U.S. geothermal, geologic patterns compared

JOHN W. SHELTON
Oklahoma State University
Stillwater, Okla.
M. K. HORN
R. H. LASSLEY
Cities Service Oil Co., Tulsa

DATA from about 30,000 wells were used in preparation of the geothermal gradient map by the AAPG-sponsored Geothermal Survey of North America (GSNA), with publication of the map by the AAPG and USGS scheduled for fall 1974.

For the United States there are data from some 20,000 wells drilled for oil and/or gas, 1,400 water wells, and 250 drill holes used specifically for crustal heat-flow measurements. On

Fig. 1

Geothermal gradients, West Texas

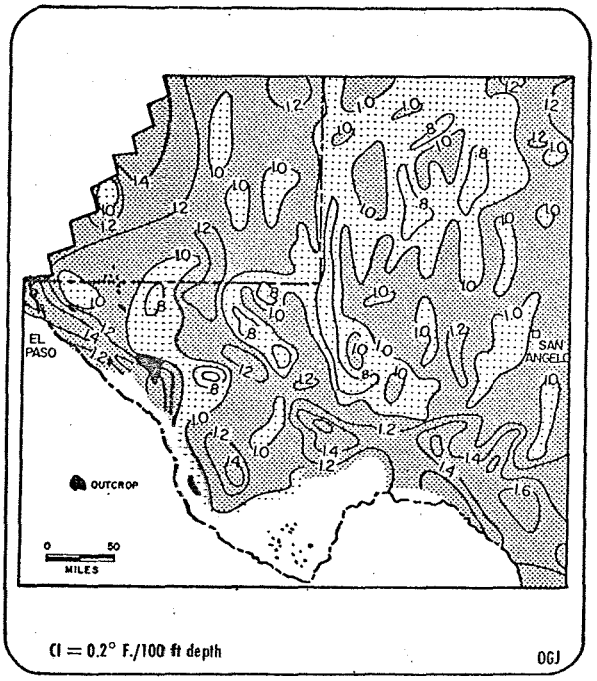


Fig. 2

Tectonic map of West Texas

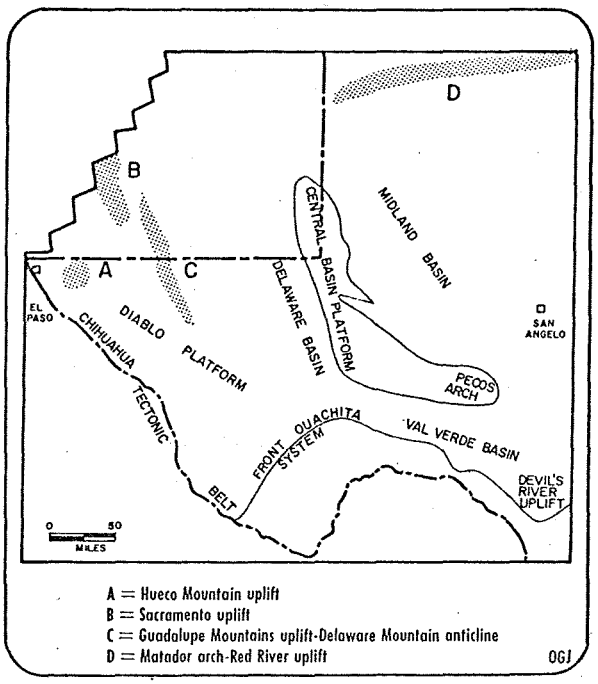


Fig. 3

Gravity features, West Texas

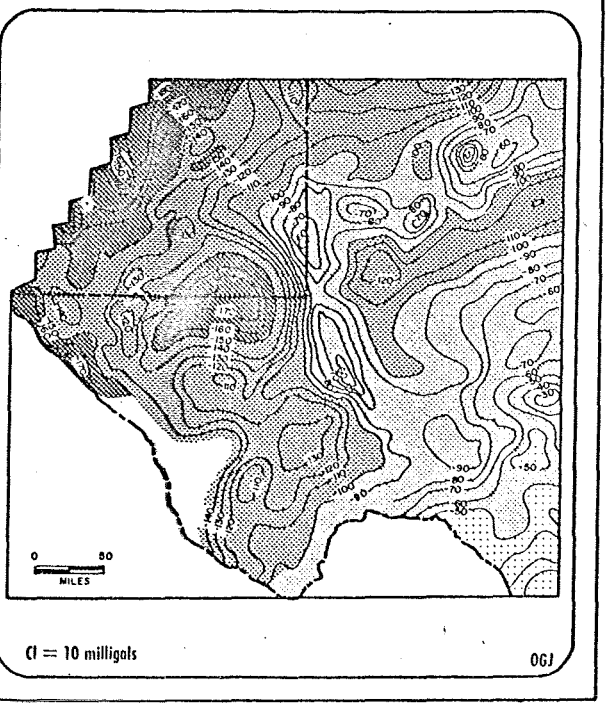
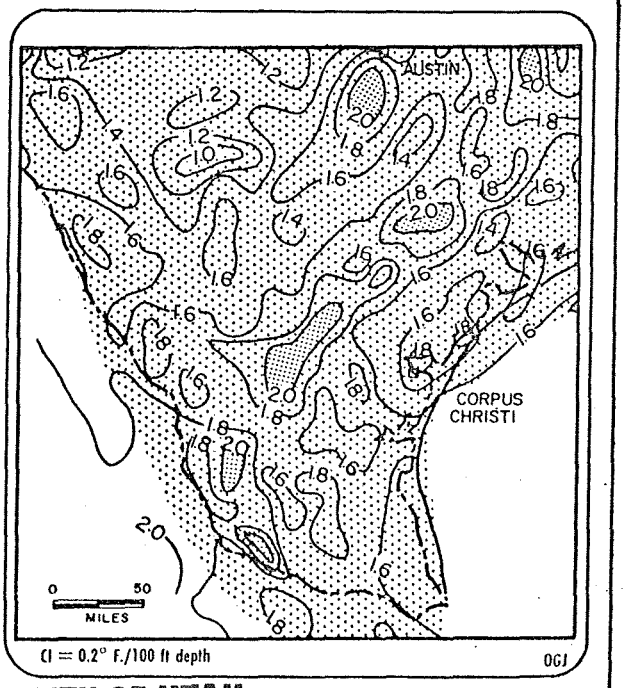


Fig. 4

Geothermal gradients, South Texas



the geothermal gradient map prepared by GSNA, contoured values in the United States range from 0.6° F./100 ft of depth at the southern tip of Florida to 3.0° F./100 ft of depth in eastern Oregon.

The map represents the geothermal regime in sedimentary rocks, which is thought to reflect a summation of a number of geologic and geophysical parameters expressed as thermal conduction and thermal convection and hydrodynamics.

In this paper typical empirical relationships in the United States will be illustrated by comparing regional geothermal patterns to geologic and gravity features in West Texas (Figs. 1-3) and South Texas (Figs. 4-6). Geothermal gradients are lower in West Texas (Fig. 1), where carbonates are a prominent part of the stratigraphic section, than in the Texas Gulf Coast (Fig. 4), which is characterized generally by a clastic-rich section.

A corresponding relationship is shown by the regional gravity field, as bouguer gravity values increase generally toward the coast (Figs. 3, 6).

In West Texas a geothermal minimum coincides with the Central basin platform and a gravity maximum (Figs. 1-3). The trend of two geothermal maxima north and east of the Ouachita system in West Texas corresponds to foreland basins, the southern part of the Delaware basin on the west and Val Verde basin on the east.

A line connecting two large gravity minima east of Alpine parallels the geothermal trend (Fig. 3). The geothermal maximum southeast of the ternd of foreland basins is the approximate location of the Devil's River uplift.

