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Abnormal Pressures in Deep Wells of Southwestern Louisiana

High fluid pressures are associated with slump-type faults and shed light on processes of compaction.

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In drilling deep wells for oil and gas in southwestern Louisiana, fluids—either oil, gas, or water—at pressures much higher than normal hydrostatic pressure are often encountered. This causes difficulty in drilling and requires elaborate measures to prevent blowouts. The high pressures are first encountered at depths ranging between 7000 and more than 16,000 feet (2100 and 5000 meters) and they are not associated with any particular stratigraphic horizon. The pattern of the high-pressure zones is not obvious but appears to be related to the peculiar patterns of faulting contemporaneous with sedimentation which are characteristic of the Gulf Coast. The shales adjacent to the permeable sands containing the fluids at high pressure are much more porous than is normal for shales at these depths. Apparently the faults prevented the expulsion of water from the pores during the normal processes of compaction and lithification. As sedimentation continued, the water remained in the pores of the sediments, and it now has to sustain a large part of the weight of the overburden. These high pressures within the pores may have facilitated sliding and slumping at the edge of the continental shelf. The growth faults themselves have many of the characteristics of slump-type landslides, and they may be old slides that ceased their activity and were buried by later sediments. Salt domes are scarce in the areas where high pressures are most common, probably because the shales never compacted to a density exceeding that of salt. The abrupt transition from normal to high pressures indicates that shales must have a lower permeability to water than has been usually supposed.

Structural and Sedimentary Patterns

During the past 20 years intensive drilling and seismic exploration for oil and gas have revealed the sedimentary pattern of the Tertiary in great detail (*1*, *2*). Figure 1 shows the pattern. The Oligocene and Miocene sediments consist of three facies: the massive sands of the continental and shoreline depositional environments ("continental and deltaic facies"), the alternating sand and shale of the neritic facies, and the shales deposited on the outer shelf and slope. As the rivers from the north poured their loads of mud and sand into the Gulf of Mexico, their deltas built out farther and farther southward. Continental and shallow-water sediments therefore overlap the marine sediments deposited earlier in deeper water. The stratigraphic units thicken in the seaward direction, and the zone of maximum thickness is found farther and farther south in younger and younger units.

The structure of the areas between the salt domes in southwestern Louisiana is dominated by growth faults (*2*, *3*). Stratigraphic units are thicker on the downthrown side of these faults than they are on the upthrown side. The only explanation is that movement on the fault plane must have been continuous during deposition. The fault plane must have cut the sea bottom while sediments were being swept over it, so that the downthrown block was covered with a thicker layer of sediment than the upthrown block, although the depth of water remained nearly the same. The activity on any particular fault reached a maximum at a particular time and then declined, as is shown by the change in the ratios of interval thickness (*4*). The motion finally ceased altogether, and younger beds extend over the tops of the fault planes with no displacement. However, another set of growth faults formed a few miles farther to the south, which cut stratigraphically higher horizons. The faults seldom extend into the massive sand section. The relative locations of the different sets of faults are shown diagrammatically in Fig. 1.

Figure 2 is north-south cross section which shows details of several of these growth faults—the disparity in thickness on either side and the increasing throw with depth. Note that the faults between wells 8 and 10 greatly increase the interval between the *Heterostegina* and the *Nonion struma* horizons, although the *Heterostegina* horizon itself is hardly displaced at all (*5*). South of well 12 the faults extend higher in the section and displace the *Heterostegina* horizon. The location of the profile of Fig. 2 is shown in Fig. 3 (jagged line).

The stratigraphic units which are overthickened on the downthrown side may thin for a few miles, although the

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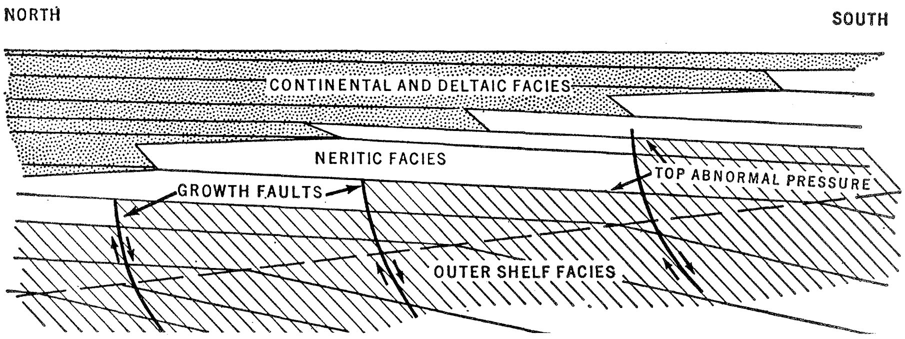

