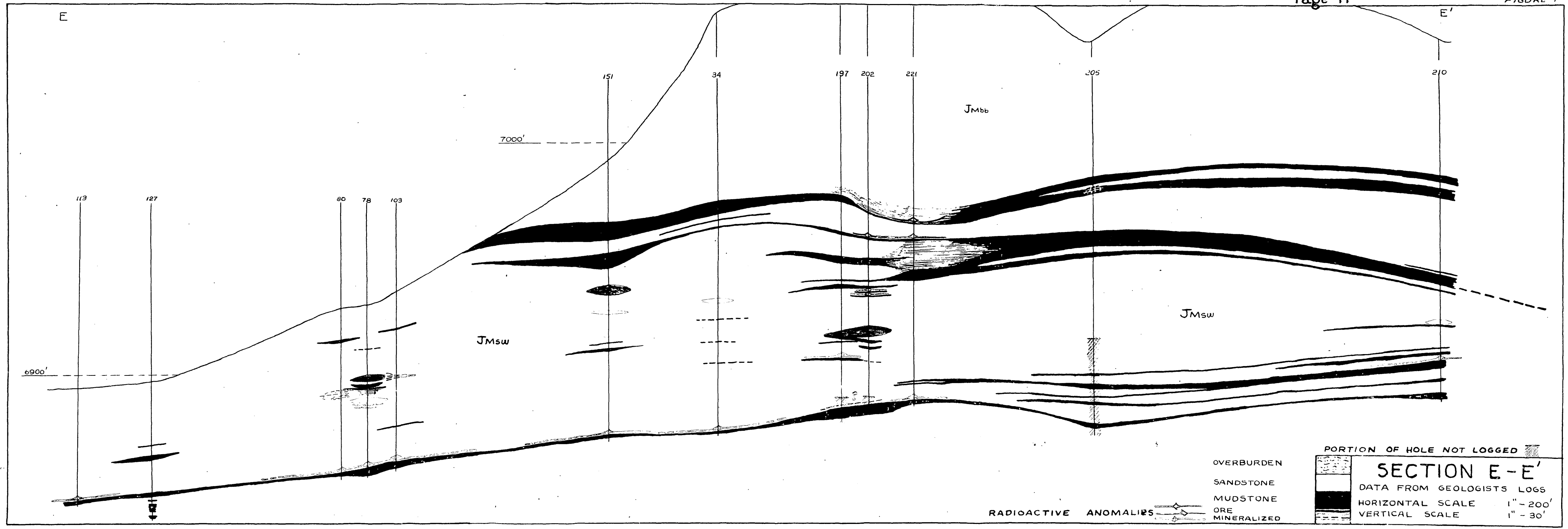
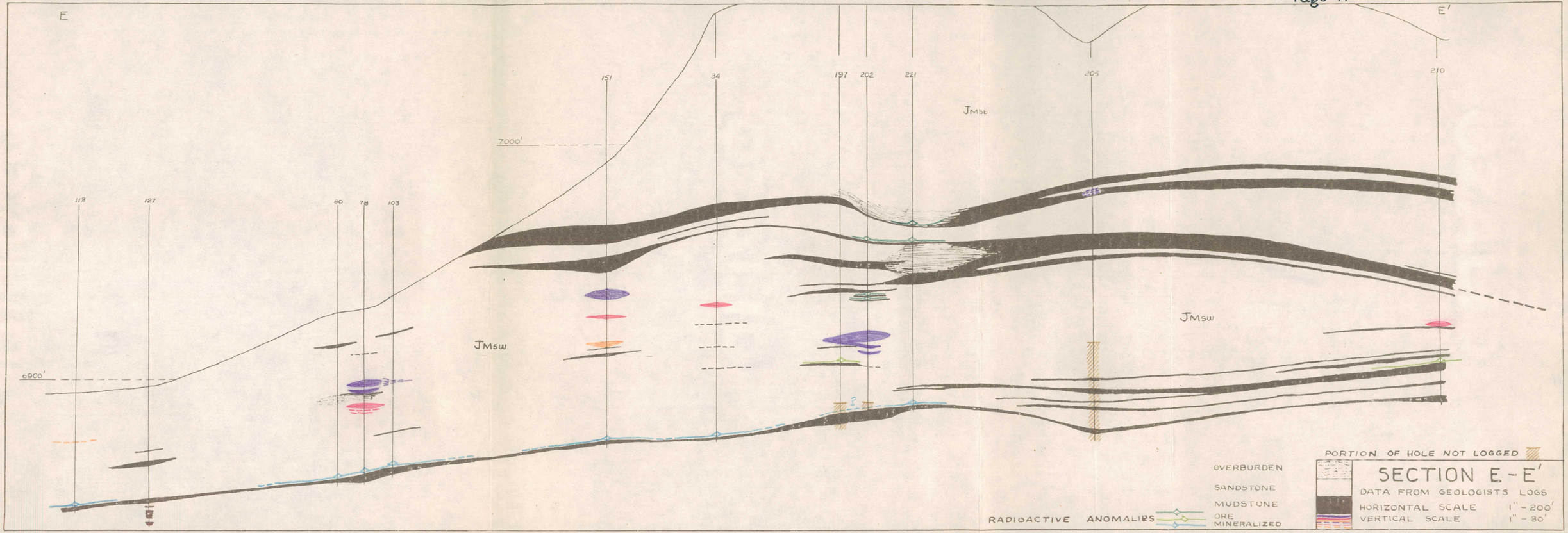

E
E'
151
34
197
202
221
205
210
113
127
80
78
103
7000'
6900'
JMbb
JMsw
JMsw
PORTION OF HOLE NOT LOGGED
OVERBURDEN
SANDSTONE
MUDSTONE
ORE MINERALIZED
RADIOACTIVE ANOMALIES
SECTION E-E'
DATA FROM GEOLOGISTS LOGS
HORIZONTAL SCALE 1" - 200'
VERTICAL SCALE 1" - 30'

FIGURE 7


E
E'
151
34
197
202
221
205
210
113
127
80
78
103
7000'
6900'
JMbb
JMsw
JMsw
PORTION OF HOLE NOT LOGGED
OVERBURDEN
SANDSTONE
MUDSTONE
ORE
MINERALIZED
RADIOACTIVE ANOMALIES
SECTION E-E'
DATA FROM GEOLOGISTS LOGS
HORIZONTAL SCALE 1" - 200'
VERTICAL SCALE 1" - 30'