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GEOTHERMAL

INTEGRATION OF GEOTHERMAL DATA ALONG THE BALCONES/OUACHITA TREND, CENTRAL TEXAS

Final Report

By
C. M. Woodruff, Jr.
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1983

Work Performed Under Contract No. AS07-79ID12057

University of Texas at Austin
Austin, Texas

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Bureau of Economic Geology
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INTRODUCTION

This report, all of which is a summary of several years of effort in delineating and assaying geothermal resources in Central Texas (see Appendix A), was funded by Department of Energy Contract No. DE-AS07-79ID12057. Specifically, it is a refinement of certain themes presented by Woodruff and McBride (1979). In that initial DOE-funded report, we recognized that thermal waters are obtained from several Cretaceous aquifers along the Balcones/Ouachita trend--a belt that extends from Val Verde County on the Mexican border, north to the Oklahoma boundary from Cooke County, and east to Bowie County. That initial report correctly identified four major geologic units that produce thermal waters: the Hosston/Trinity, the Paluxy, the Edwards, and the Woodbine aquifers. It also presented generalized lithic and hydrologic attributes of these formations. However, the specific controls on the thermal waters were merely speculated on, and many of the geologic and hydrologic depictions were incomplete, owing to lack of control or to inadequate documentation. Subsequent studies rigorously defined the geographic and thematic data that composed the two major sets of data: those for water temperature and water quality, and those pertaining to lithic attributes. The methods employed in this exercise of data management were detailed by Woodruff and others (1982a). An encyclopedia of these data along with digitized well locations was presented in appendices to this 1982 report. The statewide compilation of thermal wells and springs became the nucleus for the GEOTHERM data file that was submitted in final form to the U.S. Geological Survey, Menlo Park, CA, in August 1983. Although most of the research effort during this second year of study had a statewide scope, one section was dedicated to elucidating hydrologic factors along the Balcones/Ouachita trend. Moreover, one appendix (Woodruff and others, 1982b) focused on specific areas along the Balcones/-Ouachita trend: namely, the areas of special interest to the U.S. Air Force (USAF) in its search for alternate energy sources on military bases. Surveys performed in Val Verde, Bexar, and Travis Counties led to generalized assessments and subsequent feasibility studies that in turn resulted in a well being drilled on Lackland Air Force Base. This well will produce warm water for space heat and hot water for USAF training facilities. Further refinements of these data along parts of the Balcones/Ouachita trend were presented by Woodruff and others (1982c); in this presentation we examined the role of hydrodynamics on the localization of geothermal gradient anomalies (in Bexar County); on lineaments as indicators of possible "blind" structures beneath seemingly undeformed sedimentary strata--and hence on the location of possible controls on hydrothermal waters (in Travis, Williamson, and Milam Counties); and on the role of hydrodynamics on the localization of thermal waters (in Falls County). This report also presented a detailed picture of the status of geothermal resources in Dallas County.

From these studies, the following conclusions may be drawn:

1. Of the four Cretaceous formations that locally supply warm water, the basal sandstone unit--the Hosston/Trinity--is the most favorable target horizon as a geothermal resource. This is because it is more widespread, more uniform in thickness and in rock properties, and for a given depth range it produces waters that are typically hotter yet generally with lower dissolved solids than the other horizons.

2. Work on the Edwards Limestone in Bexar County and the Hosston Sandstone in McLennan County strongly suggests that upwelling of deep basinal waters contributes to geothermal attributes at these localities. For the Edwards in South-Central Texas and the Woodbine in northeast Texas, the high dissolved solids content of geothermal waters indicates a genetic relation with nearby oil fields in deeper parts of the adjacent basins. Questions remain, however, regarding the mechanisms of this upwelling.

This report presents data that address possible controls on warm-water resources. Data are presented on a series of maps, and interpretations appear in the brief text accompanying the maps. It is our thesis that structural controls provided by the Balcones Fault Zone on the west and by the Luling-Mexia-Talco Fault Zone on the east localize the warm waters. The ultimate controlling attribute is the foundered Ouachita structural belt, which, in turn, has controlled the orientation and magnitude of displacement of the superjacent normal fault systems. This thesis is supported by maps (in pocket) showing the following: Distribution of thermal waters measured in wells (see Appendix B) along the Balcones/Ouachita structural trend showing water temperature in °F, total depth of the well measured, water salinity in parts per million, and the geologic formation producing the water (Plate 1); structural contours on the base of the Cretaceous System showing the configuration of the Paleozoic Ouachita basement (Plate 2); structural configuration of the Balcones and Luling Fault Zone, Mexia and Talco Fault Zone, and foreland areas adjacent to the Ouachita Orogen using data from the Buda Limestone, Sligo Formation, and Ellenburger Group (Plate 3); Landsat lineaments and Bouguer gravity contours (Plate 4); and geothermal gradient contours of the Balcones/Ouachita trend based on thermal values from Paleozoic and selected Mesozoic formations (Plate 5).

DISTRIBUTION OF THERMAL WATERS

Thermal waters are defined as ground water that, when produced at the surface, has a temperature at least 10°C (18°F) above the local mean annual air temperature. This definition is at variance with that of the U.S. Geological Survey (USGS) (see Reed and others, 1983), whose nationwide geothermal assessment not only uses the minimum temperature criterion but also requires a geothermal gradient of 25° C/km. We do not adopt the gradient criterion because of uncertainty as to exactly where the water is entering the well-bore at depth. For most water wells, completion data are incomplete; even when data are complete, zones of multiple screening or (especially for carbonate aquifers) open-hole conditions further confuse the issue. Uncritical use of total depth drilled for calculating this geothermal gradient value gives a misleading (consistently low) reading.

The locations where geothermal waters are produced from Cretaceous aquifers along the Balcones/Ouachita trend extend from Lake Amistad in Val Verde County (the site of the only thermal spring along this trend) to the Bagwell vicinity in Red River County (Plate 1). Comparison to statewide structural/tectonic maps (Sellards and Hendricks, 1946; Ewing and others, in preparation) shows that the thermal wells are delimited by the Balcones Fault Zone from Kinney County north to Bell County. From Bell County north to Grayson County, Balcones faults die out and the main structural expression is monoclinal folds into the Gulf Coast Basin. There, the thermal wells have their greatest distribution along a dip-oriented line that is underlain by the eastern edge of the buried Ouachita belt. From Grayson County east, the southern extent of warm-water wells is delimited by the Talco Fault Zone. Along the entire Balcones/Ouachita trend, the locations of thrust faults mapped by Flawn and others (1961) appear to control local distribution of thermal wells. This control is not consistent, however, in that most thermal wells south of the San Marcos Arch lie coastward of the interior thrust zone, and there are no known thermal water wells across the San Marcos Arch in Comal, Hays, Guadalupe, and Caldwell Counties. From the San Marcos Arch north into Hill County, most thermal wells lie between the interior and frontal thrusts, and north of Hill County, the thrust belts become ill defined and thus their evident control on thermal wells is lost. The northeasternmost occurrence of thermal wells is along the trend of the buried Broken Bow/Benton Uplift. Probably some control is provided by Ouachita structures on the location of thermal waters in that area, but any direct control (such as migration of waters along thrust fault planes, and the like) is not documented. More likely, this basement control is an indirect one, as will be shown in the discussion of Plate 2.

From examination of aquifer distribution and the generalized location of thermal wells as presented by Woodruff and others (1982e), we conclude that any water-bearing stratum, at sufficient depth, will produce geothermal waters along this structural belt. This conclusion is partly substantiated by the localization of thermal waters from Tertiary aquifers immediately coastward of this belt in South Texas (see Woodruff and others, 1982a).

The inventory of thermal waters is a continuation of a process begun with the publication of the twenty-first annual report (Hill, 1901) of the U.S. Geological Survey. In that report, much attention was given to the artesian waters, and even at that early date, deep water wells had penetrated the thermal reaches of the aquifers that are of concern to us today. Hill correctly noted the thermal attributes of these waters, for at that time, the medicinal use of warm, mineralized waters was in its heyday. Hill's work is an invaluable baseline for subsequent research on these aquifers because in the course of our inventory no further information could be found on certain wells described by Hill. This regrettable loss of data reinforces a point made earlier during this project: "A well is a point source of information." It is necessary to carefully record the precise geographic location of these sites so that the accompanying tabular data will be meaningful. Presumably, the USGS GEOTHERM File provides this service for the benefit of future researchers.

STRUCTURAL CONTROLS--THE BALCONES/OUACHITA TREND

The Ouachita structural belt is the basement complex on which the Mesozoic stratigraphic complex was deposited (Plates 2 and 3). As noted by Woodruff and McBride (1979), this hinge zone controlled the geometry of major depositional systems--particularly the persistent break between fluvial/deltaic deposition on the west and offshore marine systems on the east. During Lower Cretaceous time the stable foreland structural setting west of the Ouachita foldbelt (Plate 5) was principally the site of fluvial depositional systems. These fluvial systems supplied sediment to a deltaic coastline along a hingeline formed by the rapidly subsiding Ouachita belt. Furthermore, the configuration of the eastern edge of the foreland (craton) acted as a massif that controlled the geometry of the Ouachita belt and subsequent Balcones faults. The structure of the craton is best exhibited by structural contours on the Ordovician Ellenburger Group (Plate 3). Structure along the Balcones Fault Zone is best displayed by contoured tops of Cretaceous formations. The abrupt thickening of the Mesozoic stratigraphic section (including documented Jurassic units) across the eastern part of this hinge probably was controlled by location of zones of maximum subsidence across the Ouachita hinge. Also the broad, graben-like structures noted at the surface in Central Texas between the Balcones and Luling-Mexia Fault Zones are surely a response to adjustments along this foundered trend.

The Ouachita structural belt (Plate 2) is well described by Flawn and others (1961). Although this research was conducted before the plate tectonics paradigm was developed, the descriptions are eminently valid and lend themselves to various constructs of structural evolution of the region in a plate tectonics context. There have been relatively few additional wells drilled into this complex since this 1961 assessment, so we have little additional insight to offer on the internal structure of the Ouachita trend. Thus, the complicated and highly interesting problems of thrust fault geometry and the localization of reservoir rocks beneath the thrust zones are not addressed here except obliquely; what little is offered here is in the section on Landsat lineaments and gravity data. What additional information we do offer is on the location and implications of igneous features along this zone, and on the evidence of local rift grabens.

Ewing and Caran (1982) conducted research on the so-called serpentine plugs along the Ouachita structural trend. Their work, which was partly supported by this geothermal project, attempted to categorize the area's igneous features as loci either of high heat flow or of upwelling waters--both of which would affect local geothermal resources. Ewing and Caran's unpublished inventory of these features included both buried and exposed examples whose remarkable linearity (especially the aligned plugs in Williamson County) suggest that they rose along certain major zones of crustal weakness. In addition, the composition of these igneous rocks--mafic alkalic--suggests a source perhaps in the upper mantle (at a depth of up to 60 km). Such data further support the hypothesis of a major crustal fracture zone. This zone may be part of a rift between the Paleozoic Ouachita basement terrane and other, still unidentified basement terranes farther east.

Flawn's work has been used in certain instances to refute the hypothesis that rifting occurred within the Gulf Coast Basin. Specifically, the presumed identification of pre-Cretaceous/post-Ouachita undeformed rocks has been used by Meyerhoff (1976) to suggest the presence of a post-Ouachita Permian seaway across the entire Gulf Basin. Morgan (1952) has been cited in this regard because of his identification of a Permian fusulinid among the red beds in the Pagenkopf #1 Blum well in Bexar County. Flawn and others (1961) noted problems with these "post-Orogenic" deposits and suggested several possible explanations. For example, the anomalous fossils may be due to reworking and redeposition during Mesozoic time of Permian rocks from farther inland in Texas. Part of this geothermal assessment also addressed the problem of these red beds, and as reported by Woodruff and others (1982b), Rb/Sr age dates of the most fine-grained clay fractions within these red beds in Bexar County indicate ages of deposition (clay diagenesis) as young as Triassic (El Shazly, personal communication, 1981). Furthermore, subsequent analysis of subsurface data in Bexar County indicates that other wells also penetrate a red bed sequence above the metamorphic rocks.

Three such wells align along a northeast-southwest trend that may be a buried pull-apart zone similar to the Triassic rift grabens within the Newark Group of the Eastern United States.

Plate 2 depicts the structural elevations on the top of the Ouachita complex as far east as it can be delineated with confidence. Generally, the basinward limit of the complex is the Luling-Mexia-Talco Fault Zone, and in some areas it is much farther inland (such as in Kaufman and Navarro Counties). This map also depicts a rough approximation of the inland extent of Jurassic strata, but such a line is largely conjectural owing to the apparent depositional continuity and lithic similarity between the Cretaceous Hosston and the (presumed) Jurassic Schuler Formations.

THE BALCONES/OUACHITA TREND--REMOTELY SENSED

An integration of surface and subsurface structural grain along the belt is provided by depictions of lineaments and Bouguer gravity data along the Balcones/Ouachita trend (Plate 4). The lineaments are the same as those presented by Woodruff and others (1981); the gravity information is derived from magnetic tapes compiled from various sources by the National Oceanic and Atmospheric Administration (NOAA).

Lineaments represent surface grain, and obvious alignments occur along topographic escarpments and stream courses. Insofar as escarpments and drainageways lie along structural boundaries, lineaments are documentable expressions of surface structures. But the role of lineaments in expressing subsurface structure is largely conjectural (Woodruff and Caran, 1982). Nonetheless, in certain areas we have used lineaments to document buried fault zones having no previously recognized explicit surface expression (Woodruff and Caran, 1981). Moreover, lineaments mark the Lower Cretaceous shelf edge in parts of South Texas and in at least one instance, lineaments mark probable circular structures around a buried salt dome (Dilworth Dome in McMullen County). Besides these few instances of documented evidence of buried structure and the more pervasive expression of topographic features that may or may not be structurally controlled, there are a large number of lineaments of unknown affinity. Some of these lineaments may be essentially meaningless: they may be artifacts of processing or figments of the imagination of the geologists conducting the survey. In these instances the lineaments constitute background misinformation or "noise," as opposed to the desired "signal" that relates to geologic features. The ambiguity in assessing lineaments is further compounded by the fact that there may be several generations of "cause" for any given feature. That is, a lineament that expresses a major fault-line scarp at the surface may also indicate a buried (perhaps basement controlled) fault zone or other such discontinuity. These and other problems have been discussed at length by Woodruff and others (1982a, b, c, d), by Woodruff and Caran (1982), and by Caran and others (1982).

As pointed out by Woodruff and Caran (1982), and by Caran and others (1982), one set of lineaments is of special interest in an overthrust belt. These are the features that are relatively long and persist within certain discrete areas normal to or at an oblique angle to the prevailing structural strike. These are the cross-strike discontinuities as discussed by Wheeler (1980), and they are surface expressions of zones where the thrust belt separates into component blocks, generally along tear faults. Commonly these horizontal adjustments have occurred where the thrust belt encounters either vertical or horizontal discontinuities, such as the presence of a crystalline basement massif (as provided by the Llano Uplift or the Devils River Uplift).

Gravity contours represent subsurface grain. As with the lineaments, however, there are components of both surface and subsurface structures represented by gravity data. Moreover, there are probably certain elements of "noise" here as there are with lineaments. In general, however, gravity data represent a more codified realm than do the lineaments: The major variables affecting gravity are taken into account in the reduction of the data, and, although generalized, these contours should be a fairly reproducible depiction of areal variations of crustal mass. These contours invite certain interpretations: In general, basinal areas are represented as relatively low gravity areas; uplifts are relatively high. Also, in a thrust belt, a relatively low area occurs where the mass of sedimentary rock is excessive--as occurs in a zone of imbricated thrust sheets or a zone of anomalous thickness owing to excessive dip or complex folding. Hence, the frontal zone of the Ouachita orogen is indicated as a belt of low-gravity anomalies. This belt is clearly recognized from northwestern Medina County to areas with low gravity values centered in northeastern Bexar County. Other similar closures occur in central Hays County, in southeastern Coryell County, and in south-central Choctaw County, Oklahoma, immediately north of Lamar County. The distinction between certain foreland basins and thickening of the Ouachita belt may be vague in places, and this is indicated by the broad, low gravity anomaly across Coryell County. This lack of distinction is understandable, in that the foreland basins would be expected to be the locus of increased thickness of the orogen, because they would be the site of greatest sedimentation adjacent to the orogenic belt. Hence, subsequent horizontal deformation would more likely result in thrusting across these basinal areas. Elsewhere, the thrust belt would tend to break around structurally uplifted areas. There should, then, be cross-strike lineaments separating the gravity highs and adjacent lows along strike.

In fact, Plate 3 shows several examples of cross-strike linear features lying along or near the areas of inflection of gravity data. One such correlation occurs near the Kinney-Val Verde county line where a north-trending lineament zone marks the approximate eastern limit of the Devils River Uplift (high-gravity anomaly). A northwest-trending zone of lineaments also occurs across the Bandera-Medina county line. This trend marks the low-gravity (-500 mgal.) anomaly that probably represents a salient of the frontal zone of the orogen into the craton. The projection of this lineament zone to the northwest also lies along a gravity inflection that may indicate basement influences along the northeastern margin of the Kerr Basin. Another elongate zone of lineaments extends from southern Blanco County, southeastward with minor offsets, through central Hays County and roughly along the course of the San Marcos River into Gonzales County. This zone of lineaments lies along the flanks of several closures: It extends along the northern flank of a positive gravity anomaly (-100 to 0 mgal.) in Blanco County. From there, it extends along the southeastern margin of the gravity low (-450 mgal.) that (as already mentioned) probably represents a thickening of relatively low density crustal materials along the frontal zone of the orogen. Farther to the southeast, the same lineament zone extends across a relatively low gravity "saddle" within what is a relatively high-gravity closure along the inner part of the Gulf Coast Basin. Another diffuse zone of strike-oblique lineaments occurs near the Brazos-Colorado divide from Burnet County southeast into Williamson and Travis Counties. This lineament zone lies along the flank of a major trend of decreasing gravity, probably resulting in a series of buried, basement-displacing faults that mark the northeast edge of the Llano Uplift. Other gravity data collected by Watkins (1961) have been used by Caran and others (1981) to suggest a major crustal discontinuity along this trend. In much of North-Central Texas there is no clear correlation between cross-strike lineaments and gravity inflections. Lineaments do mark the edges of the Muenster Arch, the Sherman Syncline, and the Preston Anticline, and these features also coincide with gravity highs and lows. However, these structures can, at least in part, be denoted using surface geology. Questions remain as to basement discontinuities beneath these structures. Farther east, there is a southwest-trending gravity high (+50 mgal) that lies along the axis of the Benton and Broken Bow Uplifts, and this zone coincides with a semicircular trend of lineaments that roughly delineate the structure. Although these lineaments extend oblique to surface strike, they are not cross-strike features in the usual sense, but instead are examples of subtle surface expressions of buried structures.

There is one other major trend that is demonstrable on the basis of both lineaments and gravity data. This trend consists of some of the largest positive gravity anomalies of the entire region and it occurs, surprisingly, along the inner reaches of the Gulf Coast Basin. This belt extends from southeastern Uvalde County northeast into Hunt County. The belt is displaced across Atascosa County along the extension of one of the cross-strike lineaments, and is again noted in central Wilson County, in east-central Bastrop County, through central Falls County, and along the Mexia Fault Zone. There is a prominent offset to the east into Freestone County, in northeast Kaufman County, and into Hunt County, where it is obscured by a lack of data and by the presence of shallow Ouachita basement along the Benton and Broken Bow Uplifts in Lamar and Red River Counties. This high-gravity trend lies within an area where the Ouachita belt is no longer penetrated by wells (at least partly caused by the abrupt thickening of the Mesozoic section). These gravity highs lie generally along one of the coastward fault zones: Luling, Jourdanton-Pleasanton, Fashing, and Mexia. Also--especially in South Texas and in part of Central Texas--these anomalies coincide with the location of buried igneous features. For the most part, lineaments extend parallel to the axis or the flank of these positive anomalies. Locally, offsets in the gravity patterns occur along the trend of cross-strike discontinuities. As pointed out earlier, the Brushy Creek lineament zone discloses a previously unmapped buried fault zone penetrated in the subsurface by Cretaceous igneous plugs. This zone lies along the flank of the trend of high gravity anomalies. These data suggest a major crustal break. And since we know that the sedimentary column has abruptly thickened in this area, we can speculate that the high gravity values represent a concentration of much denser rocks within the basement complex. Such an anomaly might be an indicator of very thin continental crust over denser mantle material, or it may indicate a zone of rifting where oceanic crust lies beneath the sedimentary column. Available seismic data do not support the rift hypothesis, however. Another possible cause may be a basement uplift within the crystalline part of the Ouachita belt--a feature similar to the Waco Uplift (which lies northwest of this anomalous gravity trend). Of these speculations, we favor a fundamental crustal break theory that involves the eastern edge of the Ouachita orogen.

