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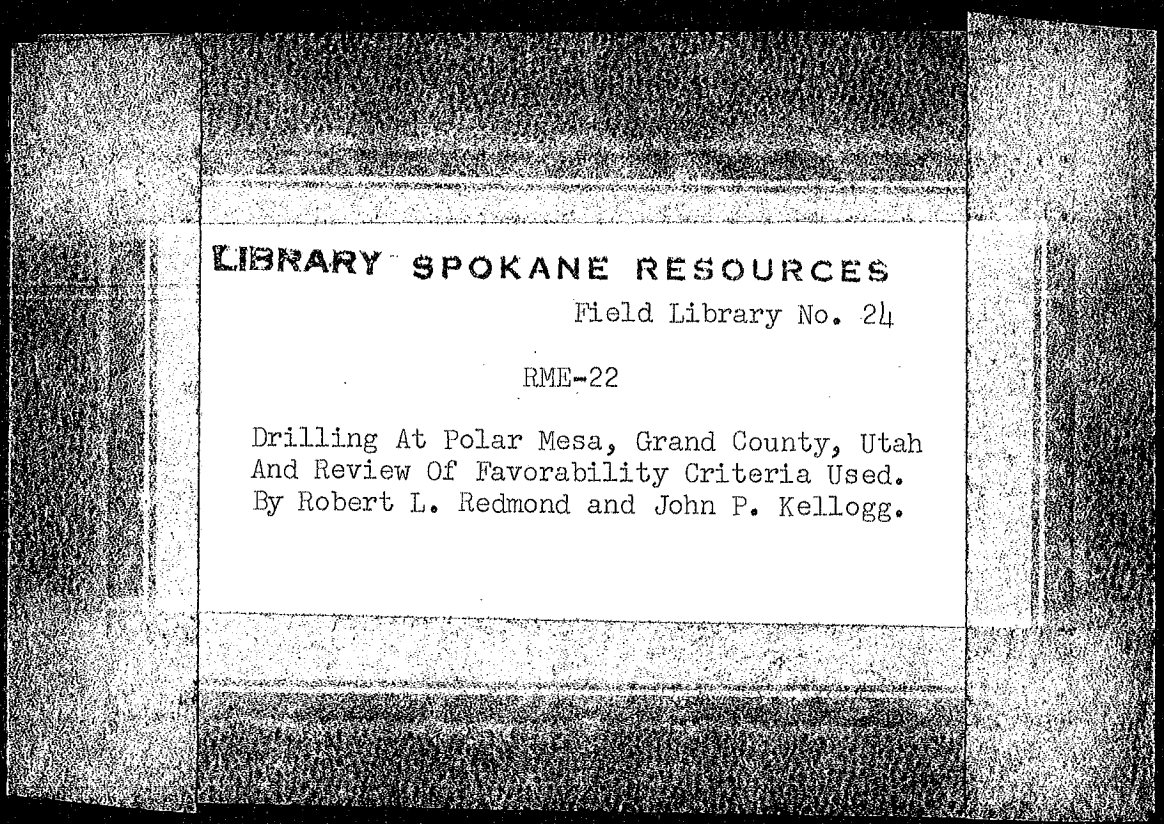


RME-22

Drilling At Polar Mesa, Grand County, Utah
And Review Of Favorability Criteria Used.
By Robert L. Redmond and John P. Kellogg.

DIVISION OF RAW MATERIALS

UNITED STATES ATOMIC ENERGY COMMISSION

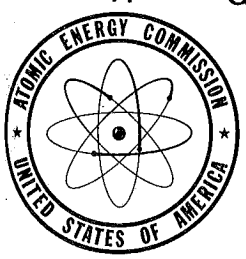
RME-22(Pt. I)

DRILLING AT POLAR MESA, GRAND COUNTY, UTAH AND REVIEW OF FAVORABILITY CRITERIA USED

By
Robert L. Redmond
John P. Kellogg

June 1954

Exploration Division
Grand Junction Operations Office
Grand Junction, Colorado



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AND REVIEW OF FAVORABILITY CRITERIA USED

(Part I) RME-22(Part I)

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ABSTRACT

On Polar Mesa in Grand County, Utah, a total of 37,904 feet was drilled by the Commission in 1950 under contract AT(30-1)-761. The mesa was again drilled during the period June 1952 to February 1953, under contract AT(30-1)-1265, which totaled 49,838 feet. This report deals primarily with the most recent project.

The principal uranium-vanadium-bearing unit of the Salt Wash sandstone is approximately 270 feet above the Entrada-Summerville contact. It is a massive yellow-brown sandstone ranging in thickness from 10 to 70 feet. A method of correlation involving the projection, parallel to the regional dip of a constant thickness of sediments was an aid in exploration drilling.

INTRODUCTION

Polar Mesa is on the northeast flank of the La Sal Mountains in Grand County, Utah. It is bounded by the Dolores River on the north and Beaver Creek on the east. The mesa, comprising an area of about 8 square miles, is in the southeast corner of T. 24 S., R. 25 E., and the northeast corner of T. 25 S., Salt Lake meridian.

A graded gravel and dirt road branching from Route 128 at Castle Valley is the main access to the mesa (fig. 1). Another road, difficult in winter, extends from Gateway, Colorado. Polar Mesa is approximately 38 miles by road from Moab, the nearest supply center. The nearest railroad points are at Cisco and Thompsons, both in Utah. A small landing strip on the mesa can be used by light planes; however, a better strip is located on the flats just south of the mesa.

Polar Mesa was examined in 1943 by the Union Mines Development Corporation. The Atomic Energy Commission drilled 37,904 feet on the mesa in 1950 under contract AT(30-1)-761. The Commission again drilled the mesa during the period June 1952 to February 1953 under contract AT(30-1)-1265, which totaled 49,838 feet. This report deals primarily with the most recent project.

Most of the claims are held by the U. S. Vanadium Corporation, and Climax Uranium Company holds a minority.

HISTORY AND PRODUCTION

Uranium ore was discovered on Polar Mesa in 1914, and the first production is believed to have been in 1918 by the Keystone Metals Reduction Company. After several years of inactivity, operations were resumed in 19[illegible] by Harbro Mines Company. No production figures are available for the perio[illegible]

