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NEW MEXICO
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# TECHNICAL REPORT NO. 69-21

# GEOTHERMAL NOISE SURVEY
# OF THE
# LORDSBURG DISTRICT OF NEW MEXICO

GEOTECH
A TELEDYNE COMPANY

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by

Field Measurement Branch Staff

GEOTECH
A Teledyne Company
3401 Shiloh Road
Garland, Texas

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ILLUSTRATIONS

# GEOTHERMAL NOISE SURVEY OF THE LORDSBURG DISTRICT OF NEW MEXICO

## 1. INTRODUCTION

A recent survey was conducted by Geotech in the Lordsburg district of New Mexico, using a Geothermal Ground Noise Detection technique, to determine the location and extent of local geothermal aquifer systems.

The survey was initiated on 21 April and terminted on 7 May 1969. Data was collected from sixteen recording stations in the Lordsburg region (see fig. 1) during this seventeen day period. One additional recording station was operated on 5 May near Kilbourne Hole, New Mexico, an area located west of El Paso, Texas.

Data evaluation was accomplished in the field by a daily audio analysis of the microseismic background. A more thorough visual analysis of the frequency and power spectra of the background signals was conducted in our data processing facilities after the survey was completed.

During the early stages of the survey, the initial area planned for investigation was expanded into a much broader survey because of the lack of geothermal ground noise. This resulted in a more complete evaluation of the geothermal probability of the Lordsburg area.

## 2. GEOLOGY

This area has had a large amount of igneous activity that has taken place in the geologic past. Geothermal aquifer areas are closely associated with igneous activity; therefore, this fact would lead one to believe that this area would be very promising for the development of geothermal energy.

Physiographically, the area is located in the southeastern portion of the Basin and Range Division and is divisible into three units: The Peloncillo Mountains on the west, the Animas Valley in the central part and the Pyramid Mountains on the east.

The Peloncillo Mountains are a north-south trending, narrow, relatively low range of hills ranging 1000 to 1500 feet above the bordering valleys. Although the mountains are of low relief and are a mile or less in width, the steep slopes make them appear much larger than they really are.

The Animas Valley is a lacustrine and alluvial filled, broad, flat northward sloping interior basin with an undefined drainage pattern. Two playa lakes occur just north of Interstate Highway 10. They are the North Alkali Flat and the South Alkali Flat. The valley is bounded on the west by the Peloncillo Mountains and on the east by the Pyramid Mountains.