GEOTHERMAL GRADIENTS

Plate 5 is a modification of the depiction of statewide geothermal gradients contoured mostly using data from key carbonate units (Woodruff and others, 1983). The map contains additional data not included on the statewide depiction contoured along the Balcones/Ouachita trend. These new data fill in areas along parts of the Balcones/Ouachita trend where there are no data for the intervals depicted on the statewide map. Unfortunately, much of the central and southern reaches of the Balcones/Ouachita trend are too shallow (less than 2,000 ft deep) for valid geothermal gradient data even from readings in the buried basement complex. Hence, contours on the buried crystalline terranes along the Ouachita trend result in a discontinuity in geothermal gradients. For those areas where data do exist, changes in thermal conductivity also occur, but the contours as drawn are probably not affected by hydrodynamic processes, as the crystalline rocks do not transmit water.

These additional data show that the Balcones/Ouachita trend has anomalously high geothermal gradients. Some upwelling of basinal waters may be suggested by these data, notwithstanding the prevalent metamorphic rock type from which the bottom-hole temperatures were obtained. These high gradients are especially marked where the several contoured horizons are examined in relation to producing oil fields along parts of the Luling and Mexia Fault Zones in Central Texas. Furthermore, areas of highest geothermal gradients measured from both the basement complex and the overlying stratigraphic column lie along fault zones and locally along the areas penetrated by igneous plugs. These correlations indicate that the faults and the cross-cutting igneous features provide avenues along which the thermal waters ascend. Certain of the upwelling waters are briny, and some contain entrained hydrocarbons--hence the oil fields associated with the plugs. Moreover, in the area south of San Antonio, recent studies have documented that a high concentration of base metals occurs in the bad-water zone of the Edwards and that fluorite is supersaturated in some of these saline waters, as evidenced by fluorite precipitation in certain well bores south of San Antonio. Note that the northern zone of high gradients along the eastern margin of the Balcones and Ouachita trend corresponds to the Brushy Creek lineament zone in Williamson and Milam Counties. Another high-gradient area occurs at the junction of Hill, Johnson, and Ellis Counties, and closure of 1.50° F/100 ft--a value still above background levels--trends east-west across Fannin County.

The main correlation noted among all these data is that high geothermal gradients tend to occur along fault zones. This supports the thesis of upwelling of deeply circulating waters along faults. Otherwise there is no clear correlation of gradient anomalies with uplifts and basins. We expected to see uplifts as the loci of relatively high gradient areas, and this occurs in certain areas, for example, along the Edwards Arch. However, along the Muenster Arch, the gradients are relatively low, and nearby along the trough of the Fort Worth Basin, the gradients are high. Closures of high geothermal gradient contours within the deep parts of basins may correlate with local structures and the presence of oil fields. Resolution is too indistinct at the scale used here to ascertain a definite correlation.

CONCLUSIONS

This report summarizes and provides final maps expanding on data presented in earlier reports (Table 1) that addressed the potential for low-temperature geothermal resources in Texas. Conclusions are as follows:

(1) Geothermal resources exist within Cretaceous aquifers along the Ouachita/Balcones structural trend in Texas.

(2) Four aquifers contain waters with acceptable temperatures, salinities, quantities, and drilling depths. These are the (a) Hosston/Trinity, (b) Paluxy, (c) Edwards, and (d) Woodbine aquifers.

(3) The occurrence and locations (distribution) of aquifers with geothermal potential were controlled by two factors. (1) The general tectonic setting provided the hingeline between the stable foreland (craton) on the west and the less stable, structurally deformed Ouachita structural belt on the east, a setting which dictated in part, the types of Cretaceous depositional systems deposited along the hingeline. These fluvial and deltaic systems controlled development of low-temperature geothermal aquifers. (2) The younger Balcones Fault System provided necessary structural displacement resulting in local occurrences of thermally and chemically acceptable waters. Balcones faults (a) provide the conduits or plumbing system whereby geothermal waters migrate from depths into shallower reservoirs, and (b) may impede updip migration, prevent mixing of anomalously warm water with low-temperature ground water, and hence, localize economically feasible geothermal reservoirs.

(4) Exploration and regional assessment of low-temperature geothermal resources can be enhanced by use of geophysical methods, interpretation of

aerial photograph lineaments, and maps of geothermal gradients because of the coincidence of lineaments and trends of geothermal gradients with faults mapped on Cretaceous formations.

(5) Geothermal gradient values range from .75 to 2.0, and appear mainly to be controlled by faults.

TABLE 1. SUMMARY OF DELIVERABLES FROM CONTRACT NO. DE-AS07-79ID12057

Item no.	Task no.	Description	Transmitted
1	1/Mod 0	Quantitative hydrologic assessment of the Hosston/Trinity, Paluxy, and Woodbine aquifers	5/20/82
2	2/Mod 0	Statewide lineament survey	5/20/82
3	3/Mod 0	Apply lineament survey to faults affecting 3 aquifers	5/20/82
4	4/Mod 0	Statewide water temperature measurements, Balcones, Trans-Pecos, and High Plains	4/30/82
5	5/Mod 0	Statewide geothermal gradient map	5/20/82
6	6/Mod 0	Data to GEOTHERM file	4/30/82
7	7/Mod 0	User geothermal map	5/28/82
8	8/Mod 1	Geothermal potential--selected military bases	5/20/82
9	1/Mod 2	Statewide water temperature measurements	4/30/82
10	2/Mod 2	Geologic/hydrologic assessments (Dallas, Austin, Marlin) investigative report	**
11	3/Mod 2	Lineament survey digitization and analysis--Report on use of technique for geothermal exploration--Texas sediments	7/19/82
12	4/Mod 2	Continue military base study in Val Verde, Bexar, and Travis Counties	5/20/82
13	1/Mod 4	Complete geothermal user map	5/28/82
14	2/Mod 4	Continue well temperature measurements and add to state geotherm file	4/30/82
15	3/Mod 4	Compile state geothermal technical map	**
16	4/Mod 4	Integrate Balcones/Ouachita Trend data--thematic maps	**

**Included with this submittal.

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APPENDIX A

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APPENDIX B

THERMAL WELLS AND SPRINGS IN TEXAS--
An Abstract of Data Submitted to
U.S. Geological Survey's
GEOTHERM File

INTRODUCTION

As a major effort in the DOE-sponsored statewide geothermal resource assessment, we conducted a survey of wells and springs that produce or have produced thermal ground water in Texas. Our criterion for "thermal" is water, which at the point of discharge, is at least 10°C (18°F) above mean ambient air temperature. This survey includes data compiled from existing files--mainly from the Texas Department of Water Resources--and data collected in the field; 1,122 wells have been identified in 104 counties as being thermal. These data have been transferred via computer tape to the U.S. Geological Survey, Menlo Park, California, where they are part of the GEOTHERM data base. The tabulation that follows is an abstract of the information stored in GEOTHERM (Bliss, 1983).

The tabulation of these 1,122 wells and springs is listed by county, and each data point is described in 7 columns that contain identifying numbers, location by latitude and longitude in degrees and minutes expressed as a fraction, and the key parameters of well depth in meters, water temperature in degrees Celsius, and a code denoting the aquifer that produces the water.

The BEG (Bureau of Economic Geology) county number is an arbitrary number used in this project for mapping purposes. These numbers are on file with maps that depict the well locations. The map depicting Geothermal Resources of Texas (Woodruff and others, 1982) also uses these numbers along with the two-letter county codes (that appears herein before the county name) for a subset of these data. The TDWR (Texas Department of Water Resources) State Well Number is a numbering system established by the TDWR that identifies water wells statewide with a unique number that connotes location (fig. 1). The two-letter county code is a necessary part of this state well number to ensure uniqueness. Well depth is generally total depth drilled and not necessarily the depth from which the water is produced, although this is not always true, and hence the value is ambiguous. If the data point is a spring, "S" is denoted in this column. "ND" denotes no data available. Aquifer code is a listing devised by TDWR, and

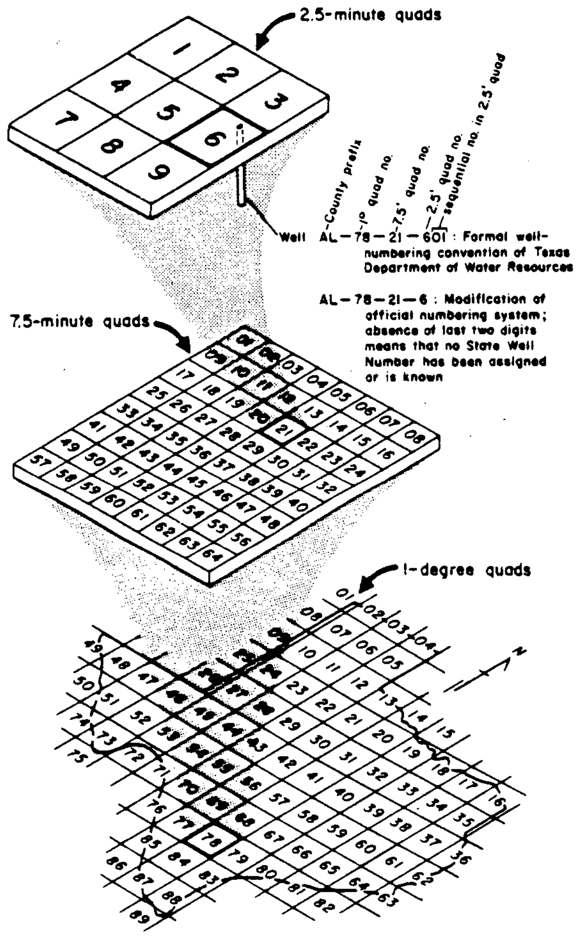

Figure 1. Texas state well numbering convention (modified from Texas Department of Water Resources).

an explanation of these codes is presented in an appendix. If the aquifer is unknown this space is left blank.

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BEG County No.	TDWR State Well No.	North Latitude	West Longitude	Well Depth (m)	Water Temp. (°C)	Aquifer Code
			AA - ANDERSON COUNTY			
08	38-11-603	31-47.611	95-39.820	472.4	30.6	190
09	38-11-901	31-45.747	95-39.661	486.5	30.0	190
10	38-11-903	31-45.186	95-37.914	594.4	33.3	190
12	38-20-604	31-40.955	95-31.315	555.3	35.0	190
13	38-20-801	31-37.785	95-34.834	323.1	28.9	030
14	38-21-704	31-38.094	95-28.876	554.1	36.1	190
15	38-21-705	31-38.149	95-29.264	551.7	36.1	190
16	38-29-105	31-37.278	95-28.712	586.7	36.7	190
			AD - ANGELINA COUNTY			
01	37-42-304	31-21.994	94-46.633	429.8	33.9	---
			AL - ATASCOSA COUNTY			
12	78-18-201	28-43.034	98-47.612	146.3	31.7	164
13	78-18-601	28-41.540	98-45.657	764.1	33.3	030
14	78-18-602	28-41.082	98-45.192	760.5	40.6	030
15	78-19-301	28-43.880	98-38.882	475.5	35.6	140
16	78-20-703	28-38.856	98-35.480	666.0	39.4	140
17	78-10-606	28-49.152	98-45.471	590.4	37.8	030
18	78-11-402	28-47.822	98-43.578	701.0	38.3	030
19	78-11-603	28-49.191	98-38.417	762.0	37.8	030
20	78-11-604	28-48.363	98-38.735	746.8	41.1	030
21	78-12-501	28-48.894	98-34.060	783.3	35.6	030
22	78-20-301	28-44.680	98-30.205	906.8	48.3	030
24	78-13-701	28-47.343	98-29.738	291.4	31.7	164
25	78-13-702	28-47.317	98-29.751	523.3	36.7	140
26	78-13-501	28-48.534	98-27.187	403.9	33.3	140
27	78-13-703	28-46.733	98-28.215	665.4	40.0	140
28	78-14-401	28-49.417	98-22.146	487.7	38.9	140
29	78-14-701	28-46.873	98-20.171	1097.3	42.8	030
30	78-14-801	28-45.289	98-18.265	1216.8	58.9	030
31	78-14-802	28-46.360	98-18.632	1116.5	37.8	030
32	78-15-505	28-48.575	98-11.013	1173.5	54.4	030
33	78-15-504	28-48.643	98-10.505	1318.6	68.3	030
34	78-15-805	28-47.064	98-10.270	1328.6	60.0	030
35	78-22-202	28-44.599	98-18.497	1259.4	46.7	030
36	78-22-201	28-43.719	98-18.235	1223.8	47.2	030
37	78-23-101	28-44.488	98-14.665	1280.2	61.7	030
38	78-23-204	28-44.775	98-12.234	1270.7	63.9	030
39	68-50-201	29-13.825	98-47.875	725.1	35.6	066
40	68-50-302	29-13.964	98-46.624	761.4	41.0	066
41	68-50-301	29-13.483	98-45.279	764.1	32.5	066

BEG County No.	TDWR State Well No.	North Latitude	West Longitude	Well Depth (m)	Water Temp. (°C)	Aquifer Code
42	68-51-101	29-13.294	98-44.286	809.5	41.0	066
44	68-60-843	29-00.131	98-34.154	501.4	31.1	030
45	68-61-807	29-01.179	98-26.380	402.3	34.4	030
46	68-61-802	29-00.402	98-26.258	402.3	31.7	030
47	68-61-902	29-00.945	98-23.864	472.4	33.3	030
48	68-62-403	29-03.885	98-22.303	420.9	31.1	030
49	78-02-602	28-56.647	98-47.014	414.5	32.2	030
50	78-02-903	28-54.873	98-46.059	426.7	32.2	030
51	78-03-405	28-56.698	98-44.031	426.7	37.8	030
52	78-03-408	28-56.199	98-43.772	533.4	34.4	030
53	78-03-710	28-54.524	98-43.799	506.9	33.3	030
54	78-03-707	28-53.666	98-42.537	478.5	35.6	030
55	78-03-807	28-53.574	98-40.516	670.6	37.2	030
56	78-03-503	28-56.226	98-41.887	381.0	32.8	030
57	78-03-507	28-56.662	98-41.026	469.4	33.3	030
58	78-03-202	28-57.840	98-40.445	456.0	34.4	030
59	78-03-605	28-55.167	98-39.544	518.2	33.3	030
60	78-03-606	28-55.359	98-39.134	490.4	33.3	030
61	78-03-901	28-53.049	98-38.236	556.6	35.6	030
62	78-04-703	28-53.189	98-37.370	579.1	33.9	030
63	78-04-204	28-58.598	98-33.164	444.4	32.2	030
64	78-04-206	28-58.358	98-32.770	426.7	31.7	030
65	78-04-205	28-58.654	98-32.811	428.2	31.7	030
66	78-04-303	28-59.160	98-30.849	426.7	32.2	030
67	78-04-602	28-56.600	98-31.818	458.7	33.3	030
68	78-04-803	28-54.368	98-32.925	597.4	36.7	030
69	78-04-905	28-54.736	98-31.593	579.1	32.2	030
70	78-04-804	28-53.326	98-34.235	614.8	33.3	030
71	78-04-805	28-52.775	98-34.371	662.3	35.6	030
72	78-04-813	28-53.445	98-34.726	585.5	36.1	030
73	78-05-117	28-59.598	98-29.201	586.7	32.2	030
74	78-05-111	28-58.960	98-28.747	359.7	31.7	030
75	78-05-101	28-58.527	98-29.334	472.4	33.3	030
77	78-05-104	28-57.645	98-29.546	518.2	36.1	030
78	78-05-407	28-57.393	98-27.778	553.8	35.0	030
79	78-05-405	28-56.978	98-27.795	533.4	35.0	030
80	78-05-502	28-57.360	98-27.110	524.9	35.6	030
81	78-05-211	28-57.503	98-25.716	579.1	35.6	030
82	78-05-304	28-58.858	98-23.031	588.3	37.2	030
83	78-05-305	28-57.649	98-23.007	579.1	37.8	030
84	78-05-308	28-58.686	98-22.736	579.1	33.9	030
86	78-05-605	28-56.988	98-24.634	646.2	38.3	030
88	78-05-802	28-54.233	98-27.508	912.3	39.4	030
89	78-05-703	28-53.592	98-28.192	457.2	32.2	140
90	78-06-401	28-56.533	98-20.667	612.6	38.9	030
91	78-06-503	28-56.089	98-18.526	792.5	39.4	030
92	78-06-603	28-56.593	98-17.133	269.7	33.9	140
93	78-06-702	28-54.318	98-22.229	1219.2	44.4	030

BEG County No.	TDWR State Well No.	North Latitude	West Longitude	Well Depth (m)	Water Temp. (°C)	Aquifer Code
94	78-06-803	28-54.618	98-19.875	1432.6	40.6	030
95	78-06-802	28-53.311	98-17.791	1188.7	48.9	030
96	78-06-901	28-53.381	98-17.320	973.8	46.1	030
97	78-06-903	28-53.433	98-16.987	1066.8	44.4	030
98	78-06-906	28-52.852	98-16.083	925.1	46.7	030
100	78-10-305	28-50.350	98-45.167	1066.8	44.4	190
101	78-11-105	28-51.502	98-44.781	463.3	36.1	030
102	78-11-101	28-51.731	98-42.956	569.7	35.6	030
103	78-11-207	28-51.618	98-42.446	607.5	33.3	030
104	78-11-205	28-51.603	98-41.524	1089.7	45.6	030
105	78-12-105	28-50.843	98-35.845	408.4	31.1	140
106	78-12-201	28-50.868	98-34.240	632.5	36.7	030
107	78-12-302	28-51.402	98-31.551	661.4	32.2	030
108	78-14-101	28-51.333	98-22.202	365.8	33.3	140
109	78-14-102	28-51.691	98-20.876	274.3	32.8	052
111	78-14-201	28-52.404	98-18.432	1005.8	43.3	030
112	78-14-302	28-50.598	98-17.057	1036.3	48.9	030
113	78-15-301	28-50.260	98-09.063	1463.0	65.6	030
115	78-04-304	28-58.069	98-32.502	457.2	33.3	---

AS - BANDERA COUNTY

19	68-17-4	29-41.178	98-58.092	128.0	28.9	408

AT - BASTROP COUNTY

21	58-63-606	30-02.733	97-09.496	264.6	30.0	030

AW - BEE COUNTY

01	79-18-8	28-39.722	97-47.717	283.5	31.1	132
02	79-35-7	28-24.113	97-44.956	ND	35.0	---
03	79-35-701	28-24.088	97-44.923	ND	35.0	132
04	79-34-901	28-24.216	97-45.023	485.2	34.0	132
05	79-35-702	28-23.922	97-44.188	496.2	34.5	132

AX - BELL COUNTY

02	58-05-902	30-52.772	97-24.720	737.9	38.9	269
07	40-62-801	31-01.340	97-18.319	719.3	35.0	269
08	40-62-102	31-05.876	97-22.201	555.3	35.6	269
11	40-54-401	31-11.594	97-20.778	505.4	34.5	178
14	40-54-601	31-12.095	97-17.373	558.7	37.2	269
15	40-61-508	31-04.560	97-26.304	390.4	30.0	269
17	58-07-701	30-54.837	97-13.618	968.7	46.7	269

