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Regional Well-Log Correlation in the New Mexico Portion of the Delaware Basin

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Abstract

Although well logs provide the most complete record of stratigraphy and structure in the northern Delaware Basin, regional interpretations of these logs generate problems of ambiguous lithologic signatures and one-hole anomalies. Interpretation must therefore be based on log-to-log correlation rather than on inferences from single logs. In this report, logs from 276 wells were used to make stratigraphic picks of Ochoan horizons (the Rustler, Salado, and Castile Formations) in the New Mexico portion of the Delaware Basin. Current log correlation suggests that: (1) the Castile is characterized by lateral thickening and thinning; (2) some Castile thinnings are of Permian age; (3) irregular topography in the Guadalupian Bell Canyon Formation may produce apparent structures in the overlying Ochoan units; and (4) extensive dissolution of the Salado is not apparent in the area of the Waste Isolation Pilot Project (WIPP) site.

DISCLAIMER

Acknowledgment

Well-log picks were initially made by a team consisting of Steven J. Lambert, Terri Ortiz, and the authors. The Applicon data base was set up by Bruce Whittet and Robert Williams. Meredith Edwards assisted greatly in preparing the final graphics.

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Regional Well-Log Correlation in the New Mexico Portion of the Delaware Basin

Introduction

Borehole geophysical logs provide records of stratigraphy and structure in the northern Delaware Basin that are more detailed than previous data obtainable from incomplete coring and poor outcrop. Structural and stratigraphic variations in a bedded evaporite sequence may be caused by sedimentation, deformation, or dissolution. Well logs provide the critical and sometimes only data for inferring which processes were or are active. Interpretations of lateral continuity of structures also come from log correlation.

Well logs from the New Mexico portion of the Delaware Basin were examined for this report (Figure 1). The area covered is a 30 × 36-mi rectangle (T21S to T25S and R29E to R34E). The northern edge of the area lies adjacent to the Capitan Reef. The resulting log correlation in this area provided a data base for previous reports on dissolution and deformation (Lambert, 1983; Borns et al, 1983, respectively) as well as for this current evaluation of earlier log correlations in the region (e.g., Anderson, 1978). In particular, this report addresses the specific problems of one-hole anomalies and ambiguity of log interpretation.

Ideal Stratigraphy

Powers et al (1978), Snyder (in Borns et al, 1983) and Lambert (1983), discuss the stratigraphy of the northern Delaware Basin in great detail. We briefly review the stratigraphy in this report; the interested reader seeking more information may refer to the references cited.

The strata studied in this report are all of Permian age. The younger Permian formations (the Rustler, Salado, and Castile) are Ochoan, and the Delaware Mountain Group (DMG) is Guadalupian. The Rustler is the uppermost evaporite unit used in this study (see Figure 2). The top of the Rustler is considered to be the top of the first persistent anhydrite bed as penetrated by oil and gas drillings. This anhydrite bed is a clear marker for stratigraphic correlations. The Rustler contains two major members, the Culebra and Magenta Dolomites, within alternating beds of anhydrite, halite, and siltstone.

The underlying Salado Formation is primarily halite. The formation is here divided into three units: the Upper, Middle, and Lower Salado. The upper and lower boundaries, respectively, of these units are the Salado-Rustler contact and Marker Bed 124 for the Upper Salado; Marker Beds 124 and 136 for the Middle Salado; and Marker Bed 136 and the Salado-Castile contact for the Lower Salado. The Lower Salado includes the Cowden Anhydrite and the Infra-Cowden Halite; the base of the Infra-Cowden is the unconformable Salado-Castile contact (cf Adams, 1944). Marker Beds 124 and 136 are 2 of the 45 numbered siliceous or sulfatic units that are numbered 100 to 145 in the Salado. This usage originated in the local potash industry (Jones et al, 1960). These marker beds are traceable in the subsurface for several kilometers, although they are not recognizable in every hole.

The Castile Formation is composed of alternating anhydrite and halite units (Lambert, 1983). The complete section of the Castile is divided into seven members (in descending order): Anhydrite IV, Halite III, Anhydrite III, Halite II, Anhydrite II, Halite I, and Anhydrite I. The section is not universally complete because of the cross-cutting effects of the Salado-Castile unconformity and lateral facies variations. In some areas within the basin, the anhydrite units are blocky, nodular, or brecciated. Such zones are interpreted to be the result of deep dissolution (Anderson, 1978).

The Bell Canyon Formation is the uppermost unit of the DMG, but it is the lower-most unit of interest in this report. The Bell Canyon is a thick section of sandstone and siltstone with some shale (King, 1948; Davies, 1983).

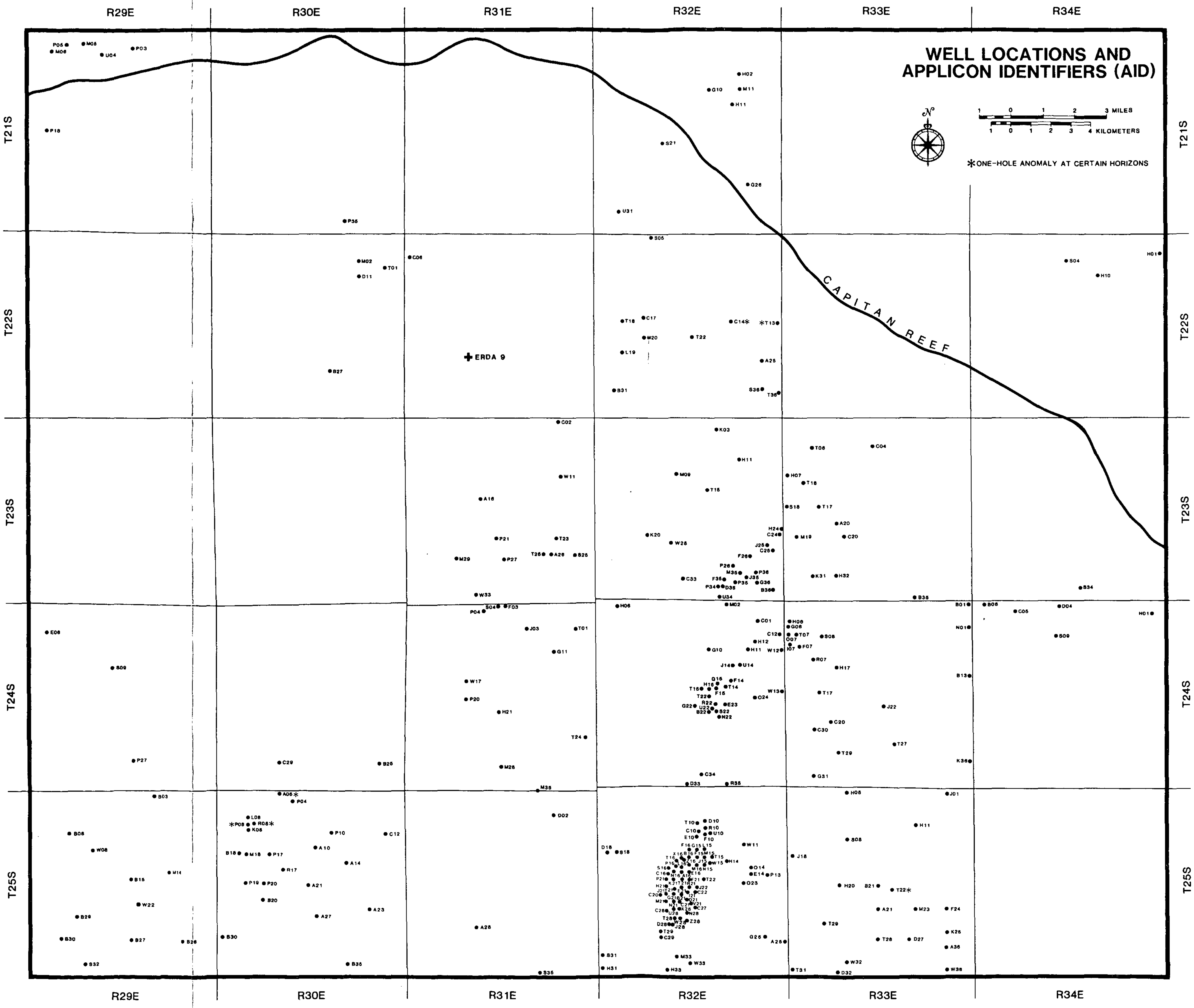


Figure 1. Well location and Applicon identifiers (AIDs) (as discussed in a later section)

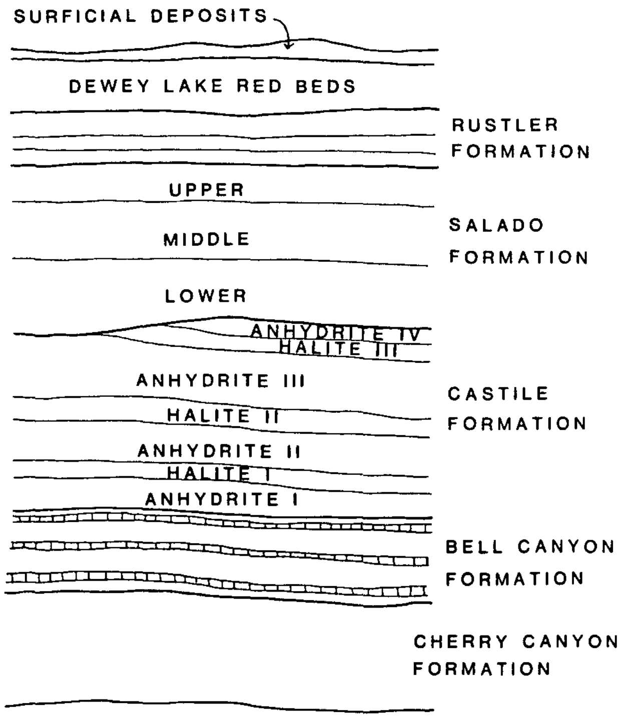


Figure 2. Idealized cross section, Northern Delaware Basin (adapted from Lambert, 1983)

Results of Log Correlations

This report is an accumulation of geophysical well-log data from 276 drillholes in the northern Delaware Basin. The maps (Figures 3 through 26) portray these data in a 30 × 36-mi area. The 24 contour maps are based on our log correlations and include maps of stratigraphic surfaces and isopach maps. The results of this study are presented here, and detailed discussions of the methods that we used for correlation are presented in later sections. The following basic observations can be made from the contour maps:

- The units incline towards the Capitan Reef, with deflection of contour lines into a parallel position with the margin of the reef.
- Away from the margin of the reef, the contour lines run N-S, reflecting a west-to-east dip for the stratigraphic surfaces.
- Stratigraphic surfaces reach their maximum depths within the southeast corner of the map area.
- Within the Rustler and Salado Formations, a linear high that runs northwest to southeast appears in the southern third of the map area. This high becomes indistinct across the Salado-Castile contact. With depth, Castile surfaces more closely parallel the top of the DMG.
- Local highs and lows are observed for any given surface within the map scale. The number of highs approximately equals the number of lows.
- Isopach maps show a generally uniform thickness in the middle of the map area, with thickening or thinning adjacent to reef and irregular structures along the southern edge of the map area.
- The middle Salado is more constant in thickness than the upper or lower Salado.
- Very broad zones of thickening and thinning are observed in the lower Salado and Castile in the southern third of the map area.

The observations made above are based on broad-scale correlations of oil- and gas-industry holes. Therefore, the detail of structures in the area adjacent to the WIPP site may be lost at the scale of mapping in this report. Structures such as the FC-92 depression (Davies, 1983 and Snyder in Borns et al, 1983) are lost. For relatively fine-detail structures in the WIPP area, the reader is referred to Griswold (1977).

As the study progressed, we became aware of the following considerations of specific interest to the WIPP project:

- Stratigraphic picks can vary among workers. Therefore, such picks need to be reviewed and compared by the entire working group.
- Variations in log signature, caused either by operational conditions or real stratigraphic complexities, can make stratigraphic picks ambiguous.
- MB 136, Cowden Anhydrite, Infra-Cowden, and Anhydrite III are commonly the most ambiguous surfaces to pick; therefore, isopachs that are based on MB 124 and the top of Halite II are less prone to error.
- Assumptions of post-Permian lateral continuity of key marker beds are not always valid.
- Structures based on one-hole anomalies need to be carefully evaluated for ambiguities in picks, errors in transcribing data, quality, and type of log used, and consistency with nearby holes. After such checks, some one-hole anomalies remain. In the course of constructing the contour maps in this report, we drew contour nests where the one-hole anomaly is supported by trends in adjacent holes. However, if adjacent holes are not consistent, we did not deflect the contours but marked the anomalous hole with an asterisk.

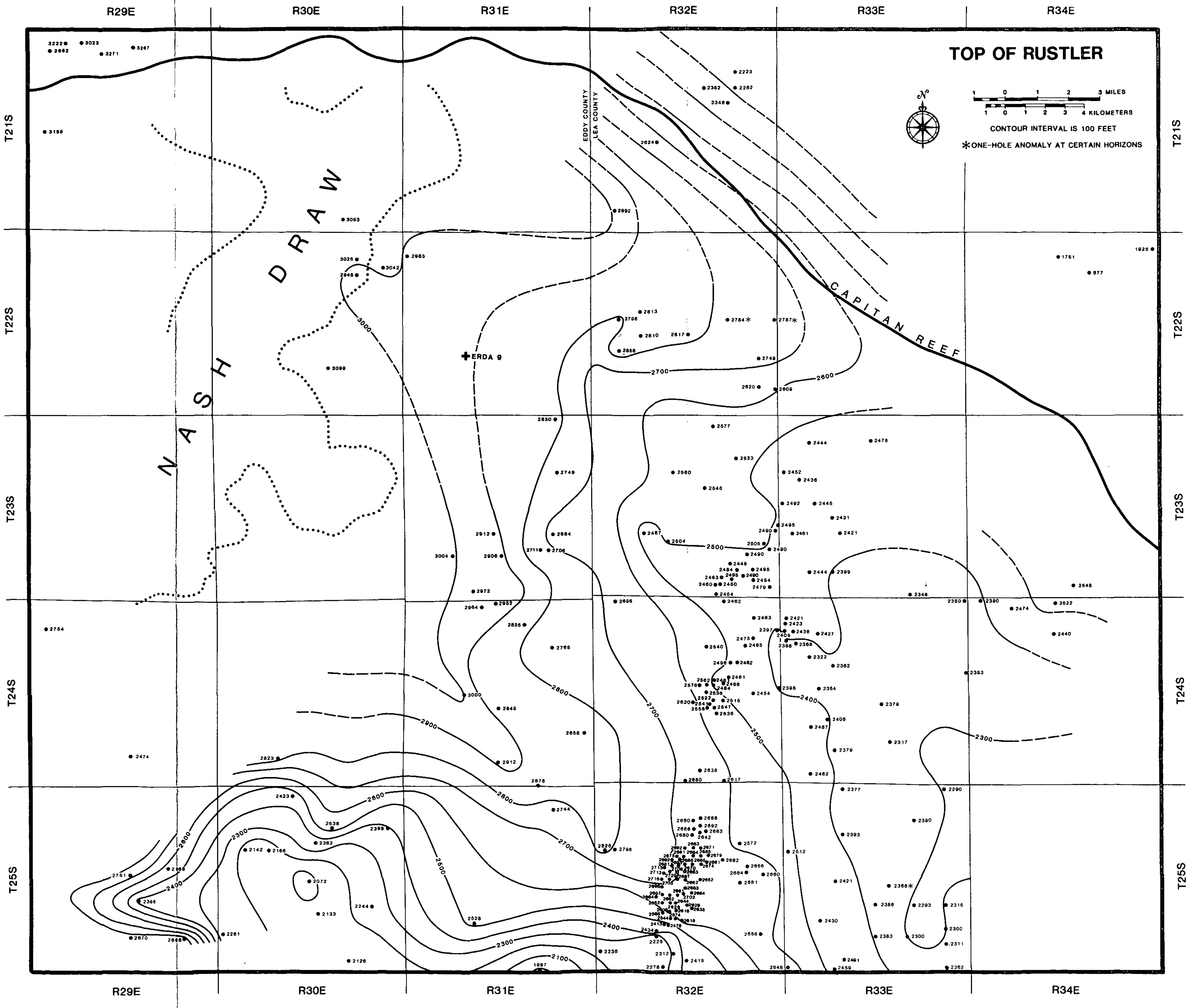


Figure 3. Top of the Rustler (Elevation above MSL in feet)

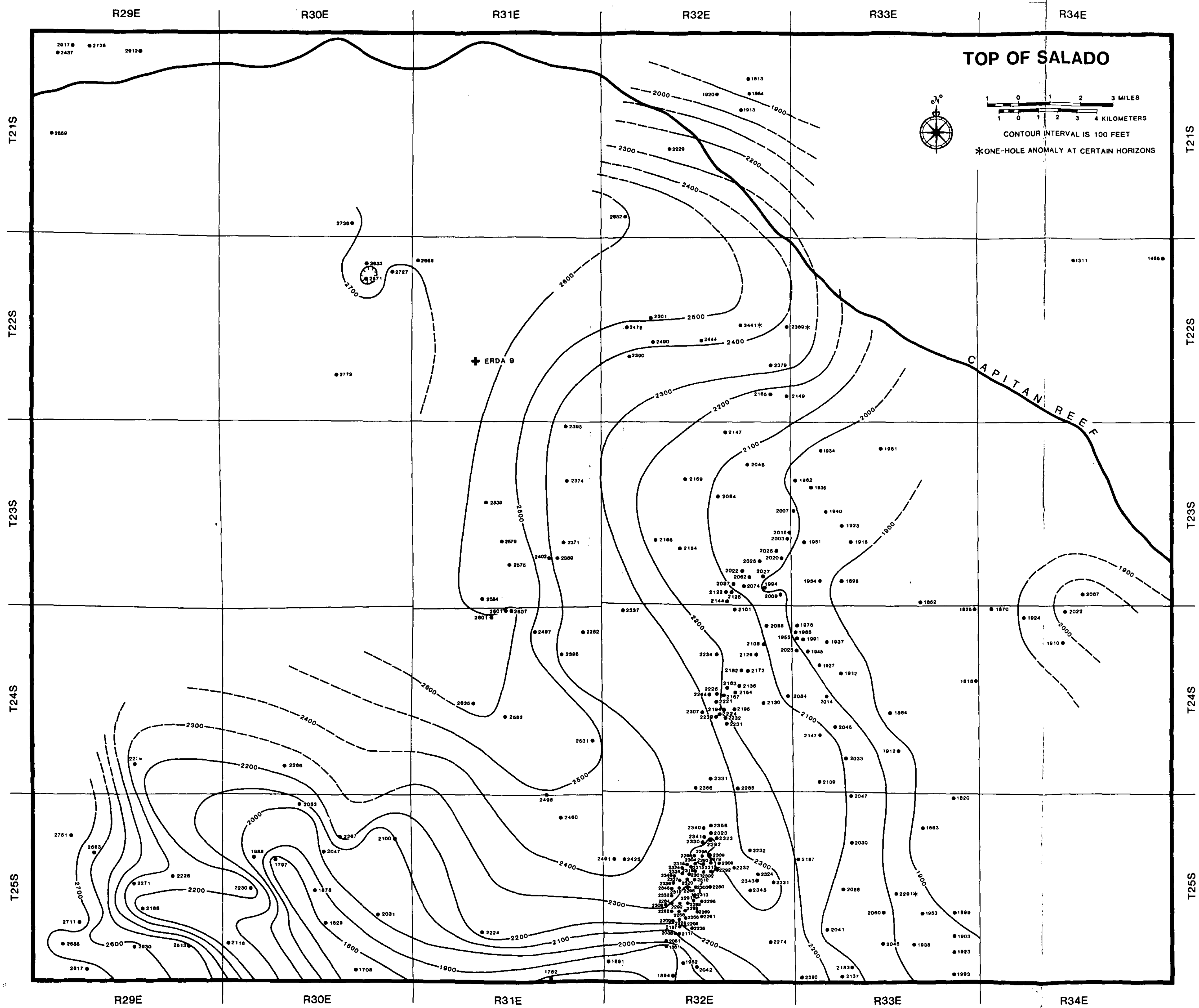


Figure 4. Top of the Salado (Elevation above MSL in feet)

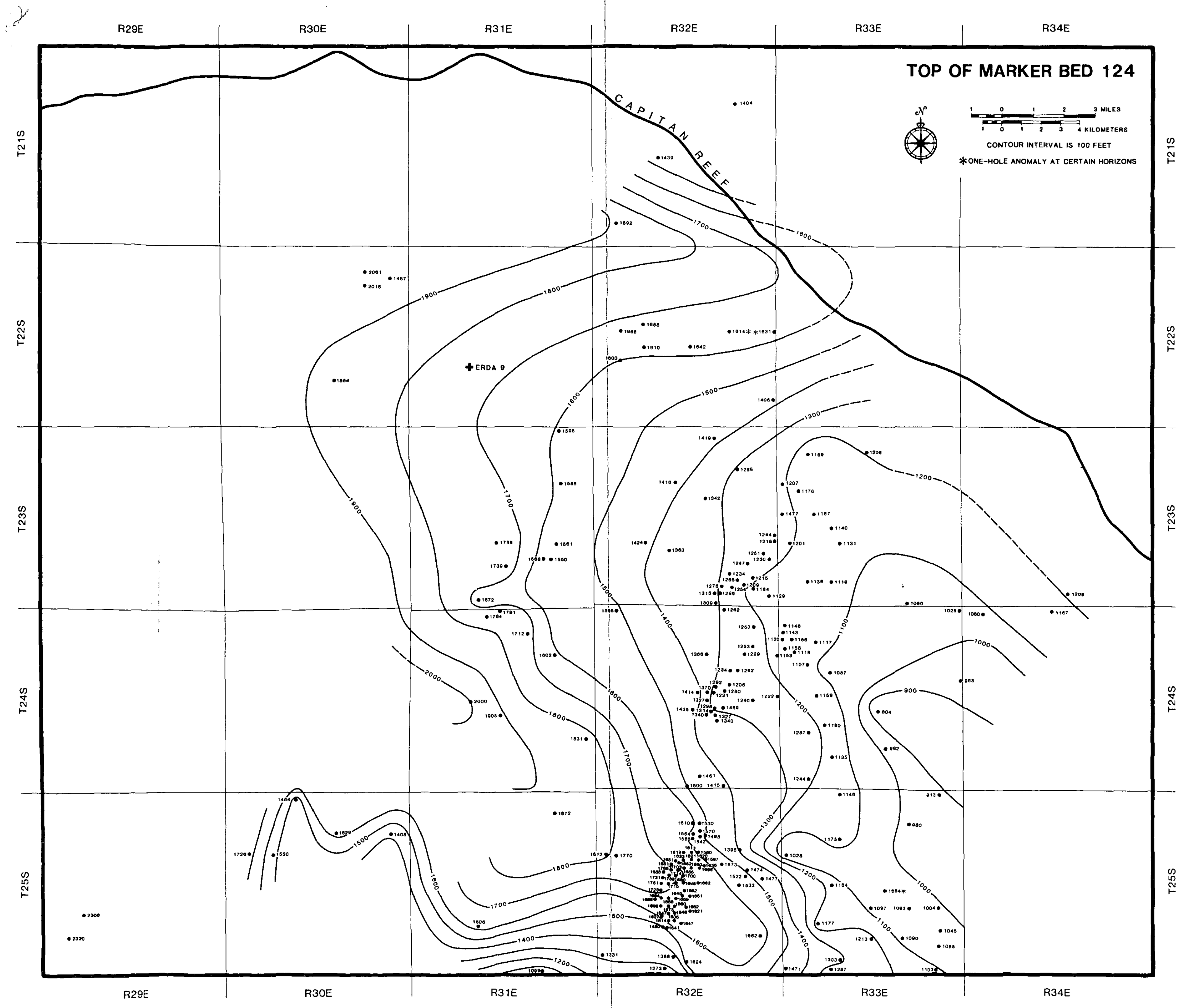


Figure 5. Top of Marker Bed 124 (Elevation above MSL in feet)