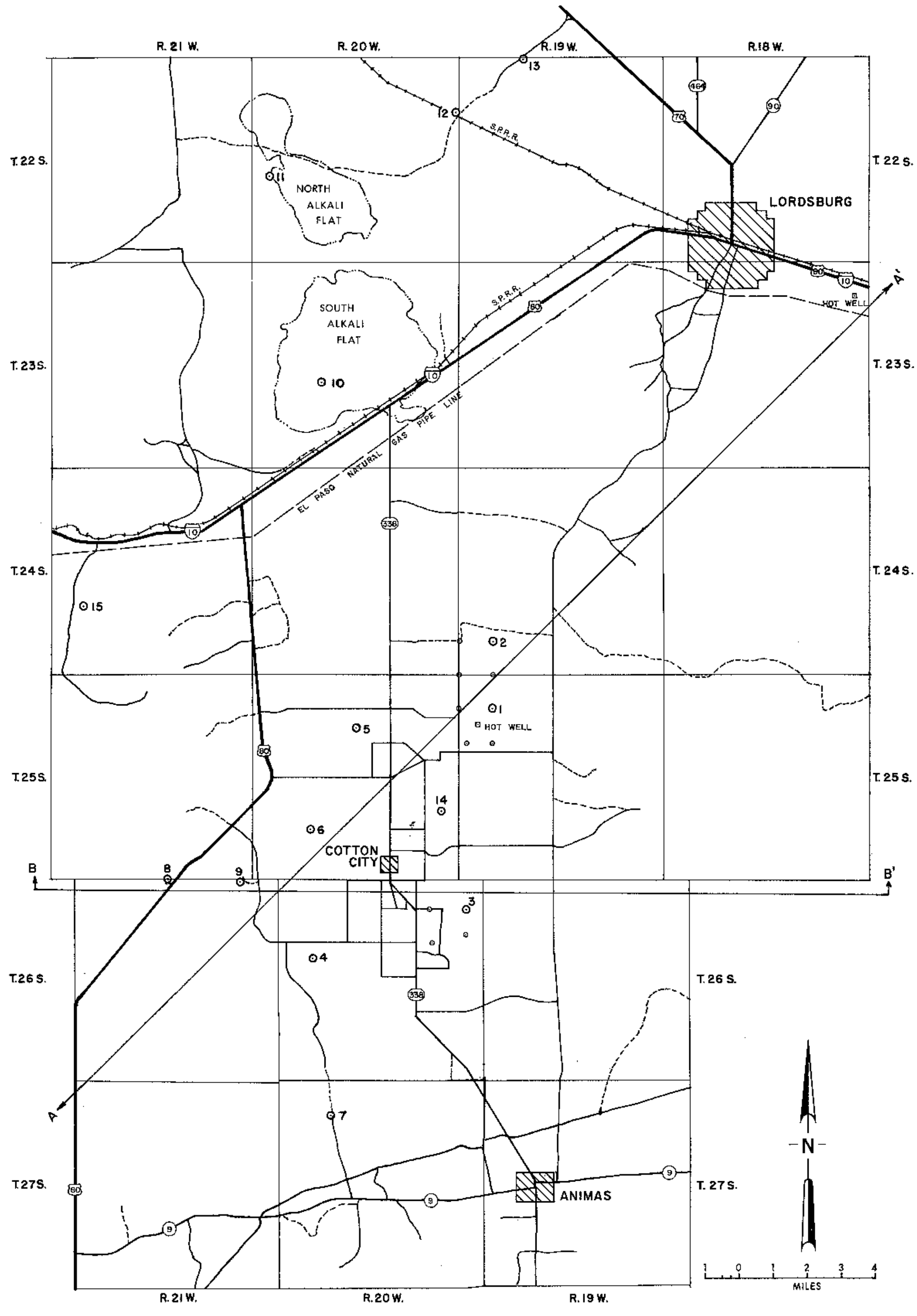


Figure 1. Location of cross sections and geothermal ground noise stations

The Pyramid Mountains are north-south trending, low hills averaging about 500 feet in relief above the valley floors on the east and west flanks. The broad, gently sloping pediments do not give the appearance of loftiness but the maximum relief is even higher than the Peloncillo range. The Pyramids are terminated on the north by the Lordsburg Draw.

Late Tertiary and Quaternary orogenic movements, which uplifted the mountains on either side of the valley, have exposed igneous and sedimentary rocks ranging in age from Precambrian to early Tertiary.

The Precambrian is represented by granite outcropping in the Granite Gap area. The total outcrop is approximately 1-1/2 square miles. The granite dips under the valley fill to the east and west and is bounded by high-angle southward dipping faults on the north and south.

The Paleozoic outcrops are mostly limestone with minor amounts of shale, quartzite, granite and other igneous material. The main outcrop of the Paleozoic limestones occur just north of Granite Gap in T.25 S., R21 W. These beds are highly fractured and faulted by northwest-southeast trending faults.

The Mesozoic is represented by sedimentary beds in the Peloncillo Mountains and igneous rocks in the Pyramid Mountains. The outcrops of the Mesozoic sedimentary beds consist of limestone, shale and sandstone and occur in northwest-southeast trending patches just north of Granite Gap. The faults affecting the Paleozoics also affect the Mesozoic sediments. The igneous Mesozoics occupy the northern portion of the Pyramid Mountains. These rocks consist of granodiorite, intrusive rhyolite, intrusive breccia, and basalt

The Tertiary aged rocks, which constitute the major part of the Pyramid Mountains and the southern part of the Peloncillo Mountains, is made up almost entirely of dikes, plugs, lava flows, pyroclastics and a minor amount of other igneous material. Some tertiary dikes, plugs and blocks can be seen in the Lower Animas Valley standing above the valley fill which surrounds them.

The valley fill in the Animas Valley consists of alluvium, lacustrine and fluvial deposits and lava flows, which occur in the southern part of the valley.

## 3. GEOTHERMAL SYSTEM

The generalized cross section in figure 2 was made along the southwest-northeast trending volcanic activity which exists in this region and can be seen on the geologic map of New Mexico. This trend is of importance because of the close relation of geothermal aquifers with volcanic activity.