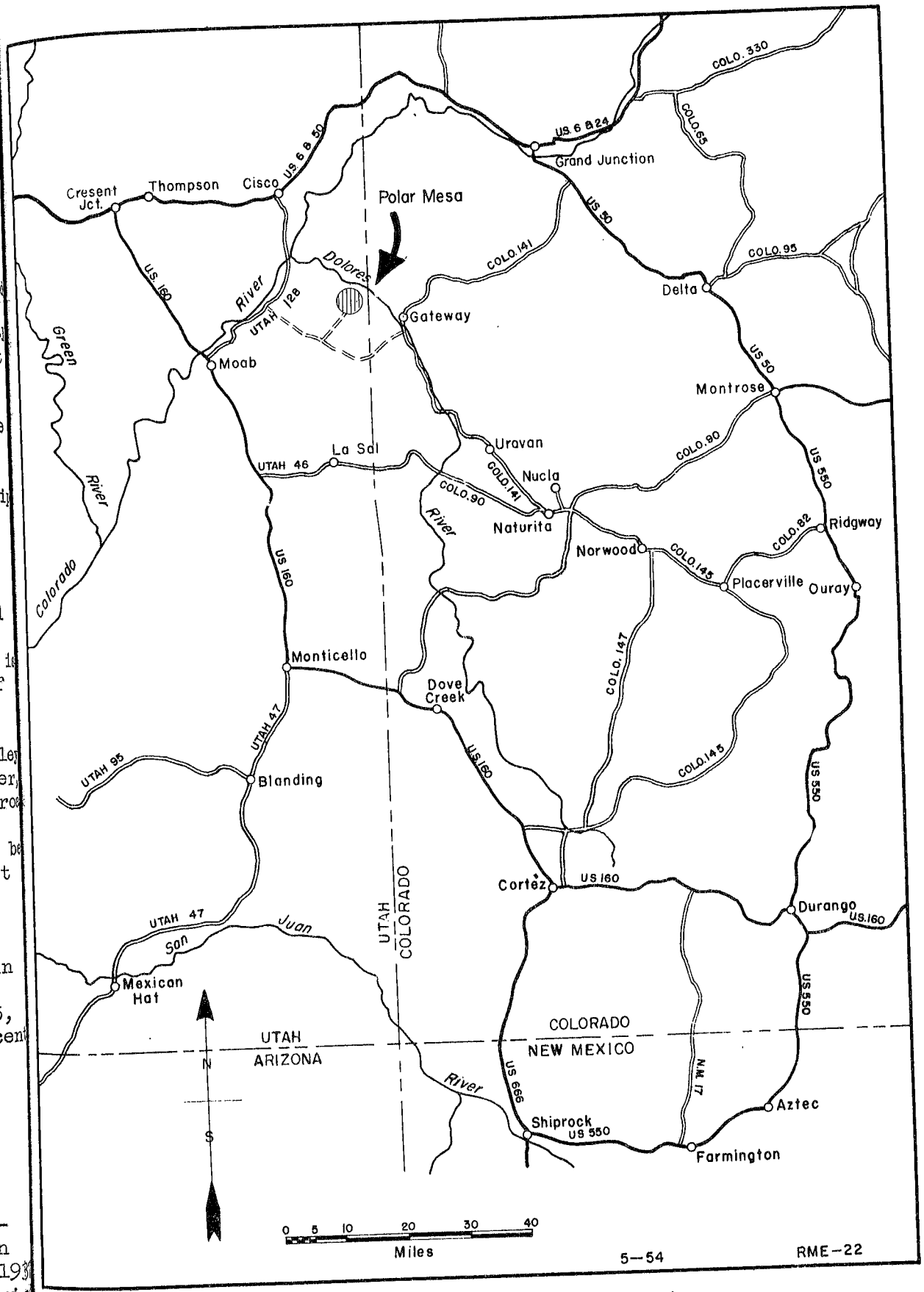


Figure 1. Location map of Polar Mesa, Grand County, Utah

from 1940 to June 1942. From June 1942 to February 1944, the mesa was worked by lessees. Exact production from 1944 to 1948 is unavailable, but it is probable that mining was entirely curtailed because there was no mark during this period. From 1948 through the end of 1952, most of the production in the area was by the U. S. Vanadium Corporation.

U. S. Vanadium Corporation conducted extensive drilling of their properties from 1948 through 1951. Climax Uranium Company has done only limited exploration on their claims.

GENERAL GEOLOGY

Stratigraphy

Only sedimentary formations are exposed at Polar Mesa. A remnant of the Cretaceous Dakota (?) sandstone caps the two highest ridges, but the greater part of the mesa is covered by alluvium and talus underlain by the Brushy Basin shale member of the upper Jurassic Morrison formation. The lower member of the Morrison formation, the Salt Wash sandstone, outcrops in vertical cliffs around the mesa. The Summerville formation and the Entrada sandstone are exposed on the steep slopes below the Salt Wash outcrops.

The stratigraphic sequence described below includes only those sedimentaries important to uranium exploration on the mesa. Descriptions of Entrada and Summerville formations are quoted from the Union Mines Development Corporation report. 1/

Entrada Sandstone

The Entrada formation is a sandstone, orange-buff to light gray, massive to cross-bedded, which weathers into sheer or rounded cliffs. It is regularly banded in alternating layers of orange-buff, gray and nearly white sandstone. Those layers vary from a few inches to 10 feet in thickness. Near the base, the member is more reddish, earthy, and forms a rather broad slope. The thickness of the Entrada, measured at three widely separated intervals, varies from 275 to 303 feet.

Summerville Formation

The Summerville formation on Polar Mesa varies in thickness from 35 to 75 feet. It consists of evenly and thinly bedded red and white sandstones and red shales. The sandstone beds show current ripple marks less than an inch in average wave length and vary little in appearance from place to place.

Morrison Formation

Salt Wash Sandstone Member: The Salt Wash member, about 300 feet thick at Polar Mesa, is composed of limonitic, yellow-brown to light gray sandstone and green and red mudstones. The upper one-third of the member is mostly thi

sandstones. The lower two-thirds is composed of almost equal proportions of sandstone and mudstone. These lower sandstones are usually finer grained, much thinner, and contain more calcium carbonate than the upper sands. The basal unit of the Salt Wash is a very fine-grained, well sorted, limy sandstone which ranges in thickness from one to five feet. This basal unit is lenticular and when it is absent other lithologic features must be used to distinguish the Salt Wash from the underlying Summerville formation.

The principal uranium-vanadium-bearing unit is a sandstone approximately 270 feet above the Entrada-Summerville contact. It is a massive, cross-bedded, medium- to fine-grained, yellow-brown sandstone, ranging in thickness from 10 to 70 feet. It is exposed almost continuously around the mesa and is locally called the "Payoff sand." Considerable carbonaceous material is present in the "Payoff sand", and green and red mudstone galls are abundant. In most places the lower part of the ore horizon is separated from the upper part by a green and red mudstone from one to 18 feet thick. This mudstone pinches out in the southern part of the mesa and there the "Payoff sand" is a single unit of sandstone.

Brushy Basin Member: Except for a few thin sandstone lenses in the upper part, the Brushy Basin member is completely covered by alluvium on Polar Mesa.

As seen in a core, the Brushy Basin consists of silty and limy mudstones, banded in gray, light gray, green and red. Associated with these are thin, lenticular, very fine-grained, high-lime sandstones containing chert fragments. The "Christmas tree chert", the basal unit of the Brushy Basin, is a sandstone, one to six feet thick, with an abundance of red and green chert fragments.

Dakota (?) Formation

C. H. Dane 2/ states, "The small isolated areas of conglomeratic sandstone on the crest of Polar Mesa are poorly exposed, and although they probably are basal Dakota (?), they could not be definitely identified as such."

Regional Structure

The structure within the area has been summarized in a report by Emerson and Smith 1/, from which the following is quoted:

"The Sager's Wash syncline and Cottonwood Canyon graben lie a few miles southwest of Polar Mesa. Neither of these features appears to have any control on ore deposition and is important only in its relationship to erosion.

"The beds on Polar Mesa have an average dip of about 4° northeast, although attitudes are not consistent throughout the mesa. Inconsistency is very apparent when different formations and intraformational units are projected from outcrops into profile sections across the mesa. A local monoclinal fold produced abnormal dips at the extreme south end of Polar Mesa."

GEOLOGY OF THE ORE DEPOSITS

Much of the Polar Mesa ore consists of sandstone in the Salt Wash impregnated with uranium and vanadium minerals and carbonaceous material. Carnotite is accompanied by vanadiferous hydrous mica that has been described as "roscoelite."

The base of the ore unit, the "Payoff sand," is approximately 270 feet above the Entrada-Summerville contact and ranges in thickness from 10 to 70 feet. Deposits are known to occur 50 feet above and below the "Payoff sand" horizon, but these deposits are always small. The main ore sand has an average thickness of 45 feet. The majority of the Polar Mesa ore bodies fall within this 45-foot unit. The basal Brushy Basin sandstones are slightly mineralized in places, and these are stratigraphically the highest mineralized beds on the mesa. Mineralized beds lowest in the section are 80 feet above the base of the Salt Wash, on the Vivian claim at the southwestern tip of Polar Mesa.

The ore forms tabular bodies of very irregular shapes and sizes. The largest ore body found by Atomic Energy Commission drilling was 5,700 tons and the smallest contained 110 tons. Mines on the western rim have produced as much as 10,000 tons from structures locally called "rolls." A single roll may yield a few tens of tons or hundreds of tons of ore. In places these rolls merge to masses containing as much as 10,000 tons of ore.