BEG County No.	TDWR State Well No.	North Latitude	West Longitude	Well Depth (m)	Water Temp. (°C)	Aquifer Code
18	58-05-901	30-52.689	97-24.238	607.5	35.0	276
20	58-04-103	30-58.817	97-36.253	233.8	30.6	295
21	58-06-601	30-56.910	97-16.322	964.1	46.7	178
22	58-07-301	30-59.902	97-09.522	1092.4	52.8	269
27	40-62-401	31-04.439	97-20.685	708.1	36.7	269
51	58-06-102	30-59.160	97-21.788	673.6	35.0	269
55	40-62-501	31-03.056	97-19.737	681.5	35.0	269
56	40-54-5	31-11.283	97-19.118	557.2	36.3	269

AY - BEXAR COUNTY

BEG County No.	TDWR State Well No.	North Latitude	West Longitude	Well Depth (m)	Water Temp. (°C)	Aquifer Code
12	68-44-6	29-19.008	98-30.646	1366.1	48.9	---
24	68-50-304	29-14.444	98-45.488	659.9	37.8	284
26	68-43-703	29-15.126	98-42.957	618.7	35.0	066
27	68-43-810	29-15.594	98-42.496	566.9	35.0	066
28	68-43-816	29-16.559	98-41.393	607.5	35.0	066
29	68-43-809	29-16.003	98-41.448	580.0	35.6	066
30	68-43-813	29-16.247	98-40.087	548.6	36.1	066
31	68-43-812	29-17.078	98-41.335	548.6	34.4	066
32	68-43-901	29-16.728	98-38.678	693.1	38.3	066
34	68-51-201	29-15.006	98-40.661	678.5	41.1	066
35	68-52-405	29-11.763	98-35.271	124.4	34.4	190
36	68-43-504	29-17.794	98-41.066	533.4	30.0	066
38	68-43-503	29-17.793	98-39.906	611.1	31.1	066
42	68-44-210	29-20.014	98-34.065	509.6	32.2	066
43	68-44-503	29-18.797	98-34.070	731.5	37.2	066
44	68-44-502	29-18.131	98-33.318	563.9	41.5	066
48	68-45-302	29-21.710	98-22.773	522.7	38.9	066
49	68-45-802	29-15.745	98-26.132	744.9	47.0	066
50	68-45-901	29-15.471	98-22.999	892.1	47.8	066
56	68-44-3	29-20.753	98-30.785	574.5	41.1	066
57	68-45-101	29-21.913	98-28.250	572.4	39.6	066
58	68-45-803	29-15.711	98-26.075	779.7	47.0	066
59	68-43-610	29-17.815	98-39.658	565.7	33.5	066
62	68-44-3	29-20.110	98-30.874	667.5	40.5	066
63	68-45-2	29-21.755	98-27.822	640.1	37.8	066
66	68-44-6	29-18.062	98-30.834	459.0	37.8	066
67	68-44-8	29-16.244	98-34.801	717.8	43.5	066
68	68-44-8	29-16.321	98-33.976	ND	40.5	066
69	68-51-202	29-15.021	98-41.082	667.5	39.4	066
70	68-43-9	29-16.715	98-38.596	1377.1	55.6	178
73	68-37-7	29-24.027	98-29.214	ND	26.5	---
76	68-43-702	29-15.320	98-42.596	626.4	38.0	066
78	68-44-405	29-18.362	98-36.321	609.6	30.5	066
79	68-44-401	29-19.048	98-37.012	467.0	28.0	066
80	68-51-102	29-13.603	98-42.612	720.2	42.5	066
82	68-43-814	29-17.444	98-40.599	579.1	33.0	066
83	68-44-6	29-18.127	98-30.109	ND	34.5	---

BEG County No.	TDWR State Well No.	North Latitude	West Longitude	Well Depth (m)	Water Temp. (°C)	Aquifer Code
84	68-43-817	29-16.789	98-41.763	594.1	35.	066
85	68-43-806	29-16.725	98-42.085	575.2	29.	066
87	68-44-215	29-21.040	98-34.641	357.8	26.5	066
88	68-44-207	29-21.069	98-34.459	513.9	27.0	066
89	68-43-815	29-16.870	98-41.767	686.1	35.0	066
90	68-43-807	29-16.521	98-40.305	698.6	36.0	066
91	68-43-805	29-16.830	98-40.993	669.0	34.	066
93	68-43-608	29-18.750	98-39.007	513.0	29.0	066
94	68-43-607	29-18.936	98-38.994	630.3	29.5	066
95	68-43-7	29-17.183	98-43.443	658.4	33.0	066
97	68-44-403	29-19.710	98-35.573	542.8	24.8	066
98	68-45-2	29-21.049	98-25.298	675.1	40.0	066
99	68-44-5	29-18.019	98-34.173	538.6	39.5	066
112	68-45-3	29-22.439	98-23.944	538.6	41.7	066
118	68-38-301	29-27.977	98-16.025	260.3	32.2	066
122	68-38-101	29-27.839	98-21.791	274.9	31.1	066
125	68-43-9	29-16.763	98-38.189	531.0	39.4	066
127	68-45-301	29-22.376	98-23.948	664.2	42.2	066
			AZ - BLANCO COUNTY			
02	57-52-903	30-08.526	98-30.181	85.3	33.3	319
03	57-54-604	30-12.632	98-17.210	51.5	31.1	050
			BJ - BRAZOS COUNTY			
02	59-20-564	30-41.350	96-33.273	457.2	33.8	032
03	59-21-205	30-43.870	96-25.888	877.8	47.1	404
05	59-21-714	30-38.638	96-28.239	932.7	47.2	404
06	59-22-401	30-40.932	96-22.266	625.8	38.9	032
07	59-21-1	30-43.301	96-27.742	878.4	46.5	404
08	59-21-207	30-44.654	96-27.212	832.1	44.5	404
09	59-21-208	30-44.448	96-26.816	863.8	45.0	404
10	59-21-209	30-43.737	96-27.127	873.9	46.0	032
12	59-21-303	30-42.902	96-24.500	899.2	47.2	404
13	59-21-723	30-39.273	96-28.824	963.2	48.3	404
			BK - BREWSTER COUNTY			
01	52-29-801	30-32.125	103-26.518	518.2	28.9	212
02	73-44-501	29-19.630	103-33.231	243.8	40.0	236
03	72-49-4	29-10.583	102-59.931	ND	41.1	---
04	72-49-4	29-10.718	102-59.718	ND	40.0	---
05	72-49-5	29-10.535	102-57.475	ND	36.1	---
06	72-19-2	29-43.326	102-41.311	ND	32.2	066
07	52-54-6	30-12.149	103-15.850	3230.9	27.0	---

BEG County No.	TDWR State Well No.	North Latitude	West Longitude	Well Depth (m)	Water Temp. (°C)	Aquifer Code
08	73-44-4	29-19.165	103-36.285	243.8	41.8	---
10	72-20-2	29-44.723	102-32.818	ND	32.2	---
11	72-13-9	29-47.373	102-22.630	ND	32.2	066
			BP - BROOKS COUNTY			
02	87-08-102	26-58.276	98-05.989	487.7	36.1	132
			BR - BROWN COUNTY			
02	41-17-502	31-42.070	98-57.512	732.1	41.2	070
04	41-18-930	31-37.863	98-46.800	43.6	28.9	180
06	42-39-303	31-29.292	99-09.332	448.1	33.2	070
			BS - BURLESON COUNTY			
03	59-27-714	30-31.728	96-42.717	400.5	30.0	030
04	59-28-202	30-37.392	96-32.471	487.7	31.1	032
06	59-28-905	30-31.155	96-31.713	475.5	32.8	140
07	59-28-906	30-31.400	96-31.892	585.2	38.9	164
08	59-29-452	30-34.857	96-29.239	365.8	31.1	140
09	59-29-535	30-34.667	96-26.592	582.8	34.4	140
10	59-37-108	30-29.354	96-29.200	472.4	38.9	140
13	59-36-802	30-23.095	96-33.912	490.4	38.3	164
14	59-37-608	30-26.739	96-22.709	314.6	31.7	204
15	59-43-501	30-19.694	96-41.979	1170.1	55.6	190
18	59-29-527	30-33.885	96-25.600	609.6	34.5	032
22	59-37-104	30-29.326	96-27.937	420.9	34.5	164
23	59-37-6	30-26.935	96-24.061	420.9	30.0	---
27	59-44-305	30-20.660	96-31.570	615.7	42.6	164
			DS - COLEMAN COUNTY			
01	42-31-401	31-34.089	99-14.073	586.7	34.0	070
			DT - COLLIN COUNTY			
13	18-50-501	33-11.913	96-48.930	821.1	38.3	312
21	18-44-601	33-17.632	96-30.015	543.5	30.0	200
22	18-44-801	33-17.078	96-34.255	476.4	32.2	200
23	18-45-603	33-17.819	96-24.225	564.8	33.9	200
24	18-45-801	33-16.778	96-25.570	579.1	30.0	200

BEG County No.	TDWR State Well No.	North Latitude	West Longitude	Well Depth (m)	Water Temp. (°C)	Aquifer Code
26	18-50-502	33-11.973	96-48.324	811.4	37.2	312
27	18-50-802	33-08.966	96-49.410	497.4	28.9	138
28	18-50-803	33-08.966	96-49.410	852.2	40.0	997
29	18-50-805	33-09.106	96-48.543	835.8	35.6	312
30	18-52-301	33-13.707	96-30.906	480.7	30.6	200
31	18-52-401	33-11.415	96-36.506	988.2	45.6	312
33	33-03-203	32-59.686	96-41.135	1002.2	38.9	312
40	18-42-604	33-19.248	96-47.061	701.0	34.5	312
43	18-45-1	33-21.785	96-27.536	502.9	34.5	200
44	18-46-402	33-18.150	96-20.377	619.4	33.2	200
45	33-03-202	32-59.184	96-41.844	637.6	39.0	138
			DW - COLORADO COUNTY			
01	66-18-604	29-41.787	96-47.162	293.5	31.0	132
02	66-18-605	29-42.113	96-46.936	604.7	37.2	---
			DX - COMAL COUNTY			
05	68-24-105	29-44.249	98-05.325	716.3	27.8	066
13	68-06-4	29-56.631	98-20.317	146.3	33.3	066
			DZ - CONCHO COUNTY			
01	42-36-701	31-23.371	99-37.259	1191.5	44.4	100
02	42-50-103	31-13.340	99-51.337	1264.9	54.4	100
03	42-50-101	31-13.183	99-50.942	1231.4	54.4	100
			HB - CORYELL COUNTY			
20	40-36-602	31-25.143	97-30.317	371.9	29.5	178
			HH - CRANE COUNTY			
01	45-37-203	31-28.142	102-26.763	26.5	34.4	001
			HL - CULBERSON COUNTY			
01	47-51-710	31-09.869	104-44.276	160.0	26.7	---
02	47-52-301	31-13.110	104-31.478	524.9	26.7	208
03	47-52-602	31-11.930	104-31.151	475.5	26.7	208
04	47-55-802	31-08.342	104-10.335	ND	31.1	236

BEG County No.	TDWR State Well No.	North Latitude	West Longitude	Well Depth (m)	Water Temp. (°C)	Aquifer Code
05	47-59-212	31-07.172	104-40.908	118.0	30.6	---

HR - DALLAS COUNTY

BEG County No.	TDWR State Well No.	North Latitude	West Longitude	Well Depth (m)	Water Temp. (°C)	Aquifer Code
14	33-26-301	32-35.691	96-45.087	984.5	42.8	312
15	33-27-202	32-35.495	96-41.185	1118.3	45.6	312
17	33-03-401	32-57.323	96-43.536	1015.9	47.2	312
23	33-01-302	32-58.524	96-54.592	693.4	37.8	312
24	33-02-102	32-57.617	96-52.385	766.6	40.6	312
25	33-02-402	32-56.388	96-52.047	781.8	41.1	312
26	33-02-902	32-54.680	96-46.794	319.1	33.3	200
27	33-03-9	32-54.122	96-38.612	706.5	40.6	---
28	33-09-103	32-51.950	96-58.157	360.9	30.6	138
29	33-09-508	32-49.875	96-57.380	661.4	35.0	312
30	33-09-802	32-46.984	96-56.576	359.7	28.9	138
31	33-09-701	32-45.778	96-58.249	637.6	34.4	312
32	33-09-707	32-45.939	96-57.409	317.0	31.1	138
33	33-09-9	32-46.448	96-52.551	723.3	35.6	---
34	33-10-401	32-49.931	96-50.111	819.6	42.8	312
35	33-10-402	32-49.461	96-50.621	465.4	32.2	138
36	33-10-5	32-47.581	96-48.617	494.7	35.6	---
37	33-10-7	32-46.631	96-51.422	766.9	40.0	---
38	33-10-705	32-45.296	96-51.454	802.8	40.0	138
39	33-10-822	32-45.861	96-49.283	838.2	43.3	312
40	33-10-8	32-46.788	96-47.730	508.4	33.3	---
41	33-10-803	32-46.076	96-47.807	505.4	32.2	138
42	33-10-901	32-45.181	96-46.427	807.7	43.3	312
43	33-11-703	32-46.719	96-43.440	969.3	45.0	312
44	33-11-806	32-46.431	96-41.900	396.8	32.8	200
45	33-11-802	32-47.329	96-40.873	405.4	31.1	200
46	33-11-801	32-47.329	96-40.826	703.2	40.0	312
47	32-24-302	32-44.847	97-00.210	350.8	28.9	138
48	33-17-1	32-44.558	96-59.305	634.0	35.0	---
49	33-17-1	32-44.576	96-59.100	654.7	34.4	---
50	33-17-801	32-38.999	96-55.343	799.2	41.1	312
51	33-17-802	32-38.150	96-55.193	778.8	39.4	312
52	33-18-201	32-43.663	96-48.448	878.7	46.1	312
53	33-18-803	32-37.545	96-48.222	942.1	46.1	312
54	33-20-102	32-42.776	96-36.180	1244.8	57.2	312
55	33-20-401	32-40.941	96-35.455	1252.7	48.9	312
56	33-25-201	32-35.312	96-57.300	271.9	30.0	200
57	33-25-401	32-34.472	96-58.521	764.1	41.1	312
58	33-26-104	32-35.876	96-52.491	848.3	39.4	312
59	33-26-102	32-35.239	96-51.606	873.9	45.6	312
60	33-27-602	32-32.900	96-39.882	423.7	34.4	200
61	33-27-605	32-33.895	96-38.106	501.4	31.7	200
95	33-03-901	32-54.630	96-38.185	1124.4	51.1	178

BEG County No.	TDWR State Well No.	North Latitude	West Longitude	Well Depth (m)	Water Temp. (°C)	Aquifer Code
			HU - DELTA COUNTY			
11	17-34-301	33-28.321	95-45.942	1015.9	44.4	138
12	17-34-601	33-26.303	95-46.884	1044.9	48.0	138
			HW - DENTON COUNTY			
27	18-41-702	33-16.675	96-59.078	467.6	32.2	312
28	19-63-603	33-02.404	97-09.313	454.8	37.8	312
29	18-57-602	33-04.925	96-53.175	734.3	37.8	312
30	32-07-205	32-59.680	97-11.320	434.0	28.9	312
			HX - DE WITT COUNTY			
02	67-62-207	29-05.329	97-17.754	357.5	31.5	132
03	67-62-208	29-05.329	97-17.754	355.1	31.7	132
04	67-62-209	29-05.321	97-17.749	353.6	32.2	132
05	79-04-402	28-55.231	97-36.670	329.8	32.2	132
			HZ - DIMMIT COUNTY			
04	77-18-707	28-38.604	99-52.051	313.3	36.7	030
05	77-18-704	28-37.769	99-51.416	317.3	33.3	030
06	77-18-710	28-38.050	99-50.746	302.4	34.4	030
07	77-18-905	28-37.711	99-46.241	352.7	35.6	030
08	77-18-904	28-37.990	99-45.767	388.0	33.3	030
09	77-27-101	28-36.495	99-43.907	361.2	34.4	030
10	77-27-103	28-36.215	99-44.578	337.7	38.9	030
11	77-27-104	28-35.762	99-43.532	375.5	40.0	030
12	77-27-201	28-35.991	99-42.058	390.8	41.1	030
13	77-27-202	28-35.805	99-42.348	380.7	40.0	030
14	77-27-203	28-35.138	99-42.404	361.2	38.9	030
15	77-27-504	28-34.755	99-41.771	349.0	35.6	030
16	77-27-302	28-37.476	99-40.117	406.3	36.1	030
17	77-27-304	28-36.814	99-39.760	415.4	35.6	030
18	77-27-305	28-35.664	99-39.719	376.7	35.6	030
19	77-28-501	28-34.832	99-32.492	499.9	38.9	030
20	77-28-601	28-33.367	99-32.373	518.2	39.4	030
21	77-27-303	28-37.267	99-39.761	415.4	35.6	030
26	77-34-310	28-29.831	99-47.406	164.6	35.6	030
31	77-35-701	28-24.052	99-42.700	311.2	32.8	030
32	77-35-802	28-23.774	99-42.029	396.2	32.8	030
33	77-35-902	28-23.359	99-38.994	457.2	34.4	---
34	77-36-401	28-27.126	99-36.986	439.2	33.9	030

BEG County No.	TDWR State Well No.	North Latitude	West Longitude	Well Depth (m)	Water Temp. (°C)	Aquifer Code
35	77-36-301	28-28.731	99-30.952	548.6	40.0	032
36	77-36-701	28-23.117	99-36.509	385.0	33.9	030
37	77-36-801	28-24.408	99-33.945	432.5	35.6	030
38	77-36-803	28-24.062	99-32.441	448.1	34.4	030
39	77-37-101	28-29.363	99-29.680	539.5	38.9	030
40	77-37-102	28-27.691	99-29.802	538.9	33.9	030
41	77-37-106	28-28.697	99-27.751	295.7	32.8	308
42	77-41-401	28-18.576	99-58.524	ND	34.4	032
43	77-42-801	28-15.150	99-49.180	418.8	37.2	030
44	77-44-101	28-21.539	99-36.078	365.8	36.1	030
45	77-44-502	28-17.916	99-34.704	605.9	39.4	030
46	77-44-102	28-20.913	99-36.785	406.6	36.7	309
47	77-44-402	28-19.729	99-36.354	436.5	34.4	030
65	77-28-404	28-34.344	99-36.981	430.7	35.0	030
			JB - DUVAL COUNTY			
02	84-22-401	27-42.308	98-22.010	385.3	36.1	132
03	84-35-302	27-28.915	98-39.984	396.2	35.0	034
04	84-35-505	27-27.357	98-42.147	292.6	37.2	034
05	84-44-104	27-22.193	98-36.634	540.1	42.2	034
06	84-44-101	27-21.304	98-36.758	487.7	35.0	034
07	84-45-301	27-20.157	98-23.167	465.4	38.9	132
08	84-46-201	27-22.062	98-19.258	365.8	40.0	132
09	84-28-8	27-30.689	98-34.979	812.9	42.0	034
10	84-37-203	27-28.584	98-26.631	701.0	45.0	034
11	84-30-102	27-38.062	98-21.272	352.0	32.2	132
12	84-36-501	27-25.374	98-34.846	271.3	34.4	132
13	84-35-303	27-29.338	98-39.141	457.2	37.2	034
14	84-37-402	27-26.547	98-27.995	701.0	44.4	034
			JD - EASTLAND COUNTY			
01	31-44-509	32-17.577	98-33.159	ND	30.0	312
			JH - ECTOR COUNTY			
02	27-60-901	32-00.244	102-31.652	ND	28.9	180
05	45-03-502	31-56.408	102-40.405	ND	28.9	180
06	45-03-901	31-54.369	102-39.261	ND	28.9	180
09	45-11-202	31-51.583	102-41.074	ND	28.9	180
10	45-12-104	31-50.176	102-35.266	ND	32.2	180
13	45-21-202	31-44.303	102-26.236	ND	34.4	180