Fig. 1. Schematic cross section showing sedimentary facies and regressive depositional pattern in southern Louisiana. Time-rock units are strata deposited during the same time interval, although they may be of differing lithology and fossil content. They are divided by the time lines which diverge southward (seaward). The rate of thickening also increases seaward. Down-to-the-basin growth faults cut successively younger units southward. The top of the interval in which fluid pressures in any fault block are abnormally high appears to be determined by the horizons at which the controlling growth fault terminates upward. [After Steinhoff (*21*)]

regional thickening is to the south. This situation results in a northward dip in the deeper horizons, contrary to the regional southward dip. This dip reversal often provides structural closure for the oil and gas fields. An example in the cross section (Fig. 2) is shown between wells 10 and 12. The *Nodosaria blanpiedi* horizon dips northward in part of the Rayne field. The fault planes dip 40 to 60 degrees to the south, and the angle of dip decreases with depth.

The areal pattern of the faults is very complex. The divergence of the key beds is so great and the facies of the rocks changes over such short distances that a particular horizon can be used for a datum in a belt only a few miles wide. The petroleum geologist uses ordinary structure contour maps for detailed study, but there are so many fault blocks that such maps do not give a clear regional picture of the configuration of the surfaces. In order to make the structural pattern evident at a glance, a plexiglass model was constructed and photographed (Fig. 3). The upper surface represents the horizon of the Homeseekers Sand, which approximately marks the top of the Lower Frio Formation. In the model the structure is greatly oversimplified, and many of the smaller faults and structural features are omitted. Each plexiglass sheet represents a vertical thickness of 500 feet, and the vertical and horizontal scales of the model are the same. The stippled areas represent oil or gas fields which produce from horizons both above and below the Homeseekers Sand.

The traces of the fault planes on the horizontal are arcuate, usually concave toward the south. The slip planes are thus spoon-shaped. Frequently the fault planes split and the same total throw is divided among several faults. Occasionally there is a fault with opposite dip and with throw down toward the north. but none of these are shown in the model. In the grabens north of such faults the stratigraphic units may be extremely overthickened. The growth faults occur in swarms roughly parallel to the coast, but they are not long linear features. Instead they form a very complex pattern of intersecting and splitting curves, mostly concave toward the south.

Certain areas, called "embayments," are partly encircled to the north by especially large growth faults. Within these areas certain stratigraphic intervals are much thicker than normal. The area that we chose for detailed study is called the "Nodosaria embayment," because the *Nodosaria*-horizon part of the section is abnormally thick.