The ground water flow direction and amount is of great importance in geothermal areas. The flow direction affects the interpretation of the noise patterns and the location of the drill holes. The amount of water available to a geotermal aquifer will determine its usefulness. A discussion with the U. S. Department of Agriculture Soil Conservation Service in Lordsburg indicates

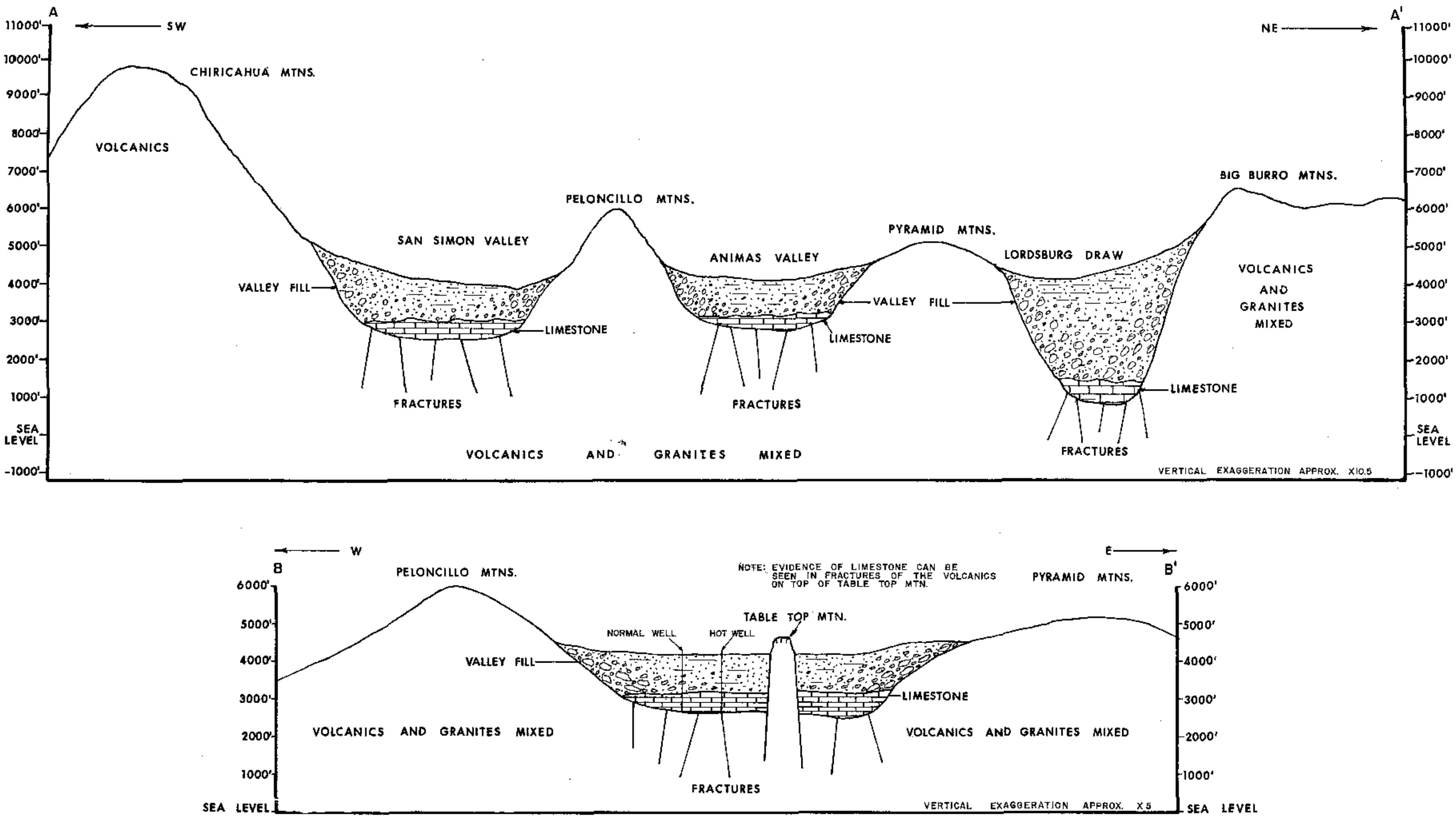


Figure 2. Cross sections suggested by local geological and ground noise evidence

that the ground water flows north down the Animas Valley, then east in the Alkali Flat region, and southeast under Lordsburg. This interpretation is probably correct as indicated by the water well depths in this region. Animas Valley's average well depth is approximately 100 feet while the wells southeast of Lordsburg average 1000 feet. Whatever the direction of flow, a large amount of water is pumped out of the ground without an appreciable lowering of the water table. This would indicate that a large amount of ground water is available and is flowing through the Animas Valley.