BEG County No.	TDWR State Well No.	North Latitude	West Longitude	Well Depth (m)	Water Temp. (°C)	Aquifer Code
			JJ - EDWARDS COUNTY			
07	55-61-903	30-02.294	100-24.161	100.6	32.2	066
			JK - ELLIS COUNTY			
03	33-33-101	32-28.578	96-59.732	735.2	39.4	312
07	33-35-503	32-25.769	96-40.098	463.9	32.2	200
17	33-25-601	32-32.753	96-52.702	291.1	31.1	200
18	33-25-902	32-30.313	96-54.560	842.2	43.9	312
19	33-26-815	32-31.267	96-49.450	335.3	29.4	200
20	33-26-902	32-31.997	96-46.804	968.7	37.2	312
21	33-27-901	32-32.046	96-39.979	455.1	33.3	200
22	32-40-301	32-27.872	97-01.533	685.5	36.7	269
23	32-40-308	32-27.875	97-01.570	377.3	31.7	138
24	32-40-606	32-25.285	97-01.425	734.9	38.3	312
25	33-33-102	32-29.220	96-59.421	765.7	38.9	312
26	33-34-301	32-28.654	96-45.128	1001.3	37.2	312
27	33-34-704	32-23.809	96-51.977	877.2	44.4	312
28	33-34-712	32-23.405	96-50.916	886.1	49.4	312
29	33-34-703	32-22.656	96-50.450	899.2	48.9	312
30	33-34-702	32-22.986	96-50.488	899.2	49.4	312
31	33-35-702	32-23.375	96-44.777	402.6	31.7	200
32	33-35-701	32-22.626	96-44.374	397.2	31.1	200
33	33-36-201	32-27.719	96-33.975	604.1	38.9	200
34	33-36-802	32-24.824	96-34.616	519.1	30.6	200
35	33-41-502	32-19.643	96-56.562	244.4	31.7	200
36	33-41-501	32-19.433	96-56.052	794.3	42.8	312
37	33-42-201	32-22.174	96-47.732	391.7	28.9	200
38	33-42-702	32-15.180	96-52.029	868.7	44.4	312
39	33-43-301	32-21.711	96-39.267	411.5	33.9	200
40	33-43-602	32-18.928	96-38.248	550.5	46.7	200
42	33-43-901	32-15.044	96-39.098	505.7	36.7	200
43	33-44-401	32-19.582	96-37.363	547.4	40.6	200
44	33-44-402	32-19.321	96-37.304	550.2	40.6	200
45	33-49-607	32-11.156	96-53.115	865.6	44.4	312
46	33-49-602	32-10.602	96-53.505	285.0	30.6	200
47	33-49-803	32-09.602	96-55.266	823.0	43.3	312
48	33-50-202	32-13.025	96-47.875	976.6	45.6	312
51	33-57-202	32-07.384	96-56.625	274.3	28.9	200
			JL - EL PASO COUNTY			
01	49-04-104	31-57.938	106-36.981	350.5	34.4	428
02	49-04-111	31-58.012	106-36.771	ND	32.2	428

BEG County No.	TDWR State Well No.	North Latitude	West Longitude	Well Depth (m)	Water Temp. (°C)	Aquifer Code
03	49-04-105	31-58.078	106-36.510	289.6	32.8	428
04	49-04-106	31-57.548	106-36.738	332.2	35.0	428
05	49-04-401	31-57.269	106-36.381	274.3	33.3	428
06	49-04-402	31-57.043	106-36.729	323.1	35.6	428
07	49-04-436	31-56.607	106-35.719	57.9	32.2	428
08	49-04-4	31-56.460	106-35.596	48.8	29.4	---
09	49-05-608	31-57.387	106-23.946	1329.8	38.9	---
10	49-12-602	31-49.868	106-32.230	515.1	37.2	428
11	49-15-503	31-49.068	106-11.326	ND	31.1	426
13	49-08-102	31-59.461	106-05.589	137.2	58.0	426
14	49-15-506	31-49.145	106-10.634	146.3	38.0	426
15	49-15-604	31-49.744	106-09.930	152.4	33.5	426
16	49-16-101	31-50.536	106-05.869	329.8	36.0	---
17	49-04-113	31-58.286	106-37.117	367.6	35.0	428
18	49-04-410	31-55.931	106-36.781	140.5	31.7	428
19	49-05-203	31-59.026	106-25.739	452.0	34.4	426
20	49-15-802	31-46.844	106-10.110	195.1	37.8	426
21	49-15-803	31-47.058	106-10.110	168.2	34.4	426
23	49-15-6	31-49.250	106-09.712	140.2	36.0	426
24	49-23-506	31-41.008	106-10.257	150.9	22.0	426
25	49-23-507	31-41.484	106-10.240	158.5	31.5	426
26	49-24-416	31-41.748	106-06.417	198.7	22.0	426

JR - FALLS COUNTY

01	39-33-604	31-25.203	96-54.851	1112.8	64.4	269
03	40-48-201	31-22.139	97-04.770	804.7	34.4	269
04	40-47-602	31-18.093	97-08.391	795.5	37.	269
05	40-48-801	31-17.075	97-03.809	876.0	48.9	269
10	40-64-101	31-07.195	97-06.944	932.4	43.3	269
25	39-33-901	31-24.572	96-53.619	1147.3	62.0	269
32	39-43-9	31-15.194	96-37.549	3161.7	21.5	---
35	39-41-6	31-18.403	96-53.567	1184.1	68.9	269
36	40-48-501	31-18.918	97-03.360	825.7	32.0	269
37	39-41-602	31-18.428	96-53.445	1029.6	51.7	82
38	39-41-604	31-18.449	96-53.664	1015.0	50.0	178
39	40-56-301	31-12.973	97-02.051	1007.4	57.3	269
41	40-64-601	31-04.165	97-00.412	1125.3	67.	269
43	39-33-301	31-27.668	96-53.268	1170.4	61.0	269
44	40-48-5	31-19.097	97-01.512	915.0	48.0	269

JS - FANNIN COUNTY

13	17-17-602	33-41.616	95-54.993	368.2	32.2	200
14	17-25-401	33-33.859	95-59.676	515.4	33.3	200

BEG County No.	TDWR State Well No.	North Latitude	West Longitude	Well Depth (m)	Water Temp. (°C)	Aquifer Code
15	17-33-501	33-25.795	95-56.813	1026.0	48.9	138
16	17-33-502	33-25.502	95-56.950	777.5	39.4	200
17	18-31-201	33-35.107	96-10.372	390.8	32.2	200
18	18-31-503	33-34.349	96-10.439	363.0	31.7	200
19	18-32-702	33-30.485	96-07.033	539.5	37.2	200
20	18-38-801	33-22.617	96-19.902	551.7	33.9	200
21	18-39-501	33-26.164	96-10.048	486.2	33.3	200
22	18-39-701	33-23.143	96-14.607	515.1	32.8	200
23	18-47-101	33-22.394	96-14.513	489.2	33.3	200
29	18-38-402	33-26.189	96-20.381	489.5	31.5	200
31	18-32-501	33-34.430	96-04.063	506.0	33.7	200
32	17-25-303	33-35.656	95-54.245	526.4	33.2	200
33	17-34-101	33-29.488	95-51.940	933.6	40.2	138
34	17-33-701	33-23.709	95-59.057	1019.6	48.0	138

KB - FRIO COUNTY

BEG County No.	TDWR State Well No.	North Latitude	West Longitude	Well Depth (m)	Water Temp. (°C)	Aquifer Code
29	77-07-501	28-55.658	99-10.198	396.2	32.2	030
30	77-07-503	28-54.965	99-10.298	420.6	32.2	030
31	77-07-903	28-52.656	99-08.531	422.1	38.3	030
32	77-07-906	28-53.626	99-08.272	524.3	36.7	030
33	77-08-403	28-55.926	99-05.429	437.1	33.3	030
34	77-08-404	28-55.701	99-05.647	429.2	34.4	030
35	77-08-409	28-56.740	99-05.190	439.8	33.3	030
36	77-08-708	28-54.435	99-05.552	ND	32.2	140
37	77-08-712	28-53.617	99-05.882	397.2	33.3	030
38	77-08-713	28-53.617	99-05.882	396.8	33.9	030
39	77-08-714	28-53.290	99-05.142	411.5	33.3	030
40	77-08-803	28-53.583	99-04.392	412.1	34.4	030
41	77-08-806	28-53.063	99-04.473	434.6	32.8	030
42	77-08-809	28-54.104	99-04.627	457.2	36.7	030
43	77-07-902	28-54.163	99-07.660	490.7	35.6	030
44	77-13-301	28-51.424	99-24.067	460.6	33.9	030
45	77-14-904	28-46.619	99-16.257	496.2	36.1	030
46	77-14-903	28-45.604	99-15.788	509.6	37.8	030
47	77-14-908	28-45.735	99-16.278	518.2	36.7	030
48	77-15-308	28-51.963	99-08.985	442.0	37.2	030
49	77-15-304	28-51.269	99-08.022	445.0	36.7	030
50	77-15-303	28-51.046	99-09.401	449.0	35.6	030
51	77-15-201	28-50.390	99-10.820	432.5	36.7	030
52	77-15-605	28-49.847	99-07.731	518.2	37.2	030
53	77-15-606	28-49.381	99-08.834	469.4	36.7	030
54	77-15-801	28-46.904	99-10.040	533.4	36.7	030
55	77-15-705	28-45.213	99-14.509	502.9	36.7	030
56	77-23-305	28-43.801	99-09.576	564.5	37.8	030
58	77-23-204	28-43.110	99-10.639	595.0	38.3	030

BEG County No.	TDWR State Well No.	North Latitude	West Longitude	Well Depth (m)	Water Temp. (°C)	Aquifer Code
59	77-23-303	28-43.074	99-09.912	595.6	38.3	030
60	77-23-503	28-42.035	99-11.192	588.3	38.3	030
61	77-23-509	28-41.188	99-12.334	624.8	34.4	030
62	77-23-602	28-40.712	99-08.030	634.0	40.0	030
63	77-23-701	28-38.938	99-14.617	623.3	40.0	030
64	77-23-801	28-39.711	99-10.077	612.6	38.9	030
65	77-23-803	28-39.919	99-10.057	634.6	35.6	030
66	77-22-803	28-39.896	99-19.450	391.7	35.6	140
67	77-22-401	28-40.399	99-20.865	391.7	39.4	030
68	77-22-603	28-40.984	99-15.282	624.8	40.0	030
69	77-22-303	28-43.569	99-17.481	572.4	37.8	030
70	77-14-805	28-46.264	99-17.564	503.8	36.7	030
71	78-01-109	28-59.602	98-59.484	ND	32.2	140
72	78-01-501	28-56.312	98-55.596	365.5	31.1	030
73	78-02-402	28-55.050	98-51.839	440.4	33.3	030
74	78-02-708	28-53.748	98-51.413	466.3	34.4	030
75	78-02-709	28-53.451	98-50.647	169.2	28.9	140
76	78-02-702	28-52.624	98-52.029	537.7	35.6	030
77	78-02-804	28-53.237	98-49.249	599.5	35.6	030
78	78-02-808	28-52.545	98-49.548	517.6	35.6	030
79	77-16-207	28-52.041	99-04.791	ND	35.6	030
80	77-16-205	28-52.074	99-03.806	478.5	34.4	030
81	77-16-201	28-51.537	99-04.202	502.0	35.6	030
82	77-16-203	28-51.088	99-04.834	502.9	35.6	030
83	77-16-107	28-50.521	99-06.902	ND	35.6	030
84	77-16-108	28-50.574	99-07.394	449.6	36.1	030
85	77-16-401	28-49.584	99-06.452	459.3	31.7	030
86	77-16-406	28-49.842	99-05.704	469.4	36.7	030
87	77-16-405	28-49.390	99-05.154	ND	37.8	030
88	77-16-501	28-49.786	99-03.913	507.5	36.1	030
89	77-16-505	28-48.903	99-04.486	530.0	35.6	030
90	77-16-502	28-48.436	99-04.744	525.8	35.6	030
91	77-16-404	28-48.682	99-06.258	490.1	33.3	030
92	77-16-703	28-47.364	99-05.790	524.3	37.8	030
93	77-16-706	28-46.964	99-05.279	552.6	35.6	030
94	77-16-708	28-47.348	99-06.616	548.6	37.8	030
95	77-16-803	28-46.387	99-03.333	584.9	37.8	030
96	78-09-101	28-51.471	98-59.044	518.2	36.7	030
97	78-09-304	28-52.145	98-53.587	430.7	35.6	030
98	78-09-504	28-49.382	98-56.278	549.9	35.6	030
99	78-09-503	28-48.843	98-55.827	518.2	36.1	030
100	78-09-506	28-49.001	98-56.614	568.1	36.7	030
101	78-09-502	28-48.771	98-55.276	535.5	35.6	030
102	78-09-602	28-48.338	98-55.200	567.5	35.6	030
103	78-09-701	28-46.791	98-59.319	548.6	36.1	030
104	78-09-801	28-46.400	98-56.114	518.2	36.7	030
105	78-10-103	28-52.189	98-51.362	472.4	35.0	030

BEG County No.	TDWR State Well No.	North Latitude	West Longitude	Well Depth (m)	Water Temp. (°C)	Aquifer Code
106	78-10-102	28-50.988	98-50.404	529.4	35.6	030
107	78-10-105	28-51.031	98-52.451	515.1	35.6	030
108	77-24-101	28-44.832	99-05.364	608.4	37.8	030
109	77-24-204	28-44.516	98-03.772	305.4	37.8	140
110	77-24-201	28-42.608	99-03.032	652.3	35.6	030
111	77-24-302	28-43.678	99-01.337	660.5	40.0	030
113	77-24-206	28-42.795	99-02.584	630.6	35.0	030
115	77-14-808	28-45.889	99-18.372	487.7	35.0	030
116	77-15-314	28-51.864	99-09.527	527.0	32.2	030
117	77-16-110	28-50.808	99-06.326	484.6	35.6	030
118	77-16-807	28-47.028	99-03.854	544.4	32.2	030
119	77-22-304	28-44.056	99-15.384	544.7	32.2	030
120	77-22-606	28-41.958	99-15.718	601.7	35.0	030
121	77-22-905	28-39.235	99-16.461	624.8	40.6	030
122	77-23-603	28-41.210	99-08.729	620.3	35.0	030
123	77-23-904	28-39.971	99-08.783	639.5	35.0	030
124	78-09-306	28-50.190	98-53.613	506.0	32.2	030
125	78-09-803	28-46.644	98-56.095	620.0	35.0	030

KD - GAINES COUNTY

BEG County No.	TDWR State Well No.	North Latitude	West Longitude	Well Depth (m)	Water Temp. (°C)	Aquifer Code
01	27-26-301	32-37.385	102-45.539	536.4	28.3	160
02	27-06-502	32-56.873	102-17.606	573.0	29.4	160
03	27-15-402	32-49.334	102-14.139	563.9	28.3	160

KR - GONZALES COUNTY

BEG County No.	TDWR State Well No.	North Latitude	West Longitude	Well Depth (m)	Water Temp. (°C)	Aquifer Code
11	67-28-202	29-35.666	97-34.987	471.8	39.0	190
12	67-28-203	29-35.707	97-34.845	488.0	38.9	190
14	67-28-902	29-30.863	97-31.808	266.4	32.2	030
15	67-30-504	29-34.076	97-18.630	701.0	43.5	030
16	67-30-401	29-33.095	97-21.671	719.3	46.7	030
17	67-37-201	29-29.805	97-27.253	533.4	43.3	030
18	67-37-203	29-28.642	97-26.327	679.7	41.7	030
19	67-36-104	29-29.448	97-36.308	283.5	31.1	030
20	67-36-501	29-26.479	97-32.658	502.9	39.4	030
21	67-35-504	29-27.436	97-40.792	ND	35.6	140
23	67-42-902	29-17.234	97-45.216	421.2	31.1	030
24	67-42-903	29-16.268	97-46.125	422.8	32.8	030
25	67-42-904	29-16.070	97-46.350	425.5	32.8	030
26	67-42-905	29-15.673	97-45.842	464.8	33.9	030
27	67-42-906	29-16.541	97-45.572	501.4	34.4	030
29	67-43-203	29-20.301	97-41.995	370.3	31.7	030
30	67-43-601	29-18.026	97-39.558	573.9	37.8	030
31	67-43-604	29-18.454	97-39.247	609.6	32.8	030

BEG County No.	TDWR State Well No.	North Latitude	West Longitude	Well Depth (m)	Water Temp. (°C)	Aquifer Code
32	67-43-802	29-18.102	97-40.778	655.3	37.2	030
33	67-43-806	29-16.197	97-41.428	608.1	37.8	030
34	67-43-901	29-16.168	97-40.627	624.8	39.4	030
35	67-43-902	29-16.067	97-39.409	685.8	42.2	030
36	67-43-903	29-15.893	97-38.196	771.1	43.9	030
37	67-43-904	29-16.467	97-38.087	726.3	43.3	030
38	67-44-201	29-21.286	97-34.643	667.5	34.4	030
39	67-44-401	29-19.395	97-36.478	716.3	38.9	030
40	67-44-402	29-18.923	97-35.496	739.1	45.6	030
41	67-44-701	29-15.263	97-35.382	904.3	54.4	030
42	67-51-102	29-13.885	97-43.738	678.2	43.3	030
43	67-30-5	29-33.714	97-18.786	ND	47.5	030
			KT - GRAYSON COUNTY			
43	18-20-709	33-38.789	96-37.360	661.1	32.2	272
44	18-20-712	33-39.299	96-35.613	663.2	32.2	272
45	18-20-713	33-38.184	96-35.566	699.5	32.8	272
46	18-28-101	33-36.508	96-36.913	725.4	32.2	272
47	18-29-301	33-36.535	96-24.525	216.1	31.7	200
48	18-29-701	33-31.214	96-29.236	359.7	27.8	200
49	18-29-902	33-30.909	96-23.475	362.4	28.9	200
50	18-29-904	33-30.474	96-23.307	423.1	30.6	200
108	18-27-901	33-32.075	96-38.677	749.8	32.0	272
109	18-28-404	33-33.191	96-36.118	762.0	32.8	272
112	18-36-503	33-25.579	96-34.979	701.0	33.0	272
113	18-27-803	33-31.926	96-42.115	685.8	32.2	272
114	18-36-502	33-25.381	96-34.570	347.5	28.0	200
			KW - GRIMES COUNTY			
02	59-47-309	30-20.718	96-7.710	431.9	31.1	104
			LA - HAMILTON COUNTY			
02	40-09-201	31-51.715	97-55.084	231.6	41.1	269
			LH - HARDIN COUNTY			
01	61-44-7	30-16.562	94-37.505	ND	51.7	995
02	61-44-7	30-16.562	94-37.505	353.3	38.3	996
03	61-44-7	30-17.299	94-34.939	292.0	37.8	994
04	61-53-5	30-10.170	94-25.197	259.1	37.8	996