Many of the tabular ore bodies are of large size, but contain low-grade material. In nearly all ore bodies fossil trees and carbonized trash are intimately associated with the ore; usually the ore mineral in these masses of organic material is carnotite.

Trends of the deposits range from almost due north to northeast. These trends are believed to be controlled by the sedimentary trends in the Salt Wash sandstone.

There is no recognizable pattern in the distribution of the ore bodies in drilling area "A" (fig. 2), although more ore was found along the western side of the area than elsewhere. Assays of samples taken from all parts of Polar Mesa 1/ indicate that the western edge of the mesa is strongly mineralized, whereas most other parts of the mesa are weakly mineralized.

GEOLOGY OF THE DRILLING AREA

Festoon bedding, ripple marks, attitude of logs, and lineation were the criteria used to determine the north to northeast sedimentary trends, and these were examined in mines, prospects and rim exposures of the "Payoff sand."

The outcrop of the "Payoff sand" was mapped in order to determine variations in color of the sand, amount of carbonaceous material, thickness of the green muds above and below the unit and intensity of mineralization.

Sections of the Salt Wash measured by the Union Mines Development Corporation were an aid to the outcrop studies of sedimentary trends which, in turn, were leads to areas of favorability.

Drilling Pattern

Polar Mesa area "A" (figs. 2 and 4) is bounded by north coordinates 100,000 to 115,000 and by west coordinates 196,000 to 202,000 which enclose an area of approximately one square mile.

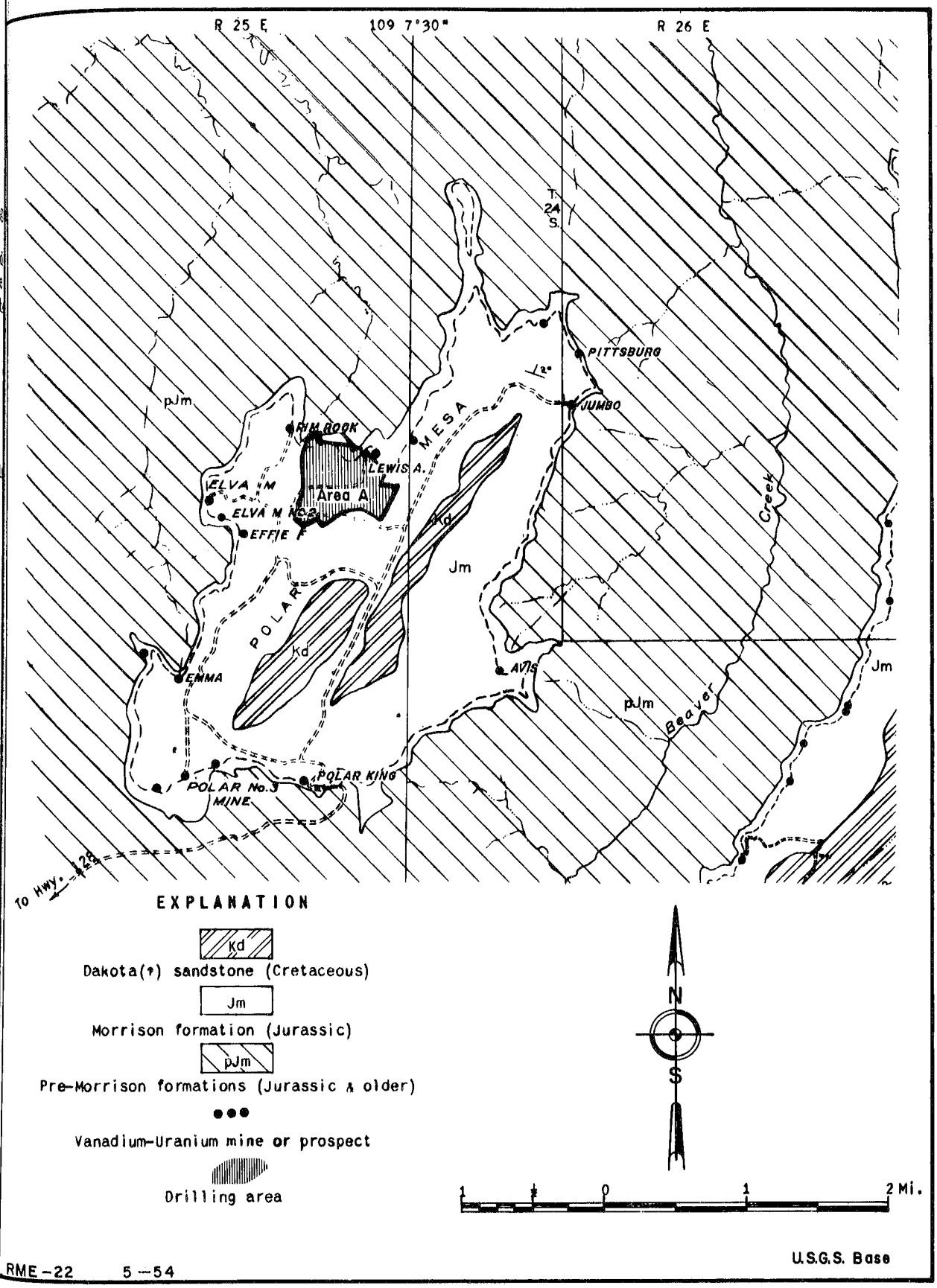


Figure 2. Index map of Polar Mesa, Grand County, Utah showing location of area "A"

An initial 800-foot grid pattern was adopted after consideration of the location of the U. S. Vanadium Corporation holes and the influence of terrain. In the area west of coordinate W. 201,500, the U. S. Vanadium Corporation had completed sufficient drilling to render further exploration unnecessary.

Drilling commenced in area "A" on June 28, 1952. Coordinate N. 112,400 was used as a base line. Extension of the drilling pattern in a southerly direction found no mineralization. For this reason, little drilling was done south of coordinate N. 111,500.

Drilling north of the base line encountered mineralization and in this region the distance between grid holes was reduced from 800 to 400 feet. In extremely favorable areas, all north of coordinate N. 112,000, the distance between drill holes was reduced to 200 feet.

Highly mineralized holes were offset 50 and 30 feet, with the majority of offset holes at 50 feet from the original mineralized hole.

Subsurface Geology

In 1952, when the Atomic Energy Commission started drilling in area "A", conventional methods of subsurface correlation were employed. These consisted of drawing fence diagrams based on rows of cored holes and attempting to relate similar lithologies throughout the area. The ore-bearing unit was generally thought to be a sandstone that varied in thickness from 30 feet to 70 feet and contained varying thicknesses of mudstone. Figure 3, an east-west line of drill holes across area "A", shows the typical section encountered in drilling. Due to rapid vertical and horizontal facies changes within the Salt Wash, it was impossible to correlate lithology from hole to hole. For this reason, a study was made of the drill logs obtained from the first east-west line of holes drilled on 400 and 800-foot centers across the center of area "A" (fig. 3) in order to find a method of correlation which could be applied to a subsurface section characterized by rapid facies changes.

CORRELATION BY CONSTANT THICKNESS METHOD

Rim studies indicated that the major ore deposits at Polar Mesa occur in a thin zone within the upper one-third of the Salt Wash sandstone. Initial discoveries of ore and mineralization were made in holes on 800-and 400-foot centers along an east-west line. Although the upper third of the Salt Wash could be identified in these holes, the rapidity of lithologic change would not permit a positive correlation of the ore-bearing sandstone unit throughout the area. Figure 3 illustrates with dotted lines the tentative lithologic correlation used in this area. It will be noticed that this is just one of several possible correlations of the lithology. There was no factor in any which would lead to a choice of a particular one.