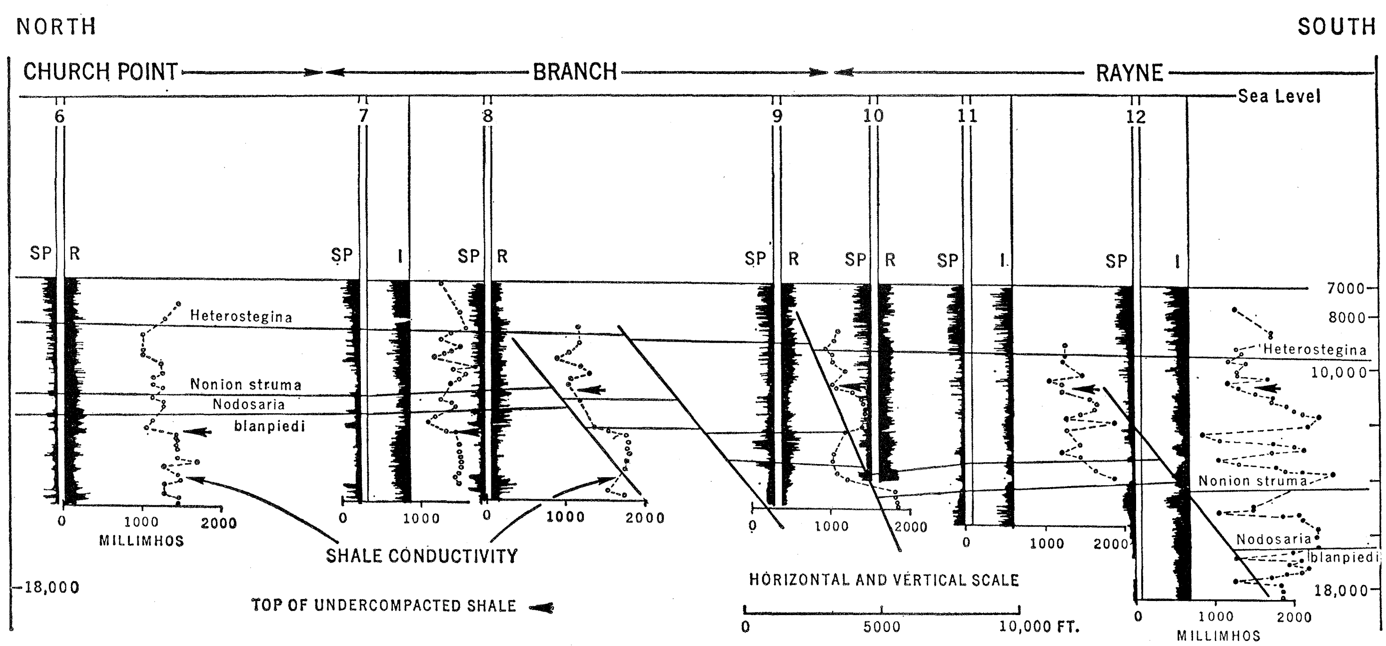

Fig. 2. Detailed well section north-south across the Nodosaria embayment, showing the growth faults and the undercompacted shales. The growth faults offset the *Nodosaria blanpiedi* horizon greatly but the *Heterostegina* horizon only slightly. At each fault there is a large disparity in the stratigraphic interval between the two horizons. The self-potential logs (SP) (see text) show the change in facies from sands above to shales below. The resistivity (R) and induction (I) logs provide data for calculating shale conductivity. An abnormal increase in shale conductivity is shown by the arrows; these mark the depths where the first abnormally high fluid pressures may be expected. Note that there is no vertical exaggeration.

Growth Faults as Landslides

All the geometrical features of growth faults enumerated above are perfectly characteristic of slump-type landslides. The spoon shape of the slip plane, concave toward the downslope, and the backward tilt of portions of the original surface, opposite to the downslope, are familiar diagnostic features of landslide topography. Grabens also commonly occur.

Figure 4, from a book on landslides (*6*), illustrates these features. It seems probable that the growth faults originated as slumps near the edge of the continental shelf during periods of active sedimentation. The abnormally high pressures of fluids in the pores of the shales, described below, would cause instability and facilitate sliding at very low angles. Apparently the sliding continued slowly, concurrently with deposition, for long periods. Finally, when the original slip plane was deeply buried and the edge of the shelf had advanced southward for several kilometers, movement ceased. A new set of slides then started on the new slope, and motion along them continued into stratigraphically younger horizons.

Bathymetric and seismic surveys indicate that faults resembling slumps do occur on the present-day shelf edge and upper slope, so there is reason to believe that sliding is occurring at the present time (*7*). A hummocky zone along the upper slope, reported by Moore and Curray (*7*) and Ewing and Antoine (*8*), which they believe results from vertical movements of salt and shale, may instead represent the toe zone of contemporary slides. (The toe is at the foot of the landslide, where material has been pushed over the undisturbed slope.) The published profiles do not seem incompatible with the topography and structure of landslide toes. Certain features of the modern bottom topography, such as depressions on the shelf near the edge, resemble back-tilts and seem to substantiate the landslide explanation. The hummocky zone is found along the upper continental slope, where slides would be expected.