BEG County No.	TDWR State Well No.	North Latitude	West Longitude	Well Depth (m)	Water Temp. (°C)	Aquifer Code
			LJ - HARRIS COUNTY			
01	65-03-505	29-57.338	95-40.863	862.6	40.0	317
02	65-02-308	29-59.461	95-45.092	267.0	38.9	430
03	65-03-501	29-57.336	95-40.861	893.1	45.6	318
04	65-06-305	29-59.957	95-15.466	262.1	37.5	430
05	65-14-103	29-50.474	95-20.012	827.2	35.6	318
06	65-15-825	29-45.417	95-11.540	515.7	31.1	430
07	65-21-804	29-38.868	95-27.012	597.4	31.7	430
08	65-22-301	29-42.525	95-15.727	780.3	35.0	430
09	65-22-602	29-42.227	95-15.906	714.8	33.3	430
10	65-22-603	29-41.809	95-15.934	765.0	36.1	430
11	65-22-604	29-41.431	95-15.804	630.6	32.2	430
12	65-22-606	29-42.092	95-15.161	516.3	31.7	430
13	65-23-108	29-42.760	95-13.934	557.5	31.5	430
14	65-23-124	29-43.120	95-12.858	589.2	31.1	430
15	65-23-128	29-43.231	95-13.841	517.2	31.1	430
16	65-23-214	29-44.170	95-10.892	595.9	32.2	430
17	65-23-236	29-43.265	95-12.035	559.3	31.1	430
			LT - HENDERSON COUNTY			
13	34-58-402	32-04.739	95-50.968	380.7	28.9	190
14	34-60-204	32-06.599	95-34.588	381.0	28.3	190
			LU - HIDALGO COUNTY			
01	87-23-9	26-39.068	98-09.388	624.8	40.6	---
02	87-31-2	26-35.294	98-10.864	624.8	41.1	---
04	87-31-5	26-33.260	98-11.699	458.1	36.4	---
05	87-31-6	26-32.594	98-08.218	277.4	33.1	---
06	87-31-9	26-31.447	98-08.917	427.9	33.6	---
07	87-32-4	26-32.575	98-07.194	373.1	35.0	---
08	87-32-6	26-32.757	98-01.835	521.2	35.6	---
09	87-39-601	26-27.323	98-08.266	336.8	34.4	---
10	87-39-6	26-25.061	98-07.980	396.2	36.1	---
11	87-40-7	26-24.623	98-06.532	410.0	36.1	---
12	87-31-6	26-33.140	98-08.161	ND	34.0	---
13	87-24-702	26-39.662	98-07.072	457.2	35.6	---
14	87-31-918	26-31.370	98-08.139	318.8	34.4	---
			LW - HILL COUNTY			
05	33-57-402	32-02.610	96-57.771	808.3	57.2	269
08	40-08-801	31-53.078	97-04.294	641.0	40.2	269

BEG County No.	TDWR State Well No.	North Latitude	West Longitude	Well Depth (m)	Water Temp. (°C)	Aquifer Code
09	39-01-602	31-55.295	96-53.731	910.7	48.9	269
10	39-09-201	31-51.541	96-55.635	957.1	42.0	269
11	39-10-201	31-50.914	96-47.707	1083.6	56.7	269
15	32-55-903	32-09.743	97-08.427	ND	35.0	200
16	32-55-904	32-09.735	97-08.412	565.7	32.2	269
18	32-62-703	32-00.615	97-21.858	366.4	29.4	269
20	32-63-908	32-00.720	97-08.160	551.7	37.8	269
21	32-63-909	32-00.277	97-08.800	543.8	31.7	998
22	32-63-910	32-00.817	97-08.890	257.6	30.0	138
23	32-64-702	32-01.671	97-07.113	571.8	35.0	178
25	40-06-105	31-58.275	97-21.888	377.3	29.4	269
26	40-06-501	31-56.914	97-19.187	391.1	30.6	269
27	40-06-506	31-56.793	97-19.506	385.6	30.6	269
28	40-06-504	31-56.602	97-17.406	448.1	33.3	269
29	40-07-101	31-58.917	97-12.500	492.9	34.4	312
32	40-15-101	31-51.845	97-13.748	456.3	33.9	178
33	39-09-901	31-45.480	96-52.860	1054.0	40.6	269

LY - HOOD COUNTY

BEG County No.	TDWR State Well No.	North Latitude	West Longitude	Well Depth (m)	Water Temp. (°C)	Aquifer Code
01	32-35-106	32-27.821	97-43.230	115.8	30.0	312
02	32-35-403	32-26.216	97-44.931	121.0	28.9	312

PA - HOUSTON COUNTY

BEG County No.	TDWR State Well No.	North Latitude	West Longitude	Well Depth (m)	Water Temp. (°C)	Aquifer Code
01	38-35-203	31-27.587	95-41.616	548.6	36.7	190
04	38-59-203	31-06.467	95-41.061	322.5	30.0	140
05	60-03-301	30-58.877	95-38.169	487.7	35.6	164
06	60-03-302	30-58.371	95-38.115	498.3	36.7	164

PB - HOWARD COUNTY

BEG County No.	TDWR State Well No.	North Latitude	West Longitude	Well Depth (m)	Water Temp. (°C)	Aquifer Code
01	28-53-103	32-12.881	101-29.211	ND	26.7	236

PD - HUDSPETH COUNTY

BEG County No.	TDWR State Well No.	North Latitude	West Longitude	Well Depth (m)	Water Temp. (°C)	Aquifer Code
01	48-54-402	31-10.521	105-21.605	289.6	37.8	236
02	48-54-405	31-10.207	105-20.706	297.2	31.1	236
03	48-64-901	31-00.512	105-01.043	305.1	41.7	332
04	48-64-902	31-00.500	105-01.028	304.8	41.1	332
05	51-01-504	30-56.505	104-57.468	613.3	37.8	332
06	50-14-1	30-51.713	105-20.258	613.3	37.2	---
07	50-14-501	30-49.492	105-19.026	S	42.2	001

BEG County No.	TDWR State Well No.	North Latitude	West Longitude	Well Depth (m)	Water Temp. (°C)	Aquifer Code
08	50-14-503	30-49.422	105-18.945	S	49.4	001
09	50-14-504	30-49.423	105-18.864	S	44.4	---
10	50-14-505	30-49.423	105-18.905	S	39.4	---
11	48-10-6	31-49.381	105-46.904	731.5	33.8	208
12	48-54-401	31-11.237	105-21.229	335.9	38.0	236
			PH - HUNT COUNTY			
22	18-48-402	33-18.782	96-06.590	727.9	28.9	200
25	18-47-502	33-17.888	96-11.840	570.0	35.5	200
			PJ - HUTCHINSON COUNTY			
01	06-20-501	35-40.611	101-34.599	127.1	27.2	---
			PR - JASPER COUNTY			
01	62-25-201	30-36.842	93-55.256	440.4	29.4	318
			PS - JEFF DAVIS COUNTY			
05	51-29-4	30-33.706	104-29.821	1219.5	45.0	176
06	51-29-7	30-31.964	104-29.791	ND	32.0	176
07	51-31-4	30-34.431	104-14.177	S	16.5	---
08	51-31-4	30-34.936	104-14.956	S	18.0	---
09	51-31-4	30-34.956	104-14.967	S	18.0	---
			PU - JIM HOGG COUNTY			
01	84-44-7	27-15.163	98-36.904	991.2	45.0	---
02	84-51-2	27-13.148	98-40.457	938.8	37.8	---
03	84-51-5	27-12.388	98-41.696	611.1	38.9	---
07	84-43-5	27-18.131	98-40.847	ND	37.2	132
08	84-43-504	27-18.688	98-40.460	431.3	37.0	132
			PW - JIM WELLS COUNTY			
02	84-40-703	27-24.448	98-06.618	748.0	46.1	132
03	84-47-810	27-16.903	98-10.543	670.6	39.4	132
04	84-39-7	27-24.873	98-13.008	718.1	38.5	132
05	84-24-401	27-42.530	98-07.508	582.2	37.0	132

BEG County No.	TDWR State Well No.	North Latitude	West Longitude	Well Depth (m)	Water Temp. (°C)	Aquifer Code
06	84-40-701	27-24.655	98-06.917	751.6	45.6	132
07	84-40-709	27-24.420	98-06.813	752.9	38.5	132
			PX - JOHNSON COUNTY			
11	32-38-102	32-29.604	97-20.084	438.0	30.6	312
12	32-38-901	32-24.318	97-15.571	496.8	30.6	312
14	32-39-703	32-24.863	97-12.834	511.1	31.9	312
16	32-47-808	32-15.961	97-10.822	521.2	28.9	312
			PZ - KARNES COUNTY			
03	78-08-3	28-59.675	98-01.415	1435.9	58.9	030
05	67-50-8	29-08.805	97-48.023	807.7	51.1	030
06	78-08-301	28-58.809	98-01.102	1086.3	64.4	030
07	78-07-901	28-54.343	98-07.910	1147.9	37.8	030
08	78-08-701	28-54.373	98-05.874	1160.4	60.0	030
09	78-08-9	28-53.082	98-02.384	1220.1	58.9	030
10	78-16-601	28-48.457	98-00.083	2439.6	80.6	030
11	79-01-9	28-53.542	97-54.249	309.4	34.4	222
12	79-01-901	28-53.366	97-53.873	265.8	33.9	034
13	79-01-9	28-52.964	97-54.110	262.1	32.8	034
14	79-10-4	28-49.000	97-50.723	914.4	53.3	204
16	79-01-202	28-57.857	97-56.695	1371.6	72.2	030
			RA - KAUFMAN COUNTY			
21	33-21-802	32-37.800	96-27.236	1442.3	35.0	200
25	33-21-102	32-44.567	96-27.953	625.1	37.8	---
26	33-12-601	32-47.604	96-30.799	866.5	47.5	138
			RD - KENEDY COUNTY			
10	83-52-901	27-09.828	97-32.389	ND	32.8	084
11	83-53-101	27-14.116	97-27.488	427.6	33.3	084
12	83-53-401	27-11.857	97-27.744	414.5	32.8	084
13	83-53-501	27-11.387	97-26.715	429.8	33.3	084
19	83-60-301	27-06.222	97-31.403	365.8	33.3	084
23	83-60-901	27-01.747	97-30.783	429.8	32.8	084
24	83-61-101	27-06.646	97-29.945	400.8	32.8	084
31	88-03-901	26-53.163	97-39.413	377.6	33.3	084
47	88-18-501	26-41.743	97-48.762	ND	32.8	084

BEG County No.	TDWR State Well No.	North Latitude	West Longitude	Well Depth (m)	Water Temp. (°C)	Aquifer Code
			RK - KIMBLE COUNTY			
01	56-17-904	30-38.904	99-53.296	56.4	30.0	066
			RP - KINNEY COUNTY			
16	70-43-3	29-20.865	100-38.969	365.8	31.1	066
17	70-44-802	29-16.563	100-33.099	429.2	34.5	066
19	70-45-5	29-19.128	100-25.929	182.9	32.2	066
22	70-44-901	29-16.495	100-30.511	30.5	31.1	004
23	70-27-301	29-35.588	100-39.471	151.2	32.2	066
24	70-52-1	29-14.812	100-35.310	489.2	36.1	066
27	70-43-3	29-21.529	100-39.077	489.2	29.5	---
36	70-44-9	29-15.077	100-32.364	489.2	36.5	066
37	70-44-8	29-15.637	100-33.308	489.2	34.6	066
			RR - KLEBERG COUNTY			
02	83-45-401	27-18.501	97-29.150	394.7	34.4	084
04	83-41-1	27-20.644	97-58.894	902.2	49.0	134
			RT - LAMAR COUNTY			
15	17-21-709	33-39.665	95-27.818	652.0	37.8	138
16	17-26-202	33-36.067	95-48.486	509.9	34.4	200
17	17-29-103	33-35.870	95-27.699	781.2	36.1	138
18	17-29-601	33-34.471	95-23.525	805.9	43.3	138
			RX - LA SALLE COUNTY			
07	77-46-804	28-16.409	99-18.691	579.1	32.8	308
08	77-47-901	28-15.536	99-08.555	938.8	36.7	030
09	77-56-202	28-14.005	99-04.635	350.5	32.2	277
10	77-56-801	28-09.142	99-03.313	1066.8	54.4	030
11	78-49-201	28-13.135	98-56.603	1188.7	57.8	030
12	78-49-802	28-08.270	98-55.189	1280.2	62.2	030
13	77-62-705	28-02.189	99-21.602	152.4	34.4	277
14	77-63-201	28-05.599	99-11.539	975.4	32.2	030
15	77-63-302	28-07.375	99-09.368	396.2	37.8	277
16	77-64-102	28-06.069	99-07.361	304.8	33.3	204
17	77-64-401	28-03.612	99-06.414	1304.5	35.6	030
18	78-50-201	28-13.757	98-48.945	1188.7	54.4	030
19	77-22-702	28-37.736	99-20.345	624.8	41.1	030

BEG County No.	TDWR State Well No.	North Latitude	West Longitude	Well Depth (m)	Water Temp. (°C)	Aquifer Code
20	77-22-802	28-38.279	99-19.102	624.5	40.0	030
21	77-23-703	28-38.530	99-13.770	701.0	32.2	030
23	78-18-702	28-38.489	98-52.105	883.9	43.9	030
24	77-29-603	28-32.816	99-23.925	ND	40.0	030
25	77-29-602	28-32.713	99-23.096	609.6	38.9	030
26	77-29-901	28-31.702	99-23.290	627.9	40.6	030
27	77-30-801	28-31.047	99-19.520	625.1	41.1	030
28	77-29-903	28-32.470	99-22.602	ND	40.0	030
29	77-30-502	28-34.811	99-19.391	618.7	40.6	030
30	77-30-602	28-34.590	99-16.035	682.8	40.6	030
31	77-30-802	28-30.334	99-18.947	625.4	41.7	030
32	77-31-502	28-33.984	99-11.593	713.2	42.2	030
33	78-25-804	28-31.229	98-56.993	838.2	36.7	030
34	78-25-803	28-31.165	98-56.586	842.2	35.0	030
35	78-25-801	28-30.914	98-56.086	914.4	45.6	030
36	78-25-501	28-32.882	98-55.077	914.4	44.4	030
37	78-26-701	28-31.849	98-51.709	1036.3	46.7	030
38	78-26-801	28-32.280	98-49.356	1005.8	43.9	030
39	78-26-802	28-31.452	98-48.400	1036.3	39.4	030
40	77-37-301	28-28.174	99-22.868	618.7	40.0	030
41	77-38-102	28-29.389	99-20.917	642.5	40.6	030
42	77-38-101	28-29.216	99-20.345	ND	40.0	030
43	77-38-201	28-28.992	99-19.457	670.6	40.6	030
44	77-38-401	28-27.054	99-20.872	615.1	38.3	030
45	77-38-601	28-25.076	99-15.507	760.5	39.4	030
46	77-39-401	28-26.297	99-14.799	701.0	40.0	030
47	77-39-402	28-26.071	99-14.267	756.8	41.7	030
48	77-39-403	28-26.072	99-13.833	714.8	42.2	030
49	77-39-404	28-25.758	99-13.852	715.4	40.6	030
50	77-39-708	28-23.911	99-13.396	768.1	42.2	030
51	77-39-301	28-28.009	99-09.301	845.8	45.0	030
52	77-40-305	28-28.200	99-00.211	835.2	32.2	030
53	78-41-302	28-22.305	98-54.483	1099.1	53.3	030
54	78-34-202	28-28.168	98-49.050	566.0	46.1	308
55	78-34-203	28-28.149	98-48.558	626.7	36.1	308
56	78-41-104	28-20.180	98-58.670	975.4	54.4	030
57	77-39-4	28-26.377	99-13.415	739.1	43.0	030

RZ - LEE COUNTY

BEG County No.	TDWR State Well No.	North Latitude	West Longitude	Well Depth (m)	Water Temp. (°C)	Aquifer Code
07	59-49-503	30-11.224	96-56.444	415.7	35.0	140
08	59-49-504	30-11.202	96-56.456	412.7	34.4	140
09	59-49-505	30-11.121	96-56.349	364.5	33.5	140
10	59-49-506	30-11.153	96-56.355	422.8	33.0	142
11	59-49-509	30-11.155	96-56.670	615.1	31.7	030
12	59-49-604	30-10.282	96-54.061	658.4	40.0	030

BEG County No.	TDWR State Well No.	North Latitude	West Longitude	Well Depth (m)	Water Temp. (°C)	Aquifer Code
17	58-56-903	30-08.122	97-00.272	439.5	32.3	140
			SB - LIBERTY COUNTY			
01	60-48-101	30-20.730	95-05.196	407.5	30.0	318
02	60-48-202	30-20.087	95-04.776	500.2	31.7	318
			SD - LIMESTONE COUNTY			
44	39-38-3	31-28.278	96-16.913	4114.8	18.	---
86	39-37-7	31-23.282	96-29.993	2812.4	16.	---
			SJ - LIVE OAK COUNTY			
01	78-23-502	28-40.203	98-11.492	1475.8	65.6	030
02	78-32-4	28-33.066	98-05.726	1084.5	34.4	204
			SL - LOVING COUNTY			
01	46-05-401	31-56.772	103-28.145	ND	28.9	161
02	46-12-402	31-48.499	103-36.842	52.7	46.1	161
			SS - McCULLOCH COUNTY			
02	42-62-101	31-06.558	99-20.537	637.6	28.5	100
03	42-54-702	31-08.072	99-20.420	644.3	29.4	100
05	42-52-6	31-12.407	99-32.077	850.4	36.2	232
06	42-37-801	31-23.414	99-25.544	746.8	31.0	070
07	42-45-601	31-19.440	99-24.611	837.0	34.0	100
10	42-54-701	31-08.470	99-20.500	648.3	29.5	100
11	42-61-301	31-07.403	99-22.921	676.0	27.5	100
12	42-52-5	31-11.386	99-32.854	975.4	36.2	232
			ST - McLENNAN COUNTY			
09	39-17-701	31-39.514	96-58.314	953.7	53.5	269
11	40-39-106	31-29.513	97-13.689	557.2	43.9	269
19	40-38-801	31-23.363	97-18.573	445.0	33.3	289
21	40-40-702	31-23.492	97-06.929	774.5	40.0	269
23	40-46-402	31-18.460	97-21.427	455.4	36.0	269
24	40-16-401	31-47.967	97-05.773	612.6	40.0	178

BEG County No.	TDWR State Well No.	North Latitude	West Longitude	Well Depth (m)	Water Temp. (°C)	Aquifer Code
26	40-29-805	31-31.907	97-26.897	286.8	30.6	276
27	40-29-601	31-33.260	97-23.185	367.6	30.6	269
28	40-22-905	31-38.053	97-15.330	365.8	30.0	312
29	40-31-102	31-36.331	97-13.495	469.4	34.4	289
30	40-31-101	31-36.320	97-13.514	487.7	34.4	289
31	40-31-501	31-34.428	97-11.787	655.6	40.6	269
32	40-31-504	31-33.044	97-11.017	655.3	40.6	269
33	40-31-612	31-35.150	97-07.624	668.7	43.3	269
34	40-31-601	31-33.953	97-08.336	623.6	38.6	178
35	40-31-608	31-33.351	97-07.963	701.0	40.0	178
36	40-31-702	31-30.296	97-12.699	590.1	37.2	269
37	40-24-101	31-42.865	97-07.252	691.6	40.0	269
38	40-24-302	31-43.898	97-00.849	704.7	45.6	178
39	40-24-701	31-37.596	97-05.992	708.1	43.3	269
40	40-24-801	31-38.316	97-04.624	731.5	47.2	269
41	40-24-802	31-37.988	97-04.677	722.4	46.7	269
42	40-32-101	31-35.799	97-05.115	731.5	30.6	269
43	40-32-102	31-35.582	97-06.352	702.0	45.8	269
44	40-32-103	31-35.841	97-05.640	730.3	46.1	269
45	40-32-403	31-34.325	97-06.409	704.7	46.1	269
46	40-32-404	31-34.564	97-06.051	724.2	46.1	269
47	40-32-405	31-33.646	97-07.226	654.4	46.1	178
48	40-32-501	31-34.713	97-04.621	759.9	45.6	269
49	39-25-401	31-34.347	96-57.938	925.1	55.0	269
50	39-25-402	31-34.342	96-57.925	899.2	54.4	269
51	39-25-501	31-34.212	96-55.869	969.6	48.9	269
52	40-38-302	31-28.971	97-15.363	452.6	35.0	276
53	40-39-108	31-29.649	97-14.224	457.2	32.2	276
54	40-39-302	31-28.422	97-09.524	638.9	39.4	269
55	40-39-702	31-23.024	97-13.212	575.5	36.1	269
56	39-33-101	31-27.817	96-59.151	859.5	55.0	269
57	39-33-104	31-29.803	96-58.139	949.5	51.7	269
58	40-46-801	31-17.356	97-18.528	512.1	37.2	269
77	39-33-202	31-28.646	96-55.188	1076.2	62.5	269
82	40-24-3	31-44.205	97-02.545	792.5	47.	269
83	40-46-403	31-18.254	97-21.505	475.8	34.5	269
86	40-40-401	31-27.094	97-06.876	762.0	43.0	269
92	40-31-604	31-32.960	97-07.915	646.8	37.2	269
94	40-30-901	31-31.536	97-17.159	414.5	26.	269
99	40-40-804	31-24.728	97-03.073	809.9	46.7	312
100	40-39-9	31-23.545	97-09.732	792.5	41.2	269
104	40-46-5	31-19.072	97-18.328	548.6	37.0	269