The valley fill in the Animas Valley, consisting of alluvium,,lacustrine and fluvial deposits, has a thickness of about 1000 feet and in the southeast Lordsburg area, the valley fill is approximately 3000 feet thick.

There is a strong possibility of a thick section of limestone full of solution cavities underlying the fill in both areas. These solution cavities are suggested because of the large output of water pumped for irrigation in this region. The evidence for this limestone can be seen in the cracks of both the volcanic blocks that have surfaced in the valley region, shown in figure 2 B B', and some of the granites that have also surfaced in a similar manner. The volcanic blocks and the granites were forced to the surface in a cold condition by extreme forces. The sedimentary material, valley fill and limestone, on top of the fractured blocks of volcanics and granites was eroded away rather quickly, leaving the only evidence of its presence in the fractures.

Underlying the limestone is about 3000 to 5000 feet of hard, volcanic, impermeable lava, which is fractured as shown in figure 2 B B'. Heat, mainly in the form of gas at high temperatures, is emitted through these fractures. This is indicated by the two wells near the Folk's property, shown as hot wells in the Animas Valley in figure 1, where boiling point water has gas emitting from it. Many other wells in the area display quite an impressive heat output, especially the two wells five miles southeast of Lordsburg, with an approximate output of 500 gal/min at a temperature of 117°, Fahrenheit. These wells would further indicate that heat in the form of hot gas is emitted through the fractures in the underlying lava. More evidence of this is seen in the fact that in many area wells with water of normal ground water temperatures are local within a very short distance of hot wells. It is possible that a geothermal aquifer could exist in this area if it had an impervious cap, but unfortunately, this is not the case. The system seems to lack any form of capping and expansion and cooling of the gases takes place readily in the limestone solution cavities overlying the lava. There may be a small system that possibly has capping in this region, but it would be extremely small and would not be of commercial value at this time.

## 4. DATA ACQUISITION AND PROCESSING

Data from each of 16 stations was recorded using Geotech Geothermal Ground Noise Survey System which includes seismometers, Model S-13-102 and tape recorder,Model 17373/4mm. The tape recorder uses 1/2 inch tape and records at a speed of 0.4 mm/sec.

Data was collected in periods of approximately 6 night hours per site. Selected segments of quiet night-time data were used in the processing of the data. Care was taken to eliminate any data containing earthquake signals. Data segments from 16 sites, approximately 2 minutes in length, were converted from analog to digital data at a sampling rate of 50 samples per second. Power spectra were computed from each data segment using 70 second time segments. The resulting output gave the amount of noise energy (in millimicrons/sec) at each frequency (.04-25 Hz) during the 70 second time period. From this data the dominant frequency and over-all noise amplitude in the 1 Hz to 20 Hz range for each site was determined.

## 5. INTERPRETATION OF GROUND NOISE

The overall total noise amplitude from 1 to 20 Hz relative to a predetermined level and dominant frequency contours shown in figures 3 and 4 are discussed in this section. The total ground noise indicated is significantly less than the quietest regions in the known active geothermal areas surveyed using this method. The lowest dominant frequency is 5 Hz, this being considerably higher than the normal dominant frequency found in high temperature geothermal areas. In interpreting the contour maps shown in figures 3 and 4, it is important to remember how much lower the ground noise is compared to other geothermal areas. The interpretation of the highest ground noise amplitude found with lowest dominant frequency in the area surveyed occurs near where the hot gases vent from the fractures indicated as hot well in figure 2 B B'. These areas are within the three low dominant frequency contours located west of Animas, northwest of Cotton City and north of the Alkali Flats, shown figure 4. The overall total noise contours also show a southwest-northeast trend of fracturing. The high total noise level contours form a similar pattern as the low dominant frequency contours which indicates a vertical system.

During the survey, local seismic events were recorded. The volcanic gas explosions, shown in figure 5, were identified by G.R.T. Clacy and occur within 10 km of the station. Figure 6 was identified as being a tectonic type local earthquake. Events of this type are occurring between 35 to 50 km from the recording station.

In addition to the survey near Lordsburg, New Mexico, a single station was operated in the Kilbourne Hole, New Mexico, area at station 16, shown in figure 7. The interpretation of the ground noise and local structure indicates the possibility of a geothermal aquifer.