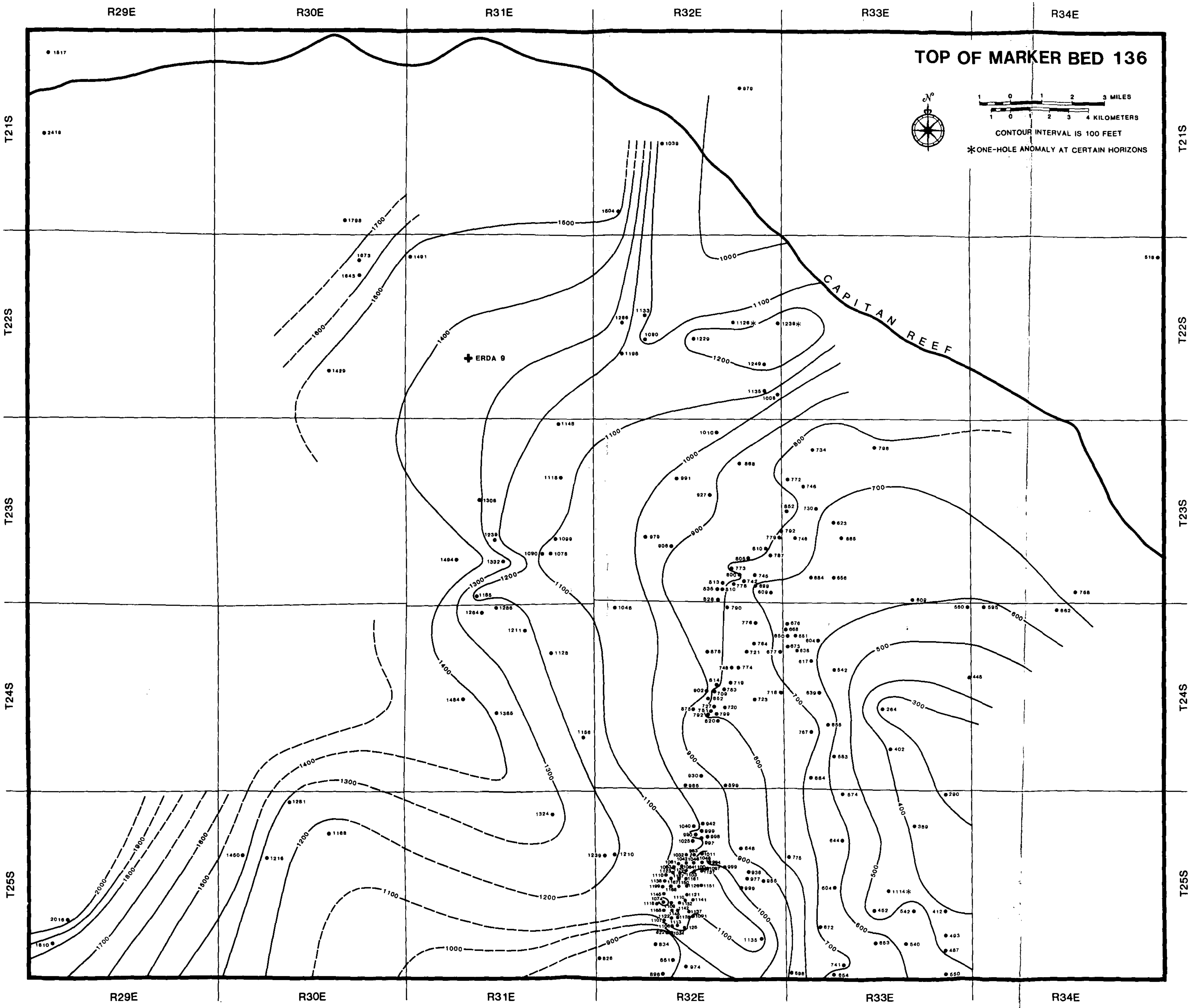


Figure 6. Top of Marker Bed 136 (Elevation above MSL in feet)

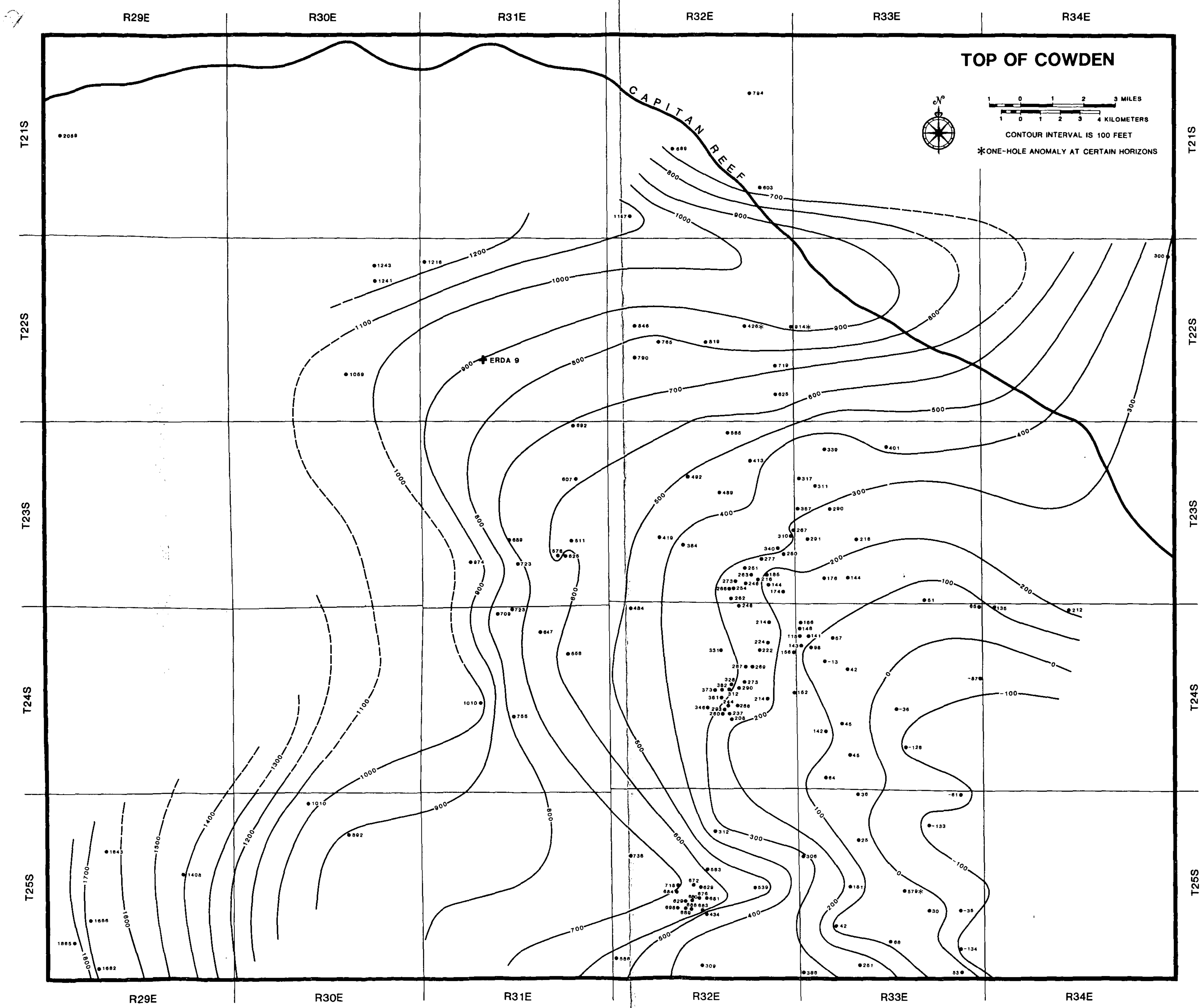


Figure 7. Top of Cowden (Elevation above MSL in feet)

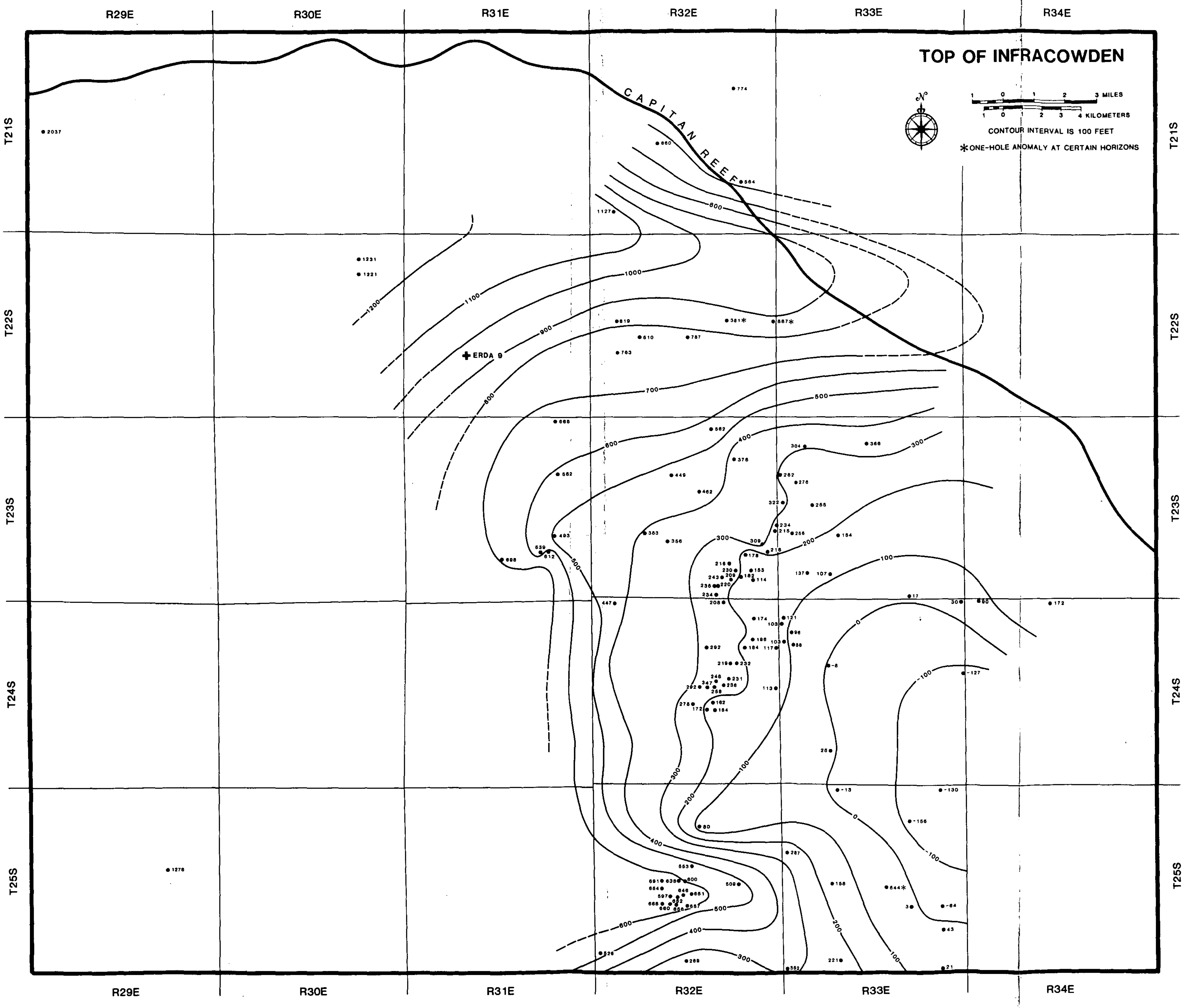


Figure 8. Top of Infra-Cowden (Elevation above MSL in feet)

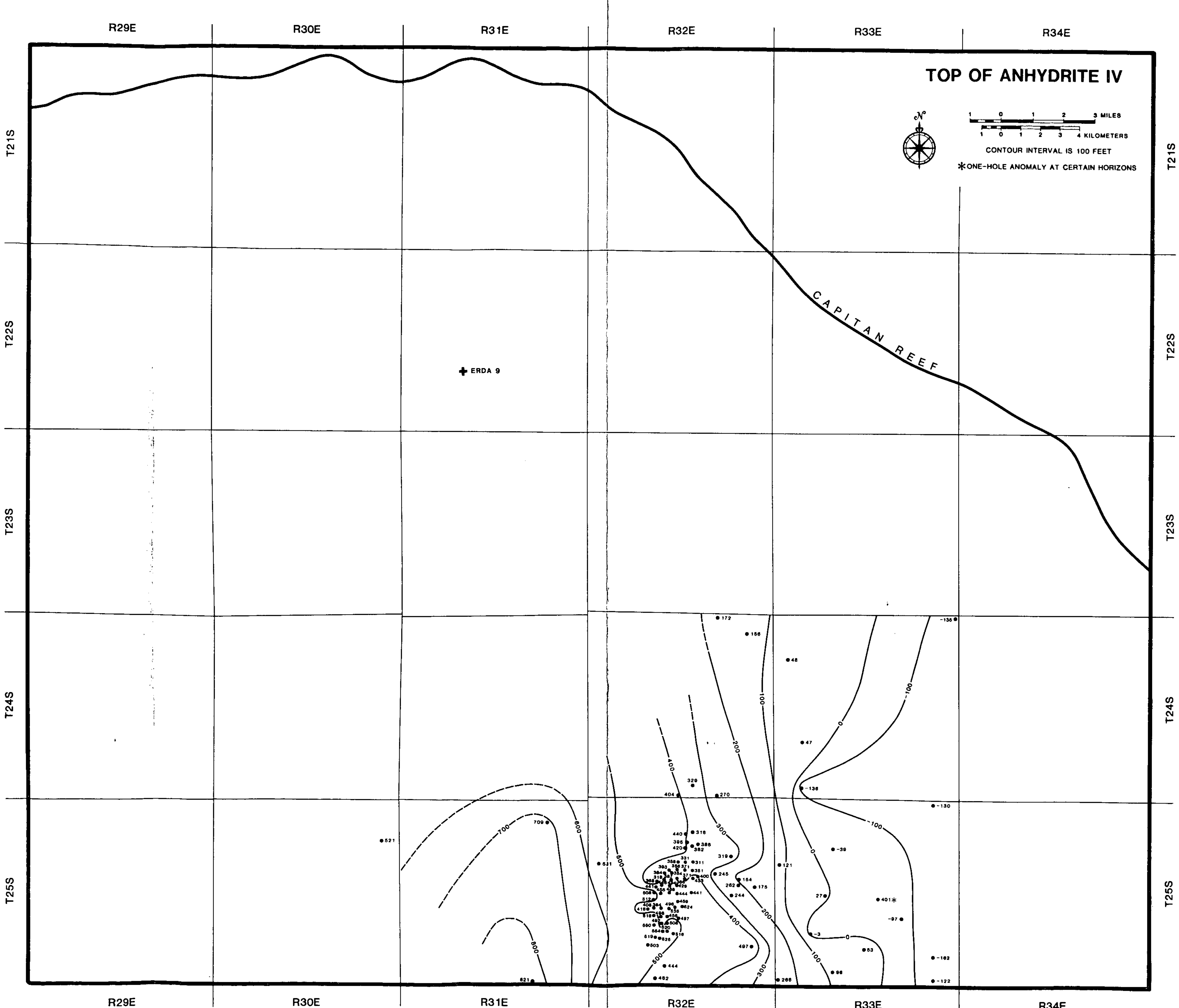


Figure 9. Top of Anhydrite IV (Elevation above MSL in feet)

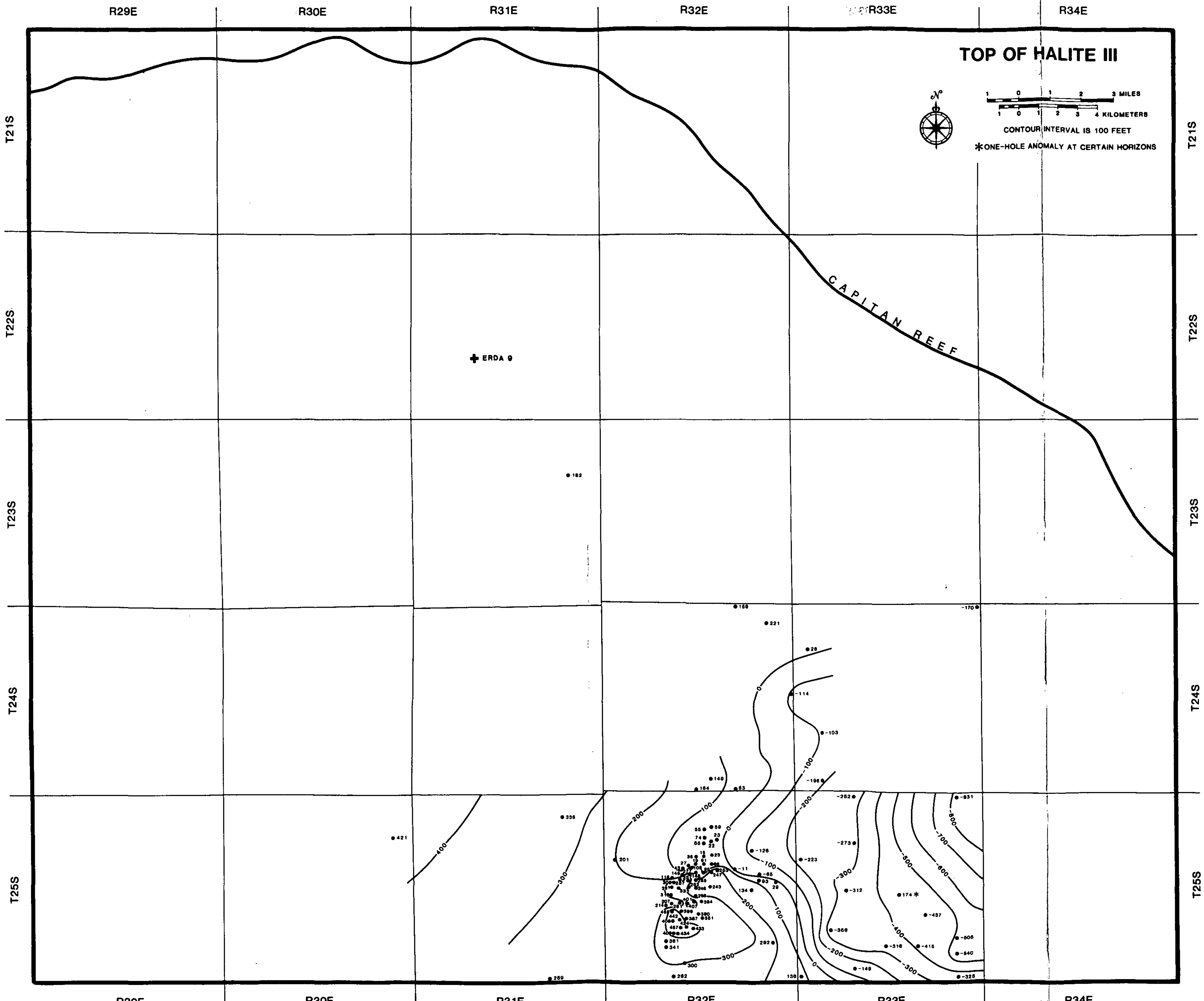


Figure 10. Top of Halite III (Elevation above MSL in feet)

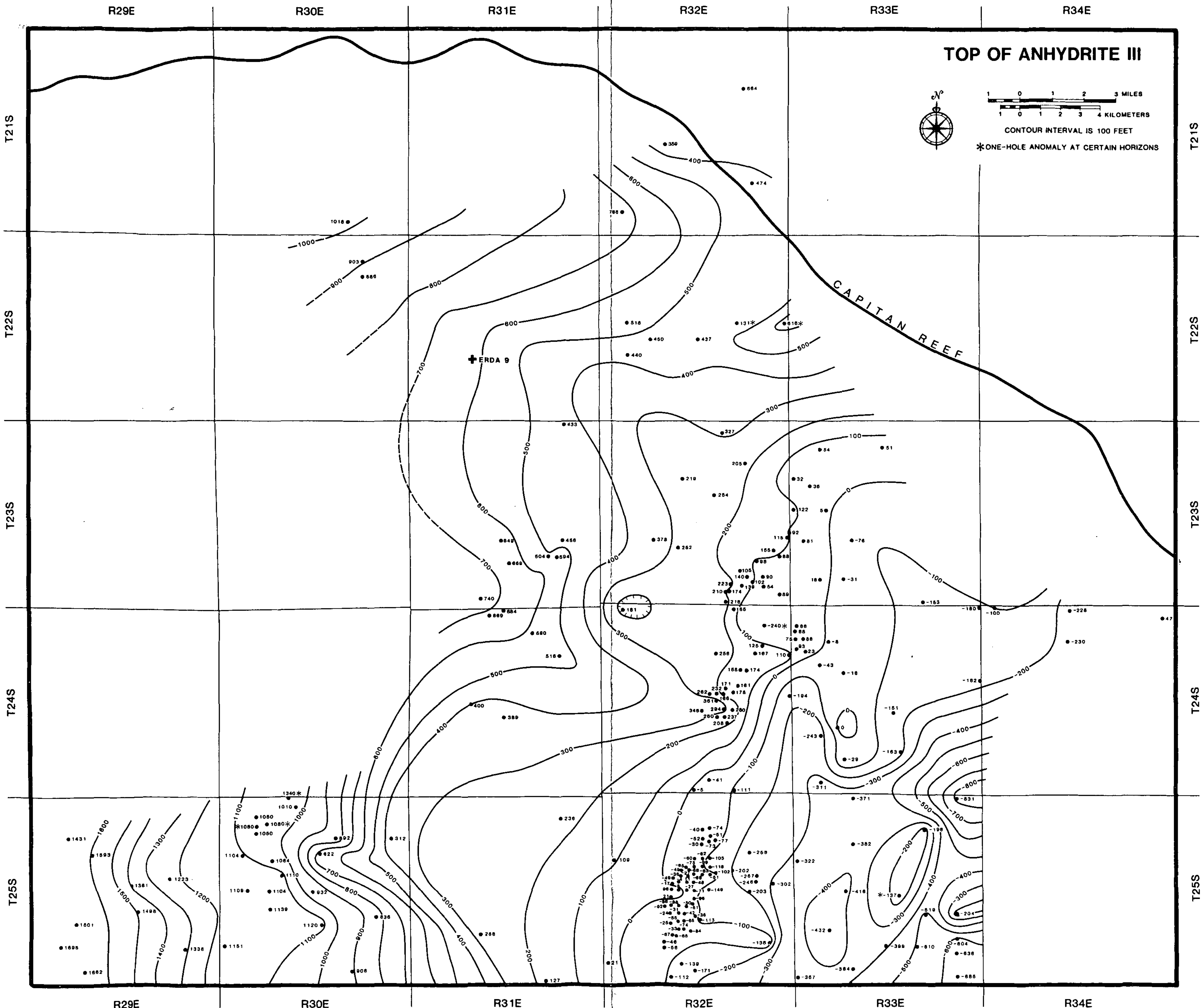


Figure 11. Top of Anhydrite III (Elevation above MSL in feet)

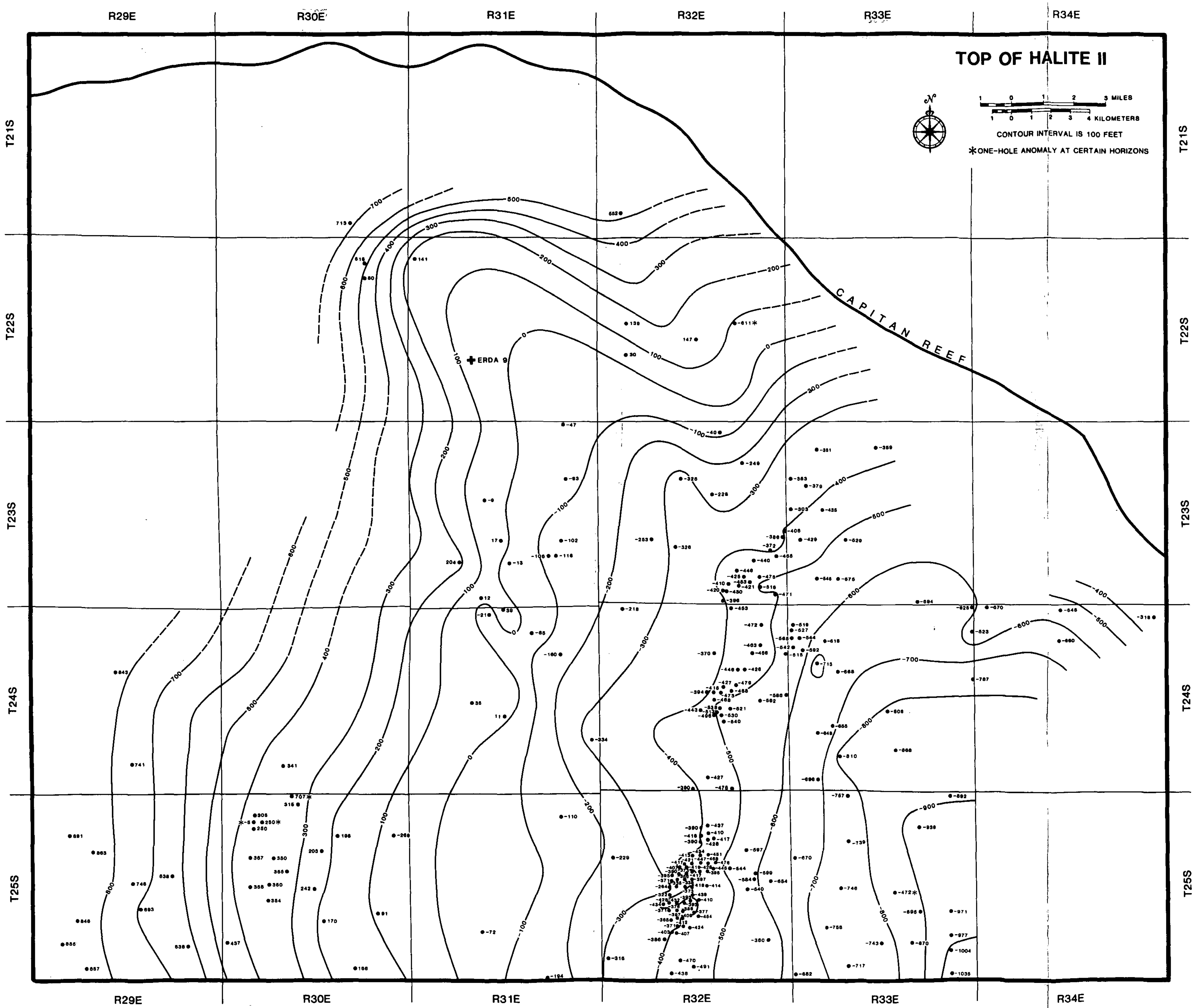


Figure 12. Top of Halite II (Elevation above MSL in feet)