An arcuate trend of two geothermal minima west of the Delaware basin delineates in a general way the Guadalupe Mountains uplift-Delaware Mountain anticline (C on Fig. 2), which is east of, but parallel to, gravity maxima extending from the Carlsbad area to Van Horn (Fig. 3). A subtle westerly to west-southwesterly trend, composed of several local geothermal maxima, may partially reflect the Matador arch-Red River uplift (D on Fig. 2).

Relatively high geothermal gradient values (1.6° to 1.8° F./100 ft of depth) along the Texas Gulf Coast north of Corpus Christi coincide with a ridge composed of Tertiary shale diapirs (Figs. 4, 5). The long geothermal maximum which parallels the coast some 80 to 100 miles inland reflects the position of a Cretaceous-Eocene fault zone (D on Fig. 5), as well as the Lower Cretaceous reef (E on Fig. 5) in the northeastern part.

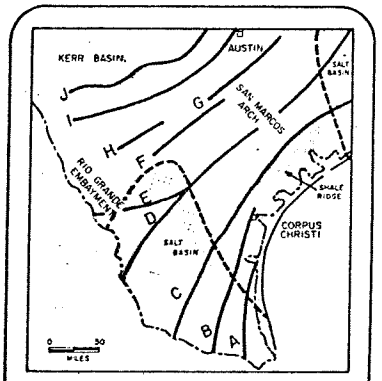
A subtle trend of gravity minima is present along part of the geothermal anomaly which coincides with the reef tract (Fig. 6). Geothermal minima northwest of the fault zone-Cretaceous reef form a trend which corresponds in the southwest to the Charlotte fault zone (F on Fig. 5) and the Luling fault zone (G on Fig. 5) in the northeast. The area of minima is characterized also by gravity maxima.

The northern part of the geothermal maximum south of Austin is part of a north-northeast trend which parallels the Balcones fault zone (I on Fig. 5) and the Ouachita system (J on Fig. 5). Although the trend is parallel to a gravity trend, the southern part of the geothermal anomaly extends obliquely across the trends toward the Luling fault zone.

The geothermal trends and patterns in West Texas and South Texas are typical of those mapped by GSNA. In the U.S. they commonly correlate with regional structural and gravity trends. Relationships also exist with stratigraphic features such as gross lithofacies. END

Fig. 5

S. Texas tectonics

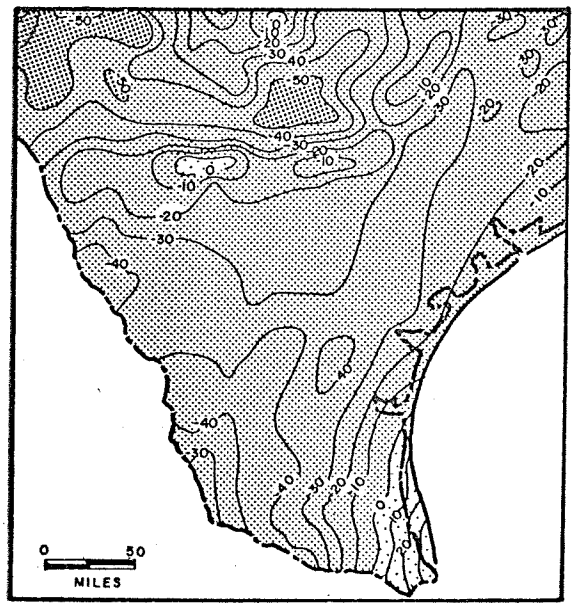


A = Willamar fault zone
B = McAllen fault zone
C = Oligocene fault zone
D = Cretaceous-Eocene fault zone
E = Lower Cretaceous reef tract
F = Charlotte fault zone
G = Luling fault zone
H = Pearsall fault zone
I = Balcones fault zone
J = Front, Ouachita system

OGJ

Fig. 6

Bouguer gravity anomaly map of South Texas



CI = 10 milligals

OGJ