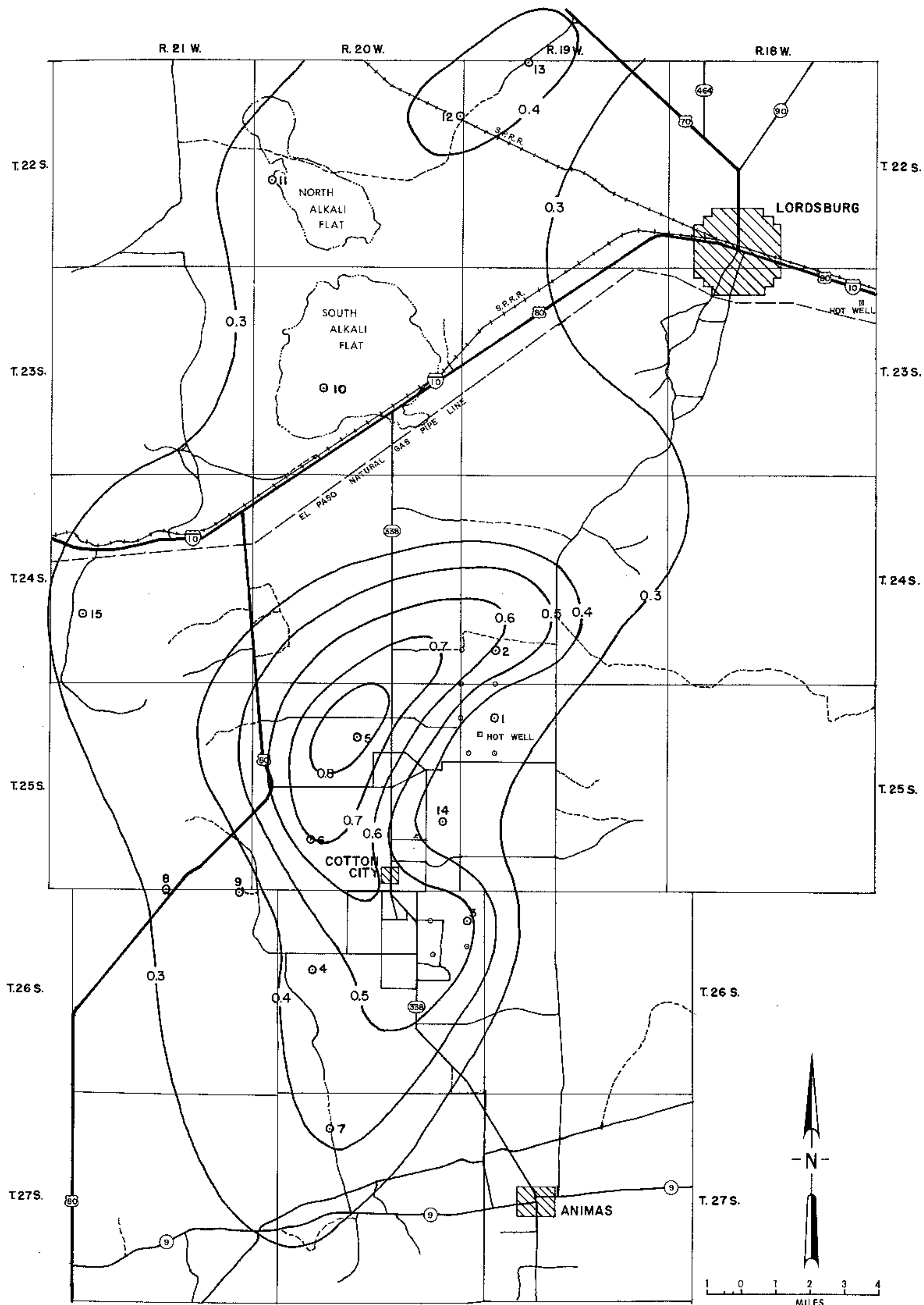


Figure 3. Over-all noise amplitude from 1 to 20 cps

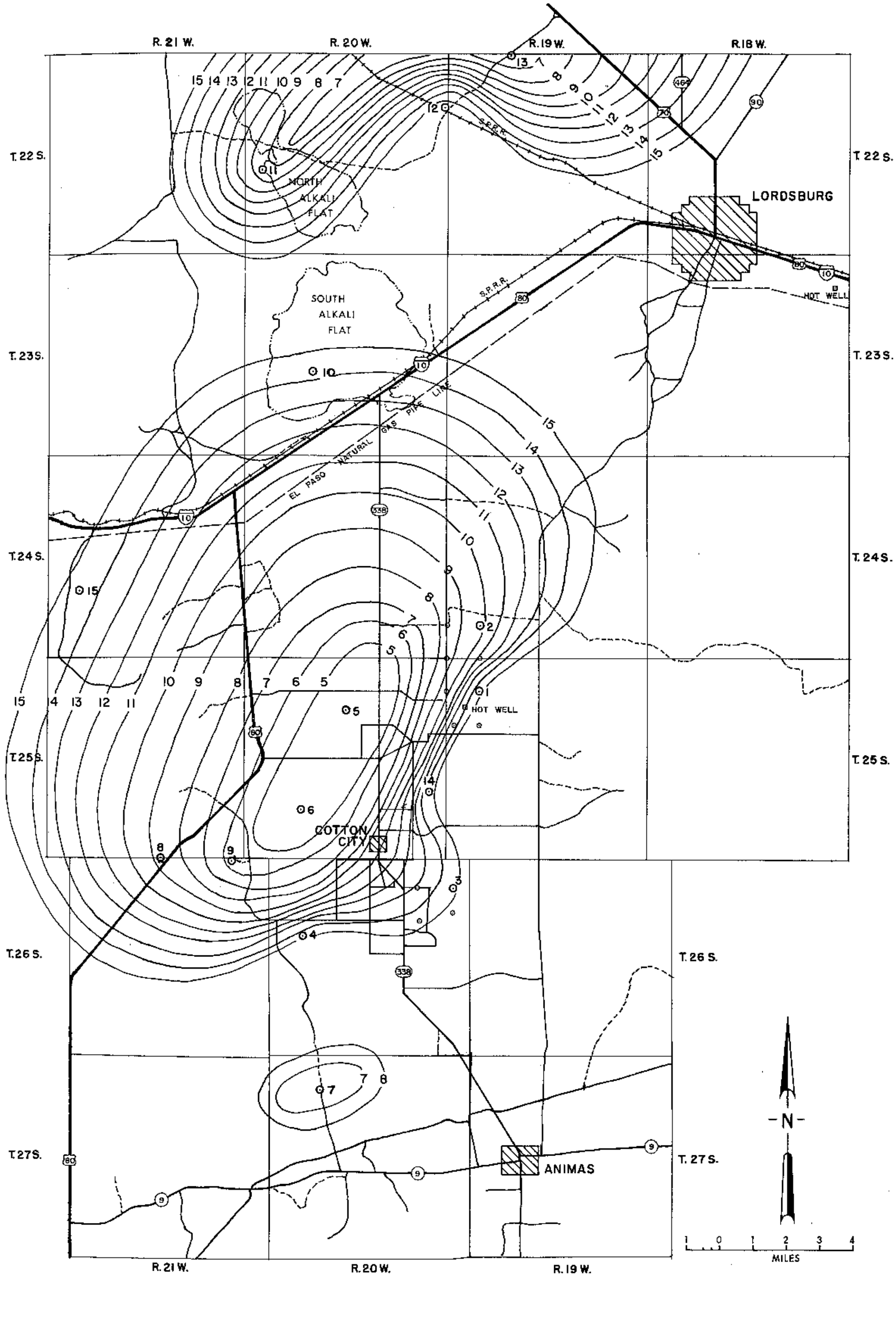


Figure 4. First dominant frequency from 1 to 20 cps

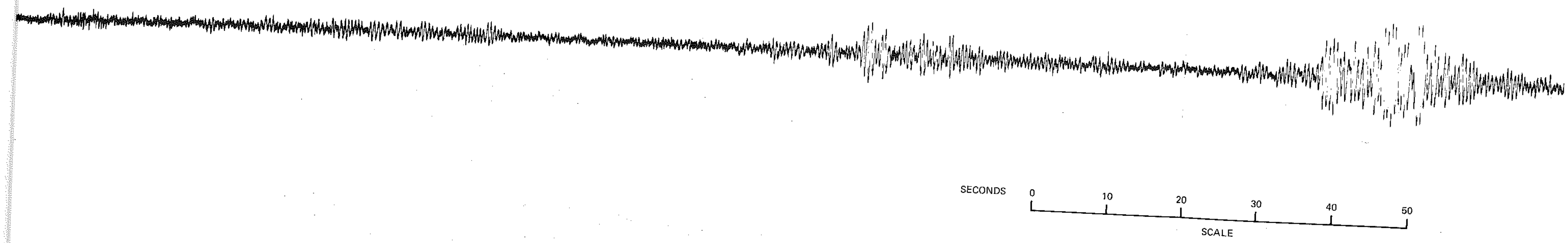


Figure 5. Volcanic gas explosion

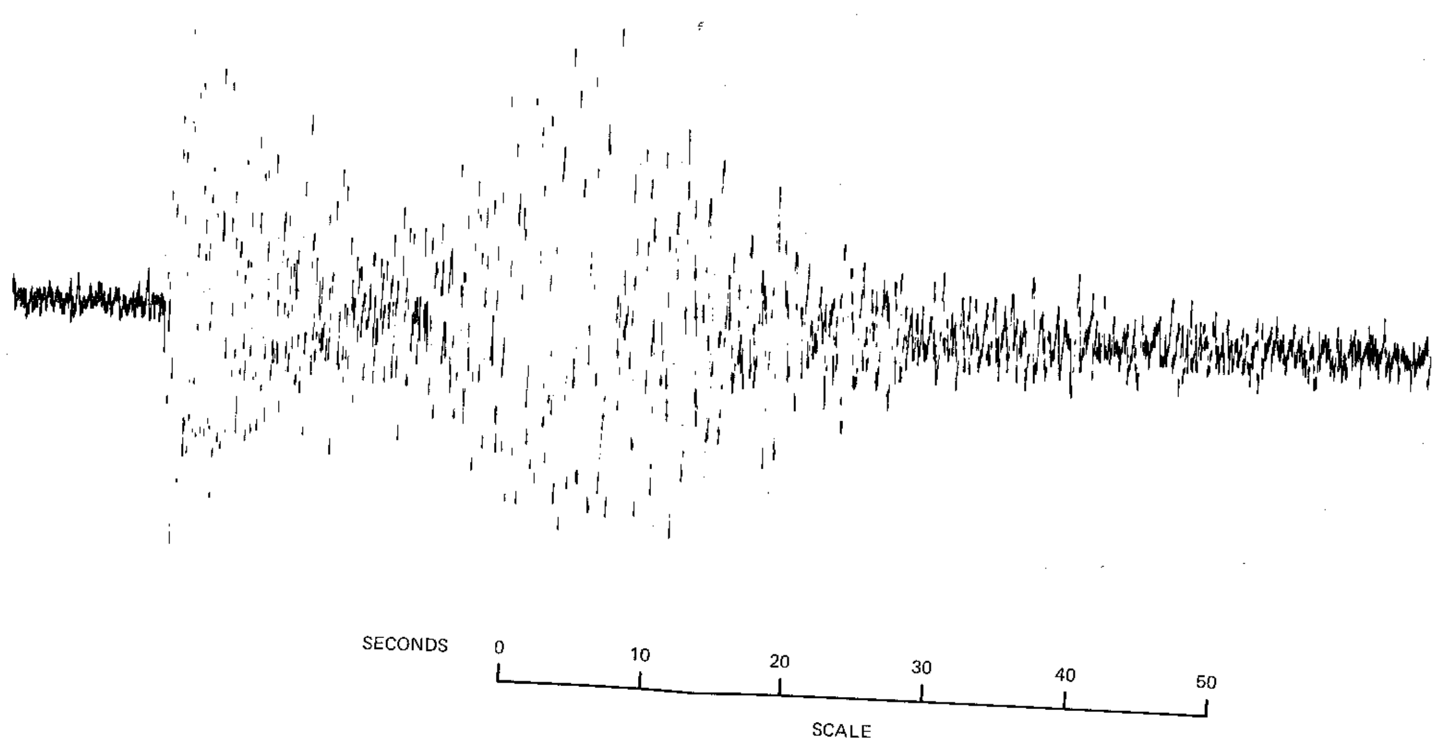


Figure 6. Tectonic earth quake

## 6. CONCLUSIONS

There is adequate heat and water in this area to produce a geothermal aquifer, but because of two important facts a contained system of sufficient size does not exist. First, the high porosity of the limestone overlying the fractured lava does not provide a cap for the system. Second, the fractured lava is impermeable and the fractures emit only hot gases. If the volcanic rock were permeable, water could penetrate it and return via the fractures as steam, thereby creating a geothermal aquifer. Unfortunately this lava is impermeable; therefore, we identify this area covered by the survey as a vertical, open geothermal system. The development of this type of system is not economically feasible, and we are confined to locating a self-contained steam producer.