Inspection of the core logs for the initial line of holes revealed that, when a constant-thickness unit of 45 feet was projected parallel to the regional dip and through the "Payoff" unit, it would include all of the ore and most of the mineralization disclosed in drilling.

East → West

Topographic elevation

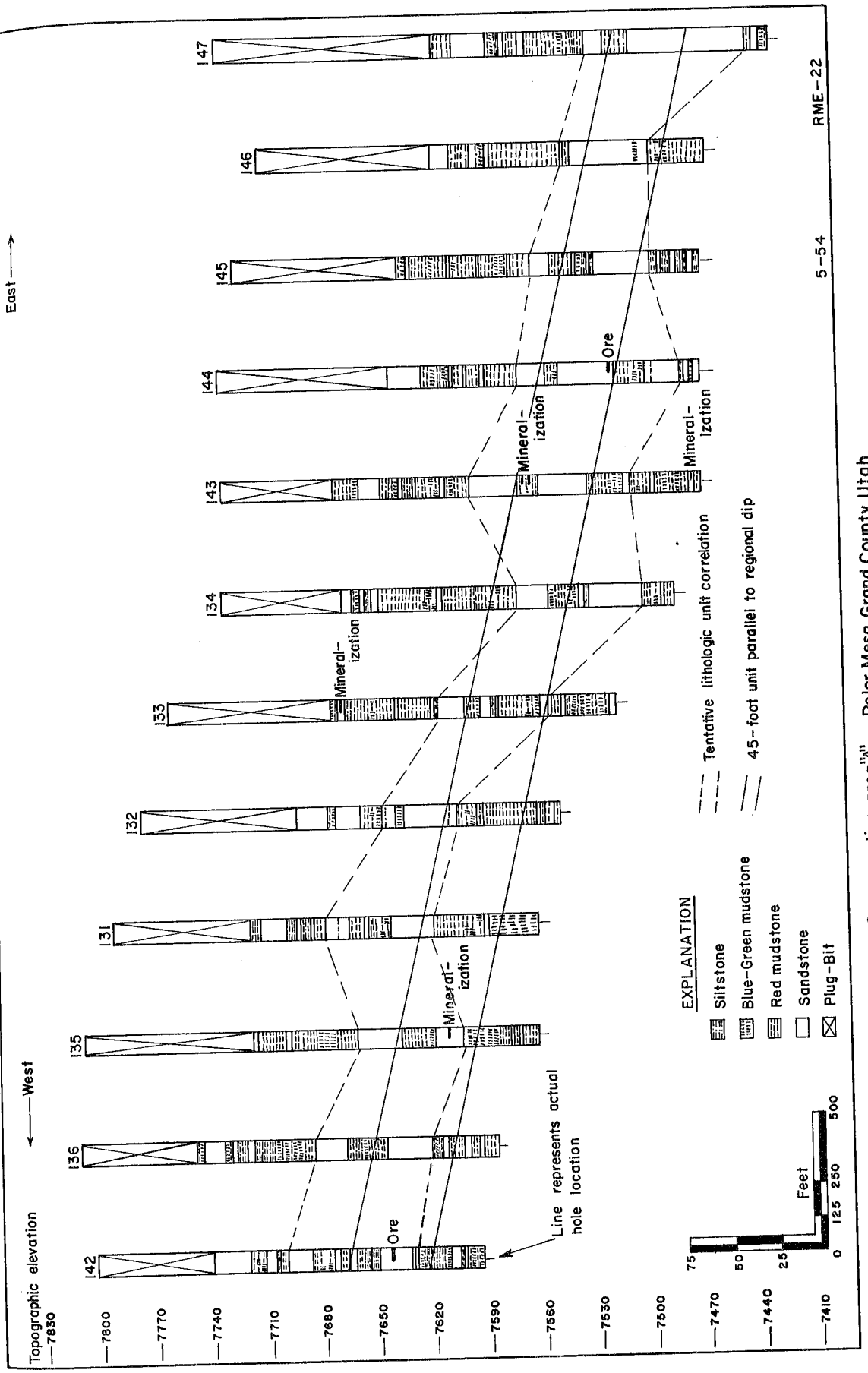


Figure 3. Cross section, area "A", Polar Mesa, Grand County, Utah
Showing initial line of holes drilled across area "A"

From a structure map of the Entrada sandstone, the base of this arbitrary unit was established at 270 feet above the top of the Entrada; the top of the unit was then 315 feet above the same datum.

A comparison of the two methods of correlation illustrates the decided economic advantage and ease of use of the constant-thickness method over lithologic correlation. Figure 3 illustrates the necessity, when employing lithologic correlation of uncertain accuracy, of coring a thick unit; it also shows how thin a unit need be cored when using the constant-thickness method.

The favorability maps included in this report were used with both methods of correlation. However, prediction of favorable ground based on the quantity and quality of criteria of favorability within a lithologic unit of dubious correlation proved to be valueless for drilling in adjacent unexplored areas. Predictions based on the quantity and quality of favorability criteria within the arbitrary unit of constant-thickness proved to be fairly reliable. Figure 10 is the final composite favorability map that was constructed at the conclusion of drilling. However, before this stage was reached, predictions of favorable ground were based on a somewhat similar map. The preliminary favorability map indicated that the northwestern part, the west central part and the north central part of area "A" were the most favorable. Holes 184, 186, and 187 were drilled in the northwestern area; 186 was an ore hole. Holes 195, 196, and 199 were drilled in the west central part of the area; 195 was mineralized and 199 cut ore. Hole 178, in the north central part of the area, was mineralized and its offsets were in ore. Of these seven holes, drilled in ground predicted to be favorable by the constant-thickness unit correlation, three located ore and were offset in ore, one was mineralized and three holes were barren but were within the range of characteristics predicted to be favorable.

Subsurface Mapping

Subsurface maps were drawn on the basis of lithologic information obtained from all holes drilled on 800-foot and intermediate 400-foot centers.

In the initial east-west drill line, holes numbered 142, 135, 143, and 144 (fig. 3) cut either ore or mineralization. A study of cores from these holes and their offsets revealed characteristics that may be a cause, or a result, of ore deposition. The association of these characteristics with mineralization was considered an indication of favorable ground. Qualitatively, these favorable characteristics do not differ from those developed in other Salt Wash areas. They are: ratio of mud to sand; ratio of gray to brown limonitic sand; amount of limonitic sand; amount of green mud; and presence of carbon and/or limonite. By use of the criteria of favorable ground, those portions of the section which were penetrated by subsequent drilling were classified as favorable or unfavorable. It was assumed that the four initial mineralized holes and their offset holes would establish a range of values for the above criteria within which range ore or mineralization might be expected elsewhere in the area. Later ore discoveries confirmed this assumption.

The following maps of subsurface features were constructed in delineating areas of favorability:

1. Mudstone to sandstone ratio x 100 (fig. 4).
2. Gray to yellow-brown sandstone ratio x 100 (fig. 5).
3. Amount of sandstone (fig. 6).
4. Amount of blue-green mudstone (fig. 7).
5. Total amount of mudstone (fig. 8).
6. Amount of yellow-brown sandstone (fig. 9).
7. Composite favorability map based on the results of figures 4 through 9 (fig. 10).

An area deemed favorable on four or more maps was considered to merit further exploration. An area within three overlays was considered to be semi-favorable and worthy of limited exploration. All grid holes were used in constructing the various favorability maps, and offsets in ore or mineralization were used as checks on favorability. Data from ore or mineralized discoveries, other than the initial discoveries in holes 142, 135, 143, and 144 were found to occupy the limits of favorability that were mapped for the ore and mineralized holes shown on figure 3.

No exploration of unfavorable ground was undertaken after the constant-thickness correlation method was initiated because of drill footage limitations.

