GRAVITY ANOMALIES, BASEMENT ROCKS, AND CRUSTAL STRUCTURE, CENTRAL AND SOUTHEAST TEXAS

J. E. Case and W. R. Moore
Texas A&M University
College Station, Texas

SUMMARY

Regional gravity surveys have been conducted (1) across the margin of the Gulf Coast geosyncline and the buried Ouachita fold belt between Bryan-College Station and Austin, Texas, and (2) over the northwestern Llano uplift, in he Llano—Mason—San Saba—Brady area. These new graviyty data have been incorporated with those previously presented by Barnes et al (1954), Watkins (1961), Almy et al (1961), Watkins and Muehlberger (1962), Muehlberger et al (1963), Gordon (1968), and the Air Force Chart and Information Center to obtain a regional gravity anomaly map of a large portion of central and southeast Texas (Figure 1).

Bouguer anomalies range from —25 to +10 milligals over the Llano uplift, and form a regional anomaly that is positive with respect to areas around the periphery of the uplift. Superimposed on this regional gravtiy high are a series of more local positive and negative anomalies of 5 to 20 milligals in amplitude that can be readily correlated with major Precambrian lithologic units (as pointed out by Barnes, Romberg, Muehlberger and their associates at the University of Texas). Most of the ovoid gravity lows are caused by granatic bodies of relatively low density. The gravity highs are caused by dense Packsaddle Schist and by local bodies of dioritic to gabbroic composition. Between the highs and lows, large areas having only a few anomaly closures and gentle gravity gradients tend to coincide with Valley Springs Gneiss. These characteristic anomaly patterns can be used to interpret basment lithology concealed by Paleozoic and Mesozoic sedimentary rocks around the flanks of the uplift.

South, east, and northeast of the Llano uplift the gravity map has a much different pattern. It is dominated by huge regional anomalies upon which are superimposed very small local anomalies of one-two milligals, only a few of which appear on the five-milligal map. A great arcuate low of 30-60 milligals coincides with the buried Paleozoic foreland basin and frontal zone of the Ouachita system. Farther to the east and south is the well-known gravity high over the interior metamorphic zone of the buried Ouachita system. Finally, to the east and southeast, over the margin of the Gulf Coast geosyncline, the regional anomalies are broad, low-amplitude highs and lows with gentle gradients.

In order to analyze these three regional anomalies it was necessary to attempt to "strip" the gravitational effects of the sedimentary rock sequence above the basement. The procedure was as follows: First, gravitational effects of the thick wedge of Cenozoic and Mesozoic sedimentary rocks in the Gulf Coast geosyncline were calculated for three sets of geologically reasonable density contrasts, —0.1, —0.15, and —0.2 g/cm^3. Minimum assumed thicknesses of the sedimentary rock sequence, up to 24,000 feet, were based on extrapolations of regional well data. These three models were used to obtain sets of geologic correction curves for the regional Bouger anomaly values. We believe that the largest average density contrast, —0.2, yields the most nearly correct correction because of the presence of the low-density evaporite sequence in the lower part of the section. Second, gravitational effects of the Paleozoic clastic rocks in the foreland basin and frontal zone of the Ouachita system—between the metamorphosed Ouachita facies and the crystalline rocks of Llano uplift—were calculated for several density contrasts and basin configurations. One model was chosen as best fitting the available geologic and geophysical data.

The computed gravitational effects of this model were then applied as a further geologic correction to obtain an anomaly profile that should represent, for the most part, effects of changes in basement properties and crustal thickness or density. Corrected regional Bouger anomaly values increase from about —10 to —20 milligals over the Llano uplift to +25 to +30 milligals over the Gulf Coast geosyncline in the vicinity of Wharton and Ft. Bend Counties. If an average crustal thickness of 40 kilometers is assumed in the Llano region, a decrease in crustal thickness to about 30 kilometers or less, similar to the model proposed by Cram (1962), is required to reproduce the regional gravity anomaly. Comparisons of the total mass in crustal and sedimentary columns in the Llano region and the Gulf Coast geosyncline (near Wharton County) indicate that the columns are of equal mass; hence, these two areas are probably in isostatic equilibrium at present.

If this is correct, it seems likely that the former site of the Gulf Coast geosyncline was not in isostatic equilibrium near the end of Paleozoic, and that an excess mass was present. We speculate that Gulfward migration of depocenters during the Mesozoic and Cenozoic took place in response to a mechanism for gradual restoration of regional isostatic equilibrium, possibly by lateral subcrustal flow or by a phase change at the crust-mantle interface.

Selected References

Almy, C. C., Jr., E. C. Lidiak, and J. J. W. Rogers, 1961, Geophysical studies of the Little Llano River and San Saba Counties Texas; Texas Jour. Sci., vol. 13, no. 4, p. 460-477.

Barnes, V. E., F. Romberg, and W. A. Anderson, 1954, Correlation of gravity and magnetic observations with the geology of Blanco and Gillespie Counties, Texas; *in* contribution de la geophysique a la geologie: Internat. Geol. Cong., 19th, Algiers, 1953, Comptes rendus, sec. 9, fasc. 9, p. 151-162.

Cram, I. H., Jr., 1962, Crustal structure of Texas Coastal Plain Region; Amer Assoc. Petrol. Geol. Bull., vol. 46, no. 9, p. 1721-1727.