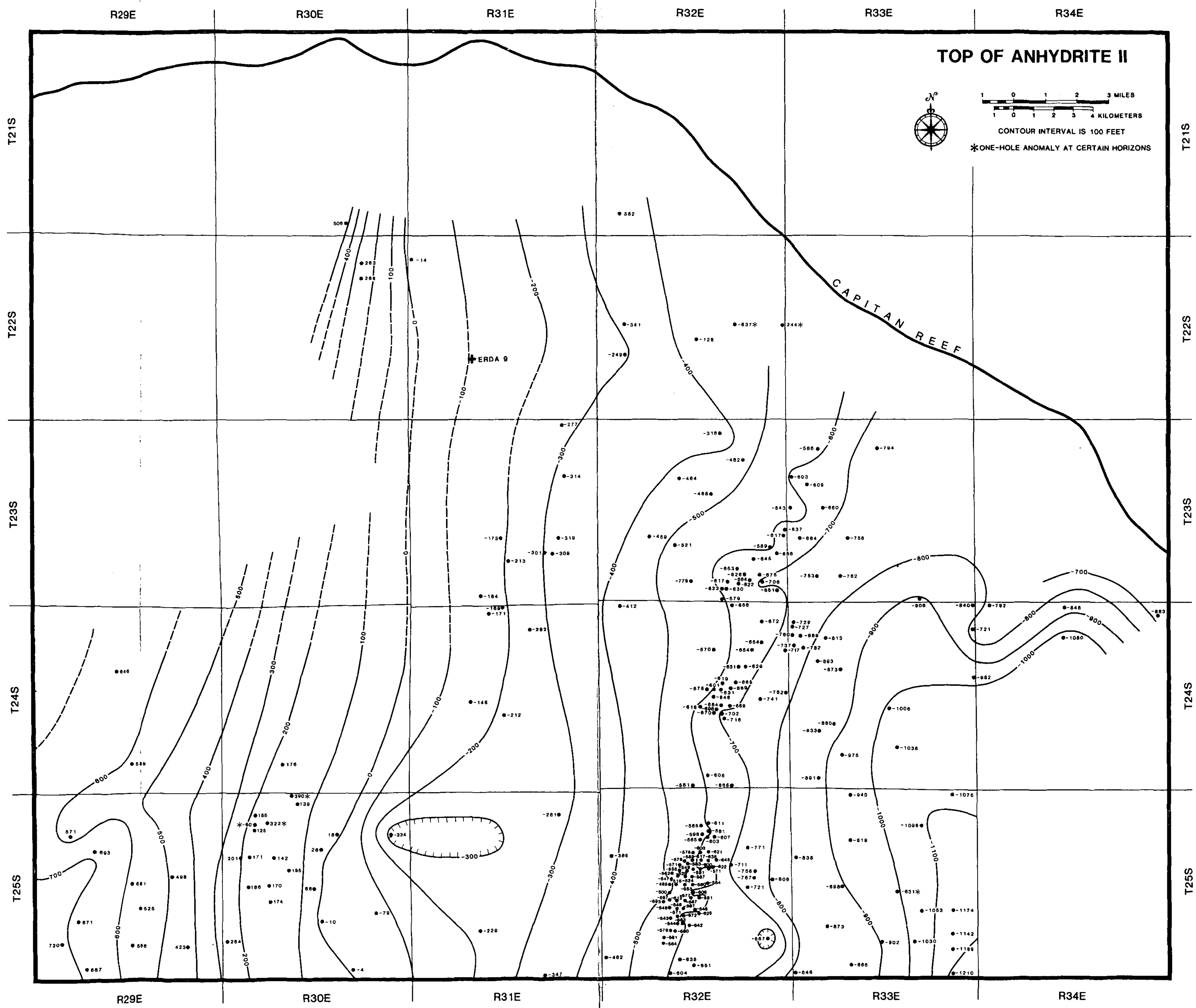


Figure 13. Top of Anhydrite II (Elevation above MSL in feet)

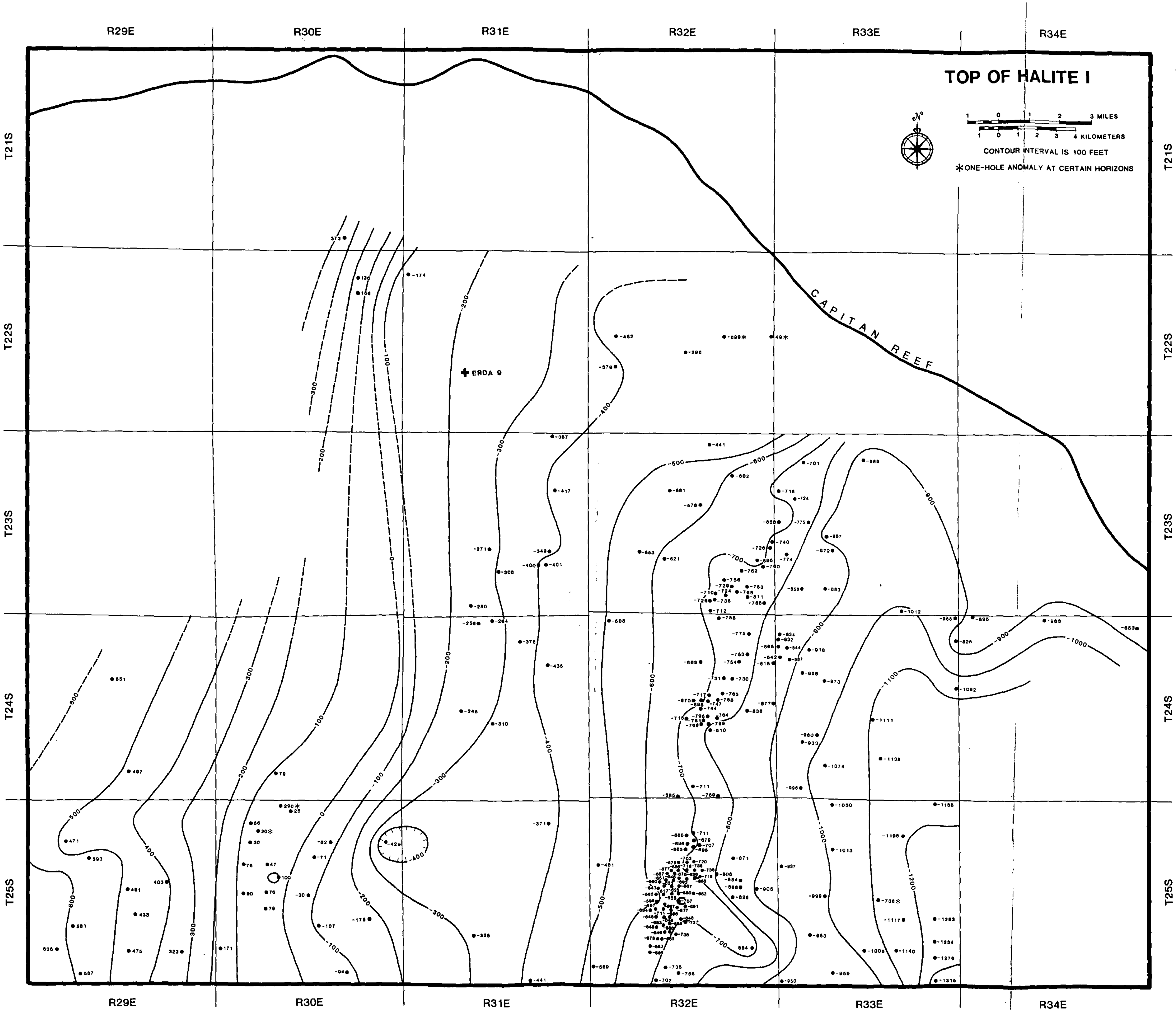


Figure 14. Top of Halite I (Elevation above MSL in feet)

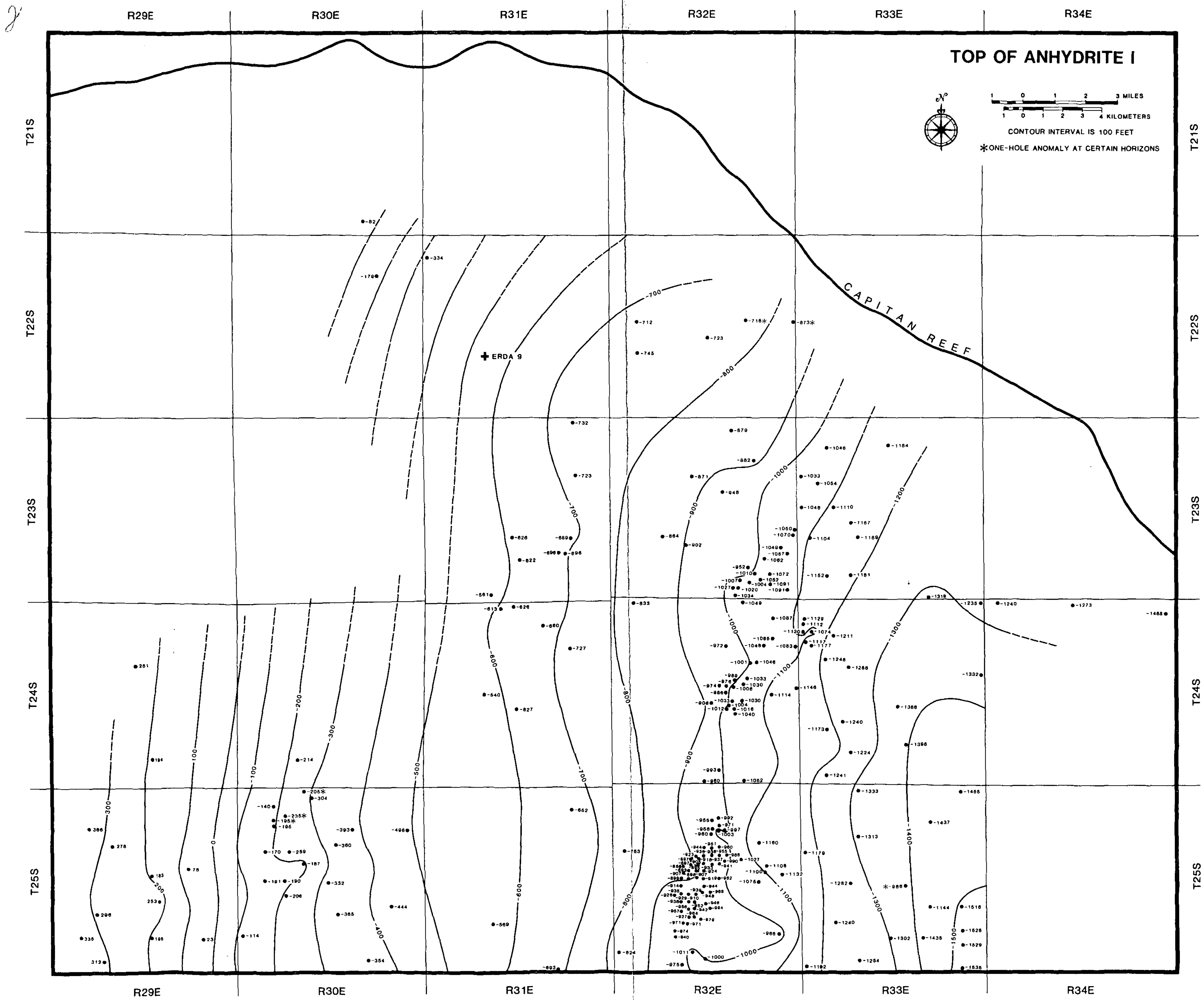


Figure 15. Top of Anhydrite I (Elevation above MSL in feet)

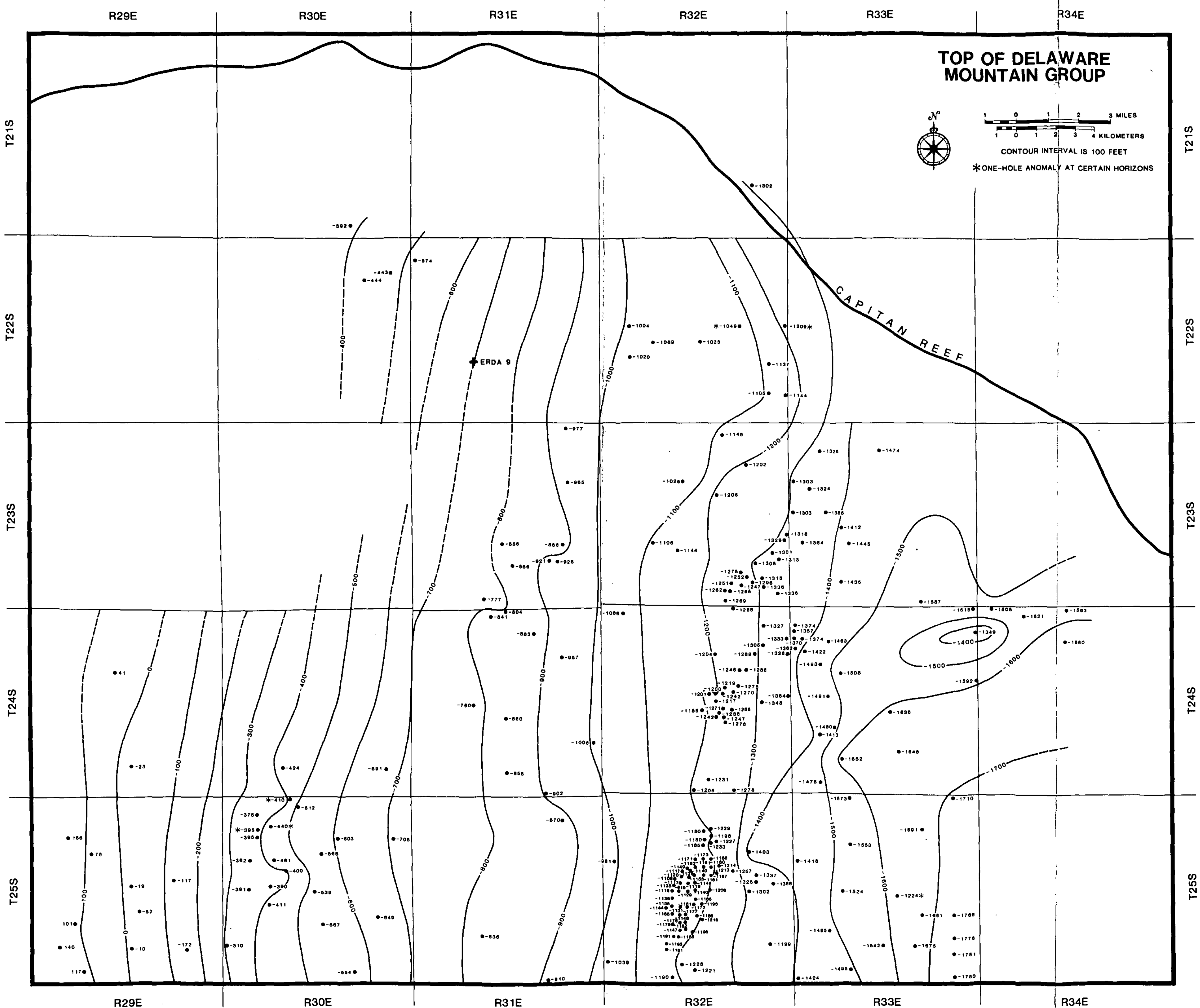


Figure 16. Top of Delaware Mountain Group (Elevation above MSL in feet)

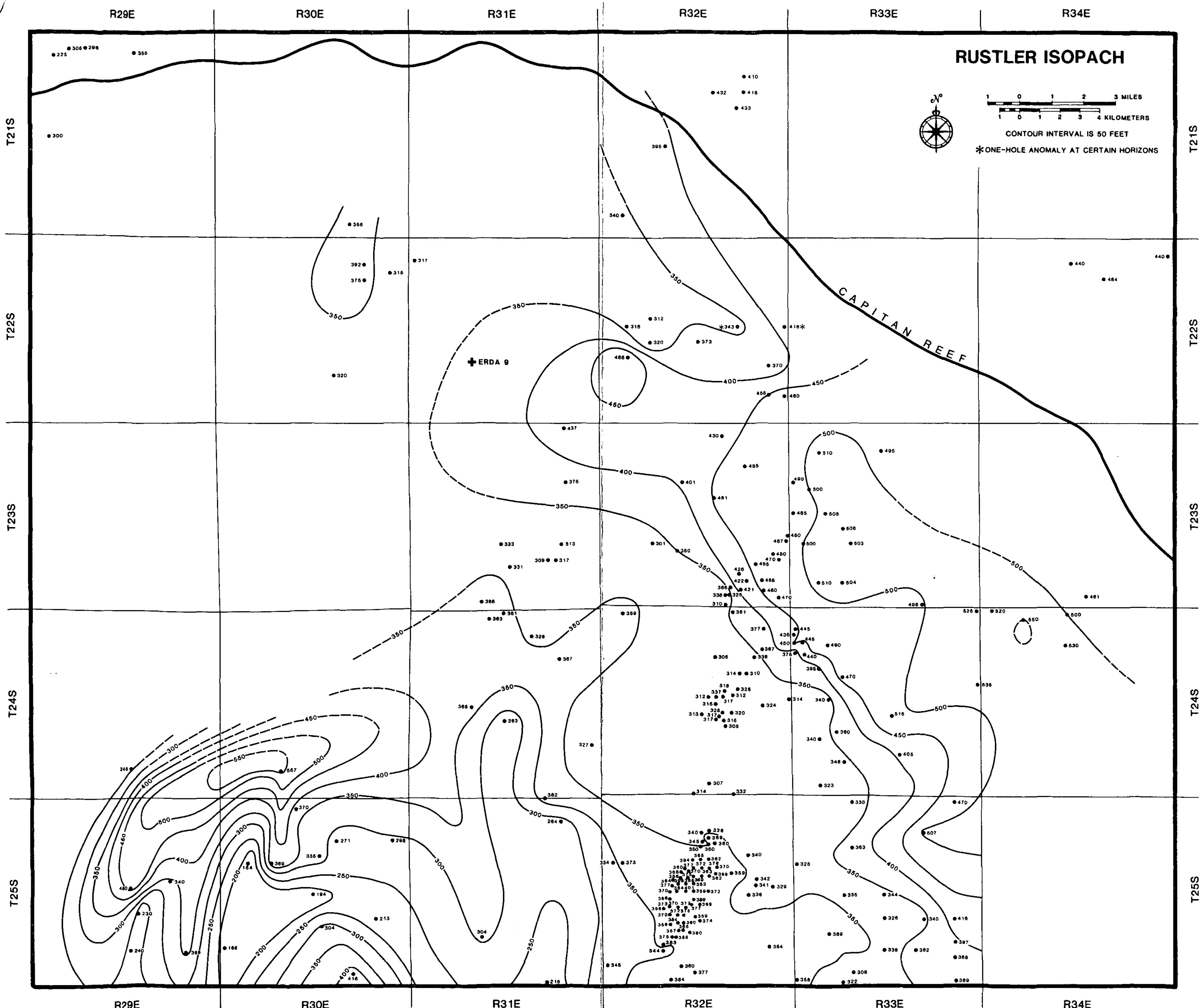


Figure 17. Rustler Isopach (Elevation above MSL in feet)

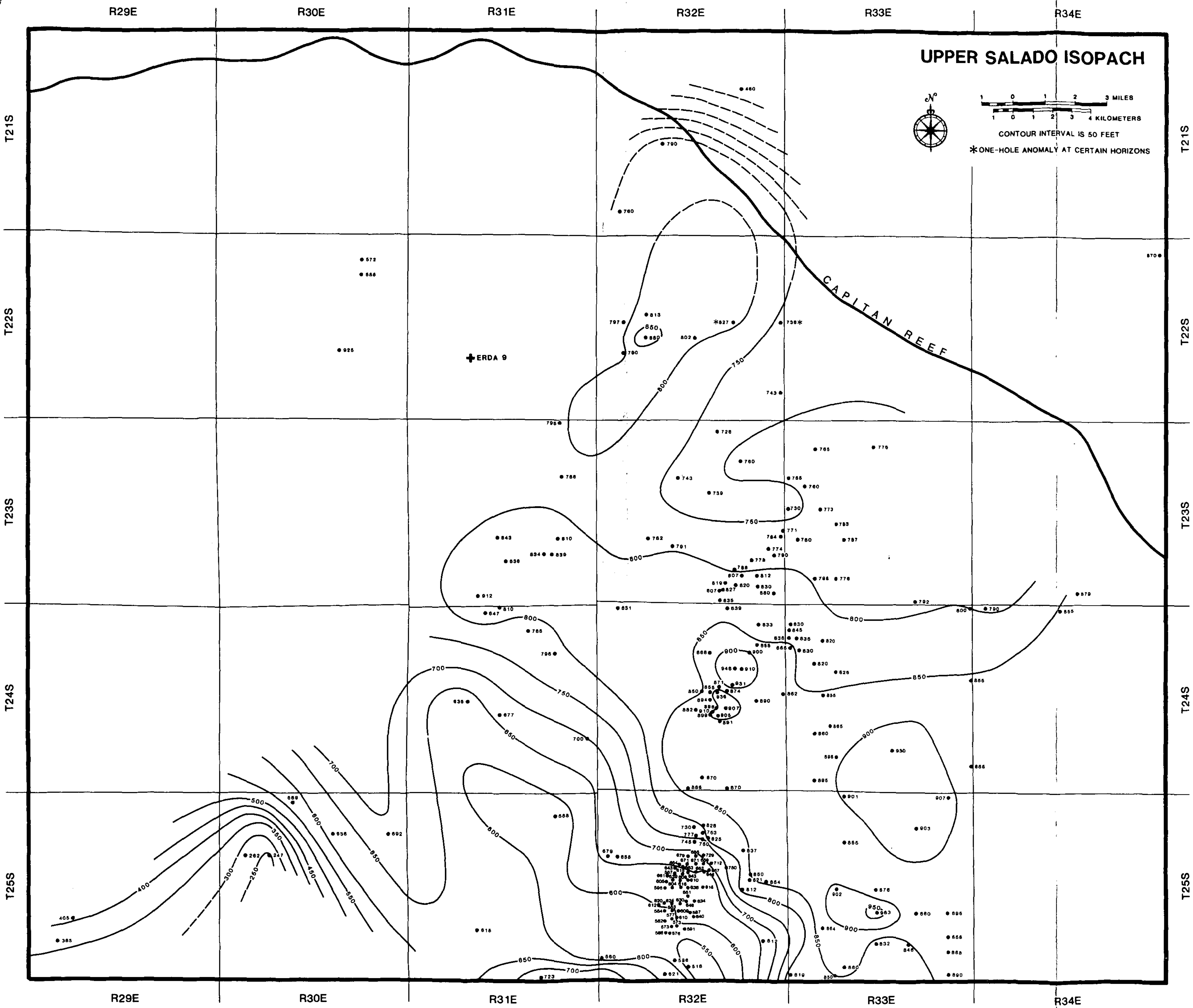


Figure 18. Upper Salado Isopach (Elevation above MSL in feet)