So far as is known, no well has been drilled deep enough to penetrate the toe zone in the subsurface. Occasionally certain stratigraphic intervals are missing, and such gaps have been ascribed to unconformities, although an erosional unconformity seems out of place in this environment (*9*). The toes of slump-type landslides push out of the slope and ride over undisturbed beds. Therefore, they will be detected in the subsurface by the repetition of certain stratigraphic intervals. Offshore wells especially may be expected to encounter such repeated intervals at depths that can be reached in drilling. Seismic profiles have certainly penetrated to this zone, and some of these profiles can be interpreted as overthrusting. Some of the disturbed shales which have been ascribed to vertical diapiric intrusion may actually be landslide toes.

Patterns of Pressures in Interstitial Fluids

In most of the older and shallower oil and gas fields of the Gulf Coast of Texas and Louisiana, the original reservoir pressure was always very close to 0.465 pound per square inch per foot of depth (0.106 bar per meter of depth) (*10*). This pressure is slightly greater than the density of the interstitial water would lead one to expect. It is probably controlled by hydraulic communication

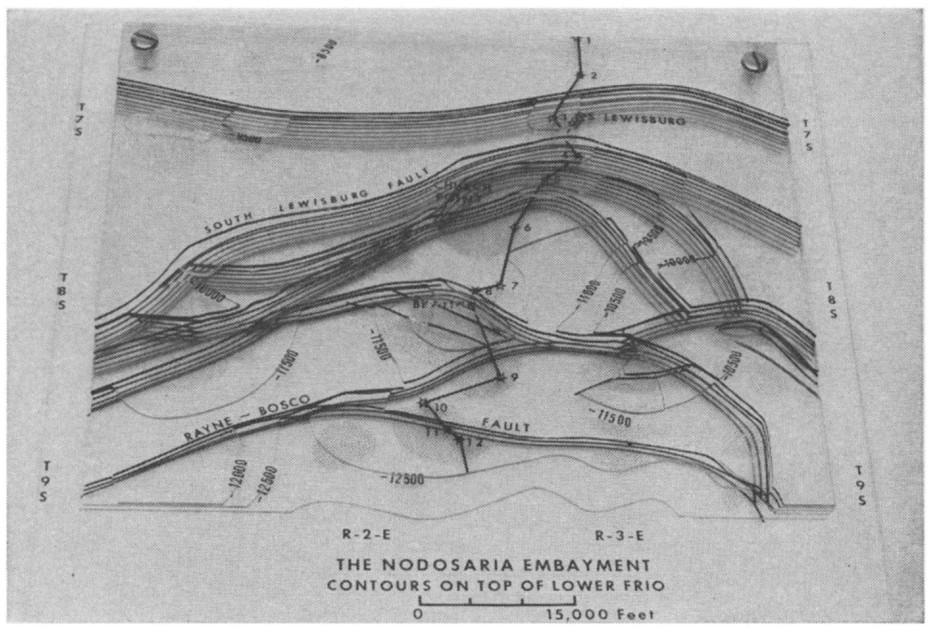

Fig. 3. Three-dimensional model of the Nodosaria embayment of southwestern Louisiana. It shows the principal growth faults, which are branching and curved, usually concave to the south. Many of the smaller faults and minor structures are not shown. The upper surface of the model is the top of the Lower Frio horizon. Each plexiglass sheet represents a thickness of 500 feet; the depths shown are depths below sea level. (No vertical exaggeration.)