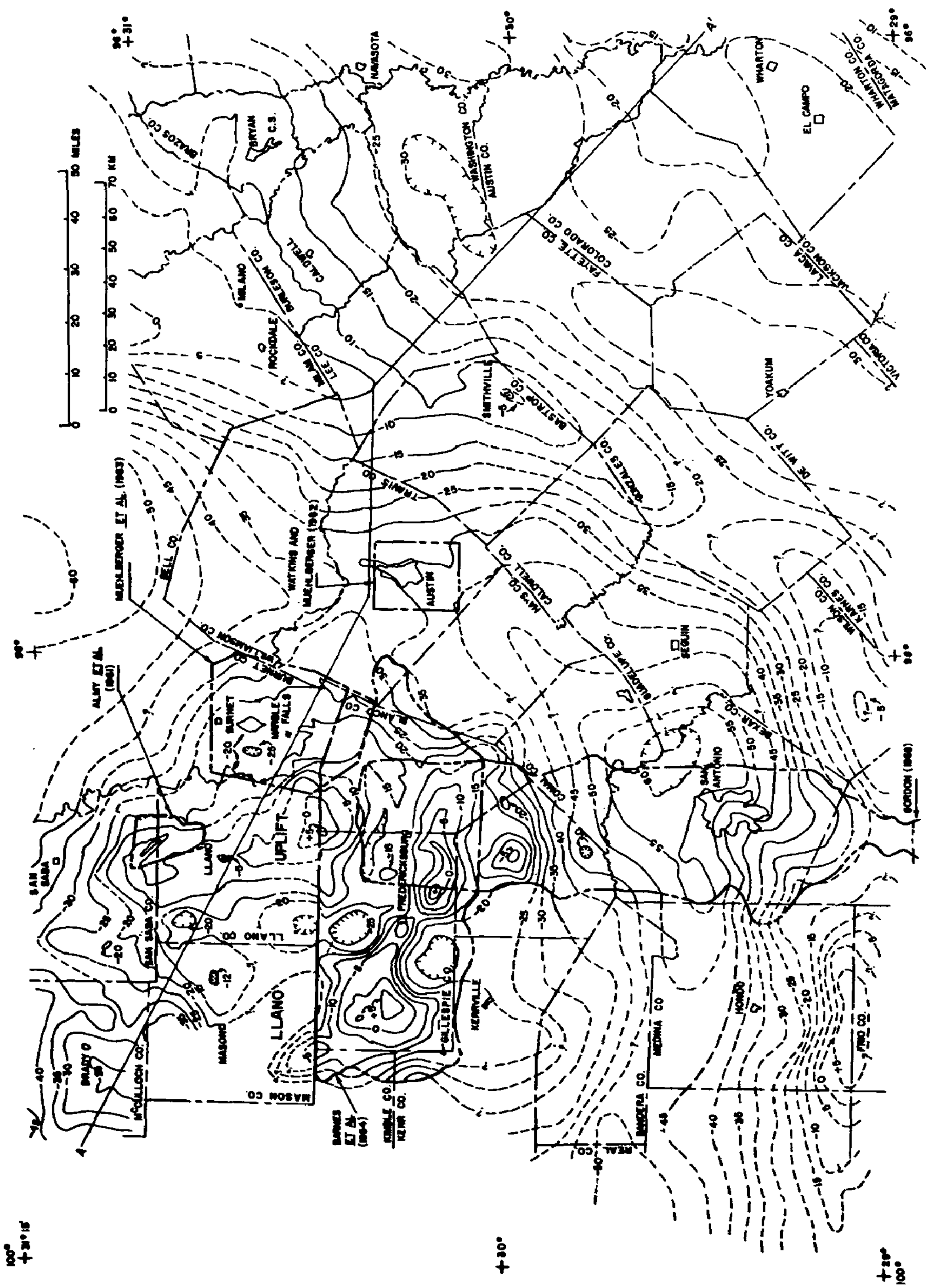

Figure 1. Generalized Bouguer anomaly map of parts of central and southeast Texas. Coutour interval 5 milligals. Bouguer anomalies computed for a factor of 0.06 milligal per foot.

Disc Contents Contents Search

Flawn, P. T., A. Goldstein, Jr., P. B. King, and C. E. Weaver, 1961, the Ouachita System; Bureau of Economic Geol., the Univ. of Texas Pub. no. 6120, 401 p.

Gordon, P. T., 1968, Correlation of gravity anomalies and geology in the San Antonio region, Texas; Texas A&M Univ., unpublished M.S. Thesis, 85 p.

Muehlberger, W. R., T. Bhatrakarn, and Y. Y. Youash, 1963, Correlation of geology and gravity observations in southern Burnet County, Texas; Texas Jour. Sci., vol. 15, no. 1, p. 35-49.

Romberg, F., and V. E. Barnes, 1944, Correlation of gravity observations with the geology of the Smoothingiron granite mass, Llano County, Texas; Geophysics, vol. 9, p. 79-93.

Watkins, J. S., 1961, Gravity and magnetism of the Ouachita structural belt in central Texas; Trans. Gulf Coast Assoc. of Geol. Soc., vol. 11, p. 25-41.

Watkins, J. S., and W. R. Muehlberger, 1962, Gravity observations in the Austin region, Texas; Texas Jour. Sci., vol. 14, no. 2, p. 216-220.