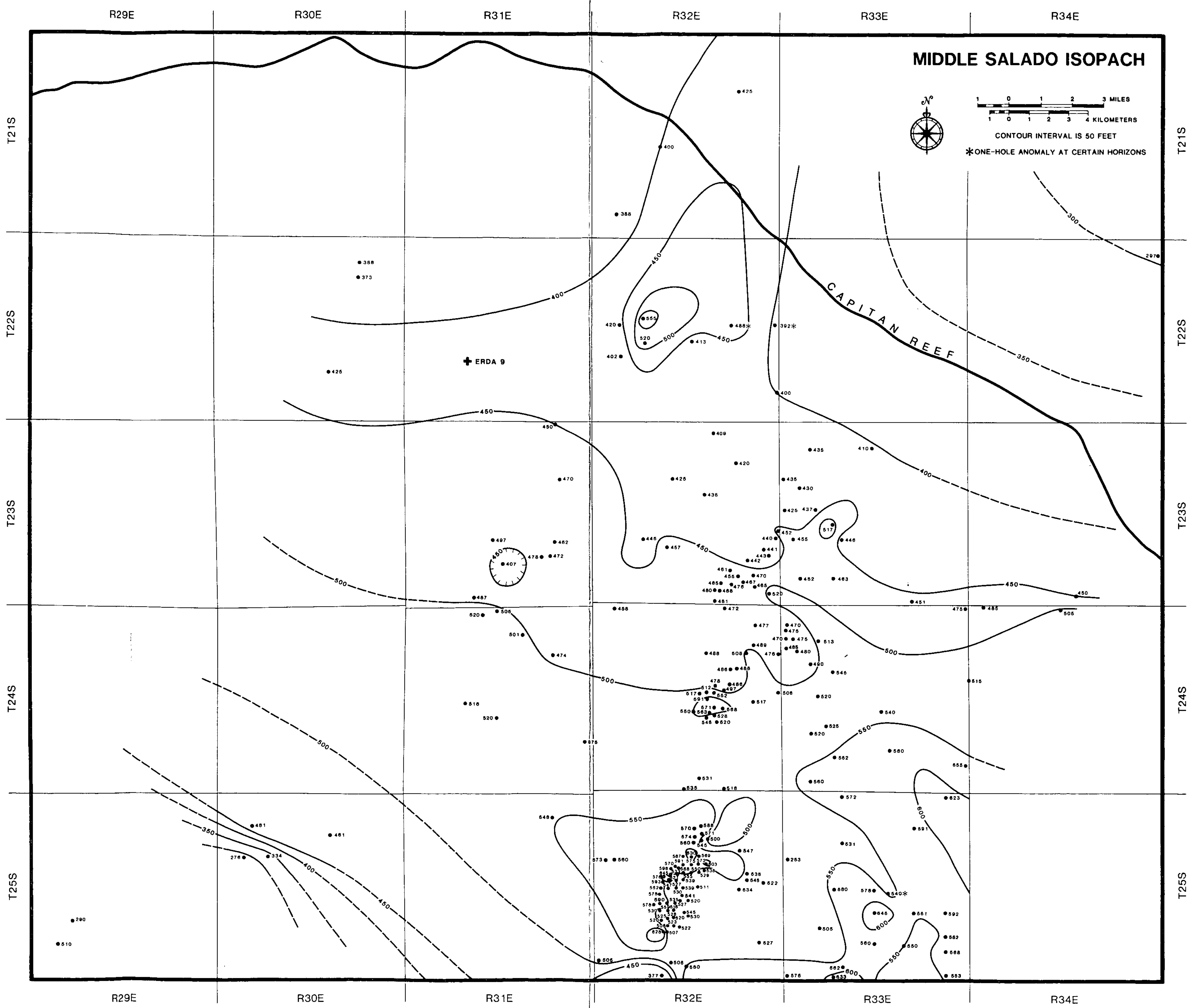


Figure 19. Middle Salado Isopach (Elevation above MSL in feet)

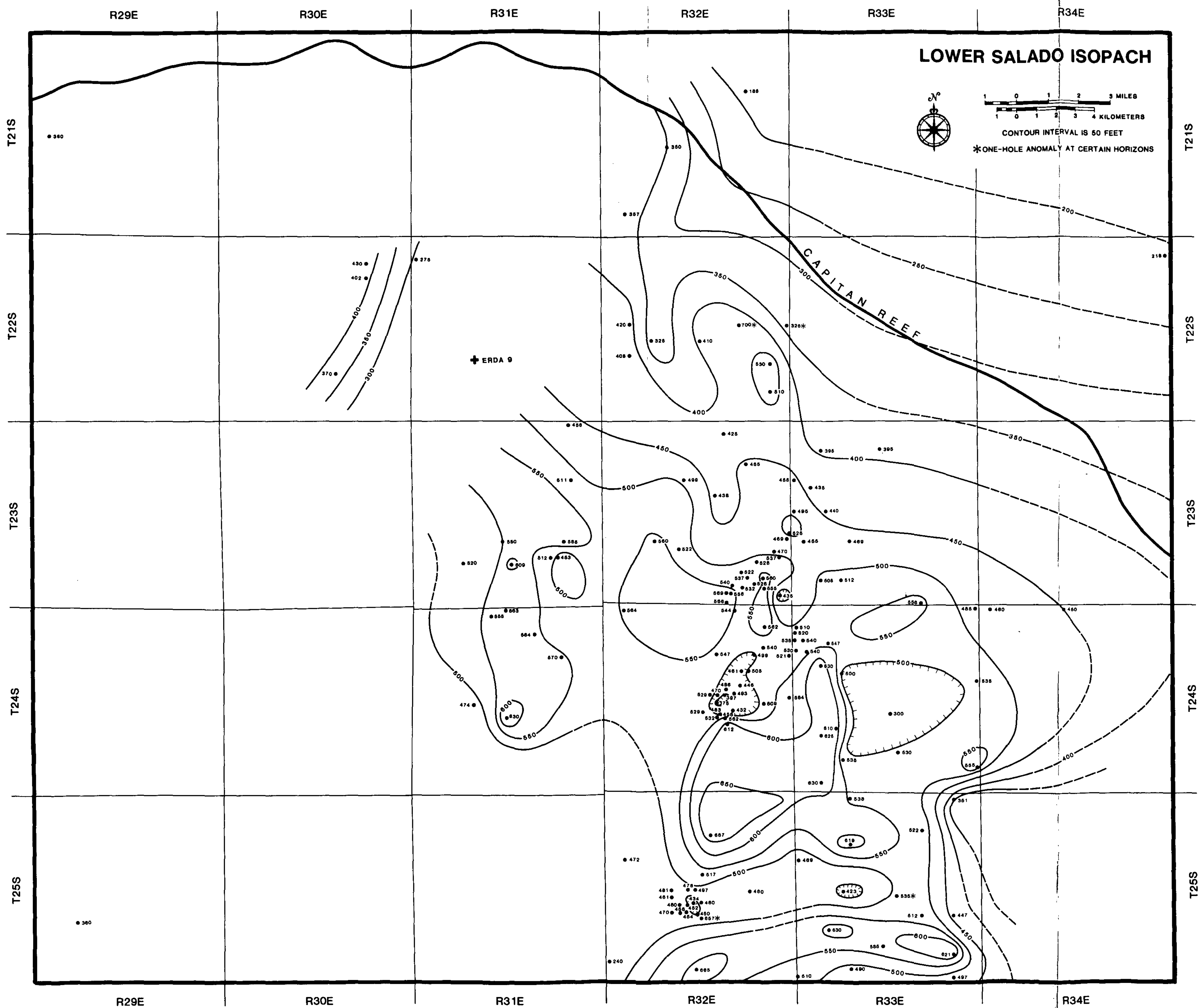


Figure 20. Lower Salado Isopach (Elevation above MSL in feet)

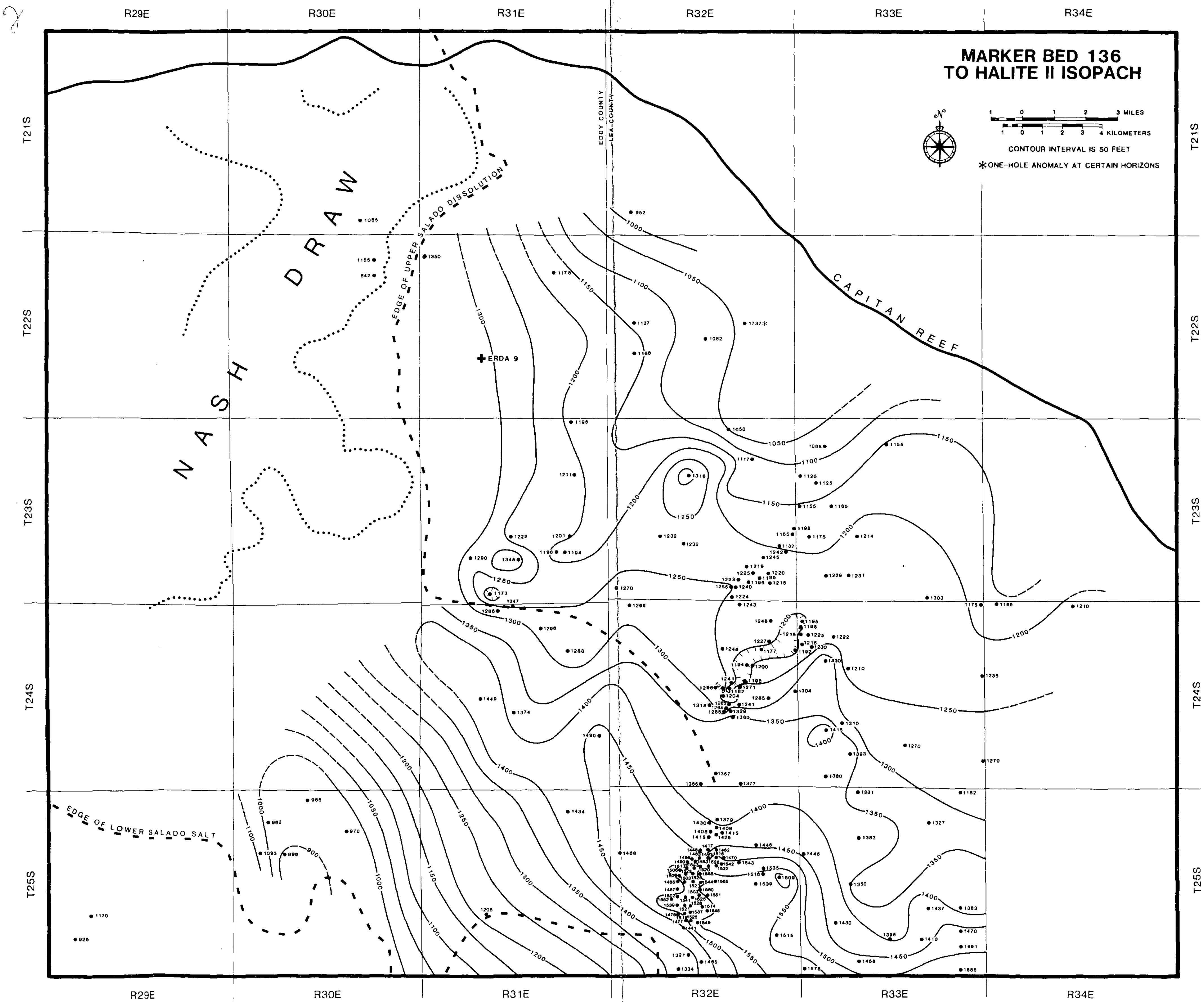


Figure 21. Marker Bed 136 to Halite II Isopach (Elevation above MSL in feet)

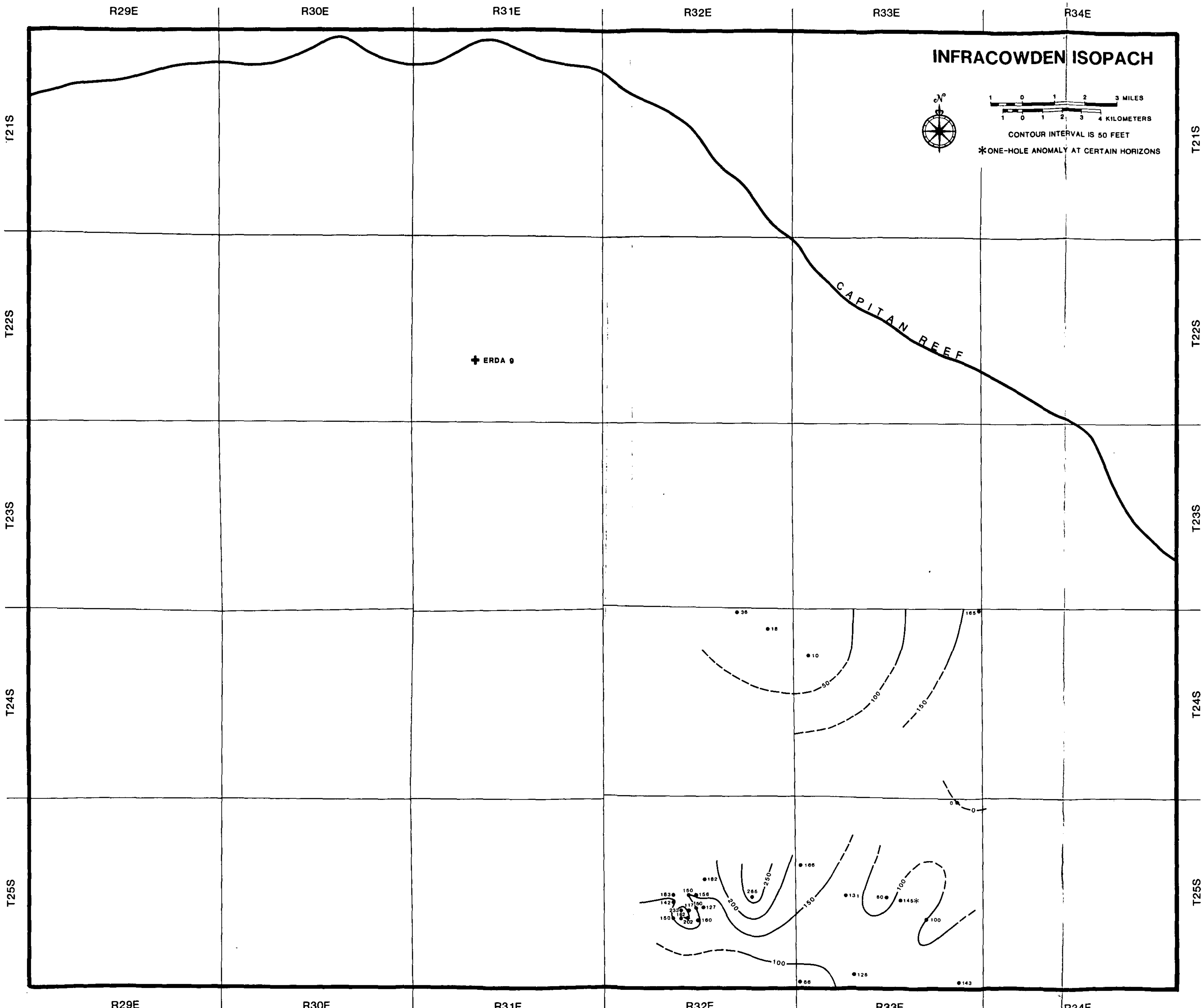


Figure 22. Infra-Cowden Isopach (Elevation above MSL in feet)

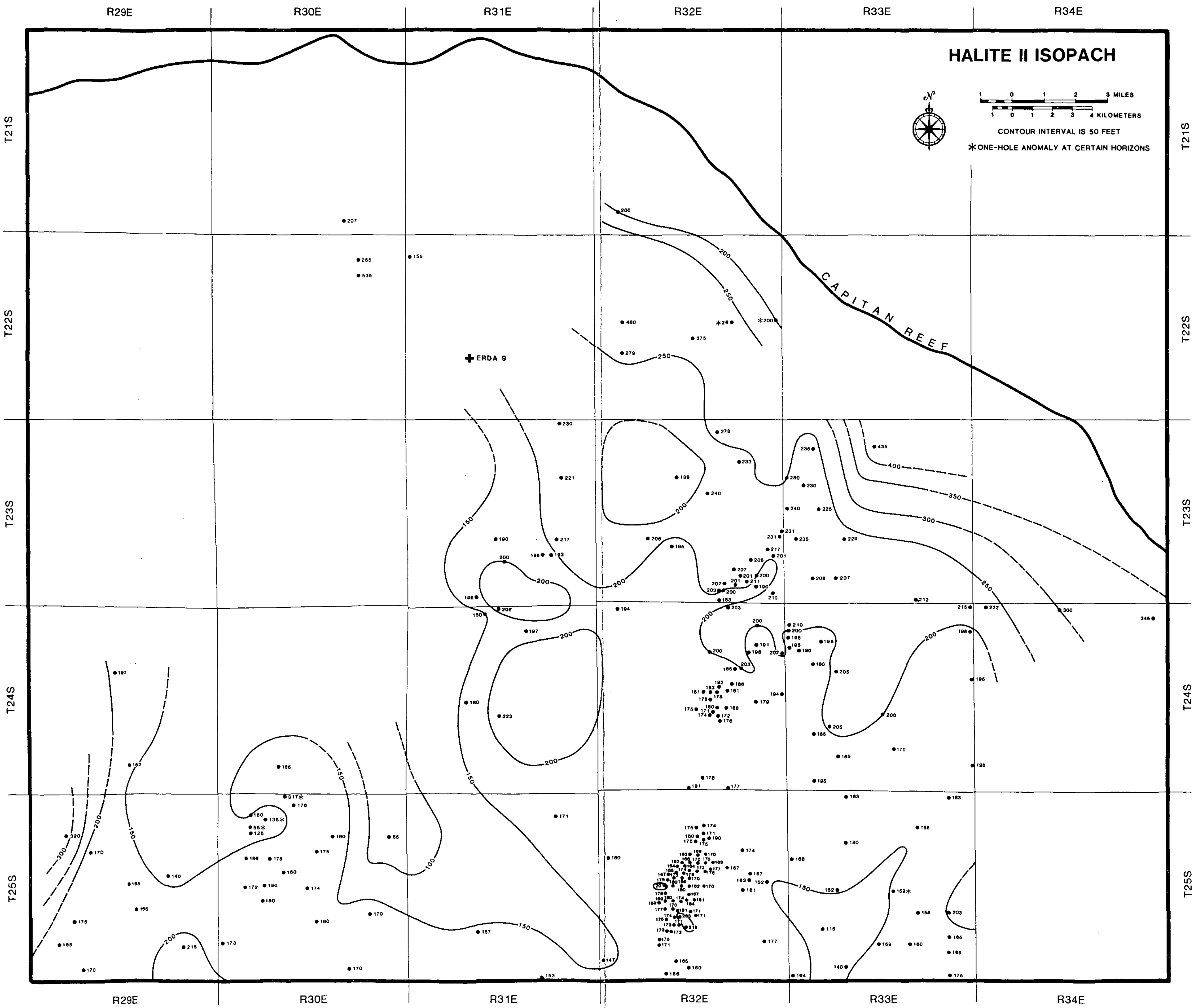


Figure 23. Halite II Isopach (Elevation above MSL in feet)

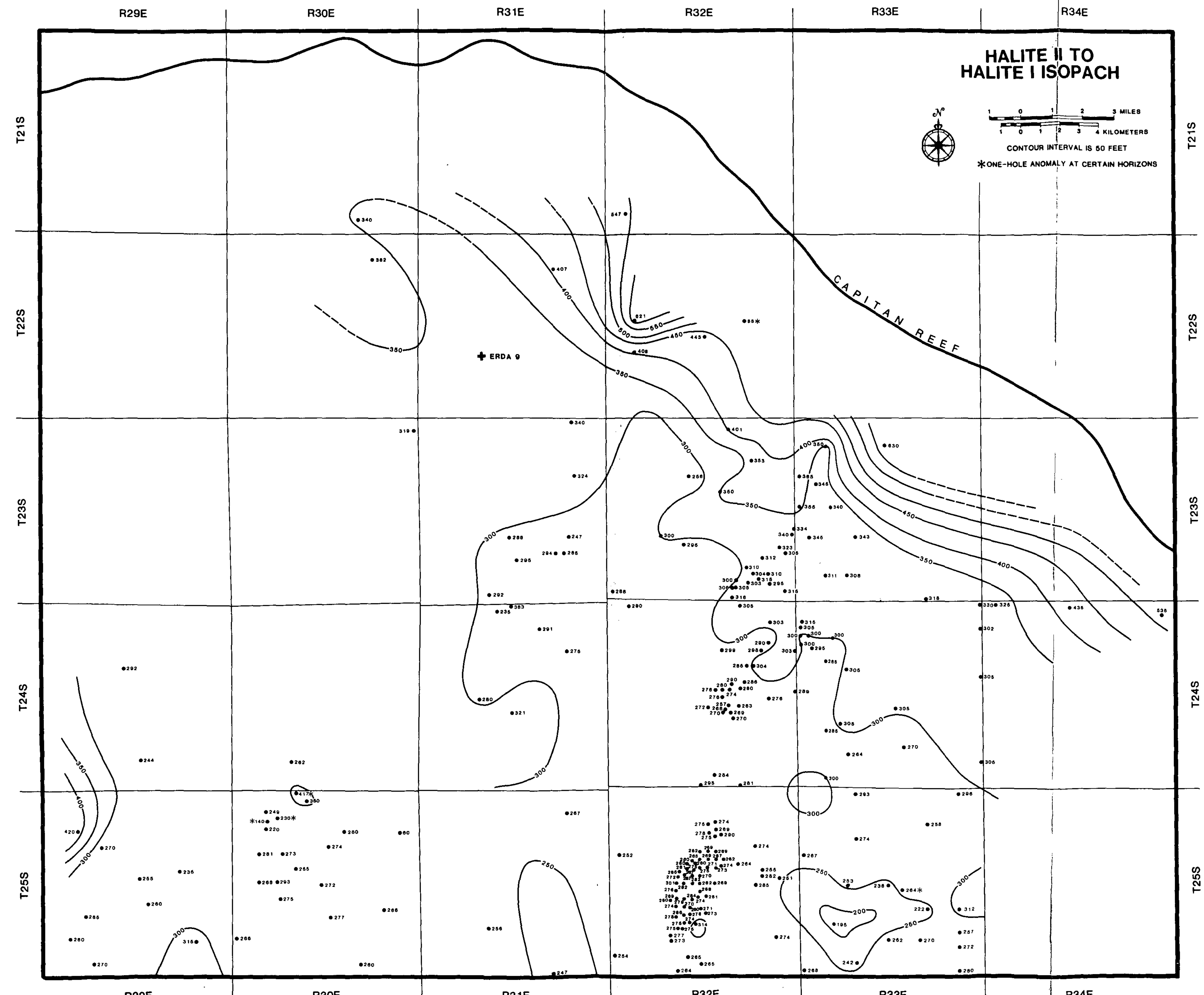


Figure 24. Halite II to Halite I Isopach (Elevation above MSL in feet)

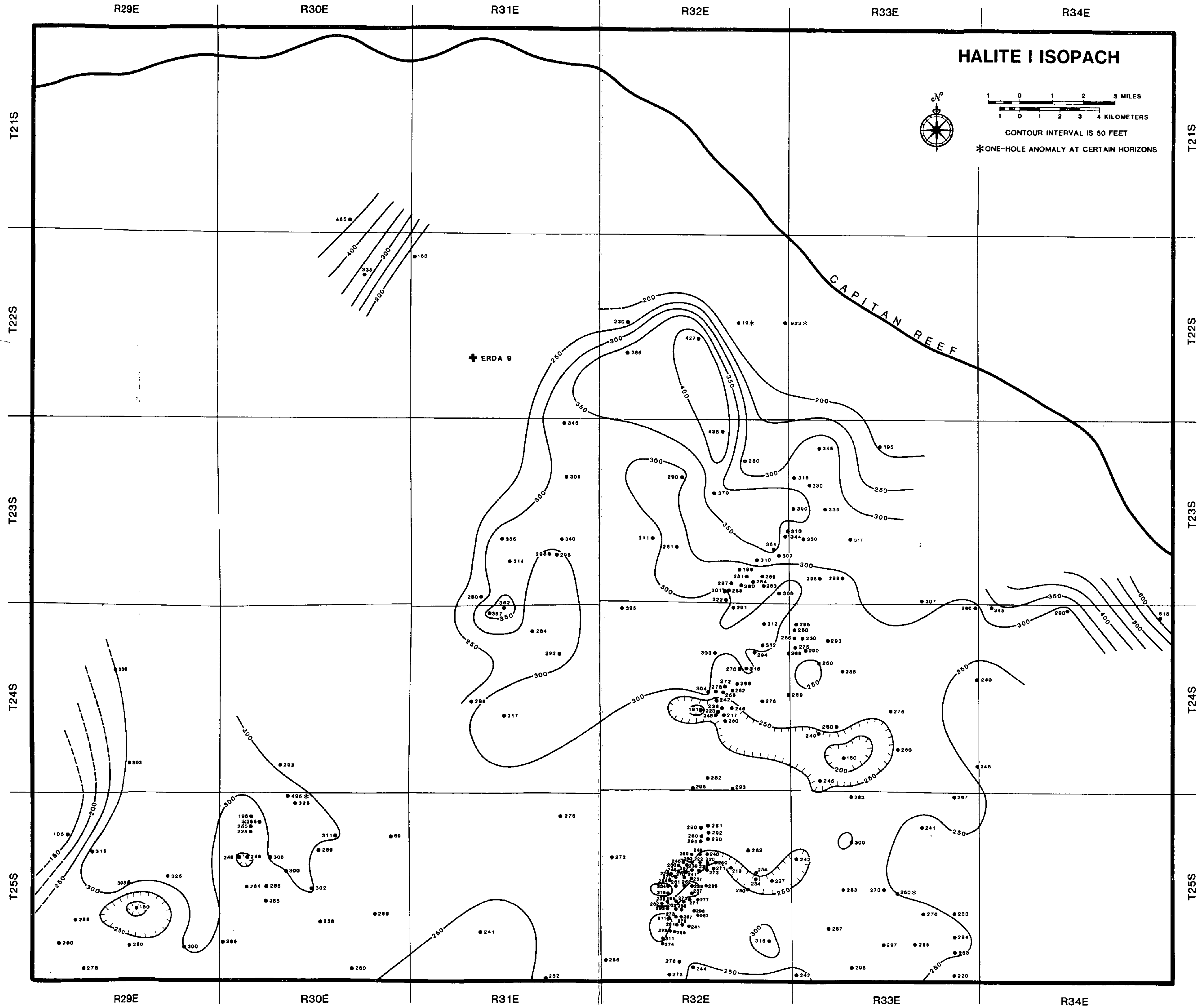


Figure 25. Halite I Isopach (Elevation above MSL in feet)