Drilling Program

The area "A" drilling contract required core drills. The initial procedure was to take no core above a predetermined depth above where the ore-bearing "Payoff sand" lithologic unit should be. From this point on, core would be taken in 10-foot runs until the hole was bottomed at a predetermined depth which made allowances for penetration below the ore-bearing sand. A large safety margin of core above and below the estimated limits of the ore-bearing sand was a necessity because of the rapidity with which the thickness of the "Payoff sand" unit changed throughout area "A". These large safety margins, used when correlation was attempted by matching similar lithologic units, are illustrated in figure 3. The average hole was 200 feet in depth and required on the average 160 feet of core per hole.

In the first phase of drilling, holes were placed along two perpendicular lines. These holes had a primary spacing of 800 feet between centers with secondary holes on 400-foot centers. One line crossed the center of the drill area from east to west, and the other crossed the center of the drill area from north to south. Figure 3 shows the initial line from west to east.

In area "A", it was found that ore or mineralization within the "Payoff sand" was always confined to a relatively narrow vertical zone. This allowed the selection of an arbitrary unit to include only the ore zone, and with this method a predetermined smaller amount of core could then be drilled in each hole. The previous lithologic unit correlation required an average of 160 feet of core per hole while the constant-thickness method of correlation required only 60 feet of core for each hole. The coring limits were not set at exactly 45 feet because it was felt that an allowance of a few feet should be made to provide for any variations of regional dip that might be encountered within the drill area.

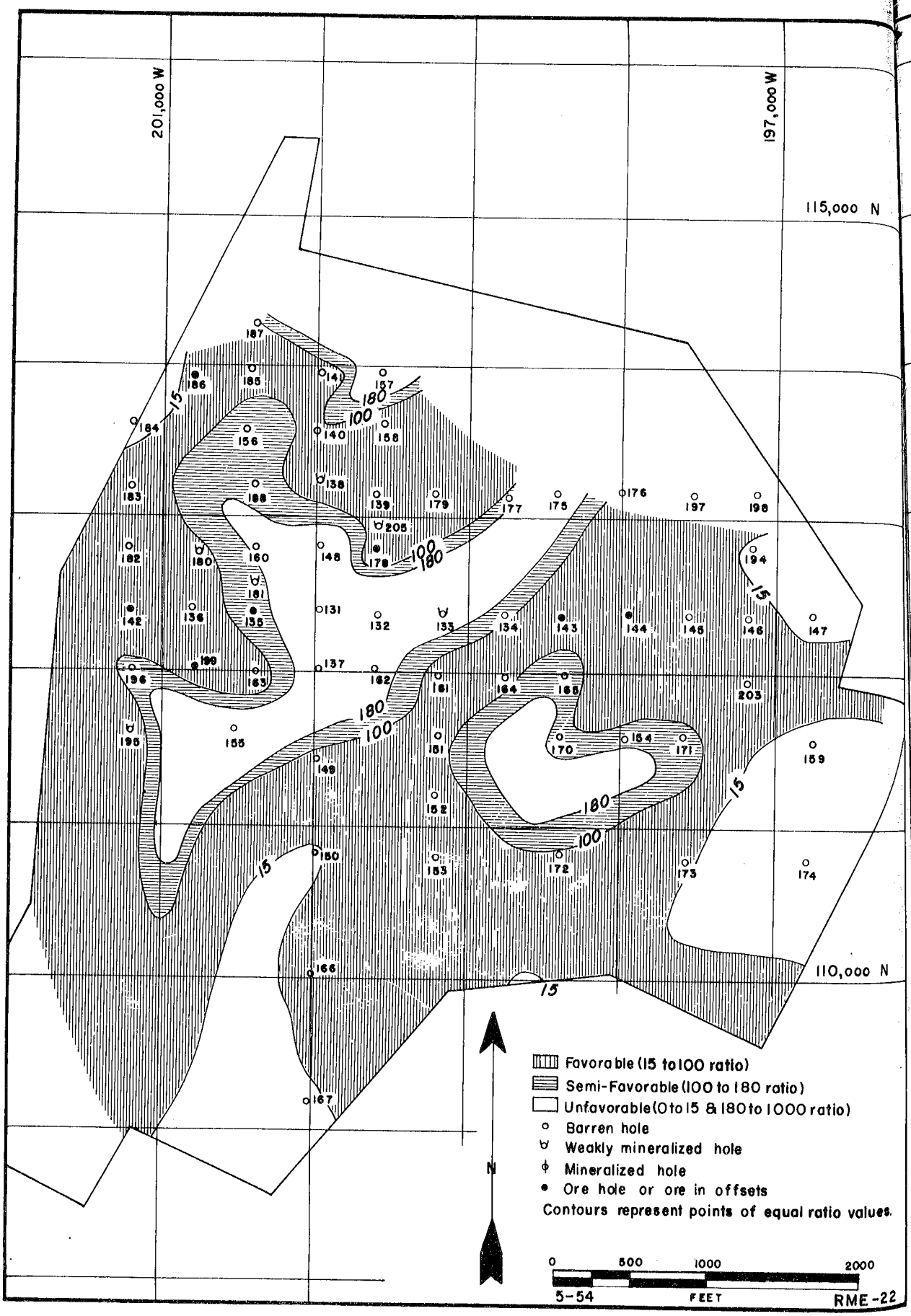


Figure 4. Mudstone/sandstone ratio map of area "A" based on total mudstone and sandstone to be found in the 45 foot constant thickness unit