## 7. RECOMMENDATIONS

We do not recommend further development of this area as a source of geothermal steam power. However, this area should be reconsidered as economical heat extraction techniques become available.

We recommend that a more extensive survey be conducted in the Kilbourne Hole, New Mexico, area located west of El Paso, Texas.

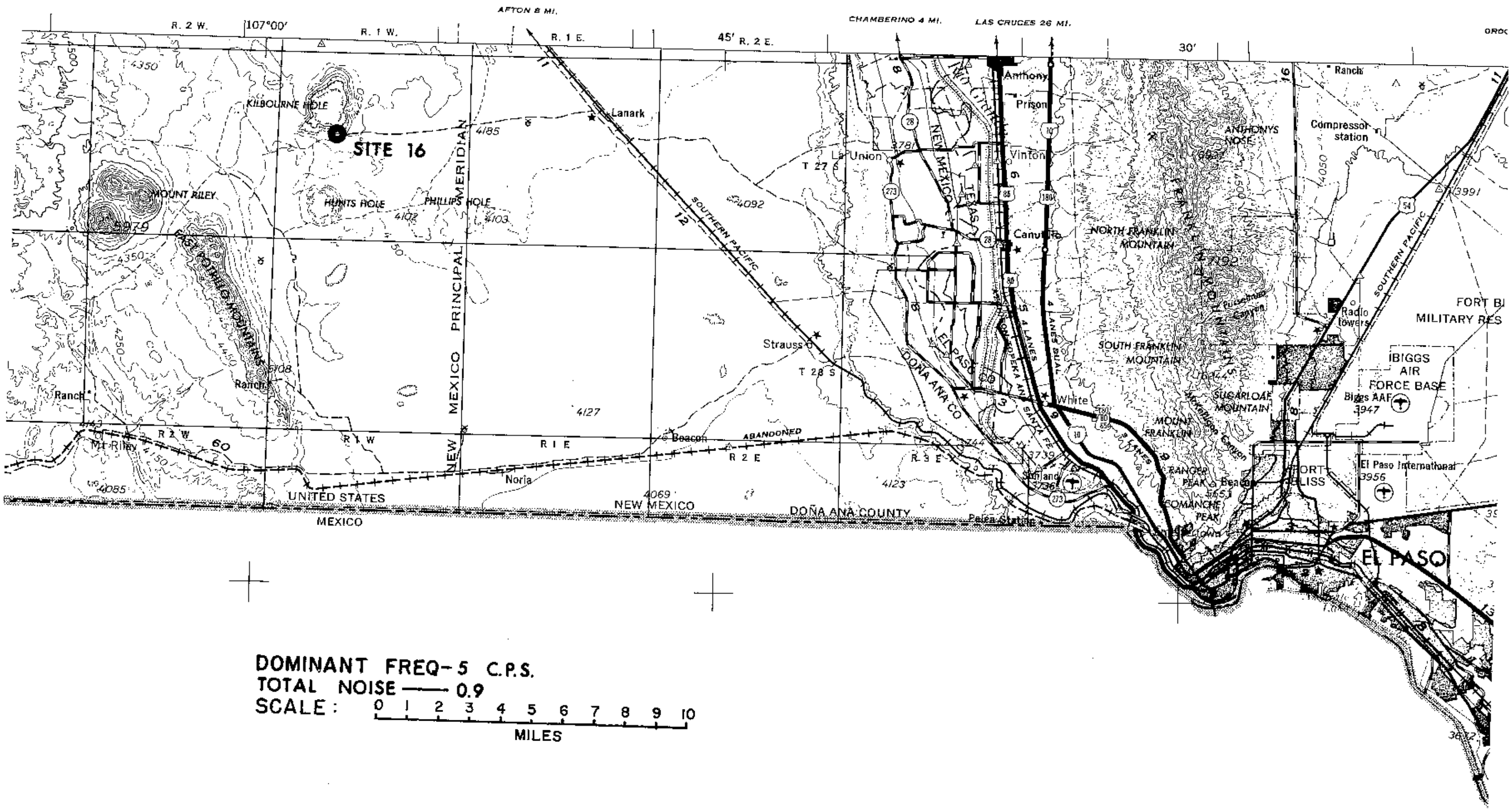


Figure 7. Location of site 16 west of El Paso, Texas