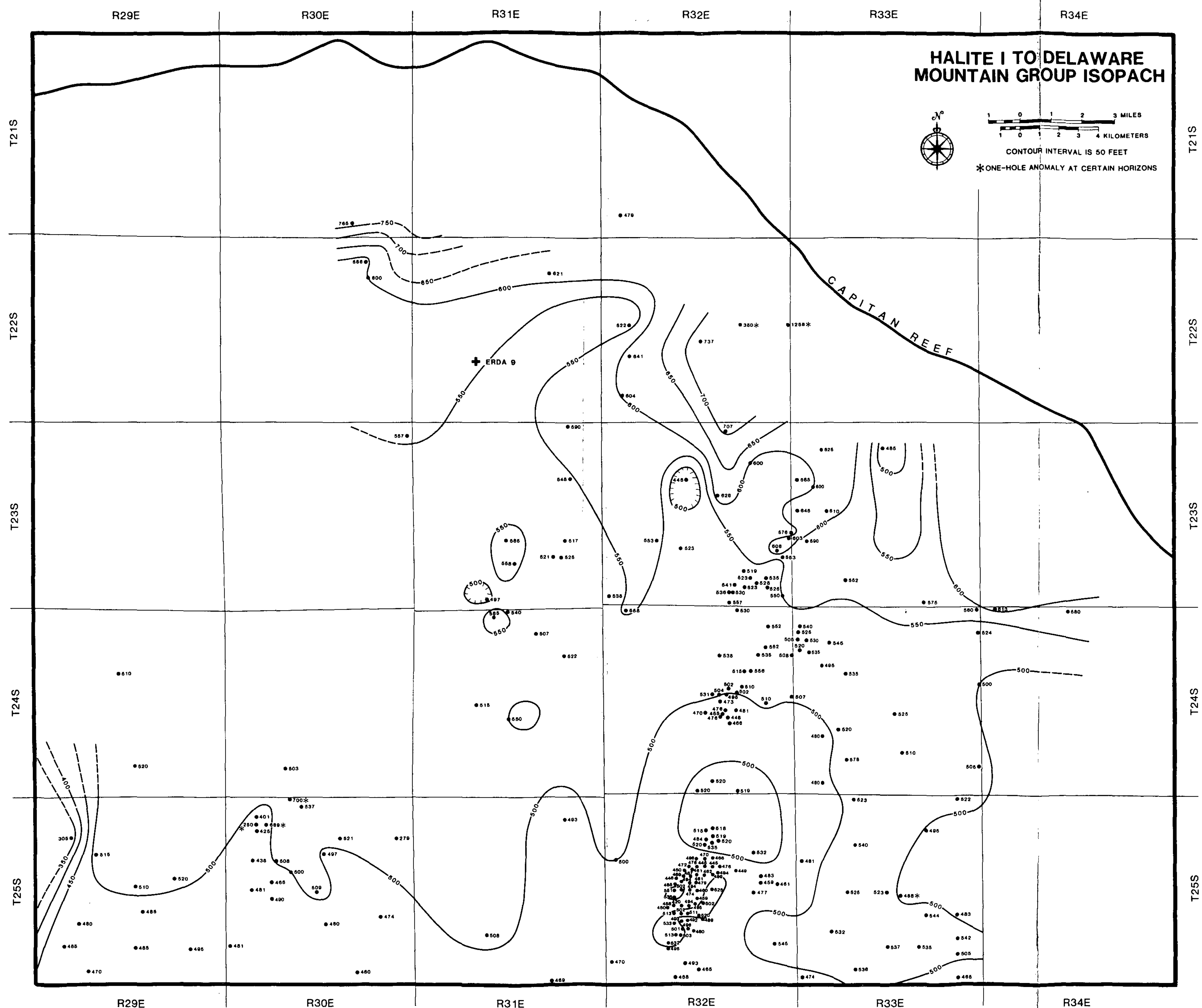


Figure 26. Halite I to Delaware Mountain Group Isopach (Elevation above MSL in feet)

Methods and Problems of Log Correlation

A file of well-location symbols, each with an associated identification text, was constructed on an Applicon Graphics System. Well locations were digitized from well ownership maps published by the Midland Map Company. The selected wells were marked on the maps and individually identified by unique seven-character identifiers. An example identifier is PO8,2533 in which the well name is identified by a letter (PO8,2533) and in which the section (PO8,2533), the township (PO8,2533), and range (PO8,2533) for the hole are numerically identified. The alphabetic prefix is a letter taken from the name of the well that uniquely identifies a given well in a single section.

A data set of depths for stratigraphic surfaces was compiled for each hole from geophysical logs. Each data set had a field of 18 entries relating to well location and identification, as well as stratigraphic information. Appendix A is a complete printout of the data sets with wells arranged by location. The Applicon was also used to produce base maps for isopach contours and structure contours on upper surfaces of the rock units.

We considered primarily the hydrocarbon industry holes in the region. Stratigraphic correlations, based on Waste Isolation Pilot Project (WIPP)-related holes in the site area, were previously reported by Griswold (1977) and Snyder (Chap. 2 in Borns et al, 1983). We used well logs from ERDA 9 on which the WIPP site is centered as a reference log for stratigraphic picks in the Salado, which was completely cored in ERDA 9.

Many of the boreholes in the Delaware Basin were not logged in the upper 4000 ft of the section, since economically significant oil and gas are not found in this interval of interest for our study. Thus many of the available logs do not include sections above the Delaware Mountain Group (DMG). Other logs were discarded because of uncertainty as to the true location of the borehole, or because the record was obscured by noise. In the end, information from 276 wells was used (Figure 1).

There are several important components of log correlation. One component is determining a characteristic geophysical signature for the ideal stratigraphic section. A second component is applying the ideal log signature to more ambiguous log signatures and, in turn, determining the limits to picking stratigraphic markers from the logs. A third component is recognizing significant departures in the local stratigraphy or in its geophysical signature. Both types of departure may confuse the process of log correlation. In the following, we try to show how these components have affected the interpretation of logs in this study and in other studies in the region.

Ideal Well-Log Signatures

Logs can be used in two basic ways:

- To determine specific properties, such as rock type, porosity, and permeability within a single hole
- To correlate hole-to-hole the continuation of structure or rock unit.

The latter requires core data to corroborate the inferred structure or unit identity. Logs such as densilog, gamma ray, and acoustilog allow the dominant rock-forming mineral (e.g., anhydrite, halite, polyhalite or clay) to be inferred for the section of interest. A specific example is the use of the gamma-ray spike to identify the base of the Cowden Anhydrite. The question arises whether specific rock types such as dissolution breccias can be inferred from log signatures. Logs alone identify only a physical property from which to infer mineralogy. To identify a rock type, some assumptions must be made regarding the unit's mineralogy, porosity, density, etc. This can be done only with core truth, as Lambert (1983, p 75) has done by using logs from Nash Draw where dissolution is known to occur. The characteristic signature from Nash Draw is used, herein, to distinguish dissolution residues elsewhere in the basin. Even in this example the assumptions are important; e.g., that dissolution processes are similar between Nash Draw and the rest of the basin. However, other processes such as original rapid depositional oscillations in rock type may result in log patterns similar to those of a dissolution residue. Thus, the validity of any log interpretation depends on its corroboration by drill core and correlation to other logs from additional holes.

To develop a regional correlation map, a geologist needs to convert the geophysical data of well logs into stratigraphic picks. This process suffers from various degrees of subjectivity. We will begin with a discussion of ideal log signature and progress into the complications of stratigraphic picks.

The most useful logs for stratigraphic picks in the evaporite section of the Delaware Basin are Borehole Compensated Sonic (BHC) or Acoustilogs and Natural Gamma-Ray Spectrometry (NGS,or γ-log). The marked density differences between halite and anhydrite or polyhalite interbeds show up distinctly in the BHC and Acoustilogs. The γ-log can often pick up clay seams that characterize the base of certain marker beds.

Figure 27 shows the ideal well log signature on which stratigraphic picks were based in this study. Using this log signature as a basis, we made picks where possible in 276 holes for the tops of the following units: the Rustler Formation, the Salado Formation, Marker Bed 124, Marker Bed 136, the Cowden Anhydrite, the Infra-Cowden Halite, Anhydrite IV, Halite III, Anhydrite III, Halite II, Anhydrite II, Halite I, Anhydrite I, and the Bell Canyon Formation.

Ideal Versus Ambiguous Logs

The information obtainable from a log can vary greatly due to whether the log is characterized as ideal or ambiguous. Examples of ideal and ambiguous logs are shown in Figures 28 and 29: Figure 28 shows the Rustler, Salado, and uppermost Castile Formations in an ideal log (ERDA 9) and two ambiguous logs; Figure 29 depicts the lowermost Salado, the Castile Formation, and the upper Bell Canyon in an ideal log and an ambiguous log. (An ideal log is legible and displays the expected signature of the ideal stratigraphy. Ambiguous logs may be too noisy, such as when the sensitivity is too high.) Some of the available logs have been taken through the casing of the well, diminishing the reliability of lithologic information. Departures from the ideal stratigraphy make stratigraphic picks uncertain in ambiguous logs. The problems of ambiguity are discussed in sections below.

In our specific examples of ideal and ambiguous logs (Figures 28 and 29), the ideal log comes from the ERDA 9 borehole, which is substantiated by a drill core. Marker Bed 124 shows its characteristic signature (a double spike) in the ERDA 9 log. In the ambiguous logs, a double peak is not distinct. Lower in the section, the Cowden Anhydrite takes a typical shape in the ERDA 9 density log, accompanied by the characteristic gamma log spike at its base. In the ambiguous logs, the density or acoustilog signature of the Cowden is not identifiable; any pick, if it can be made, is based on a gamma log spike. An ideal log from ERDA 9 is on the left of the figure. (Stratigraphic units in the Rustler, Salado, and uppermost Castile Formations are distinct in the ERDA 9 logs. However, in the well logs from the two holes that are represented in the center and on the right side of this figure, the same stratigraphic indicators are indistinct over the same depth interval.)

Log-Correlation Error

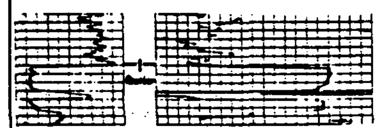
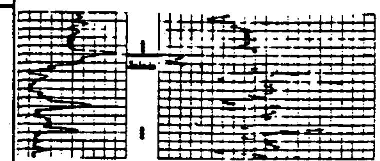
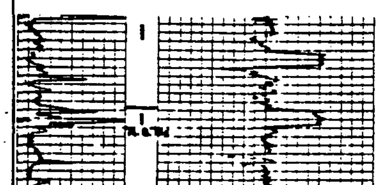
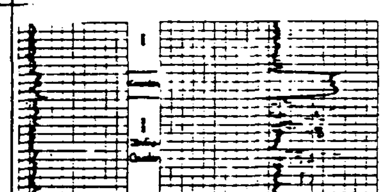
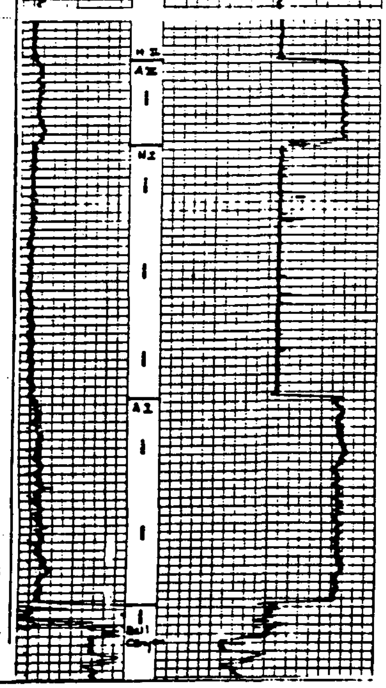
It is difficult to assess the amount of error incorporated in log correlation and the stratigraphic picks in one well log. To our knowledge, no systematic study has been made of the reliability and reproducibility of interpretations of stratigraphy and correlations thereof between wells. The data used in reports such as this are the products of human inference; hence, errors are individualistic and not systematic. Other possible errors are in the original well data. Examples are in the elevation of the hole; location, whether ground level or, the Kelly-bushing is used as the base level, and deviation of the hole from vertical. Barring total mislabeling of the log, such errors are not significant for the maps in this report since the contour intervals, whether 50′ or 100′, are larger than the possible error.

Basic Assumptions of Stratigraphic Picks

Important theories for stratigraphic anomalies in the evaporite sequence in the northern Delaware Basin have originated from log interpretation and correlation. Namely, Anderson (1978) and Davies (1983) postulated deep disolution from their regional deformation patterns. Snyder (in Borns et al, 1983) advanced the idea that syndepositional salt flowage was indicated by the Salado-Castile stratigraphy. Borns and Barrows (in Borns et al, 1983) proposed that gravity-driven salt flow, which is possibly ongoing, created the structures observed. In the following sections, we discuss the assumptions made in applying log data to these theories. We also examine some log data in much finer detail, e.g., single holes or arrays of closely spaced holes, than log correlation maps permit. This exercise allows us to examine the problems of one-hole anomalies and log correlation in regional interpretation. Important structures are based on stratigraphic picks from logs. Such correlation of a log-signature-lithotype to a specific stratigraphic unit is an inferential process based on certain assumptions:

- Log signatures are easy to interpret and unambiguous (see sections above and Figure 27 for discussion of the ideal log).
- All units initially exhibited lateral continuity. For example, Anderson (1983) has stated that virtually every salt bed in the upper Castile can be traced laterally with little change in thickness until it encounters the Salado-Castile unconformity.

- Stratigraphic Picks

Formation or Marker Bed	Basis for Stratigraphic Picks	Sample log*
Rustler Formation	The top of the Rustler is the 1st continuous anhydrite encountered--an increase on velocity, acoustic, or density logs is seen, and a decrease on gamma logs.	
Salado Formation	The top of the Salado registers as a sharp change from the Rustler, with an abrupt, brief increase on the gamma log and an abrupt, brief decrease in acoustic, velocity, or density logs.	
Marker Bed 124	Marker Bed 124 is the lower of two well-developed spikes; it frequently registers as a double spike itself on both gamma logs and acoustic, velocity, or density logs.	
Marker Bed 136	Marker Bed 136 generally is seen as a heavy spike with triple peaks or as a group of three spikes on acoustic, velocity, or density logs, and has a well-developed spike or spikes on the gamma log.	
Cowden Anhydrite Infracowden	The Cowden shows as a heavy spike on velocity, acoustic, or density logs, and is characterized by a small, sharp gamma peak at the base of the anhydrite.	
Castile Formation Halite-Anhydrite Sequence	The anhydrites show a regular, fairly high trace on acoustic, velocity, or density logs, and a small less regular trace on gamma logs. Halites have a regular, medium level trace, somewhat lower than anhydrites on acoustic, velocity, or density logs, and a decrease in the gamma logs as well.	
Bell Canyon Formation Delaware Mt. Group	The top of the Bell Canyon shows a sharp increase in gamma logs and a sharp decrease in acoustic, velocity, or density logs, followed by an irregular trace on the logs.	

*Sample log from Neil H. Wills Continental State No. 1, T25SR33E, S. 32, Gamma Ray and Acoustilog

Figure 27. Gamma-ray and acoustilog signatures for ideal well log from which the stratigraphic picks are unambiguous (Neil H. Wills Continental State #1, T25SR33E, S.32)

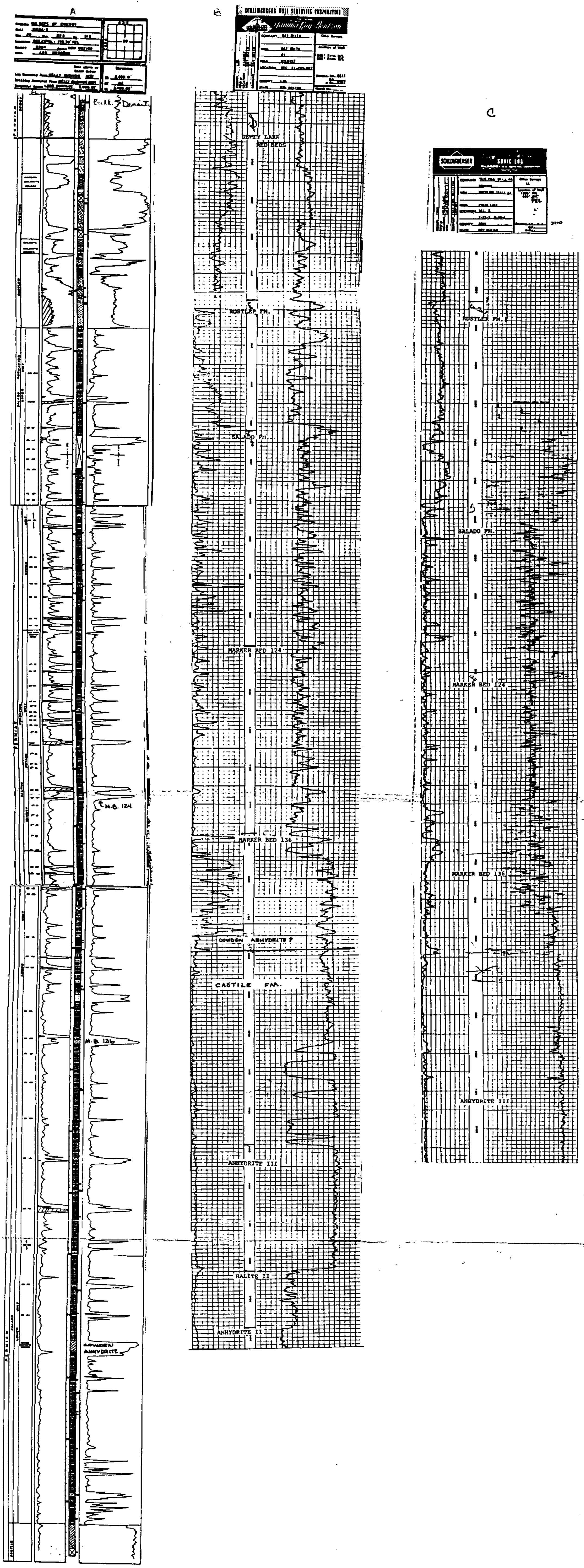


Figure 28. Comparison of ideal and nonideal well logs for the section from the Dewey Lake formation through the Salado Formation. (An ideal log from ERDA 9 is on the left.)

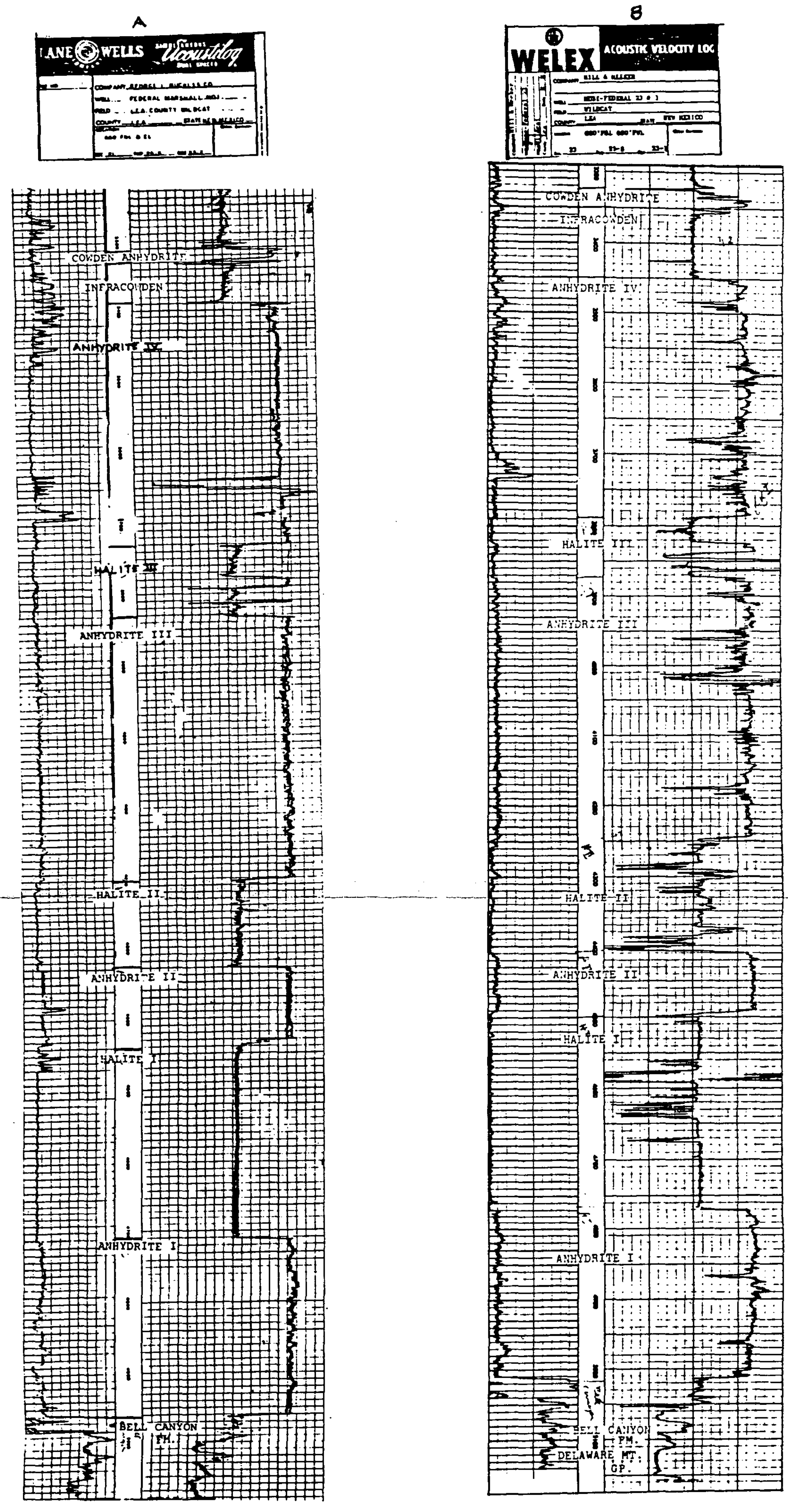


Figure 29. Comparison of ideal and nonideal logs of the lower Salado and Castile stratigraphy. (Ideal log is on the left. Stratigraphy is more complicated in the right-hand log; e.g., halite interfingers in AIII and anhydrite bed in HI.)

With regard to the first assumption, these logs are not necessarily straightforward to interpret. Such difficulties are caused either by the quality of the log or the deviation of the log signature from the ideal. These ambiguities are greatest for the Lower Salado (MB 136 and below) and Upper Castile (above Halite II). For comparison of isopachs, the approach of Lambert (1983) is recommended in which distinct markers such as MB 124 and Halite II are used.

The second basic assumption is lateral continuity of halites in the Upper Castile. This assumption precludes any syndepositional thickening and thinning and lateral facies variation (Anderson, 1981 and 1983). Thus, any observed thickening and thinning would be construed as the result of post-Permian deformation and/or dissolution. However, the inferred Poker Lake structures (see following sections) show the problems with this assumption. Within the cluster of four holes in Section 8, a thin halite bed that has been tagged in some logs as HIII can be traced at a consistent elevation but with variable thicknesses.

Poker Lake Structures

At first glance, the numerous industry exploration holes in the Delaware Basin seem to provide an excellent record for log correlation. However, the distribution of holes from which logs have been analyzed is not uniform. Of the 276 holes used in this report, large localized concentrations occur; e.g., in T25S R32E (see Figure 1). Hence, the structural detail cannot be extended with the same confidence from area to area. Early log interpretations in the Delaware Basin resulted in contour maps (e.g., Figure 4, Anderson, 1978 and Figure 30 in this report). This specific example of a Halite I isopach map is instructive. The map shows detailed contouring and a fabric that is imparted by the orientation of contour structures. However, the map detail is misleading since the synforms and antiforms are largely based on one-hole anomalies. The areal extent and fabric of the structures shown have been inferred and drawn in; the actual size of such structures needs to be carefully established. We will concentrate on the Poker Lake structures in T25S R30E to illustrate the problems of extrapolation of one-hole data.