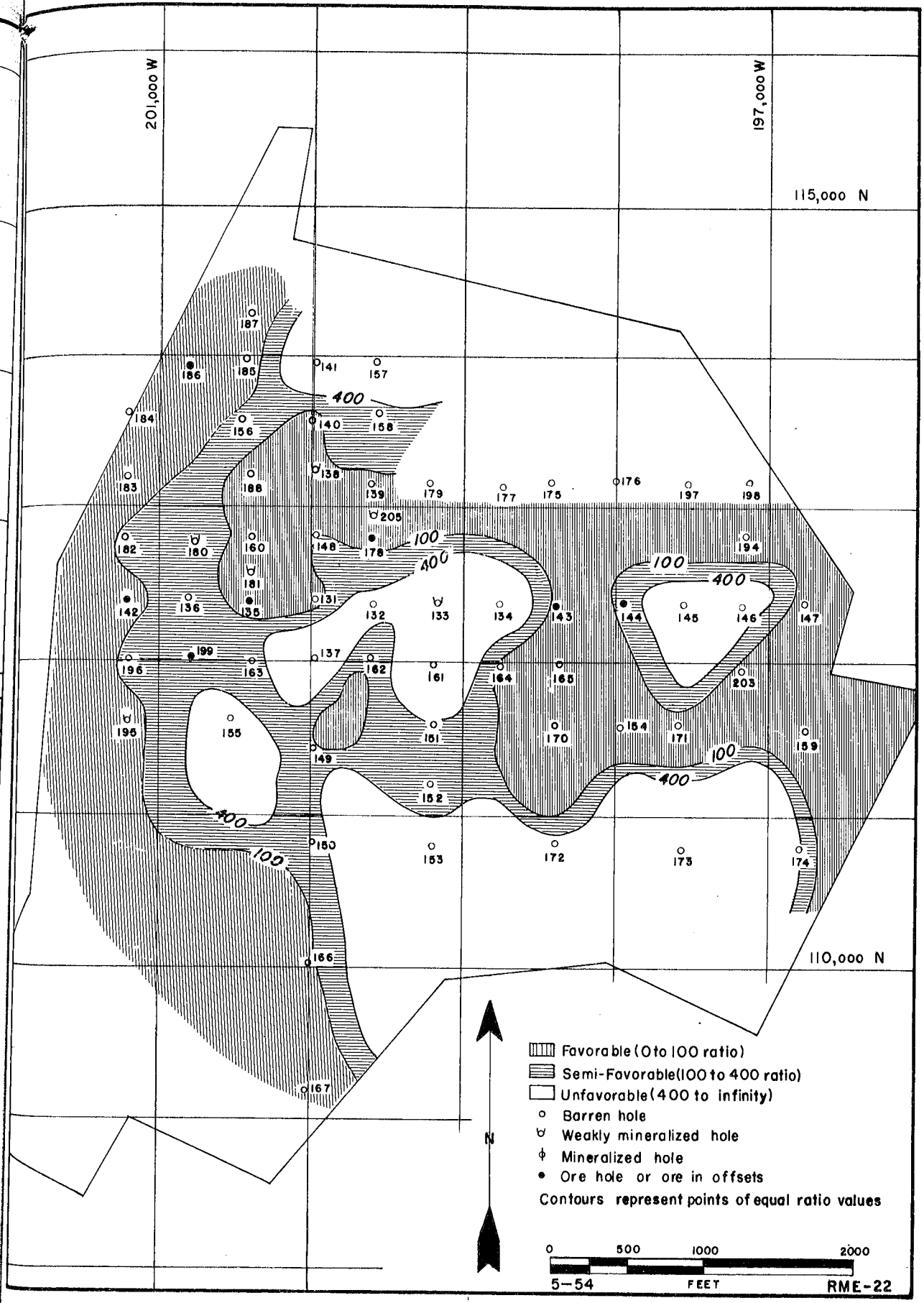


Figure 5. Gray sandstone / yellow-brown sandstone ratio map of area A based on total grey sandstone & total yellow-brown sandstone to be found within the 45 foot constant thickness unit.