SU - McMULLEN COUNTY

10	78-20-801	28-38.465	98-34.748	701.0	41.1	140
11	78-21-801	28-38.220	98-27.411	1097.3	48.9	032

BEG County No.	TDWR State Well No.	North Latitude	West Longitude	Well Depth (m)	Water Temp. (°C)	Aquifer Code
12	78-26-502	28-33.206	98-48.073	641.6	34.4	140
13	78-26-601	28-32.636	98-47.614	1005.8	47.8	030
14	78-27-503	28-33.365	98-41.771	1079.0	35.6	030
15	78-27-502	28-32.907	98-40.309	605.0	38.9	140
16	78-28-101	28-36.145	98-35.573	1218.6	51.1	030
17	78-28-501	28-34.525	98-33.469	1194.8	37.2	030
18	78-28-303	28-35.920	98-30.506	842.8	36.7	140
19	78-28-702	28-30.800	98-36.230	1233.2	42.8	030
20	78-28-601	28-34.946	98-30.556	842.8	41.1	140
21	78-28-603	28-34.500	98-32.148	1167.4	51.7	030
22	78-29-603	28-34.279	98-23.517	261.8	33.9	104
23	78-29-604	28-34.123	98-23.338	228.6	34.4	104
24	78-35-602	28-26.413	98-38.902	1066.8	47.8	140
25	78-36-203	28-28.838	98-33.317	1249.7	62.2	140
26	78-36-201	28-27.640	98-33.011	1295.4	51.7	030
27	78-36-901	28-24.797	98-31.784	1463.0	65.0	032
28	78-36-902	28-24.483	98-31.958	1437.1	48.9	030
29	78-37-103	28-27.529	98-29.073	1585.0	62.2	030
30	78-43-401	28-17.840	98-44.790	1914.1	60.0	030
31	78-46-102	28-21.806	98-20.922	351.1	37.8	104
32	78-51-201	28-12.746	98-42.396	1539.2	48.9	030
			SW - MADISON COUNTY			
01	38-57-701	31-02.258	95-57.686	462.1	32.2	030
02	60-01-201	30-57.914	95-55.218	345.0	31.1	164
03	60-01-602	30-56.896	95-54.457	401.1	32.2	164
04	60-03-202	30-57.691	95-42.372	455.4	36.1	164
			SX - MARION COUNTY			
01	35-13-703	32-45.565	94-29.407	ND	28.3	140
02	35-15-601	32-48.914	94-09.752	ND	27.8	030
			TD - MEDINA COUNTY			
34	68-49-813	29-09.749	98-56.420	973.5	41.7	066
43	69-30-7	29-30.074	99-22.398	672.4	32.8	180
44	69-54-6	29-10.394	99-17.339	762.0	27.5	066
45	69-56-507	29-10.320	99-03.294	823.0	35.4	066
46	68-50-202	29-13.500	98-49.313	741.0	36.1	066

BEG County No.	TDWR State Well No.	North Latitude	West Longitude	Well Depth (m)	Water Temp. (°C)	Aquifer Code
			TK - MILAM COUNTY			
01	58-07-901	30-52.580	97-07.688	1051.0	54.0	269
12	59-11-205	30-52.105	96-41.843	176.8	42.2	190
13	58-31-201	30-37.232	97-11.116	680.0	52.2	213
			TL - MILLS COUNTY			
03	41-33-2	31-27.747	98-55.348	856.5	28.6	102
04	41-33-502	31-27.261	98-55.452	1008.9	34.5	102
			TR - MONTAGUE COUNTY			
01	19-09-506	33-49.010	97-56.389	32.0	35.6	215
02	19-09-508	33-49.114	97-56.034	67.1	29.4	215
03	19-10-701	33-47.393	97-52.003	15.2	30.0	215
04	19-11-733	33-47.726	97-43.385	95.4	32.2	215
			TY - NAVARRO COUNTY			
20	33-60-6	32-04.573	96-30.138	1005.8	58.9	200
21	33-60-6	32-04.682	96-30.049	812.3	51.7	200
23	33-58-501	32-04.889	96-48.131	360.9	33.3	200
24	33-59-102	32-05.547	96-43.172	488.6	36.7	200
25	33-59-301	32-05.945	96-38.321	502.9	36.1	200
26	33-61-102	32-05.281	96-27.884	766.6	48.9	200
27	39-04-401	31-56.852	96-36.923	533.4	32.8	200
			US - PECOS COUNTY			
01	52-16-3	30-50.622	103-01.533	418.5	31.7	146
02	45-49-103	31-14.416	102-58.420	1219.2	34.0	028
03	45-49-2	31-14.815	102-55.143	ND	31.5	028
04	45-49-2	31-14.380	102-55.831	ND	32.8	028
05	45-50-3	31-12.695	102-45.146	ND	30.0	154
06	52-16-608	30-48.132	103-00.512	ND	28.5	146
07	52-16-6	30-47.534	103-01.388	ND	28.5	146
08	52-16-609	30-48.079	103-01.528	ND	30.0	146
			UW - PRESIDIO COUNTY			
01	51-28-701	30-30.376	104-36.674	305.1	36.1	176
02	51-43-201	30-20.203	104-42.152	2073.2	82.2	236

BEG County No.	TDWR State Well No.	North Latitude	West Longitude	Well Depth (m)	Water Temp. (°C)	Aquifer Code
03	51-51-301	30-14.226	104-38.043	ND	37.2	001
04	51-52-501	30-12.236	104-35.097	S	36.7	176
05	51-52-702	30-08.131	104-36.958	S	32.2	176
06	51-60-401	30-03.696	104-33.490	42.1	51.1	420
07	51-60-701	30-02.213	104-35.563	ND	45.6	001
08	51-60-802	30-00.376	104-33.778	195.1	33.9	---
09	74-04-203	29-57.576	104-33.918	74.1	32.8	176
10	74-13-8	29-47.381	104-27.610	ND	30.0	---
11	51-43-101	30-22.156	104-43.072	874.2	82.2	236
14	51-28-9	30-30.243	104-30.798	ND	29.8	176
15	51-28-9	30-31.103	104-30.798	ND	60.0	176
18	51-29-7	30-30.235	104-28.742	ND	45.0	176
19	51-29-7	30-31.097	104-29.777	ND	32.0	176
			WB - RED RIVER COUNTY			
15	17-07-402	33-56.959	95-12.601	123.7	28.3	138
16	17-22-902	33-39.646	95-15.945	617.2	35.0	138
20	17-31-2	33-36.418	95-12.436	640.1	36.2	138
			WD - REEVES COUNTY			
03	46-41-801	31-16.809	103-56.229	92.0	27.8	---
04	46-43-201	31-21.175	103-40.708	274.3	30.0	---
05	46-43-305	31-20.654	103-39.692	91.4	31.1	001
06	46-43-307	31-20.655	103-39.367	391.4	33.3	---
07	46-43-906	31-15.117	103-38.908	347.5	28.3	---
08	46-50-201	31-14.645	103-47.541	397.8	31.1	397
09	46-51-516	31-12.256	103-41.818	269.1	30.0	240
10	46-51-518	31-12.084	103-40.521	423.7	30.0	240
			WH - REFUGIO COUNTY			
02	80-41-101	28-22.044	96-58.549	292.6	31.7	116
			WK - ROBERTSON COUNTY			
25	39-61-1	31-07.311	96-28.983	4221.5	33.0	---
			WL - ROCKWALL COUNTY			
06	33-05-401	32-55.809	96-27.481	1018.6	46.7	138

BEG County No.	TDWR State Well No.	North Latitude	West Longitude	Well Depth (m)	Water Temp. (°C)	Aquifer Code
		WU - SAN JACINTO COUNTY				
01	61-25-404	30-34.448	94-58.755	187.8	30.6	317
		WX - SAN SABA COUNTY				
02	41-33-802	31-24.890	98-55.997	730.9	27.5	100
03	41-42-601	31-17.628	98-45.988	1063.1	40.6	100
04	41-43-901	31-16.228	98-38.696	1072.9	31.7	100
06	41-52-101	31-14.875	98-37.287	902.2	32.8	070
07	41-33-801	31-24.739	98-57.493	839.7	31.7	100
09	41-61-2	31-05.186	98-27.464	ND	23.2	070
10	42-40-4	31-26.267	99-05.059	335.3	29.0	070
		XH - SMITH COUNTY				
07	34-38-302	32-27.555	95-15.870	386.8	30.0	190
		XT - SWISHER COUNTY				
01	11-25-502	34-33.921	101-55.769	304.8	30.0	225
		XU - TARRANT COUNTY				
11	32-07-402	32-57.170	97-13.808	447.4	31.1	312
12	32-08-503	32-56.341	97-04.546	545.6	32.8	312
14	32-14-3	32-50.764	97-16.219	390.1	28.9	312
17	32-14-604	32-47.570	97-16.038	347.5	28.3	312
18	32-15-409	32-49.300	97-13.565	406.9	28.3	312
19	32-15-403	32-48.413	97-14.068	389.2	31.1	312
20	32-14-605	32-48.688	97-16.339	391.4	31.7	312
21	32-16-202	32-51.370	97-04.763	546.2	30.6	312
23	32-16-105	32-50.430	97-05.041	542.2	31.7	312
25	32-16-406	32-49.234	97-06.107	518.5	32.2	312
26	32-16-504	32-49.754	97-03.291	562.7	32.2	312
27	32-22-602	32-40.822	97-16.918	392.6	28.9	312
29	32-22-903	32-39.966	97-16.635	410.3	28.9	312
31	32-23-106	32-43.873	97-13.426	419.4	28.9	312
32	32-23-103	32-43.679	97-13.138	436.5	28.9	312
33	32-23-101	32-43.417	97-13.017	415.4	28.9	312
34	32-23-102	32-42.843	97-13.413	412.1	28.3	312
35	32-23-104	32-43.471	97-13.347	405.4	28.9	312
38	32-23-307	32-42.664	97-09.804	493.5	31.7	312

BEG County No.	TDWR State Well No.	North Latitude	West Longitude	Well Depth (m)	Water Temp. (°C)	Aquifer Code
39	32-23-3	32-42.809	97-08.069	531.3	31.1	312
40	32-24-101	32-44.250	97-07.044	541.0	30.0	312
41	32-30-405	32-34.812	97-21.992	167.6	29.4	138
42	32-30-506	32-34.044	97-18.556	395.0	30.0	312
43	32-30-605	32-34.235	97-15.279	465.1	31.1	312
44	32-31-605	32-33.670	97-08.649	528.8	32.8	312
45	32-31-606	32-34.419	97-08.477	538.0	33.3	312

YD - TRAVIS COUNTY

17	58-44-204	30-20.452	97-33.681	993.0	43.3	269
18	58-51-102	30-14.379	97-44.817	684.6	37.	269
19	58-44-601	30-18.642	97-32.087	990.6	34.4	269
35	58-43-911	30-15.721	97-39.542	12.2	29.4	001
40	58-51-901	30-08.826	97-37.873	916.8	37.8	269
42	58-43-303	30-22.332	97-39.370	443.8	30.6	248
49	58-43-703	30-16.067	97-44.438	685.8	35.0	269
50	58-43-704	30-15.965	97-44.379	617.2	37.8	385
52	58-44-201	30-20.445	97-33.521	914.7	43.3	269
53	58-44-202	30-20.445	97-33.521	780.3	33.9	180
55	58-51-103	30-14.916	97-44.209	486.2	33.3	178
56	58-51-701	30-09.894	97-43.137	739.1	34.4	269

YP - UVALDE COUNTY

19	69-44-703	29-15.060	99-35.074	513.6	32.8	066
22	69-52-401	29-11.911	99-36.982	429.8	33.5	066
23	69-52-402	29-11.912	99-37.412	384.7	32.5	066
24	69-53-703	29-08.768	99-28.858	384.7	36.7	066
31	69-52-902	29-08.107	99-30.054	683.4	38.0	066
32	69-53-2	29-14.150	99-25.198	1368.6	30.0	220
33	69-43-7	29-15.646	99-43.086	923.5	29.5	080
36	69-44-7	29-15.426	99-35.120	ND	29.0	066
37	69-52-101	29-13.529	99-34.690	478.8	32.8	284
38	69-52-901	29-08.873	99-30.407	802.2	40.6	066
39	69-51-7	29-08.287	99-44.920	487.7	34.5	066
40	69-51-7	29-07.652	99-44.610	670.6	36.0	066
41	69-59-1	29-07.428	99-43.790	603.5	35.5	066

YR - VAL VERDE COUNTY

71	71-31-7	29-32.049	101-15.025	603.5	28.9	066

BEG County No.	TDWR State Well No.	North Latitude	West Longitude	Well Depth (m)	Water Temp. (°C)	Aquifer Code
			YU - WALKER COUNTY			
01	60-03-902	30-52.851	95-39.210	705.3	40.6	164
			YW - WALLER COUNTY			
01	66-08-602	29-55.550	96-02.136	490.1	34.4	383
02	59-64-206	30-05.630	96-04.870	399.3	31.0	132
			YX - WARD COUNTY			
01	46-32-901	31-32.087	103-00.201	1347.5	32.2	028
06	46-24-812	31-38.416	103-02.914	1310.6	32.8	028
08	46-24-814	31-38.695	103-03.556	1341.1	32.5	028
13	46-32-209	31-37.039	103-02.942	1341.1	33.0	028
14	46-32-210	31-37.466	103-03.117	1262.2	32.8	028
15	46-32-304	31-37.165	103-02.465	1371.6	33.0	028
23	46-32-620	31-34.960	103-02.170	1371.6	33.0	028
			YY - WASHINGTON COUNTY			
02	59-53-905	30-09.552	96-23.843	461.8	32.2	034
			YZ - WEBB COUNTY			
01	85-28-901	27-32.106	99-30.902	763.5	42.2	030
04	85-12-102	27-51.979	99-37.427	563.9	34.4	030
05	77-59-401	28-03.105	99-44.500	548.6	35.6	030
06	77-58-301	28-07.237	99-45.873	498.3	35.0	032
07	77-50-601	28-10.675	99-46.966	478.5	36.7	030
08	85-32-3	27-37.045	99-02.041	670.6	50.0	140
09	77-59-5	28-03.294	99-40.054	607.8	33.2	030
11	85-04-502	27-56.421	99-33.121	819.6	35.2	030
12	85-04-701	27-54.605	99-36.515	592.8	25.6	030
			ZJ - WILLACY COUNTY			
01	88-34-9	26-24.696	97-47.207	589.8	33.3	088

BEG County No.	TDWR State Well No.	North Latitude	West Longitude	Well Depth (m)	Water Temp. (°C)	Aquifer Code
			ZK - WILLIAMSON COUNTY			
12	58-13-503	30-47.625	97-25.796	797.7	42.	269
13	58-21-203	30-43.327	97-26.485	794.3	41.	269
19	58-29-607	30-34.997	97-25.007	1028.1	48.	269
24	58-21-201	30-43.236	97-26.603	771.4	41.1	269
25	58-29-601	30-34.674	97-24.602	993.6	46.1	180
26	58-29-602	30-34.941	97-24.610	1008.3	36.7	269
27	58-29-604	30-34.552	97-24.350	1022.9	46.7	269
29	58-21-1	30-44.376	97-29.476	234.7	26.	066
30	58-21-1	30-44.356	97-29.496	240.8	26.	066
31	58-29-501	30-33.715	97-27.260	339.9	24.4	066
			ZL - WILSON COUNTY			
25	68-54-901	29-08.575	98-16.656	310.9	30.6	030
26	68-54-903	29-08.810	98-17.546	310.0	30.6	030
28	68-55-801	29-08.368	98-12.142	294.4	33.3	030
29	68-55-802	29-09.874	98-11.526	219.5	31.1	030
31	68-55-902	29-08.028	98-09.770	292.6	32.8	030
32	68-55-903	29-07.724	98-08.917	426.7	32.8	030
34	68-56-403	29-12.280	98-05.045	296.0	31.1	030
35	68-56-502	29-10.605	98-04.399	318.2	32.2	030
37	68-62-103	29-05.731	98-22.288	359.7	30.6	030
38	68-62-101	29-05.208	98-21.641	413.0	31.1	030
40	68-62-401	29-03.889	98-21.249	310.9	31.1	030
41	68-62-203	29-06.213	98-18.575	310.6	31.1	030
42	68-62-601	29-04.624	98-16.002	411.2	35.6	030
44	68-62-604	29-04.084	98-16.934	429.8	34.4	030
45	68-62-802	29-01.621	98-18.243	487.7	36.7	030
46	68-62-902	29-01.574	98-16.503	487.7	40.6	030
47	68-62-904	29-01.286	98-16.309	520.6	38.9	030
48	68-63-402	29-04.754	98-14.017	402.3	35.6	030
49	68-63-701	29-01.422	98-14.845	585.2	38.3	030
50	68-63-802	29-00.504	98-11.442	733.7	45.0	030
51	68-64-103	29-07.383	98-05.926	374.9	38.9	030
52	68-64-401	29-04.069	98-05.081	612.6	47.8	030
53	68-64-402	29-04.334	98-05.277	619.4	47.2	030
54	78-06-302	28-57.863	98-15.768	616.3	42.8	030
58	67-49-401	29-11.205	97-59.286	289.6	32.2	030
60	67-50-701	29-09.419	97-50.382	678.2	32.2	030
62	68-48-8	29-16.821	98-03.366	ND	22.0	---

BEG County No.	TDWR State Well No.	North Latitude	West Longitude	Well Depth (m)	Water Temp. (°C)	Aquifer Code
			ZX - ZAVALA COUNTY			
13	69-61-526	29-03.844	99-25.982	1063.1	46.1	284
32	77-04-606	28-56.072	99-30.297	324.3	32.2	030
33	77-04-421	28-55.609	99-37.296	ND	31.1	030
34	77-04-422	28-55.433	99-37.335	297.2	31.1	030
35	77-04-418	28-56.388	99-37.494	274.3	32.8	030
37	77-04-415	28-55.259	99-36.783	289.6	31.1	030
38	77-04-709	28-54.147	99-36.907	306.3	31.1	030
47	77-09-708	28-45.422	99-57.818	224.0	31.1	030
48	77-09-709	28-45.109	99-57.937	228.9	31.1	030
53	77-10-609	28-49.335	99-45.416	316.4	32.2	030
54	77-10-611	28-48.885	99-46.089	275.2	32.2	030
55	77-10-613	28-48.918	99-45.694	316.4	32.2	030
56	77-10-601	28-48.847	99-45.180	321.0	32.2	030
57	77-10-605	28-48.641	99-46.010	333.1	32.2	030
58	77-10-603	28-48.154	99-45.933	305.1	31.7	030
59	77-10-610	28-47.979	99-45.223	301.4	33.3	030
60	77-10-614	28-47.878	99-47.078	301.4	33.3	030
61	77-11-403	28-48.603	99-44.391	301.4	33.3	030
62	77-11-701	28-47.142	99-44.356	354.5	34.4	030
63	77-11-703	28-47.071	99-43.764	341.4	32.2	030
64	77-11-705	28-46.513	99-43.213	348.4	33.3	030
65	77-11-716	28-46.342	99-44.319	ND	33.3	030
66	77-11-702	28-45.298	99-44.046	350.5	33.9	030
67	77-11-601	28-47.893	99-38.866	365.8	34.4	030
68	77-11-707	28-45.299	99-44.480	350.8	32.2	030
80	77-17-602	28-42.427	99-52.732	ND	32.8	030
81	77-17-603	28-41.870	99-52.654	279.5	33.3	030
83	77-18-402	28-42.181	99-51.391	297.5	32.2	030
84	77-18-401	28-41.727	99-50.091	321.3	32.2	030
85	77-18-510	28-41.623	99-49.775	289.6	31.1	030
86	77-18-503	28-41.691	99-49.420	303.3	31.1	030
87	77-18-511	28-41.170	99-49.697	274.3	31.1	030
88	77-18-502	28-41.097	99-47.725	326.1	31.1	030
89	77-18-607	28-42.729	99-46.223	329.8	31.7	030
90	77-18-602	28-41.651	99-46.502	316.4	31.1	030
91	77-19-705	28-39.282	99-44.576	ND	32.2	030
92	77-19-711	28-38.932	99-43.591	ND	35.6	030
93	77-19-804	28-38.755	99-42.054	396.2	36.1	030
94	77-19-803	28-39.241	99-41.816	398.4	36.1	030
95	77-20-101	28-44.579	99-35.604	1432.0	35.6	030
96	77-09-605	28-49.634	99-54.629	258.5	31.1	030