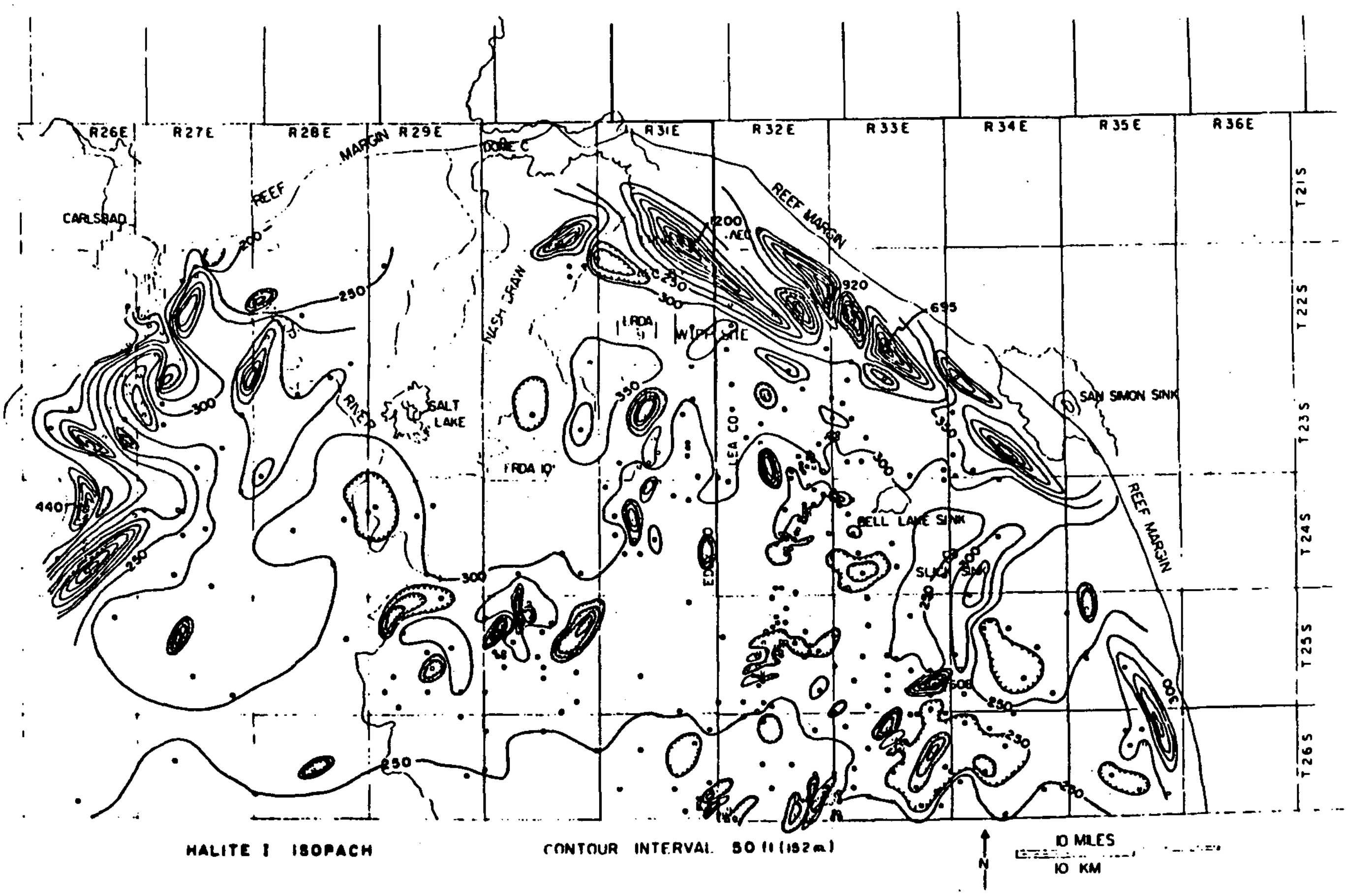


Figure 30. Isopach Map of Halite I in the northern Delaware Basin (from Anderson, 1978. Such maps can display a fabric and topography of structures that are indicated not so much by well data as by inference of expected geology. Hence, such fabrics may be misleading.)

Poker Lake structures were shown as a N-S-trending syncline-anticline pair by Anderson and Powers (1978). The contour maps in Anderson and Powers (1978 Figure 6, p 82) suggest an apparent N-S length for these doubly plunging structures of 15 000 ft, and an apparent E-W width of 6000 ft (Figure 31 in this report). Such inferred structures are curiously large when the detail of available boreholes is examined (Figure 32). The anticline-syncline pair is based on two holes, AO5,2530 and PO8,2530, respectively. Within Section 8, the synclinal node (PO8,2530) is constrained by three other holes (LO8,2530, RO8, 2530, and KO8,2530). These three holes are within 0.5 mi north, east, and south of the anomalous hole (Figure 33). Horizons can be correlated with normal stratigraphy and structure within the Castile among the three bounding holes. Hence, the size of any synclinal structure is less than the spread of the boundary holes (0.5 mi), and the existing structure is much less in areal extent than portrayed in the older contour maps.

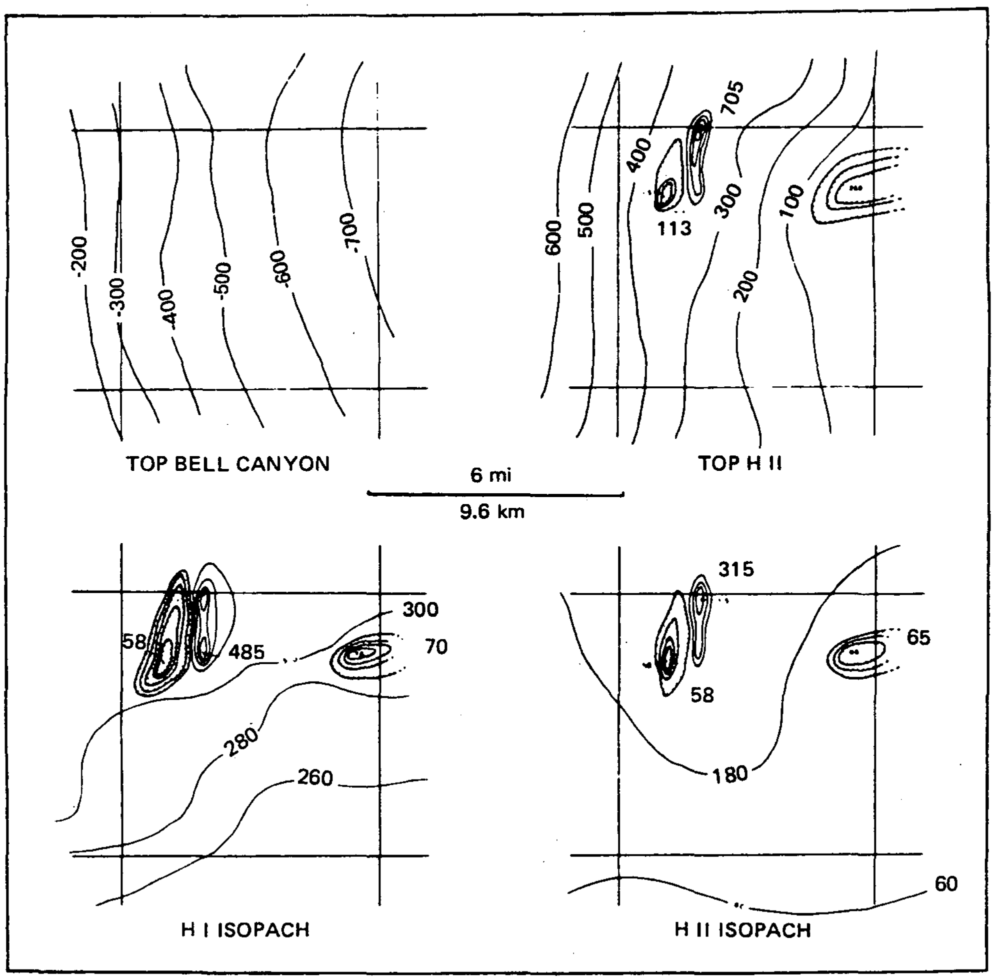


Figure 31. Poker Lake structures (as shown in Anderson and Powers, 1978. The complete square outlines the township boundaries. Section 8 is astride the two structures in the northwest corner of the township.)

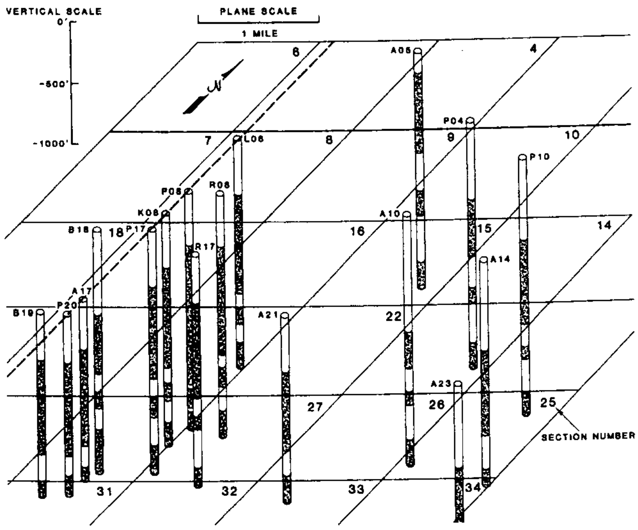


Figure 32. Oblique view of holes in Northwest corner of Figure 31. (This figure combines areal distribution with the stratigraphic picks in the Castile and lower Salado Formations. Stippled units are anhydrites; unpatterned units are halite. The uppermost stippled unit is the Salado and Anhydrite III combined across the Salado-Castile unconformity. The next lower unit, unpatterned, is Halite II. Below Halite II is the stippled Anhydrite II, etc. Dashed and bold lines are trace of cross sections in Figures 34 and 36.)

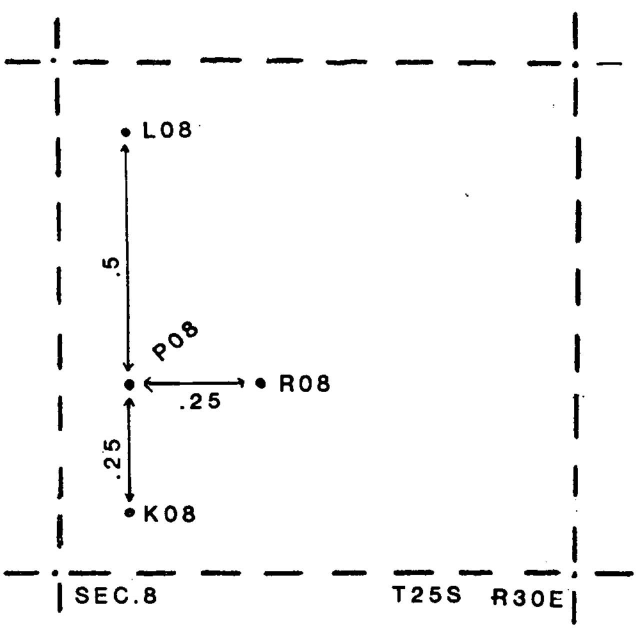


Figure 33. Detail map showing locations of Poker Lake boreholes in Section 8, northwest corner, of Figures 31 and 32

Poker Lake Syncline

Synclinal structures such as this one are most often taken as evidence of dissolution (Anderson, 1983; Davies, 1983). In their models, the synform is produced by removing salt through fractures that connect the Bell Canyon aquifers with the Castile halites, or through some as-yet-undiscovered aquifer in the upper Castile or Salado. Since the Poker Lake synform is the result of thinned Castile halites (see Figure 34), the former process would need to be the active one for dissolution to have occurred in this area. However, dissolution-caused downbuckling apparently does not affect the upper Castile and Salado (see Figure 34). This observation would suggest that the synform developed before the Permian deposition of the units above it.

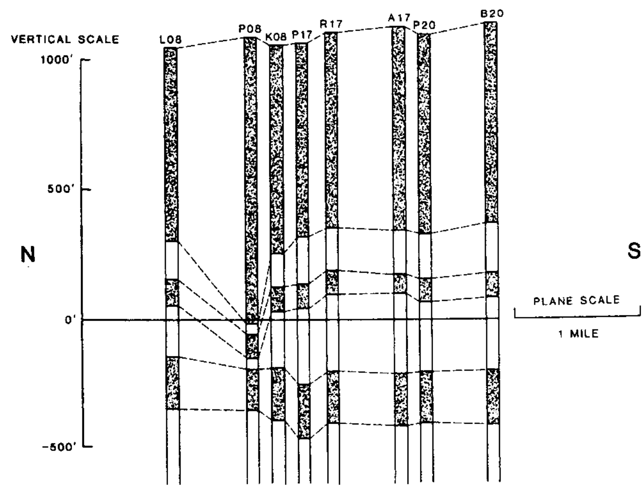


Figure 34. Fence diagram along a north-south line through the Poker Lake structures. (See Figure 32 for location of line and an explanation of units. Stippled pattern is anhydrite; unpatterned is halite.)

The evidence for this conclusion is that the upper anhydrite, Anhydrite III and lower Salado, in the center of the synform (PO8,2430), is level with or above the same unit in adjacent holes. The structural low could be interpreted as having developed by salt flowage or by sedimentary channel-cutting before deposition of the overlying anhydrite. Thickening of the overlying anhydrite was a compensation response to the downwarp of the deposition surface after deformation.

A counterargument is that the nonbuckling of the upper anhydrite units in the synform is unreal and that the near equivalent elevation of upper anhydrite is coincidental. In this argument, the massive upper anhydrite masks downwarped Anhydrite III and Cowden layers in the synform. Hence, the synform extends upward but cannot be seen in this argument. This type of conclusion, coincidental, can be disregarded if one observes the nearly level correlation of secondary markers in the upper Castile and the lower Salado between adjacent holes in the Poker Lake structures (Figure 35). Therefore, this very localized depression of mid-Castile surfaces is an example of snydepositional thinning related to salt flowage or to sedimentary channel-cutting or channel-dissolution.

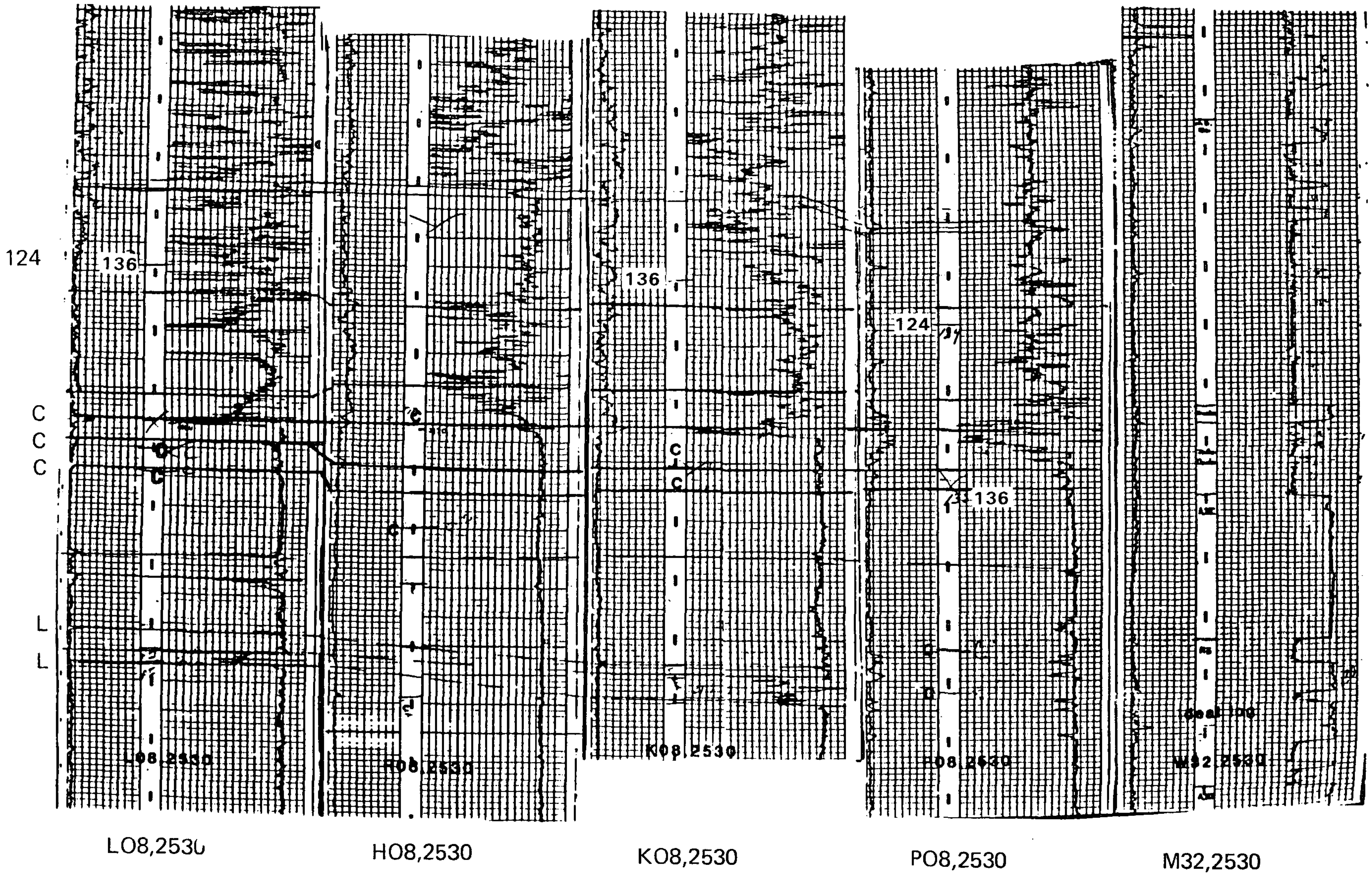


Figure 35. Detail of upper section of massive anhydrite from holes in Poker Lake structures (Lines indicate inferred continuity of distinctive markers. "C", "124", and "136" represent different stratigraphic picks made for the same unit by different workers, which again attests to the inherent ambiguity. Log on the far right (M32,2530) is an "ideal" log for comparison of thicknesses and position of markers.)

Poker Lake Anticline

The second major structure in the Poker Lake area is the antiform (Figure 36). The significant difference between this structure and the Poker Lake synform is that the upper anhydrite is displaced in the antiform. Hence, deformation probably occurred after deposition of the units. Halite I and II are thickened relative to adjacent holes; Halite I is the most thickened. This structure is typical of a salt-flowage structure as seen north of the WIPP site (Borns et al, 1973).

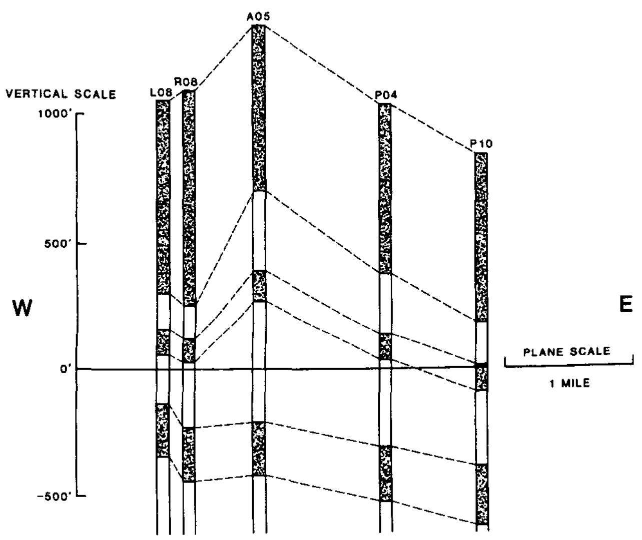


Figure 36. Fence diagram along an east-west line through the Poker Lake structures. (See Figure 32 for location of line and an explanation of units. Stippled pattern is anhydrite; unpatterned is halite.)

Another observation from the dense pack of holes in the Poker Lake area is that the upper surface of the DMG exhibits an uneven topography. Such irregularities can produce apparent flow or dissolution structures in the lower and mid-Castile. However, the depression on the sedimentary surface existed before and during deposition.

Examples have been provided above for (1) the misleading contour extrapolation for one-hole anomalies and (2) the ambiguous nature of certain stratigraphic picks. However, resultant maps (Anderson, 1978; Davies, 1983) have been used as compelling evidence for dissolution and other processes in the Delaware Basin. In the case of the Poker Lake structures, the actual sizes of the anticline and syncline are significantly smaller (6x) in map view, than the structures extrapolated by Anderson (1978) and Anderson and Powers (1978). The remaining smaller structures (one-hole anomalies) can still be attributed to salt flowage and/or dissolution since the Permian.

Disruptions of Ideal Stratigraphy

The preceding example of the Poker Lake structures demonstrates the lateral variations in a stratigraphy from one hole to another in a closely spaced array. The sources of such variations can be deformation, dissolution, or lateral facies change. Deformation and facies changes such as the Salado-Castile unconformity cannot be detected from individual well logs. We infer such structures by regionally comparing logs and following distinctive units through lateral correlation. In this step, log ambiguity is the greatest hazard.

Figure 37 shows the conceptual effects on log signatures of the Salado-Castile unconformity and selective dissolution in the upper Castile and Lower Salado. Anderson (1983) has argued that the stacking of anhydrite residues can produce an apparently compensated thickness of anhydrite across the unconformity. The massive anhydrite signature would need to mask intervening residues after halite removal. The volume of halite that must be removed to create the stacked effect should probably create residue zones of an extent that would be hard to mask. From Figure 37, we see the feasibility of the apparent thickening by dissolution and collapse. However, the compensation of thickness for Castile thickening and thinning can only be fortuitous. Some depression of a marker bed surface would probably be observed and would reflect the mass removal of halite only if removal were post-Permian.

The arguments above have depended on log-to-log comparison. Within an individual log, dissolution breccias or residues may be detected by rapid oscillations in the log signature as corroborated by Nash Draw core (Lambert, 1983). One needs to be careful that such oscillations are not merely the result of amplified background when the log sensitivity is relatively high.

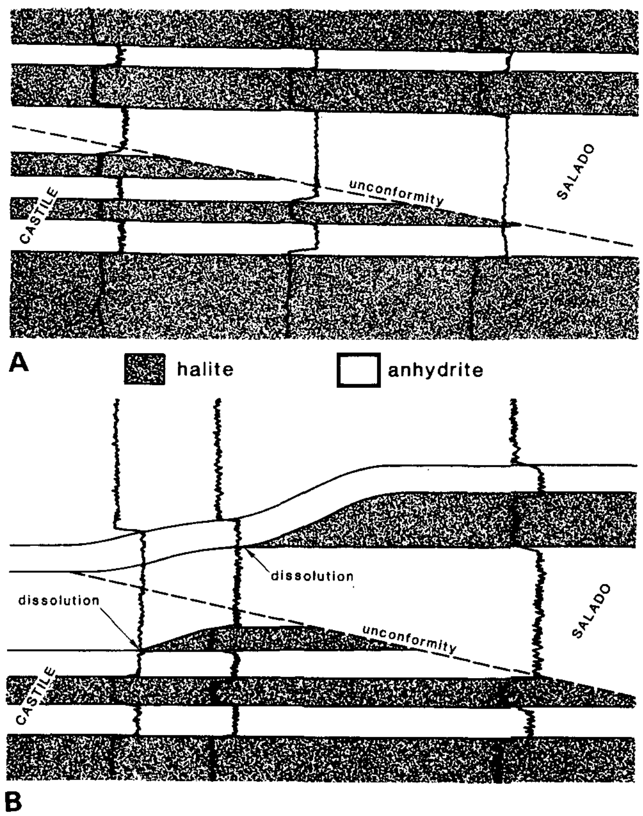


Figure 37. Idealized effects of (A) Castile-Salado unconformity (Anderson, 1983) on acoustilog (similar on Sensilog or Sonic Log) (Note thickening of anhydrite signature.); and (B) selective halite dissolution in addition to unconformity. (Thickening of anhydrite occurs, but marker surfaces do not remain level.)

Conclusions

Regional log correlation remains our most useful tool for determining the regional stratigraphy and structure in the northern Delaware Basin. Because interpretation cannot be based on inferences from single logs but needs regional log-to-log correlation, we need to continuously update our data base. The basic conclusions will remain the same, but as coverage increases, current ambiguities will decrease. Current log correlations suggest the following:

- The Castile is characterized by thickening and thinning. Hence, mass redistribution rather than mass removal is the dominant process.
- Thinning in some lower Castile structures was compensated for by thickened upper Castile and lower Salado sedimentation. This relationship suggests that the synform existed during Permian (Ochoan) sedimentation.
- Irregular topography in the top of the Bell Canyon can produce apparent structures in the overlying Ochoan units.