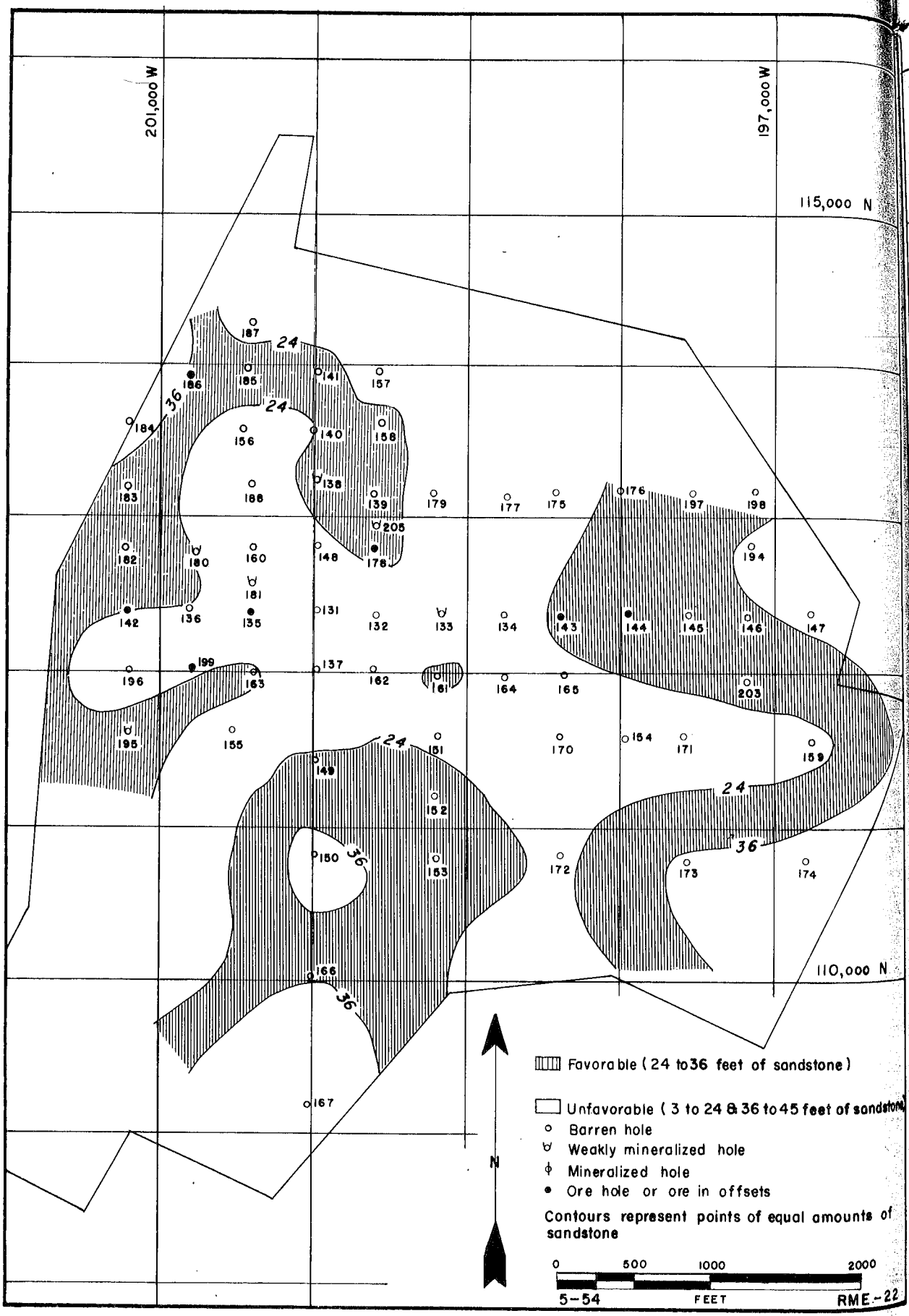


Figure 6. Amount of sandstone to be found within the 45 foot unit in area A

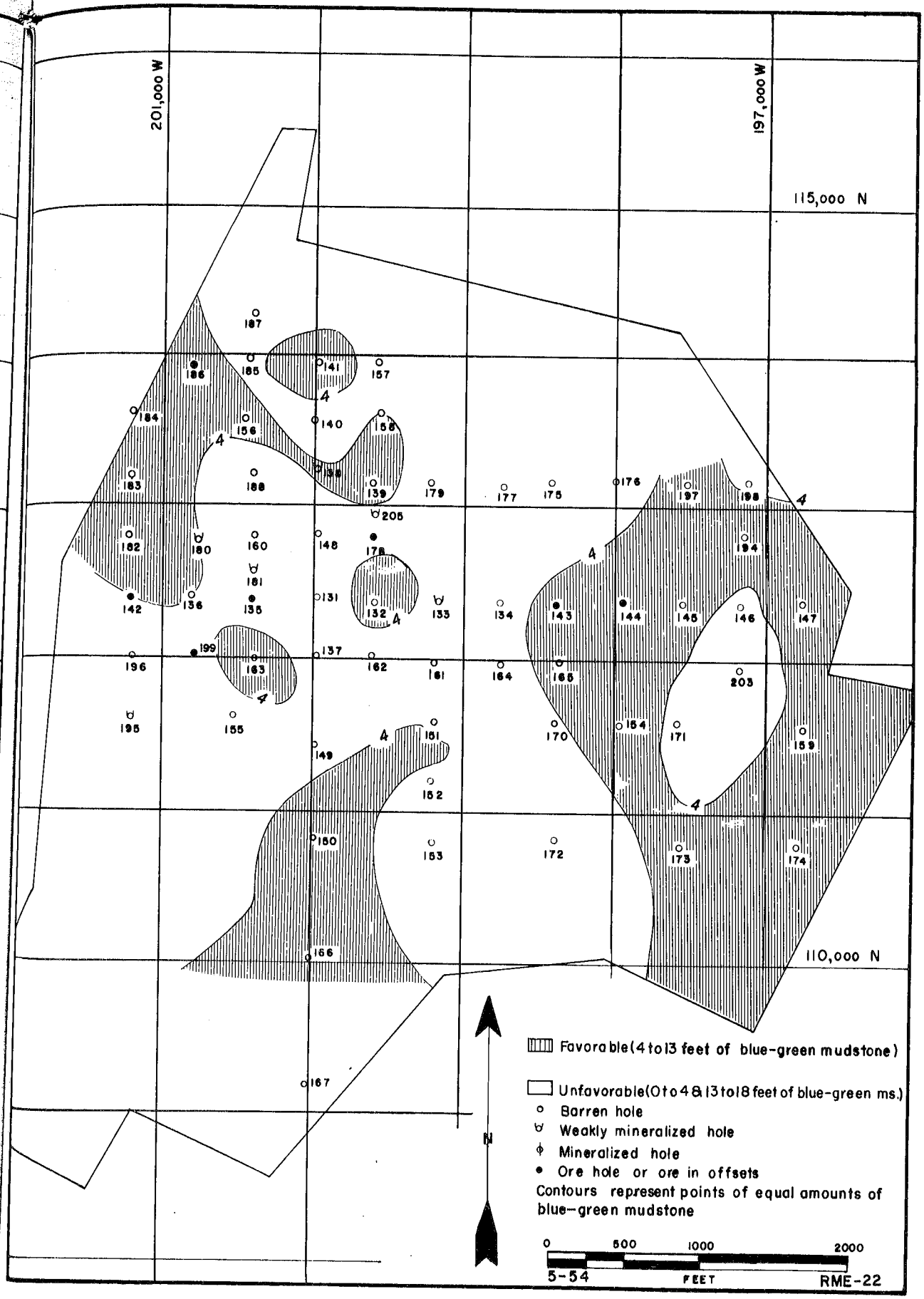


Figure 7. Amount of blue-green mudstone to be found within the 45 foot unit in area "A"

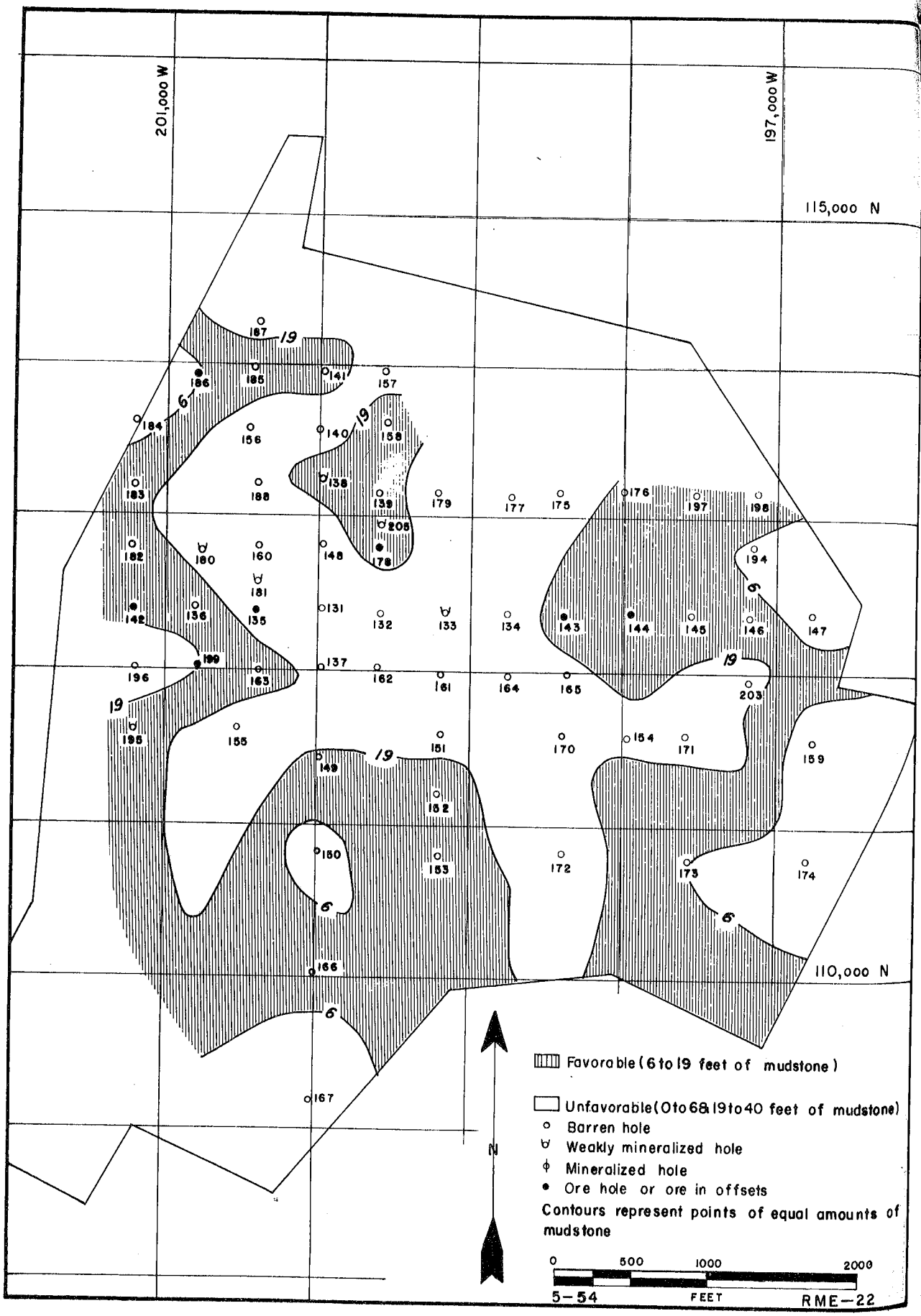


Figure 8. Total amount of mudstone to be found within the 45 foot unit in area "A".