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PLATE I
GEOTHERMAL DATA ALONG BALCONES/
OUACHITA TREND, TEXAS

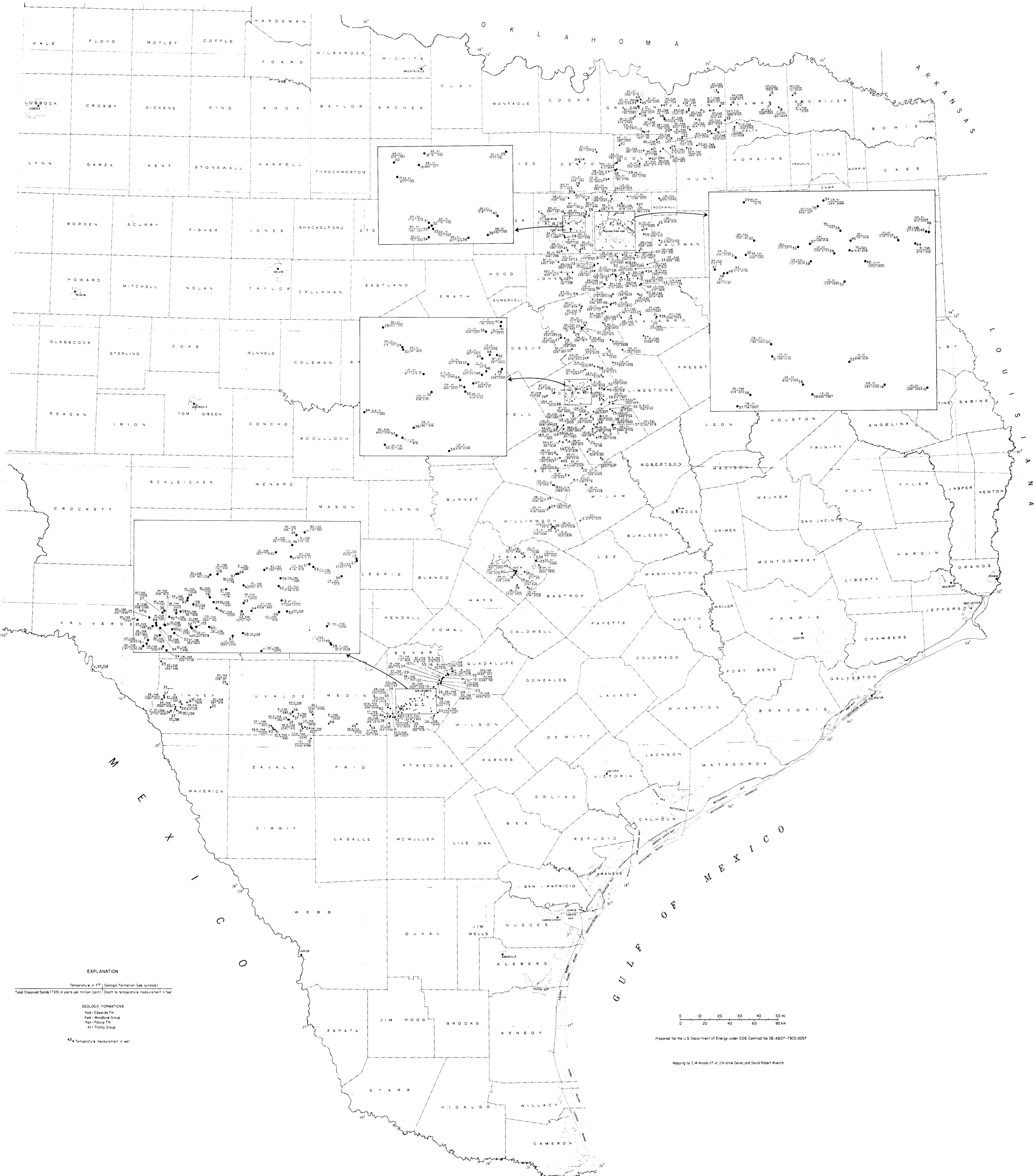

PLATE I. DISTRIBUTION OF THERMAL WATERS ALONG THE BALCONES/OUACHITA TREND, TEXAS
1984

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BUREAU OF ECONOMIC GEOLOGY
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PLATE 2
STRUCTURE CONTOUR MAP: BASE OF CRETACEOUS ALONG BALCONES/
OUACHITA TREND, TEXAS

Prepared for the U.S. Department of Energy under DOE Contract No DE-AS07-79ID12057

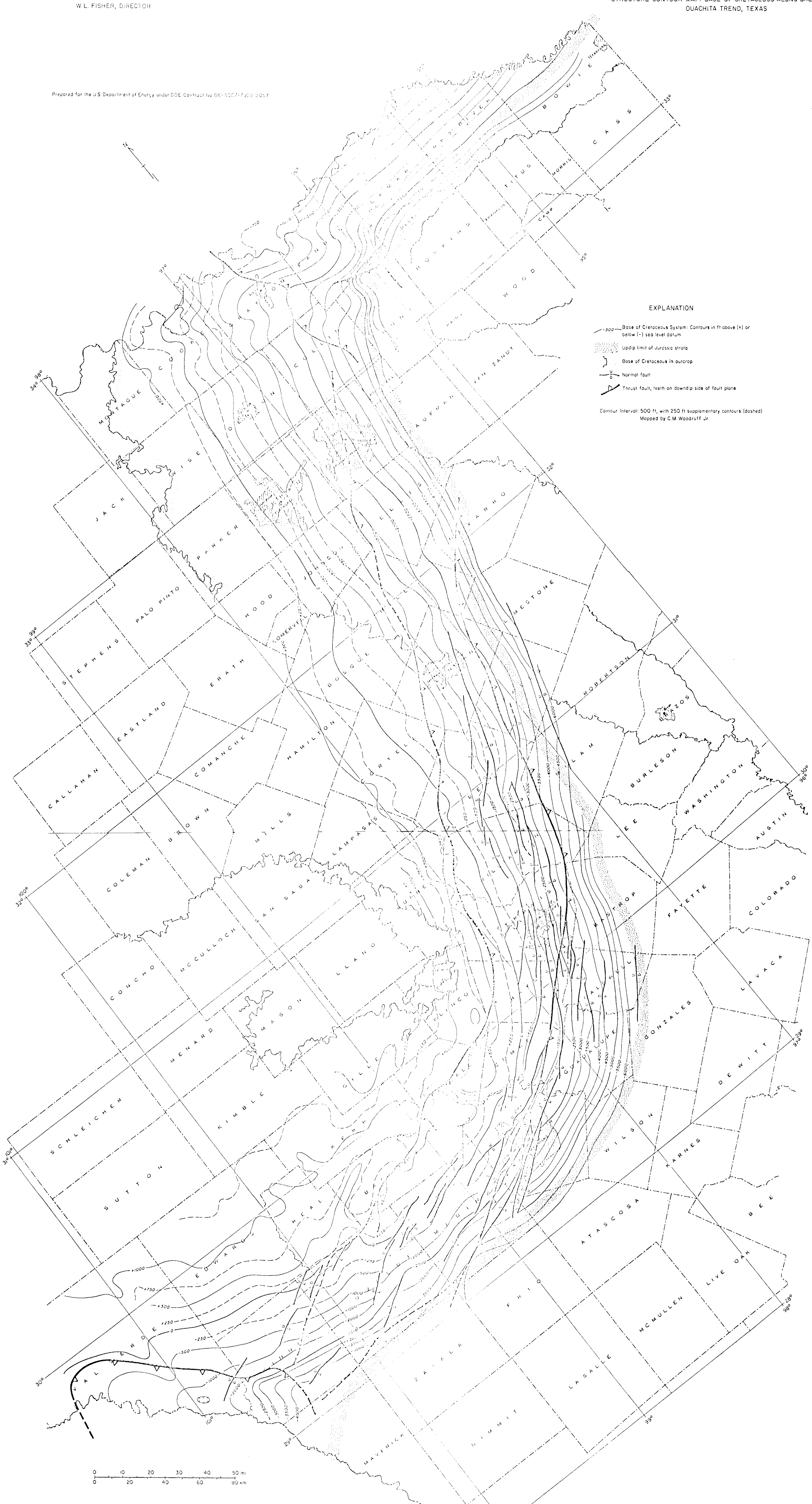

PLATE 2. STRUCTURE CONTOUR MAP ON THE BASE OF THE CRETACEOUS SYSTEM (PALEOZOIC OUACHITA BASEMENT), TEXAS
1984

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PLATE 3
STRUCTURE CONTOUR MAP

PLATE 3. STRUCTURE CONTOUR MAP OF THE BALCONES AND LULING FAULT ZONES, MEXIA AND TALCO FAULT ZONES, AND FORELAND AREAS ADJACENT TO THE OUACHITA OROGEN, TEXAS

1984

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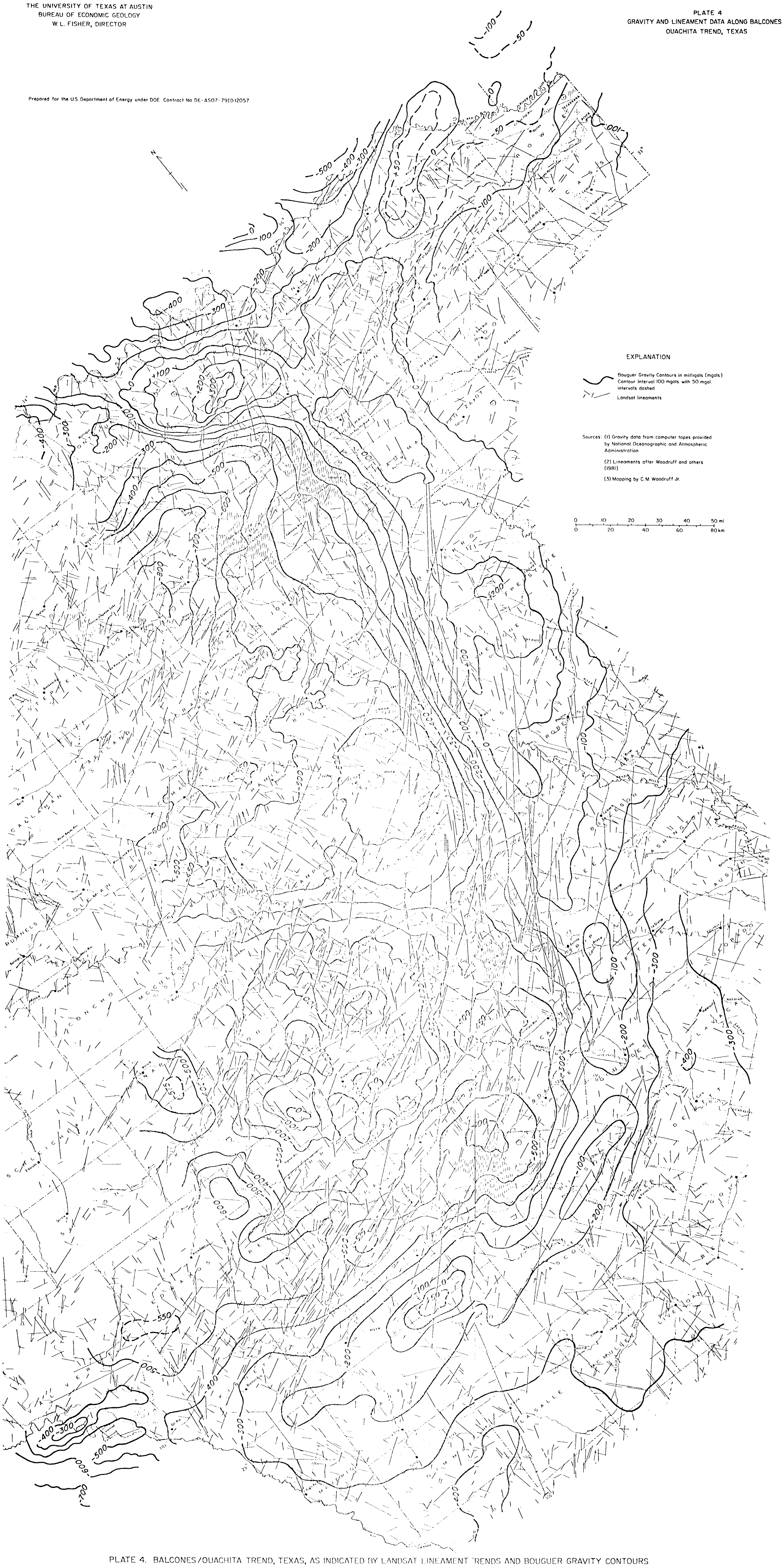
PLATE 4
GRAVITY AND LINEAMENT DATA ALONG BALCONES/ OUACHITA TREND, TEXAS

Prepared for the U.S. Department of Energy under DOE Contract No. DE-AS07-79ID12057



EXPLANATION

Bouguer Gravity Contours in milligals (mgals) Contour interval 100 mgals with 50 mgal intervals dashed

Landsat lineaments

Sources: (1) Gravity data from computer tapes provided by National Oceanographic and Atmospheric Administration

(2) Lineaments after Woodruff and others (1981)

(3) Mapping by C.M. Woodruff Jr.

0 10 20 30 40 50 mi
0 20 40 60 80 km

PLATE 4. BALCONES/OUACHITA TREND, TEXAS, AS INDICATED BY LANDSAT LINEAMENT TRENDS AND BOUGUER GRAVITY CONTOURS
1984

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PLATE 5
GEOTHERMAL GRADIENTS ALONG THE
OUACHITA TREND, TEXAS

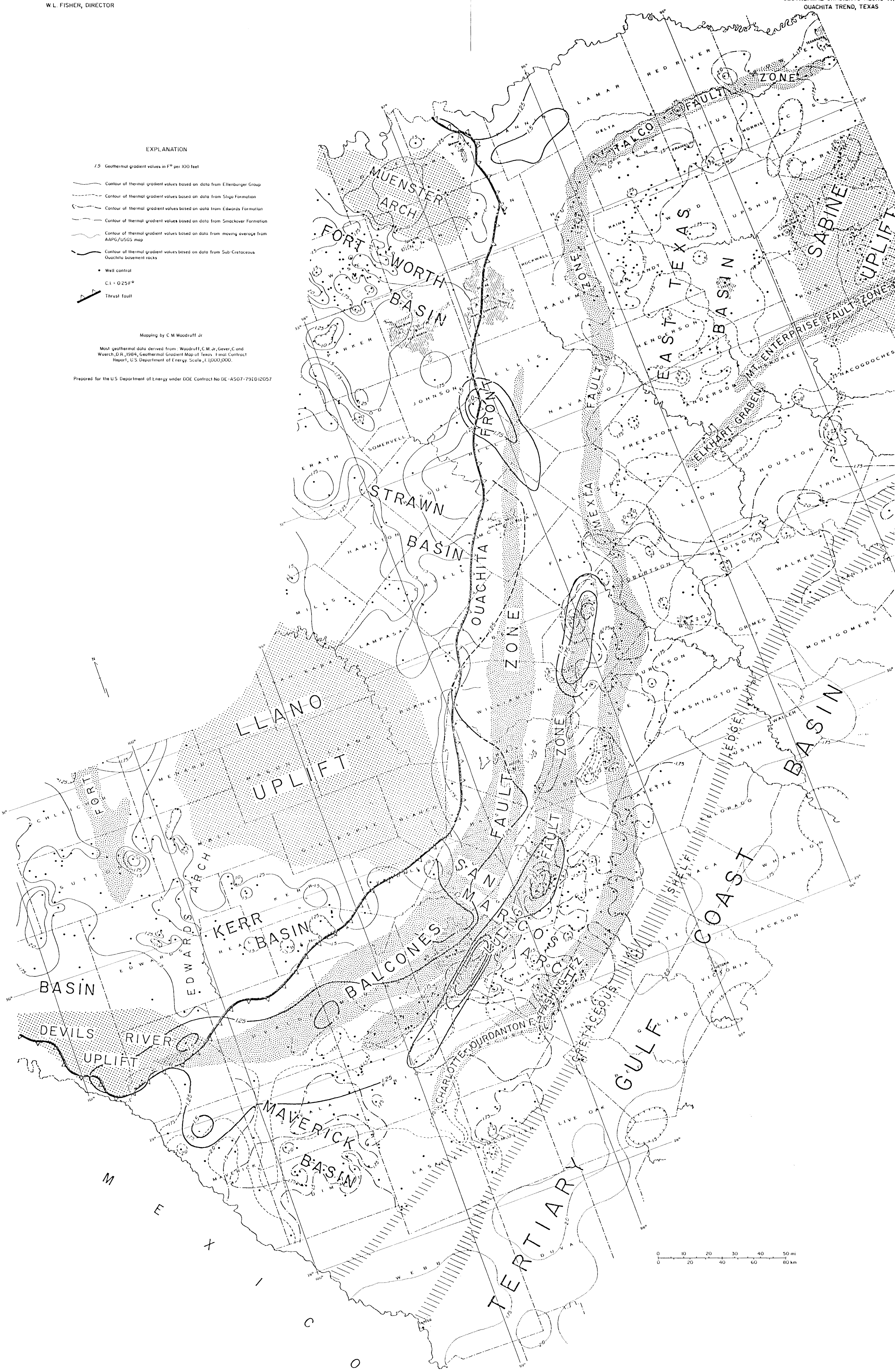
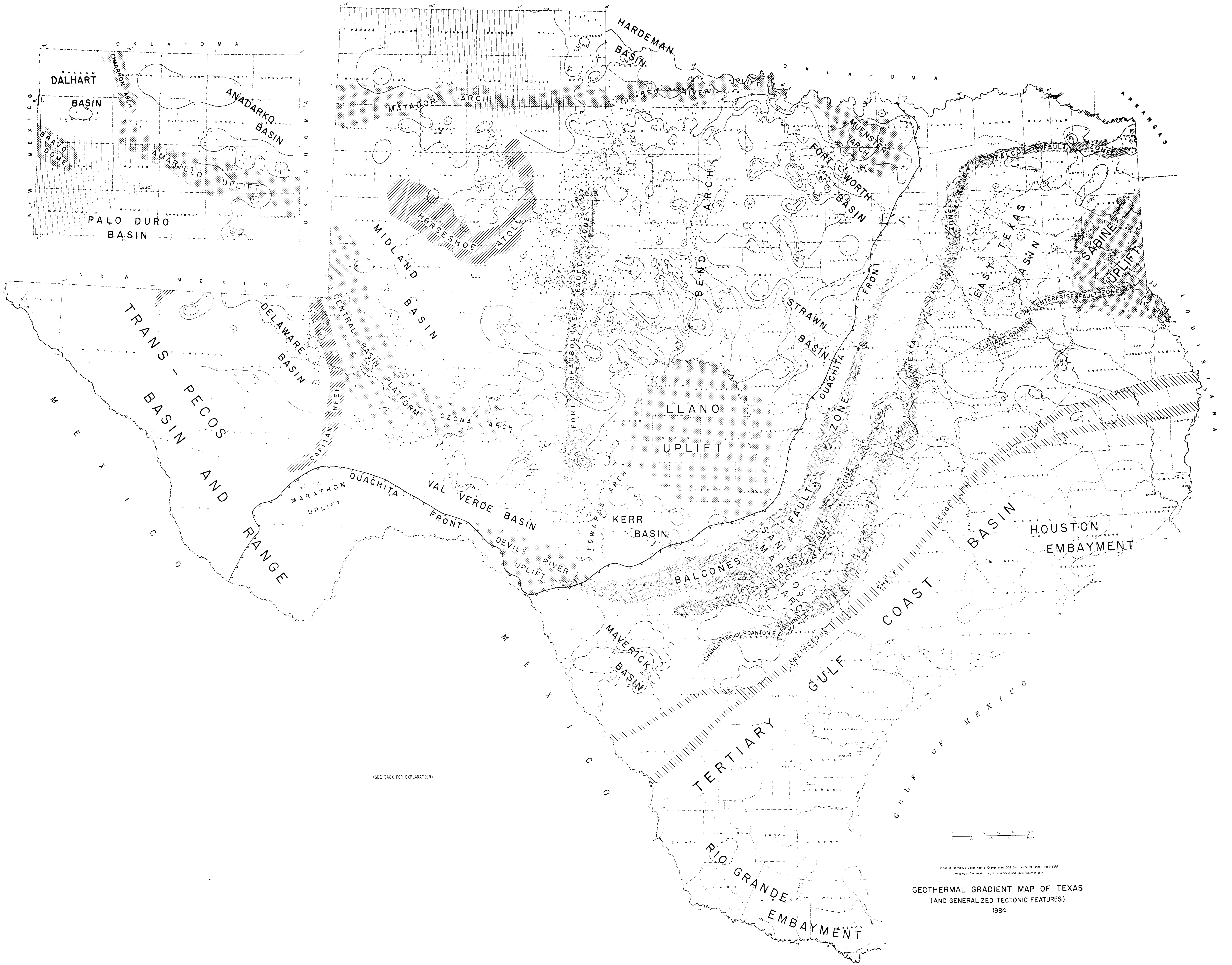