Anderson (1978, 1981, 1983) has proposed deep dissolution as a major mechanism of salt removal in the northern Delaware Basin. He suggested that dissolution was marked in two zones, which are linear series of sinks. One zone trends SSE from the Poker Lake structures with a linear extent >30 km; the other zone, which includes San Simon Sink, is a line of troughs overlying the Capitan Reef on the eastern side of the basin. The northern end of Anderson's dissolution structure appears in the southwestern corner of the area covered in Figures 3 through 26. This zone is 20+ km SSW of the WIPP site. It is conceivable that this set of troughs was caused by dissolution, although the mechanism may not be deep dissolution but dissolution related to the ancestral Pecos River (Bachman, 1983). At the scale of resolution for the spacing wells, no continuation is observed of this structure NNE towards the WIPP site.

Locally, Davies (1983) has proposed that finger sands within the Bell Canyon control dissolution; such finger sands have higher transmissivities than do adjacent rock types. These finger sands trend NE. Structure contours do not reflect these sands; nor, in fact, do Anderson's line troughs. Davies has also proposed that a structural depression in the mid-Salado is evidence of deep dissolution two miles north of the WIPP site center as marked by the contour maps of Snyder in Borns et al (1983). The size of this structure is such that it does not appear on maps based on hydrocarbon industry holes. However, DOE has proposed to drill this structure to investigate its origins.

Lateral dissolution within the Rustler has occurred ~15 km west of the WIPP site as marked by Nash Draw. Within this 15-km radius, there is no compelling evidence for deep dissolution.

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APPENDIX

Well-Log Data Arranged by Township, Range, and Section (all elevations in feet)

Example Entry

Hatmesa 2#2/Phillips Pet. Co — alpha identification

H11, 2132, 3861 — Applicon identification text (id),

- 3861 — ground elevation in ft
- 11 — township and range
- 1 — section
- H — well identifier

1515, 1948, 2430, 2855, 3040, 3060, -1, -1, 3170, -1, -1, -1, -1, -1

1 2 3 4 5 6 7 8 9 10 11 12 13 14

Elevations

1 Top of Rustler
2 Top of Salado
3 Top of MB 124
4 Top of MB 136
5 Top of Cowden
6 Top of Infra-Cowden
7 Top of Anhydrite IV
(in this case, -1 indicates that no pick was made)
8 Top of Halite III
9 Top of Anhydrite III
10 Top of Halite II
11 Top of Anhydrite II
12 Top of Halite I
13 Top of Anhydrite R
14 Top of Bell Canyon Formation

```
PANAMERICANPET.CORP.BIGEDDYUNIT#18
P03,2129,3412
145,500,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1
UNIONOIL/CO.OFCALIF.COWDENFEDRAL#1
U04,2129,3471
200,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1
MEADCOPROP.LTD.HARRISBELL#2
M05,2129,3468
445,740,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1
MEADCOPROP.LTD.HARRISBELL#1
P05,2129,3472
250,555,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1
MEADCOPROP.LTDHARRIS'6'#1
M06,2129,3487
825,1050,-1,1970,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1
PANAMER.PETCORPBIGEDDYUNIT16
P18,2129,3309
150,450,-1,890,1250,1272,-1,-1,-1,-1,-1,-1,-1,-1
PHILLIPSPET.COJAMES'C'1
P35,2130,3218
125,480,-1,1420,-1,-1,-1,-1,2200,2505,2712,2845,3300,3610
PHILLIPSPETCOHATMESA'A'1
H02,2132,3793
1570,1980,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1
SUPERIONOILCO.GOVT.'H'COM#1
G10,2132,3800
1448,1880,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1
HATMESA2#2/PHILLIPSPET.CO.
H11,2132,3861
1515,1948,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1
PHILLIPSHATMESA#1
M11,2132,3834
1552,1970,2430,2855,3040,3060,-1,-1,3170,-1,-1,-1,-1,-1
SKELLEY.OILCO.SALTLAKESO.UNIT#1
S21,2132,3679
1055,1450,2240,2640,2990,3019,-1,-1,3320,-1,-1,-1,-1,-1
```

GULFOILSANSIMON#1

G26,2132,3798

-1,-1,-1,-1,3195,3234,-1,-1,3324,-1,-1,-1,-1,5100

UNIONCARBIDEAEC7

U31,2132,3662

670,1010,1770,2158,2515,2535,-1,-1,2896,3110,3310,-1,-1,-1

CABANA#1/TROPOROOILANDGASCO.

T01,2230,3357

315,630,1870,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,3800

PHILLIPSPETCOJAMES'A'#1

M02,2230,3193

168,560,1132,1520,1950,1962,-1,-1,2290,2675,2930,3057,-1,-1

PHILLIPSPET.COJAMES'E'#1

D11,2230,3221

275,650,1205,1578,1980,2000,-1,-1,2335,2420,2955,3065,3400,3665

RICHARDSON&BOSSFEDERALLEGG#1

B27,2230,3309

210,530,1455,1880,2250,-1,-1,-1,-1,-1,-1,-1,-1,-1

CAMPANANO1/MCKNIGHTANDTROPORO

C06,2231,3376

393,710,-1,1885,2160,-1,-1,-1,-1,3235,3390,3550,3710,3950

STATE'D'#1/SKELLEY

S05,2232,3623

1840,2285,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1

TEXACOETAL,B&HFEDERAL/RAYSMITHDRILLINGCO.

T13,2232,3644

857,1275,2013,2405,2730,2757,-1,-1,3028,-1,3400,3525,4517,4853

#2REDTANKUNIT/CARPERDRILLINGCO.

C14,2232,3731

947,1290,2117,2605,3305,3350,-1,-1,3600,4342,4368,4430,4449,4780

FEDERAL1-17/CLEARYPETROLEUMCORP.