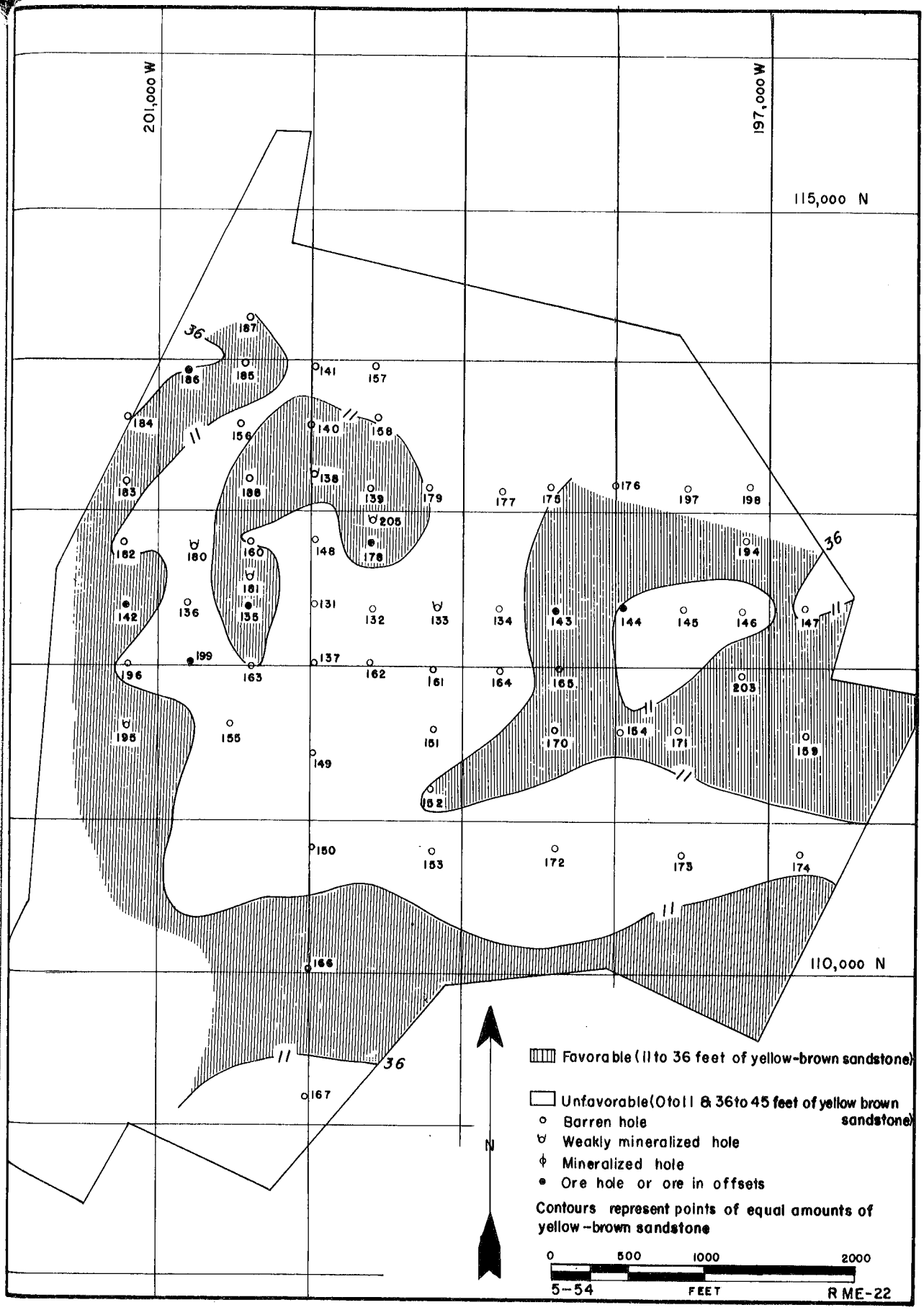


Figure 9. Amount of yellow-brown sandstone to be found within the 45 foot unit area "A"

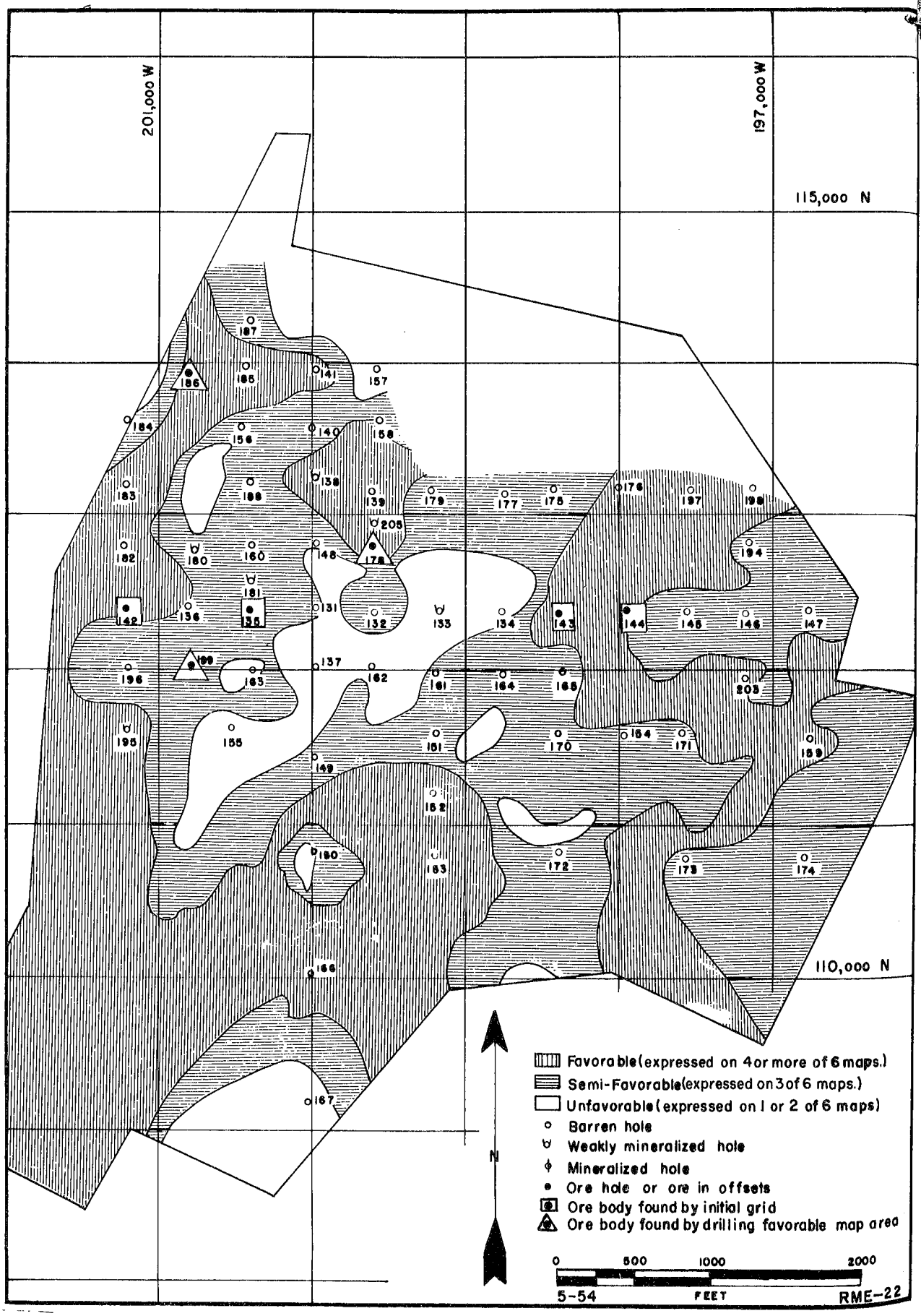
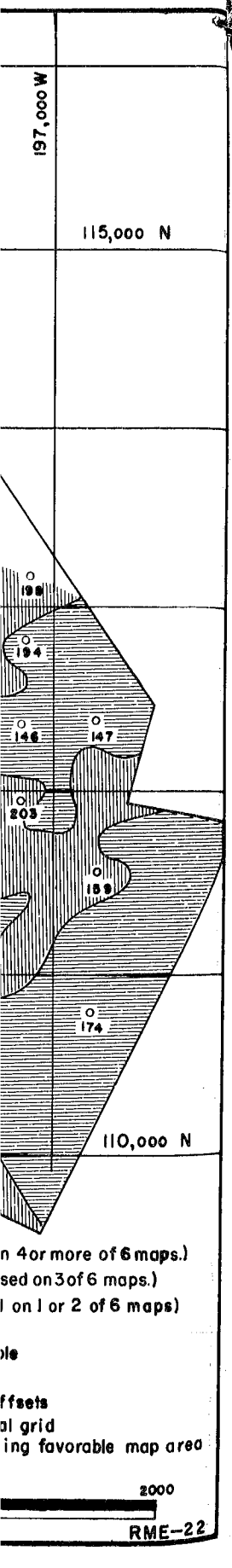


Figure 10. Composite favorability map of area "A".



A saving of $13 to $26 per hole was made by converting the usual amount of coring above the ore horizon unit to the cheaper non-core drilling; and, by deleting the lower large safety margin of core, an additional $38 to $76 was saved per hole. A total saving of $51 to $102 per hole was thus obtained. The Polar Mesa contract allowed $3.80 per foot of core and $2.50 per foot of plug-bit drilling.

CONCLUSIONS

Use of the constant-thickness method resolved the difficulty of correlation in the rapidly changing lithology of the Salt Wash. Subsurface maps constructed on lithology encountered in the 45-foot constant-thickness unit indicated favorable areas in which subsequent drilling located ore bodies or extended the boundaries of known favorable ground.

This method of correlation offers two economic advantages. One is a saving in drilling time accomplished by taking a smaller margin of core above and below the arbitrary unit. The other advantage is a saving in coring expense by drilling a smaller but fixed amount of core per hole by bottoming the hole at a shallower depth than is possible with the lithologic unit correlation.

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