PLATE 5. GEOTHERMAL GRADIENTS AND GENERALIZED TECTONIC FEATURES ALONG THE OUACHITA TREND, TEXAS, BASED ON DATA FROM SELECTED PALEOZOIC AND MESOZOIC FORMATIONS.
1984



GEOTHERMAL GRADIENT MAP OF TEXAS
(AND GENERALIZED TECTONIC FEATURES)
1984

GEOTHERMAL GRADIENTS OF TEXAS

Geothermal gradient contours are commonly used to show presumed variations in the earth's internal heat. Many researchers apply the heat-flow equation literally (*see* inset table 1), assuming that geothermal gradients change as a function of heat flow. But the underlying premise of the heat-flow equation is that radiogenic heat flows from high- to low-potential areas by means of solid-state conduction. Rarely do such conditions occur in nature owing to the interaction of hydrodynamics. Moreover, thermal conductivity is a factor in the heat flow equation. Thermal conductivity varies inversely with geothermal gradient. Clearly, for any correlation between geothermal gradient and heat flow to be meaningful, one must allow for the thermal conductivity of rock in which the geothermal gradient is measured. It is also important for users of this map to be aware that many of the apparent areal perturbations of geothermal gradient may be due to subsurface water flow; thus, Darcy's Law, as discussed below and as shown in table 1, is important.

Within these constraints this map shows geothermal gradients contoured for a few specific geologic horizons across Texas. Uniformity of rock type was the main criterion used in choosing the horizons presented here. This ensures a more or less constant thermal conductivity, thus avoiding perturbations of geothermal gradients owing to areal variations in thermal conductivities.

It would have been desirable to depict statewide geothermal gradients as a single set of contours representing a single rock type and, preferably, a single rock unit. The best possible situation would be a statewide sampling of, for example, granitic basement, because a crystalline basement complex would yield gradient values that (theoretically) indicate thermal conditions in the crust. In fact, this ideal case (readings confined to granitic rock) cannot be attained because of (1) geologic realities—granitic basement probably does not occur throughout Texas; and (2) data constraints—the paucity of wells penetrating basement across the state. Given these geologic and data constraints, we collected readings on bottom-hole temperature (BHT) and depth for a uniform rock type within as few geologic units as possible but allowing for adequate well control over a broad area.

Sedimentary carbonate rocks (limestone and dolomite units) are the best compromise on the basis of these criteria. Carbonate rock units are generally thick and widespread and have little internal lithic variation. Moreover, many limestone and dolomite units are petroleum reservoirs and thus there is widespread electric log control for use in computing geothermal gradients.

Four carbonate rock units provide data for contouring geothermal gradients for most of Texas inland of the Stuart City/Sligo Reef Trend (Lower Cretaceous Shelf Edge). These include three Mesozoic formations beneath the inner Gulf Coastal Plain: the Jurassic Smackover Formation and the Sligo/Pettet and Edwards Formations, both of Cretaceous age. For the remainder of the state west of the Balcones/Ouachita Trend we employed data mostly from the Ellenburger Group of Ordovician age. Coastward of the Lower Cretaceous Shelf Edge, however, fundamental geologic changes occur. There, few wells are completed in carbonate rocks owing to radical facies changes and excessive depths to correlative Mesozoic units. Most of the BHT/depth (bottom-hole temperature) data exist for Tertiary and Quaternary clastic rock units, and within these units there is no assurance of lateral or vertical lithic continuity. Hence, for this region (the Tertiary Gulf Coast Basin) we present a separate set of contours based on a moving average of the gradient data derived from the 1:1,000,000-scale version of the Geothermal Gradient Map of North America (American Association of Petroleum Geologists and U.S. Geological Survey, 1976). In this way, we were able to smooth contours that otherwise would suggest geothermal anomalies but that may in fact merely be due to penetration of sandstone and mudstone in adjacent wells.

In short, five sets of data are contoured on this map: the moving-average contours for the Tertiary Gulf Coast Basin and separate contours for each of the four discrete geologic units. The carbonate rock units are depicted as separate sets of contours so that each set will be internally consistent while still being broadly comparable to one another. The local overlapping of contours for different units indicates local, apparent geothermal perturbations that probably result from hydrodynamic conditions within the rock unit and *not* from variations in heat flow. This mosaic of contours thus allows better resolution of certain controls on local anomalies and allows direct comparison of geothermal gradients to subsurface structures mapped on key horizons (namely the Ellenburger and the Edwards; compare this map to that by Sellards and Hendricks, 1948; also an updated depiction of statewide structures is forthcoming [Ewing and others, in progress]). However, the segregation of the gradient map by rock unit promotes a fragmented view of statewide geothermal trends: because of uneven well control there are significant blank areas on this map; compare this depiction to the inset figure 1. Gaps in contouring occur along the Balcones/Ouachita Trend, along the Llano Uplift, in parts of Trans-Pecos Texas west of the Delaware Basin, and in West Texas along parts of the Amarillo Uplift and the Matador Arch. These gaps appear where there are no wells penetrating the designated horizons or correlative strata, or, as occurs along parts of the Balcones trend, the target horizons do not lie within the proper depth range. We attempted to obtain all readings from points deeper than 2,000 ft (to avoid near-surface hydrologic perturbations) but shallower than the range of geopressured conditions (because of the abrupt discontinuities of geothermal gradients in that zone).

The data, which were obtained from electric logs in state-agency files and, in some areas, from commercial printouts of BHT's, drill-stem tests, and the like, were then further screened. We disregarded BHT readings that were blatantly inconsistent with values that should occur at the depth recorded. Since BHT values are *not* measured to record actual earth temperatures but to calibrate electric-log response with mud resistivity, the goal of the engineer logging a hole is to have a "correct" electrical response indicated on the log. Hence, there is a prevalence of BHT's at suspicious "even" increments (for example, 100°F) for a wide range of depth. We tended to cull any such "reading of convenience" unless (a) there were no other data available in the area, and (b) the reading was in line with locally prevailing gradients. In some areas, well control is so dense that we reduced the readings to a manageable number. A convenient maximum density of well control is one well within any given 2.5-minute area (that is, within a one-ninth subdivision of a 7.5-minute quadrangle). When wells penetrating a horizon of interest were more dense than this, we selected a data point by the use of random numbers. When a well was measured for BHT more than once for a horizon, we selected the reading that would yield the lowest geothermal gradient, thus ensuring that any bias of the data would be conservative.

The BHT and depth data thus selected for the designated horizons were then equilibrated using an empirical curve developed by Cheung (1975) for readings within the depth range of 2,000 to 15,000 ft (inset fig. 2). For the few readings at depths greater than 15,000 ft we used the curve developed by Kehle and others (1970). We favored Cheung's curve especially for shallow depths because it correctly allows for the surface effects that result in apparent increases in geothermal gradients as depths within this range become shallower. These equilibrated data were plotted on standard Army Map Service 1° by 2° Quadrangle Maps (1:250,000 scale), which were then reduced to 1:500,000, at which scale the data were contoured. These interim maps are on file at the Bureau of Economic Geology.

Given the guidelines imposed on the selection of data and the segregation of contours into sets according to discrete geologic horizons, we have removed thermal conductivity as a major variable. Considering the heat-flow equation alone, it would appear that we have ensured that geothermal gradient is a simple positive function of local heat flow. As already pointed out, this is not the case. Porous and permeable sedimentary rocks also transmit water, and water is an excellent conveyor of heat. In fact, the movement of water through a porous medium is controlled by several variables (expressed in Darcy's Law), that are clearly analogous to the variables in the heat-flow equation (*see* inset table 1). Hence, at any locality, a geothermal gradient may be a simple function of conductive heat flow, or it may be related to the flow of ground water within the stratum penetrated. Moreover, local anomalies may also be a result of errors in the reading or recording of the BHT or depth values, although in our selection process we took pains to ferret out these false anomalies.

In short, the controls on geothermal gradients as contoured on this map are still ambiguous. Nonetheless, at least one major variable, thermal conductivity (and the analogous hydraulic conductivity in Darcy's Law), has been removed. Our hypothesis is that most of the variability in geothermal gradients shown here is a result of hydrodynamics: Upwelling waters yield a positive anomaly; downflowing (recharging) waters yield a negative anomaly. The basis of this hypothesis is the fact that the carbonate rock units studied here are porous and permeable. Since they are hydrocarbon reservoirs, fluids obviously migrate through them. Also, they generally are *not* immediately superjacent to a "basement" (largely non-porous and non-permeable) medium in which conductive heat flow would be expected to dominate. Finally, as mentioned earlier, the local variations in the shapes of mapped geothermal-gradient contours where they overlap for different stratigraphic units indicate that water flow and *not* heat flow is responsible for the variations observed. The presentation of these contours, keyed to specific horizons, should be viewed as an adjunct to regional structural maps. This depiction may be applied to any resource that depends on thermal conditions related to flowing water including geothermal prospects, loci of hydrocarbon migration and entrapment, and hydrothermal ore deposits.

EXPLANATION

Geothermal gradient values in F° per 100 feet

- (solid line) Contour of thermal gradient values based on data from Ellenburger Group
- (dashed line) Contour of thermal gradient values based on data from Sligo Formation
- (dash-dot line) Contour of thermal gradient values based on data from Edwards Formation
- (dash-dot-dot line) Contour of thermal gradient values based on data from Smackover Formation
- (dotted line) Contour of thermal gradient values based on data from moving average from AAPG/USGS map

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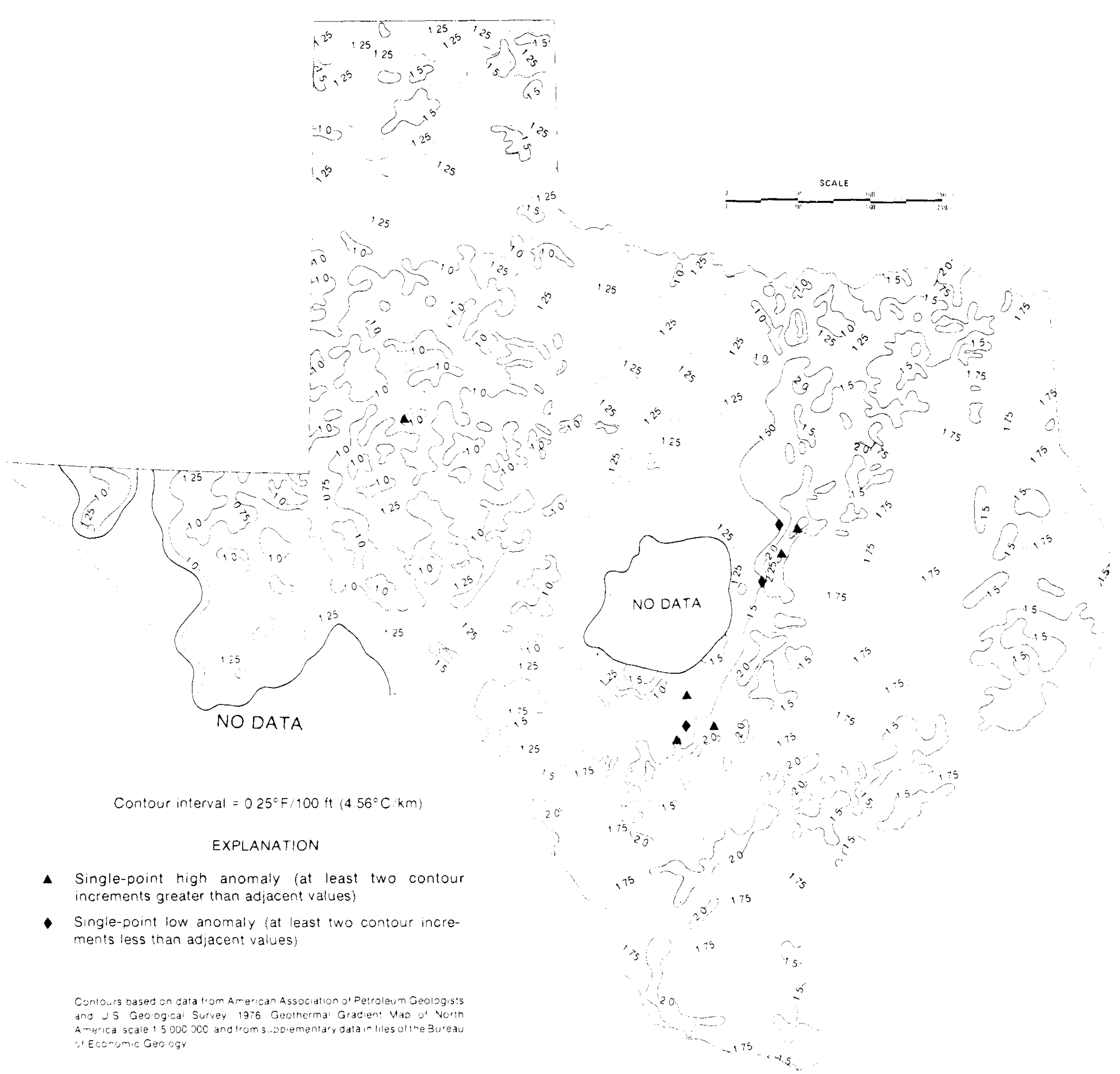

Figure 1. Geothermal Gradients of Texas.
(Contoured without regard to geologic horizon or rock type)

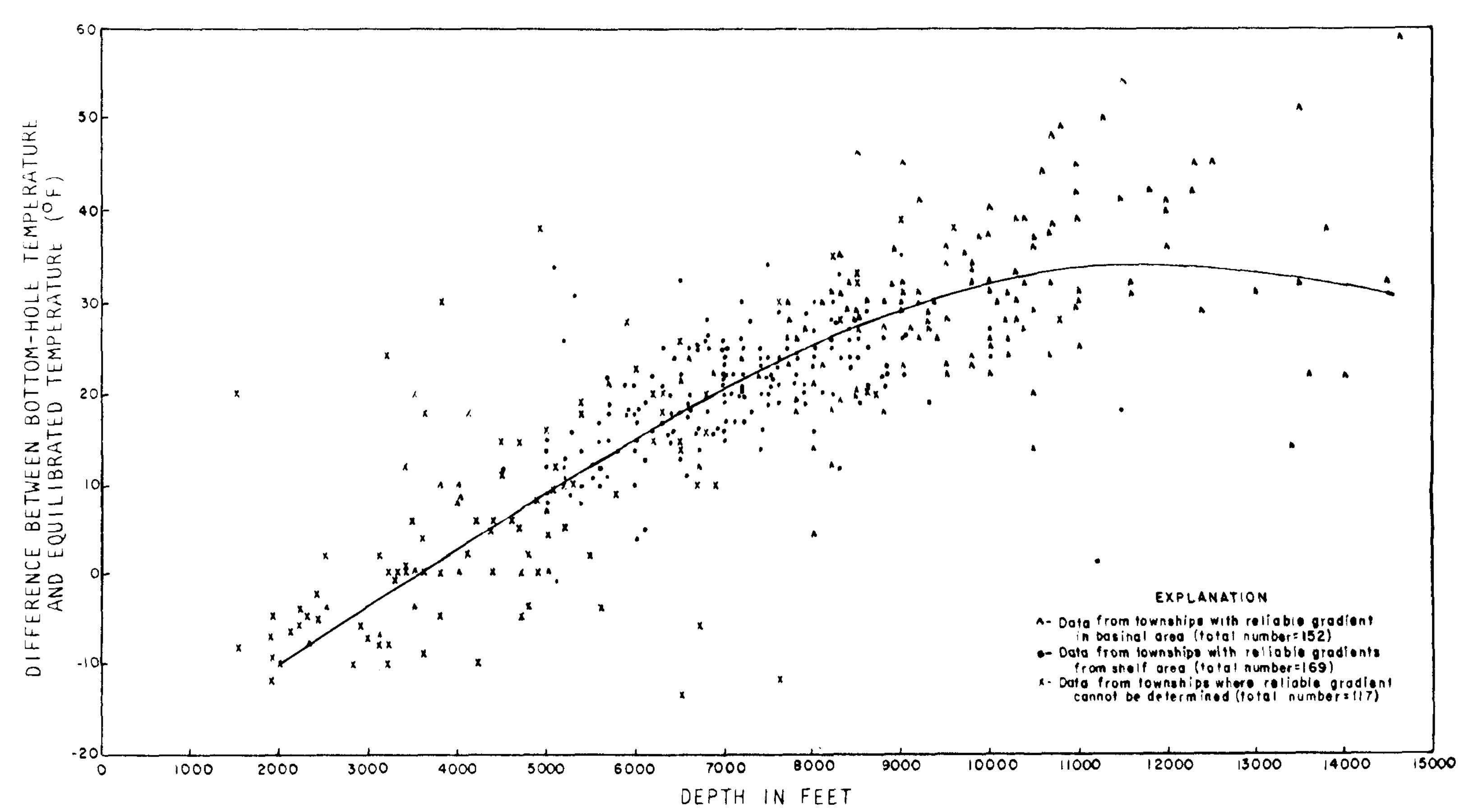

Figure 2. Equilibration curve for BHT/depth data, from Cheung (1975).

Heat Conduction	Hydrodynamics
$Q = \frac{df}{dt}$	$Q = \frac{df}{dt}$
(heat flow per unit of time)	(fluid flow per unit of time)
K	K
(thermal conductivity)	(hydraulic conductivity)
T (temperature)	H (pressure)
$\frac{dT}{dz}$	$\frac{dH}{dl}$
(thermal gradient across path length, z)	(pressure gradient across path length, l)
$Q = -KA\frac{dT}{dz}$	$Q = -KA\frac{dH}{dl}$
(Fourier's Law, the Heat-Flow Equation)	(Darcy's Law)

A = path cross section; minus sign indicates negative slope on Cartesian graph.

Table 1. Comparison of the Heat-Flow Equation and Darcy's Law (after Guyod, 1946).