C17,2232,3701

888,1200,2013,2568,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1

FEDRALJENNINGS1-18/JOHNH.TRIGG

T18,2232,3696

900,1218,2010,2430,2850,2877,-1,-1,3178,3557,4037,4178,4408,4700

```
BASSFEDERAL#1/RALPHLOWE
L19,2232,3620
762,1230,2020,2422,2830,2857,-1,-1,3180,3590,3869,3999,4365,4640
#1FEDERAL/R.J.ZONNE
M20,2232,3640
830,1150,2030,2550,2875,3130,-1,-1,3190,-1,-1,-1,-1,4729
FEDERALREDTASKUNIT1-22/TRIGGCO
T22,2232,3687
870,1243,2045,2458,2868,2900,-1,-1,3250,3540,3815,3983,4410,4720
COVINGTON'A'FEDRAL1/GULFOIL
A25,2232,3789
1040,1410,-1,2540,3070,-1,-1,-1,-1,-1,-1,-1,-1,4926
PERRYFEDERAL#1-31
B31,2232,3338
752,1240,2077,2600,-1,-1,-1,-1,3080,3687,3857,3976,4317,4580
RICHARDSON&BASSSTATE'AQ'#1/TIDEWATER
T36,2232,3756
1147,1607,2350,2750,-1,-1,-1,-1,-1,-1,-1,-1,-1,4900
SHELLETALBOOTLEGRIDGEUNIT/SHELLOIL
S36,2232,3775
1155,1610,-1,2640,3150,-1,-1,-1,-1,-1,-1,-1,-1,4880
N.M.STATEBS#1/HUMBLEOIL
H01,2234,3640
1715,2155,2825,3122,3340,-1,-1,-1,-1,-1,-1,-1,-1,-1
SKELLYSTATENO.1'V'/ASHMUN&HILLIARD
S04,2234,3611
1860,2300,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1
ALLISONFEDRAL#1/HUDSONANDHUDSON
H10,2234,2573
1696,2180,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1
STATEAA2-1CONTINENTALOILCO
C02,2331,3453
623,1060,1855,2305,2761,2785,-1,-1,3020,3500,3730,3840,4185,4430
BAUERDORFFEDERAL#1/MAXM.WILSON
W11,2331,3492
743,1118,1904,2374,2885,2910,-1,3310,3408,3585,3806,3909,4215,4457
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ARCOSTATE#1-16/ELPASONAT.GAS

A16,2331,3381

474,842,1606,2075,2750,2780,-1,-1,2810,3390,3530,3780,3910,4150

MUSEFEDERAL#1/PATOIL

P21,2331,3374

462,795,1638,2135,2685,-1,-1,-1,2725,3357,3547,3645,4000,4230

TODD'23'FEDERAL#1/TEXASAMER.OILCO.

T23,2331,3461

777,1090,1900,2362,2950,2968,-1,-1,3005,3563,3780,3810,4150,4327

TODD35FEDERAL#1-2/SKELLY

S25,2331,3506

663,1190,2015,2462,2960,-1,-1,-1,3050,3660,3780,4270,4378,4520

TODDFEDERAL'26'NO.1/TEX.AMOILCO.

T26,2331,3464

753,1062,1896,2374,2886,2925,-1,-1,2960,3570,3765,3864,4160,4385

TODD26FEDERAL#2/TEX,AM.OILCO.

A26,2331,3454

748,1065,1904,2376,2829,2842,-1,-1,2860,3570,3763,3855,4150,4380

WRIGHT-FEDRAL#1/PATOILCORP.

P27,2331,3402

496,827,1663,2070,2679,2704,-1,-1,2733,3415,3615,3710,4024,4268

MOBIL-FEDERAL#1/ELPASONAT.GAS

M29,2331,3374

370,-1,-1,1880,2400,-1,-1,-1,-1,3170,-1,-1,-1,-1

WRIGHT-FEDERAL#2

W33,2331,3392

420,808,1720,2207,-1,-1,-1,-1,2652,3380,3576,3672,3953,4169

O.B.KILLJR.FEDERAL#1

K03,2332,3727

1150,1580,2308,2717,3142,3165,-1,-1,3400,3767,4045,4168,4606,4875

MCBEEOILCO,CONTINENTALFEDERAL#1-9

M09,2332,3699

1139,1540,2283,2708,3207,3250,-1,-1,3480,4024,4163,4280,4570,4725

HILL&MEEKER&AMBASSADOSOILCORP.MYTHEWS'11'#1

H11,2332,3728

1195,1680,2440,2860,3315,3350,-1,-1,3523,3977,4210,4330,4610,4930

JOHNH.TRIGGFEDERALCONTINENTAL1-15

T15,2332,3722

1177,1638,2377,2795,3233,3260,-1,-1,3468,3950,4190,4300,4670,4928

KIRKLINDRILLINGCO.FEDERALEST.11AF-1

K20,2332,3697

1210,1511,2273,2718,3278,3314,-1,-1,3319,3950,4156,4250,4561,4803

H.L.JOHNSTONE,SR.CONOCO FIELDSFEDERAL#1

H24,2332,3720

1225,1705,2476,2928,3453,3486,-1,-1,3628,4126,4357,4460,4770,5036

CONTINENTALOILCOFEDERALFIELDS#1

C24,2332,3725

1235,1722,2506,2946,3415,3510,-1,-1,3610,4111,4342,4451,4795,5054

H.L.JOHNSTONSR.WEHRLI-FEDERAL#1

J25,2332,3720

1215,1695,2469,2910,3380,3411,-1,-1,3565,4092,4309,4415,4769,5021

CONTINENTALOILCOFIELDSNO.2

C25,2332,3700

1210,1680,2470,2913,3450,3484,-1,-1,3612,4155,4356,4460,4767,5013

P.M.DRILLINGCO.FEDERALFIELD#1

P26,2332,3658.5

1210,1636,2424,2885,3407,3442,-1,-1,3553,4104,4311,4414,4610,4933

P.M.DRILLINGCOFEDERALJAMES#4

F26,2332,3705

1215,1680,2458,2900,3428,3527,-1,-1,3607,4145,4350,4457,4767,5013

MAXWILSONCONTINENTALFEDERAL#1

W28,2332,3684

1180,1530,2321,2778,3300,3328,-1,-1,3432,4010,4205,4305,4586,4828

CURTISHANKAMERHOLDERFEDERAL#1

C33,2332,3666

1200,1520,2520,2890,3285,-1,-1,-1,3356,3980,4445,4530,4610,4846

UNIONOILOFCALIFORNIAFEDERAL'L'NO.1

U34,2332,3624

1170,1480,2315,2796,3362,3390,-1,-1,3406,4020,4203,4336,4658,4893

THEPUREOILCOFEDERAL'K'NO.1

P34,2332,3630

1170,1508,2315,2795,3364,3395,-1,-1,3420,4050,4253,4356,4657,4892

JOHNH.TRIGGFEDERAL'WL'NO.2-35

J35,2332,3692

1202,1450,2483,2950,3476,3510,-1,-1,3590,4145,4356,4460,4744,4988

P.M.DRILLINGCO.FEDERALPAYNENO1

P35,2332,3689

1194,1615,2435,2911,3443,3480,-1,-1,3550,4110,4311,4413,4693,4936

P.M.DRILLINGCOFEDERALPAYNE#3

D35,2332,3630

1180,1505,2332,2820,3376,3410,-1,-1,3456,4060,4260,4365,4650,4895

P.M.DRILLINGCO.PAYNENO.2

M35,2332,3700

1216,1638,2445,2900,3437,3470,-1,-1,3560,4125,4326,4429,4710,4952

P.M.DRILLINGCO.PAYNEFEDERALNO.4

F35,2332,3663

1200,1566,2385,2850,3390,3420,-1,-1,3440,4073,4280,4373,4670,4914

PUREOILBRINNENSTOOLDEEPUNIT#1

B36,2332,3689

1210,1680,2560,3080,3515,-1,-1,-1,3600,4160,4370,4475,4780,5025

DAVIDFASKENGULFSTATE#1

G36,2332,3664

1210,1670,2500,2965,3520,3550,-1,-1,3610,4180,4370,4475,4755,5000

PENROCOILCORPTRISTESTATE#1

P36,2332,3695

1200,1668,2480,2950,3510,3542,-1,-1,3605,4170,4370,4478,4767,5013

CABEENEXP.CORP.CONTINENTALFED.#1-P

C04,2333,3636

1160,1655,2430,2840,3235,3270,-1,-1,3585,3995,4430,4625,4820,5110

WM.H.&EDWARDR.HUDSONSHELLFEDERAL#1-6

T06,2333,3704

1260,1770,2535,2970,3365,3400,-1,-1,3650,4055,4290,4405,4750,5030

W.A.&EDWARDHUDSONFEDERAL7WELL#1

H07,2333,3722

1270,1760,2515,2950,3405,3440,-1,-1,3690,4075,4325,4440,4755,5025

P-MOILCOMPANYTEXACOSTATE#1

T17,2333,3715

1270,1775,2548,2985,3425,3460,-1,-1,3710,4150,4375,4490,4825,5100

TENNECOOILCOMPANYSKELLYSTATE#1

T18,2333,3726

1290,1790,2550,2980,3415,3450,-1,-1,3690,4105,4335,4450,4780,5050

HELBINGANDPODPECHAN#1ASHELLSTATE

S18,2333,3722

1230,1715,2245,2870,3365,3400,-1,-1,3600,4025,4265,4380,4770,5025

CONTINENTALOILCOMARSHALL#3

M19,2333,3711

1230,1730,2510,2965,3420,3455,-1,-1,3630,4140,4375,4485,4815,5075

AMER,QUASARBRINNINSTOOL#1

A20,2333,3713

282,1790,2573,3090,-1,-1,-1,-1,-1,-1,-1,4670,4870,5125

LEVICKFEDERAL#1

C20,2333,3701

1280,1783,2570,3016,3485,3517,-1,-1,3777,4230,4459,4573,4890,5146

LEASTATE#1

K31,2333,3696

1252,1762,2560,3012,3520,3559,-1,-1,3680,4241,4449,4552,4848,-1

HUMBLESTATE#1-32

H32,2333,3667

1268,1772,2548,3011,3523,3560,-1,-1,3698,4242,4449,4550,4848,5102

STATE1-35

B35,2333,3659

1311,1807,2599,3050,3608,3642,-1,-1,3812,4353,4565,4671,4978,5246

SHELLOILCOANTELOPERIDGEUNIT34-1

S34,2334,3490

942,1403,2282,2732,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1

FEDERALREID#1/ELCAPITANOIL

E06,2429,2984

230,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1

CEDARCANYON9D#1/SKELLY

S09,2429,2941

-1,-1,-1,-1,-1,-1,-1,-1,1730,2098,2295,2390,2690,2900

MOBIL-FEDERAL"27"#1/PENNZOILV.I.

P27,2429,2924

450,695,-1,-1,-1,-1,-1,-1,-1,2183,2335,2427,2730,2947

BASSFEDERAL#1-25/HILL&MEEKER

B25,2430,3429

-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,4120

FEDERALNETTLES#1/FORDCHAP&ASSOC.

C29,2430,3266

443,1000,-1,-1,-1,-1,-1,-1,-1,2925,3090,3187,3480,3690

TODD'2'STATE1/SKELLYT01,2431

T01,2431,3502

853,1250,-1,2065,2460,-1,-1,-1,-1,-1,-1,-1,-1,4430

JENNINGSFEDERAL#1/MAXWILSON

J03,2431,3500

675,1003,1788,2289,2853,-1,-1,-1,2910,3585,3782,3876,4160,4383

JENNINGSFEDERAL#1/J.L.MCCLELLAN

F03,2431,3430

-1,823,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1

BETTYFEDERAL#1/SUNDANCEOIL

B04,2431,3414

450,813,1630,2150,2705,-1,-1,-1,2745,3435,3585,3670,4027,4255

M.M.STEWARTFEDERAL#1/TEXACO

S04,2431,3436

484,835,1645,2150,2713,-1,-1,-1,2752,3397,3605,3700,4062,4240

FEDERALLITTLEFIELD'CT'#1/GULF

G11,2431,3528

763,1130,1926,2400,2970,-1,-1,-1,3010,3688,-1,3963,4255,4485

CONTINENTALFEDERAL#1/W.J.WEAVER

W17,2431,3553

665,1015,1609,2233,2740,-1,-1,-1,-1,3700,3977,4052,4173,4394

JENNINGSFEDERAL#1/PAULEYPETRO.

P20,2431,3530

0530,895,1530,2046,2520,-1,-1,-1,3130,3495,3675,3775,4070,4290

CARPERFEDERAL#1-21/HILL&MEEKER

H21,2431,3535

690,953,1630,2150,2780,-1,-1,-1,3146,3524,3747,3845,4162,4395

T.HEFDIN-FEDERAL#1/THETEXASCO.

T24,2431,3551

693,1020,1720,2395,-1,-1,-1,-1,-1,3885,-1,-1,-1,4557

POKERLAKEUNIT#36/PANAMPETR.CO.

M28,2431,3502

590,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,4360

COTTONDRAWUNIT#67/TEXACO

M35,2431,3508

630,1012,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,4410

CONTINENTALFEDERAL#1-L/CABEEN

C01,2432,3623

1160,1537,2370,2847,3409,3449,3467,3844,3863,4095,4295,4398,4710,
4950

BONDURANTFEDERALNO1/C.HANKAMER

H06,2432,3584

888,1247,2078,2536,3100,3141,-1,-1,3403,3802,3996,4092,4417,4650

OHIOSTATENO.1%P.M.<

M02,2432,3632

1170,1531,2370,2842,3386,3424,3460,3473,3477,4085,4288,4390,4681

FEDERALHANAGAND#1/GULF

G10,2432,3628

1088,1394,2262,2750,3297,3336,-1,-1,3372,3998,4198,4297,4600,4832

FEDERALHANAGAND#3/GULF

H11,2432,3637

1172,1508,2408,2916,3415,3453,-1,-1,3470,4093,4291,4391,4685,4926

WIMBERLY12#1/CONTINENTAL

W12,2432,3590

-1,-1,2437,2913,3434,3473,-1,-1,3480,4105,4307,4408,4673,4916

HANAGANFEDERALNO3/C.HANKAMER

H12,2432,3605

1130,1497,2352,2841,3381,3409,-1,-1,3480,4068,4259,4358,4670,4910

WIMBERLY"12"2/CONTINENTAL

C12,2432,3600

1203,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,4933

#1USAJENNINGS/TENNECO

J14,2432,3628

1132,1446,2394,2880,3341,3409,-1,-1,3470,4074,4259,4359,4629,4874

WOOLLEY#1/WESTATESPET.CORP.OFTX

W13,2432,3586

1188,1502,2364,2870,3434,3473,-1,3700,3780,4174,4368,4463,4732,4910

U.S.A.JENNINGSNO2/TENNECO

T14,2432,3588

1122,1434,2308,2805,3298,3352,-1,-1,3410,4076,4257,4356,4618,4858

USAJENNINGS#3/TENNECO

U14,2432,3624

1142,1452,2362,2850,3355,3392,-1,-1,3450,4050,4253,4354,4670,4910

JENNINGSFEDERAL4/TENNECO

F14,2432,3591

1130,1455,2386,2872,3318,3360,-1,-1,3430,4070,4256,4356,4624,4866

FEDERALHANAGAN'B'#3/GULF

G15,2432,3591

1110,1428,2299,2777,3263,3343,-1,-1,3420,4018,4210,4308,4580,4810

FEDERALHANAGAN'B'#1/GULF

H15,2432,3622

1060,1397,2252,2770,3240,3275,-1,-1,3390,4040,4223,4320,4598,4822

FED.HANAGAN'B'#2/GULF

F15,2432,3606

1122,1439,2375,2897,3294,3348,-1,-1,3440,4079,4257,4353,4612,4848

HICKS-FEDERAL#1/TENNECO

T15,2432,3602

1026,1338,2188,2700,3229,3310,-1,-1,3340,3996,4177,4272,4576,4803

U.S.SMELTINGUSA#1/TENNESSEE

T22,2432,3602

1066,1381,2275,2866,3241,-1,-1,-1,3241,4070,4248,4346,4588,4819

USSMELTINGUSA#2/TENNECO

G22,2432,3618

998,1311,2193,2743,3272,3340,-1,-1,3272,4061,4236,4333,4524,4803

USSMELTINGUSANO3/TENNECO

S22,2432,3607

1060,1375,2280,2808,3370,3453,-1,-1,3370,4137,4309,4406,4623,4854

USSMELTINGUSA#4/TENNECO

U22,2432,3604

1063,1380,2290,2853,3311,-1,-1,-1,-1,4117,4288,4385,4608,4840

USSMELTINGUSANO5/TENNECO

N22,2432,3592

1056,1361,2252,2772,3384,-1,-1,-1,3384,4132,4308,4402,4632,4868

BRADLEY#1/C.B.READ

B22,2432,3608

1052,1369,2268,2816,3348,3436,-1,-1,3348,4104,4278,4374,4620,4850

BRADLEY#2/C.B.READ

R22,2432,3604

1072,1400,2296,2867,3350,3432,-1,-1,3500,4132,4292,4289,4627,4865

ERNESTFEDERAL#1/C.HANKAMER

E23,2432,3609

1093,1413,2320,2888,3320,-1,-1,-1,3320,4129,4297,4392,4638,4873

BUNDURANTFEDERALNO1/OSBORNETAL

O24,2432,3584

1130,1454,2344,2861,3370,-1,-1,-1,-1,4146,4325,4422,4698,4932

COTTONDRAWUNITWELL#72/TENNECO

D33,2432,3510

830,1144,2010,2545,-1,-1,3106,3346,3515,3900,4091,4195,4490,4715

COTTONDRAWUNIT#69/TEXACO

C34,2432,3519

881,1188,2058,2589,-1,-1,3190,3370,3560,3946,4124,4230,4512,4750

FEDERALDELBASIN#1/S.W.RICHARDSON

R35,2432,3524

907,1239,2109,2625,-1,-1,3254,3471,3635,4002,4179,4283,4576,4802

NEWMANFEDERAL#1/HONDODRILLING

N01,2433,3581

-1,-1,-1,-1,-1,-1,-1,-1,-1,4104,4302,4406,-1,4930

BELLLAKEUNIT7/CONTINENTALOIL

B01,2433,3625

1275,1800,2600,3075,3560,3595,3760,3795,3805,4250,4465,4580,4860, 5140

GULFSTATENW#1/HONDODRILLING

G06,2433,3598

1175,1610,2455,2930,3450,3495,-1,-1,3510,4125,4325,4430,4710,4955

GULFN.W.#2/HONDODRILLINGCO

H06,2433,3606

1185,1630,2460,2930,3440,3485,-1,-1,3520,4125,4335,4440,4735,4980

STATE@O@#1%TOML.INGRAM<

O07,2433,3590

1185,1635,2470,2940,3475,-1,-1,-1,3515,4155,4350,4455,4720,4960

STATE"O"#2/TOML.INGRAM

I07,2433,3603

1205,1580,2445,2930,3460,3500,-1,-1,3510,4145,4340,4445,4720,4965

STATE'P'#1/TOML.INGRAM

T07,2433,3636

1200,1645,2480,2955,3495,3540,-1,-1,3550,4180,4325,4480,4910,5010

STATE#1-7/GEORGEW.RILEYINC.

R07,2433,3547

1225,1620,2440,2930,3560,-1,-1,-1,3590,4260,4440,4545,4795,5040

GULFSTATE#7-2/DAVIDFASKEN

F07,2433,3578

1190,1630,2460,2940,3480,3520,3530,3550,3555,4170,4360,4465,4755,
5000

N.M.STATEA.G.#1/SUNRAYMIDCONTINENT

S08,2433,3637

1210,1700,2520,3033,3580,-1,-1,-1,3645,4255,4450,4555,4848,5100

HOLLAND#1/BYAROBENNETT

B13,2433,3598

1245,1780,2635,3150,3685,3725,-1,-1,3760,4385,4580,4690,4930,5190

HOLLY-STATE#1/ROBERTB.HOLT

H17,2433,3592

1210,1680,2505,3050,3550,3600,-1,-1,3610,4260,4465,4565,4850,5100

STATELOWE#1/TENNECOOIL

T17,2433,3554

1200,1540,2395,2915,-1,-1,-1,-1,-1,-1,-1,-1,-1,5045

STATE'BB'20N01/CONTINENTALOIL

C20,2433,3540

1135,1495,2360,2885,3495,-1,-1,-1,3540,4195,4400,4500,4780,5020

STATE#1/F.R.JACKSON

J22,2433,3594

1215,1730,2790,3330,3630,-1,-1,-1,3745,4400,4600,4705,4980,5230

SUNRAYSTATE#1/TENNECOOIL

T27,2433,3502

1185,1590,2520,3100,3630,-1,-1,-1,3665,4370,4540,4640,4900,5150

STATE'AP'#1

T29,2433,3525

1146,1492,2390,2942,3480,3500,-1,-1,3554,4335,4500,4599,4749,5177

CONTINENTALSTATE#1/KIRKLINDRILLINGCO.

C30,2433,3557

1070,1410,2270,2790,3415,-1,3510,3660,3800,4205,4390,4490,4730,4970

CONTINENTALSTATE#1/ALBERTGAEKLEOP.

G31,2433,3524

1062,1385,2280,2840,3470,-1,3660,3720,3835,4220,4415,4520,4765,5000

#1LEAST."GX"/GULF&KIRKLIN

K36,2433,-1

1165,1695,2580,3135,3690,-1,-1,-1,3785,4405,4600,4710,4955,5215

#1GERDING/HANAGANPETROLEUM

H01,2434,3447

-1,-1,-1,-1,-1,-1,-1,-1,3400,3765,4110,4300,4915,-1

FEDERAL@BE@#1/SHELLOIL

D04,2434,3567

1045,1545,2400,2905,3355,3395,-1,-1,3795,4115,4415,4550,4840,5130

BELLLAKEUNIT#14/CONTINENTALOIL

C05,2434,3619

1145,1695,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,5140

BELLLAKEUNITNO.3/CONTINENTALOIL

B06,2434,3630

1240,1760,2550,3035,3495,3540,-1,-1,3730,4200,4422,4525,4870,5130

HALLFEDERAL#1

S09,2434,3570

1130,1660,-1,-1,-1,-1,-1,-1,3800,4230,4650,-1,-1,5230

SUPERIORFEDERAL#1-3/J.GLENNBENNET

B03,2529,2985

340,900,-1,-1,-1,-1,-1,-1,-1,2280,2455,2650,2870,3065

SUPERIOR#1-8/J.GLENBENNET

B08,2529,2921

-1,170,-1,-1,-1,-1,-1,-1,1490,2030,2350,2450,2555,2755

SUPERIORFEDERAL#1/NEILH.WILLS

W08,2529,2923

-1,260,-1,-1,1280,-1,-1,-1,1330,2060,2230,2330,2645,2845

CORRALDRAWUNIT#1/MOBIL

M14,2529,3118

550,890,-1,-1,1710,1840,-1,-1,1895,2480,2620,2715,3040,3235

SUPERIORFEDERAL15NO1/J.GLENBENNETT

B15,2529,3041

290,770,-1,-1,-1,-1,-1,-1,1660,2295,2460,2550,2858,3060

CORRALDRAWUNIT#2/MOBILOIL

W22,2529,3078

680,910,-1,-1,-1,-1,-1,-1,1580,2385,2550,2645,2825,3130

NO.1-26SUPERIORFEDERAL/J.GLENNBENNET

B26,2529,3043,5

175,530,-1,-1,-1,-1,-1,-1,1705,2405,2620,2720,3020,3215

SUPERIORFEDERAL1-27/J.GLENNBENNET

B27,2529,2990

120,360,-1,-1,-1,-1,-1,-1,-1,-1,2424,2515,2795,3000

FEDERAL$1/BELLPETROLEUM

B29,2529,2936

-1,225,630,920,1280,-1,-1,-1,1435,2090,2265,2355,2640,2835

CITIESSERVICEFEDERAL#1/BELLPETROLEUM

B30,2529,2945

-1,260,625,1135,1080,-1,-1,-1,1250,2060,2225,2320,2610,2805

STATE#1/D.B.SCULLY

S32,2529,3012

-1,195,-1,-1,1330,-1,-1,-1,1350,2155,2325,2425,2700,2895

R&BFEDERAL#1PATOILCORP

P04,2530,3273

850,1220,1809,1992,2263,-1,-1,-1,2263,2958,3134,3248,3577,3785

SUPERIORSTATE#1/REDPOOL

R08,2530,3210

233,760,1203,1684,1839,-1,-1,-1,1934,2646,2888,2995,3482,3684

POKERLAKE#44/BASSENT.

P10,2530,3317

779,1050,1688,2149,2425,-1,-1,-1,2425,3119,3299,3399,3710,3920

POKERLAKEUNIT#5X-1A/ALAMO

A10,2530,3282

900,1235,-1,-1,-1,-1,-1,-1,2660,3079,3254,3453,3642,3850

SHUGARTFEDERALNO1/CHOCTAW

C12,2530,3371

973,1271,1963,-1,-1,-1,2850,2950,3059,3640,3705,3800,3869,4079

POKERLAKEUNIT#10A-61ALAMO

A14,2530,3349

1237,1530,-1,-1,-1,-1,-1,-1,-1,3250,3550,3660,3787,4010

HERZOGFEDERAL#1/P.R.BASS

P17,2530,3230

1064,1433,1680,2014,-1,-1,-1,-1,2166,2910,3088,3183,3489,3691

R&BFEDERAL#1%R.LOVE<

M18,2530,3192

1050,1204,1466,1742,-1,-1,-1,-1,2088,2835,3021,3116,3362,3554

JENNINGSFEDERALNO.1/P.R.BASS

B18,2530,3186

725,1072,1385,-1,-1,-1,2042,2333,2360,2797,2985,3082,3330,3531

POKERLAKEUNITNO38/CENTRALSTATES

P19,2530,3209

-1,979,-1,-1,-1,-1,-1,-1,2100,2851,3023,3119,3400,3600

POKERLAKEUNIT#6-2A/ALAMO

A21,2530,3252

1180,1374,-1,-1,-1,-1,-1,-1,2320,3010,3184,3282,3584,3791

POKERLAKEUNIT9-A-5/ALAMO

A23,2530,3311

1067,1280,-1,-1,-1,-1,-1,-1,2475,3220,3390,3486,3755,3960

POKERLAKEUNIT#8-A-4/ALAMO

A27,2530,3260

1127,1431,-1,-1,-1,-1,-1,-1,2140,3090,3270,3367,3625,3827

#1-30SUPERIORFEDERAL/J.G.BENNET

B30,2530,3101

820,985,-1,-1,-1,-1,-1,-1,1950,2664,2837,2930,3215,3411

RICHARDSON&BASSFEDERALNO1/D.FASKIN

B35,2530,3246

1120,1538,-1,-1,-1,-1,-1,-1,2340,3080,3250,3340,3600,3800

COTTONDRAWUNITNO65/TEXACO

D02,2531,3476

732,1016,1604,2152,-1,-1,2767,3141,3240,3586,3757,3853,4128,4346

POKERLAKEUNIT7-A-3/ALAMO

A28,2531,3348

820,1124,1742,-1,-1,-1,-1,-1,3090,3420,3577,3676,3917,4184

#1DELBASINFEDERAL/GOLD...SANTANA

S35,2531,3319

1322,1537,2260,-1,-1,-1,2498,3050,3192,3513,3666,3760,4012,4229

E.F.RAYFEDERAL'B'NO.2/TEXACO

R10,2532,3464

772,1141,1894,2465,3152,3384,-1,-1,3515,3874,4045,4143,4435,4662

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TENNESSEEGAS&OILCO/RAYUSA#1
T10,2532,3460
780,1120,1850,2420,-1,-1,3020,3405,3500,3850,4025,4125,4415,4640
TEXACOE.F.RAYFEDERALNCT-1#2
F10,2532,3437
795,1145,1895,2440,-1,-1,3055,3415,3510,3865,4040,4135,4440,4670
EMILYFLINTRAYUSA#41/TEXACOOIL
E10,2532,3470
790,1140,1885,2445,-1,-1,3050,3405,3500,3860,4035,4135,4430,4655
COTTONDRAWUNITNO40/TEXACO
D10,2532,3478
792,1120,1948,2536,-1,-1,3160,3419,3552,3915,4089,4189,4470,4707
COTTONDRAWUNITNO39/TEXACO
C10,2532,3472
786,1131,1908,2482,-1,-1,3077,3398,3524,3890,4070,4168,4428,4652
TEXACOINC,COTTONDRAWUNIT#62
U10,2532,3468
785,1145,1970,2470,-1,-1,3080,3445,3545,3885,4075,4175,4465,4695
UNIONFEDERAL#1/PATOIL
P13,2532,3468
808,1137,1991,2513,-1,-1,3293,3439,3770,4122,4274,4373,4600,4834
CONTINENTALFEDERAL#1/WESTATES
W11,2532,3409
837,1177,2014,2561,-1,-1,3090,3535,3667,4006,4180,4280,4569,4812
FEDERAL"O"#1/J.I.O@NEILL,JR.
F14,2532,3445
761,1102,1923,2468,-1,-1,3163,3352,3691,4029,4212,4311,4545,4770
FEDERAL"O"#2/J.IO@NEILL
O14,2532,3454
788,1130,1980,2518,-1,-1,3300,3519,3711,4053,4210,4308,4562,4791
ORAHALLFEDERAL14#1/HILL&MEEKER
H14,2532,3455
773,1132,1882,2456,-1,-1,3210,3466,3657,3999,4166,4263,4482,4712
TEXACOINC.G.E.JORDANFEDERAL%NCT-1<#6
T15,2532,3447
768,1138,1850,2453,-1,-1,-1,-1,-1,3923,4092,4185,4435,4661
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G.E.JORDANFED%NCT1<#2/TEXACO

J15,2532,3455

781,1143,1789,2318,-1,-1,3022,3208,3506,3850,4026,4123,4396,4622

G.E.JORDANFEDERAL%NCT2<WILLNO1/TEXACO

F15,2532,3451

787,1159,1830,2405,-1,-1,3080,3360,3550,3898,4068,4167,4389,4612

G.E.JORDONFEDERAL%NCT2<NO2/TEXACO

G15,2532,3455

792,1157,1842,2472,-1,-1,3124,3440,3537,3889,4058,4158,4406,4628

G.E.JORDAN#31TENNESSEE

L15,2532,3451

780,1142,1871,2440,-1,-1,3140,3428,3554,3902,4072,4171,4411,4637

G.E.JORDANUSA#2/TENNESSEE

M15,2532,3443

788,1164,1823,2395,-1,-1,3092,3377,3561,3911,4081,4178,4398,4623

G.E.JORDANUSA#4/TENNESSEE

N15,2532,3441

776,1139,1791,2341,2858,2888,3070,3346,3524,3869,4041,4140,4378, 4602

COTTONDRAW-UNITNO46/TEXACO

W15,2532,3440

779,1148,1805,2343,-1,-1,3040,3187,3542,3885,4062,4159,4430,4653

CONTINENTALSTATE#1/SHORELINE

X16,2532,3443

768,1128,1792,2362,-1,-1,3050,3416,3508,3860,4022,4120,4366,4592

STATEZ16#1/CONTINENTAL

Z16,2532,3444

759,1129,1792,2380,-1,-1,3090,3336,3510,3863,4027,4123,4362,4584

STATEE.L.BRADLEY#1/TENNESSEE

B16,2532,3444

763,1140,1811,2402,-1,-1,3088,3425,3517,3865,4033,4130,4380,4606

STATEBRADLEY#2/TENNESSEE

F16,2532,3458

766,1160,1839,2426,-1,-1,3100,3423,3518,3871,4034,4133,4402,4629

STATEE.L.BRADLEY#3/TENNECO

T16,2532,3434

742,1110,1753,2351,-1,-1,3050,3391,3483,3841,4005,4101,4331,4551

STATEMONSANTO#1/TENNESSEE

M16,2532,3439

769,1138,1781,2336,-1,-1,3073,3291,3507,3856,4030,4131,4372,4592

MONSANTO#2/TENNESSEE

E16,2532,3433

770,1123,1733,2272,-1,-1,3004,3148,3481,3830,4000,4100,4357,4579

STATEMONSANTO#3/TENNESSEE

A16,2532,3434

728,1114,1720,2247,-1,-1,2940,3077,3423,3772,3958,4059,4329,4553

STATEMONSANTO#4/TENNESSEE

N16,2532,3421

696,1094,1633,2254,-1,-1,2975,3134,3425,3777,3950,4044,4314,4538

STATEMONSANTO#5/TENNECO

L16,2532,3437

744,1119,1734,2267,-1,-1,3050,3160,3464,3810,3986,4085,4342,4572

STATEMONSANTO#6/TENNECO

P16,2532,3423

742,1098,1655,2300,-1,-1,3105,3278,3459,3813,3978,4074,4320,4543

STATEMONSANTO#7/TENNECO

C16,2532,3411

698,1075,1680,2273,-1,-1,2970,3106,3428,3782,3958,4054,4318,4539

MONSANTOSTATE#8/TENNECO

S16,2532,3426

713,1077,1738,2316,-1,-1,3058,3308,3475,3821,3988,4086,4312,4532

TEXASCO.JACKB.SHAWFEDERAL#1

S18,2532,3438

640,1013,1668,2228,2700,-1,-1,-1,-1,-1,-1,-1,-1,-1

COTTONDRAWUNIT64/TEXACO

D18,2532,3431

606,940,1619,2192,-1,-1,2900,3230,3322,3660,3820,3912,4184,4412

COTTONDRAWUNIT#42/TEXACO

C20,2532,3394

730,1086,1698,2276,-1,-1,2978,3180,3486,3828,3987,4088,4320,4538

EUGENEH.PERRYUSA#1/TENNESSEE

T21,2532,3428

731,1132,1748,2278,2756,2790,2940,3146,3455,3801,3981,4083,4335,
4567

E.H.PERRYUSA#2/TENNESSEE

P21,2532,3408

692,1062,1657,2209,2690,2717,2900,3017,3312,3672,3873,3973,4307,
4524

#3E.H.PERRYUSA/TENNESSEE

E21,2532,3422

739,1173,1765,2339,3012,3208,-1,-1,3512,3855,4020,4118,4339,4557

E.H.PERRYUSAWELLNO36/TENNECO

H21,2532,3404

706,1072,1681,2259,2720,2750,2892,3088,3383,3726,3904,4002,4318,
4540

COTTONDRAWUNIT44/TEXACO

C21,2532,3400

756,1131,1740,2258,2712,2742,2944,3309,3442,3786,3967,4066,4352,
4577

COTTONDRAWUNIT#57/TEXACO

D21,2532,-1

740,1114,1758,2278,2748,2778,2900,3020,3452,3796,3960,4060,4360,
4586

PERRYFEDERAL#1/PANTHERCITY

F21,2532,3430

768,1127,1765,2304,2801,2830,2986,3184,3501,3848,4010,4110,4349,
4570

PERRYFEDERAL#2/PANTHERCITY

R21,2532,3421

719,1108,1759,2300,-1,-1,2962,3123,3517,3860,4027,4128,4365,4587

H
PERRYFEDERALNO5/PANTERCITY

G21,2532,3409

747,1117,1741,2300,2780,2812,3045,3128,3497,3841,4021,4120,4319,
4540

PERRYFEDERALNO6/PANTHERCITY

Y21,2532,3400

726,1107,1740,2306,2784,2812,3060,3165,3491,3837,3993,3994,4312,
4538

PERRYFEDERALNO7/PANTHERCITY

K21,2532,3415

712,1096,1700,2247,-1,-1,2960,3083,3407,3750,3930,4032,4313,4334

PERRYFEDERAL#27

I21,2532,3406

738,1115,1761,2296,2730,2760,2910,3005,3457,3799,3983,4083,4354,
4578

PERRYFEDERAL#28/PANTHERCITY

B21,2532,3413

752,1124,1754,2281,2733,2761,2878,3006,3463,3806,3980,4080,4352,
4574

PERRYFEDERAL#35/PANTHERCITY

J21,2532,3384

727,1100,1720,2310,-1,-1,2976,3177,3470,3812,3981,4081,4319,4539

PERRYFEDERAL#37/PANTHERCITY

M21,2532,3398

746,1116,1700,2230,2700,2730,2880,2930,3422,3769,3946,4043,4[illegible],
4556

PERRYFEDERAL#38/PANTHERCITY

N21,2532,3404

776,1148,1731,2259,2715,2744,2906,3005,3435,3780,3950,4050,4336,
4552

PERRYFEDERAL#43/P.R.BASS

V21,2532,3382

754,1113,1700,2245,2695,2725,2885,2992,3417,3759,3930,4030,4328,
4550

G.E.JORDANFEDERALNCT-1NO5/TEXACO

T22,2532,3421

769,1141,1759,2270,-1,-1,2980,3178,3570,3835,4005,4104,4403,4629

G.E.JORDANFEDERALNO3/TEXACO

J22,2532,-1

748,1128,1752,2287,2761,2791,2935,3056,3529,3870,4038,4138,4385,
4612

COTTONDRAWUNITNO48/TEXACO

C22,2532,3411

747,1116,1750,2270,2730,2760,2887,3017,3481,3821,4002,4102,4379,
4604

FEDERAL'F'NO.1/J.I.O@NEILL

O23,2532,3429

748,1084,1896,2430,2890,2920,3185,3295,3632,3969,4150,4254,4504,
4731

GEJORDANFEDERAL#4%TEXACO<

G25,2532,3430

772,1156,1768,2295,-1,-1,2933,3138,3468,3810,3987,4084,4402,4629

ASHMON&HILLIARDFEDERALNO1-25

A25,2532,3332

1043,1390,2270,2855,-1,-1,3558,3900,4005,4363,4550,4650,[illegible],[illegible]70

COTTONDRAWUNITNO61%TEXACO<

C27,2532,3391

756,1130,1770,2300,2957,-1,-1,3040,3504,3845,4016,4118,4385,4607

JDSENAUSA#1%TENNECO<

J28,2532,3375

899,1258,1834,2341,-1,-1,2850,2941,3443,3782,3955,4057,4346,4560

JDSENAJR.USA#2%TENNECO<

D28,2532,3370

957,1332,1920,2548,-1,-1,2851,2961,3437,3773,3946,4048,4341,4561

COTTONDRAWUNIT#45%TEXACO<

C28,2532,3382

817,1173,1755,2275,-1,-1,2832,2974,3407,3750,3925,4028,4339,4581

COTTONDRAWUNIT#47%TEXACO<

U28,2532,3392

784,1168,1745,2270,-1,-1,2900,2950,3447,3789,3963,4075,4348,4568

COTTONDRAWUNIT#5%TEXACO<

T28,2532,3412

868,1225,1798,2306,-1,-1,2858,2955,3445,3783,3956,4058,4339,4559

COTTONDRAWUNIT#51%TEXACO<

X28,2532,3398

780,1140,1750,2270,-1,-1,2890,3011,3463,3807,4070,4083,4340,4575

COTTONDRAWUNIT#56%TEXACO<

N28,2532,3388

738,1118,1739,2276,-1,-1,2875,3012,3464,3806,3886,3989,4355,4576

COTTONDRAWUNITNO.54%TEXACO<

W28,2532,3386

812,1177,1750,2273,-1,-1,2866,2962,3460,3798,3969,4072,4350,4568

COHONDRAWUNITNO59%TEXACO<

Z28,2532,3386

768,1148,1739,2261,-1,-1,2870,2953,3470,3810,4028,4124,4365,4584

CONOCOFEDERAL#1-29%I.W.LOVELADY<

C29,2532,3366

1141,1485,-1,2532,-1,-1,-1,3025,3422,3259,3930,4032,4306,4527

COTTONDRAWUNIT58/TEXACO

T29,2532,3356

922,1305,-1,-1,-1,-1,2853,2995,3402,3742,3917,4019,4330,4551

HANKAMERNO1/CONTINENTALFEDERAL

H31,2532,3551

862,1208,2026,2492,3070,3114,-1,-1,3123,3762,3951,4050,4356,4588

RAYSMITH#1

S31,2532,3311

1075,1420,1980,2485,2725,2785,-1,-1,3290,3626,3773,3880,4135,4350

WESTATESPET.COOFTX,JENNINGS#1

W33,2532,3349

930,1307,1825,2375,3040,3060,-1,-1,3520,3840,4000,4105,4349,4570

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JENNINGSFEDERAL#33-1/HILL-MEEKER
M33,2532,3354
1042,1402,1998,2503,-1,-1,2910,3054,3493,3824,3987,4089,4365,4582
HALLFEDERAL"33"#1/HILL-MEEKER
H33,2532,3332
1054,1438,2059,2436,-1,-1,2870,3050,3444,3770,3936,4034,4307,4522
PERRYR.BASSFEDERALMUSI#1
J01,2533,3490
1200,1670,2577,3200,3551,3620,3620,4321,4321,4382,4565,4678,4745,
                                                            5200
HILL&MEEKERBASSFEDERAL#1
H05,2533,3480
1103,1433,2334,2906,3444,3493,-1,3732,3851,4237,4420,4530,4813,505
SANTANAPET.CO/ANNIEBASSFEDERAL#1
S08,2533,3457
1064,1427,2282,2813,3432,-1,3496,3730,3839,4196,4376,4470,4770,501
CURTISHANKAMER/MUSEFEDERAL#1
H11,2533,3424
1034,1541,2444,3035,3557,3580,-1,-1,3620,4362,4520,4620,4861,5115
SAMH.JOLLIFFEJR.#1/BASSFEDERAL
J18,2533,3497
985,1310,2469,2722,3191,3210,3376,3720,3819,4167,4335,4434,4676,
                                                            4915
CURTISHANKAMAFEDERALBASE#1
H20,2533,3431
1010,1345,2247,2827,3250,3273,3404,3743,3847,4177,4329,4430,4713,
                                                            4955
AMERICANQUASARPETCO./VACADRAW#1
A21,2533,3392
1006,1332,2295,2940,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1
GEORGEL.BUCKLESCO./FEDERALMARSHALNO1
B21,2533,-1
1038,1382,2260,2838,3312,3330,3390,3733,3832,4204,4333,4440,4710,
                                                            4963
TEXACOCO/COTTONDRAWUNITNO18
T22,2533,3414
1046,1123,1760,2300,2835,2870,3013,3240,3551,3886,4045,4150,4400,
                                                            4638
HILL&MEEKER/MUSEFEDERAL23#1
M23,2533,3353
1060,1400,2260,2811,3323,3350,3450,3790,3872,4248,4406,4470,4497,
                                                            5014
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R.B.FARRISPERRYFEDERAL

F24,2533,3359

1044,1460,2355,2947,3394,3423,-1,-1,3563,4330,4533,4642,4875,5125

KINGRESOURCESPANAMERICANFEDERALNO.1

K25,2533,3343

1043,1440,2298,2850,-1,3300,-1,3848,3947,4320,4485,4577,4871,5119

ROBERTA.DEANHARRYDICKSON#1

D27,2533,3320

1020,1382,2230,2780,-1,-1,-1,3735,3830,4190,4350,4460,4755,4995

TIDEWATEROILCO/ANNIER.BASSFEDERAL#1

T28,2533,3353

970,1308,2140,2700,3285,-1,3300,3669,3752,4096,4255,4358,4650,4895

TENNECOOILCO,W.H.JENNINGSINC.USA#1

T29,2533,3422

992,1381,2245,2750,3380,-1,3425,3778,3854,4180,4295,4375,4662,4907

TENNESSEEGASTRANSMISSIONRICHARDSON&BASSUSA#1

T31,2533,3386

738,1096,1915,2490,3000,3034,3120,3250,3743,4068,4232,4336,4578,
4810

NEILH.WILLSCONTINENTALSTATENO.1

W32,2533,3391

900,1208,2088,2650,3140,3170,3295,3540,3775,4108,4256,4350,4645,
4886

PUREOILCOMPANYREDHILLSUNIT#1

D32,2533,3332

873,1195,2045,2678,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1

ASHMONHILLIARDOILCO.STATE#1-36

A36,2533,3346

1035,1423,2291,2859,3480,-1,3508,3886,3982,4350,4515,4622,4875,512

MAXK.WILSONMARATHONSTATE#1

W36,2533,3325

963,1332,2222,2775,3272,3304,3447,3650,4010,4360,4535,4640,4860,
5105

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