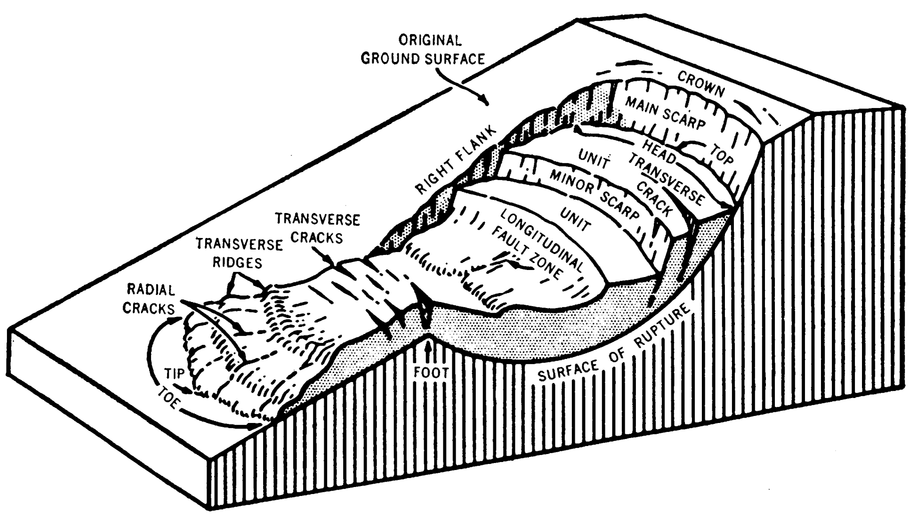

Fig. 4. Diagram of a slump-type landslide. Note the spoon-shaped slip plane, and the back tilt of the surfaces. The toe zones of such slides are low-angle overthrusts of more or less disturbed strata. The surface over the toe zone is hummocky. [From *Landslides and Engineering Practice* (*6*)]

between the aquifer and the outcrop through the "massive sand" facies. At depths greater than 10,000 feet, reservoir pressures are sometimes found which greatly exceed the normal hydrostatic pressures. Dickinson (*11*) pointed out that these abnormally high pressures occur in lenticular sands of the neritic facies, from which the water could not escape during compaction because the sands were surrounded by shale.

Recently it has been shown that the sands with abnormally high fluid pressure are enclosed by shales of abnormally high porosity (*12*, *13*). The porosity of shale usually decreases logarithmically with depth of burial, as a result of compaction (*14*). In this region something must have happened to stop the expulsion of the water. It remained in the pores of the shales, where it has to carry not only the weight of the superincumbent pore water but a large part of the weight of the overlying solids as well.

The porosity of the shales is reflected in the values of their electrical conductivity and also in the velocity of acoustic waves. Conductivity is measured in all wells drilled, by either the resistivity or the induction log. The conductivity of the shales normally decreases with depth because of the decrease in porosity, and a plot of the conductivity values against depth often shows a well-defined trend. In many wells a reversal takes place at a certain depth, and the conductivity and porosity start to increase with depth. The depth where the abnormal increase in conductivity of shale begins has been shown by observations on many deep wells (*15*) to coincide with the beginning of the zone of abnormally high fluid pressures in the porous sandstones. The thickness of the transition from normal to very high pressures ranges up to 1000 feet or more, but it is often very abrupt. Wallace (*12*) published electrical-conductivity logs of two wells only 2000 feet apart (Fig. 5). The shales in well B change from normal to abnormally high porosity between depths of 11,250 and 11,350 feet. Well A is separated from well B by a fault. Apparently the fault completely shut off the flow of water, because the shales below 11,000 feet in well A are normally compacted.

The significance of this observation to structural geology is very great. It means that pore water has been able to move across the bedding planes of shale hardly at all, in spite of a pressure gradient exceeding 10 pounds per square inch per foot during scores of millions of years. Obviously shales have small but appreciable permeability to water; otherwise how could compaction occur? But after a certain stage of compaction has been reached, the flow of water must be almost exclusively parallel to bedding planes.

This observation contradicts the hypothesis, advanced to explain supposed hydrodynamic phenomena in oil fields (*16*), that water moves extensively across bedding planes. Shale permeability is difficult to measure, and no reliable values have been published. In view of the porosity of shales, their average permeability should be appreciable. Perhaps the best explanation for the lack of movement is that the water exhibits non-Newtonian behavior in the finer interstices of porous media. That is, its viscosity changes with rate of flow, and it acquires some of the properties of a solid (*17*). It may be that there is a threshold pressure which must be exceeded before any flow takes place.

The observation that the fault planes mark pressure discontinuities is equally significant. Many geologists believe that fluids are able to move vertically across bedding planes, along faults and fractures. The presence of ore-bearing veins indicates that such movement is possible in well-consolidated rocks. However, faults are almost never channels in unmetamorphosed sediments. Students of petroleum-reservoir behavior have long known that faults which cut oil reservoirs form pressure discontinuities and are therefore seals rather than channels. The growth faults clearly have sealed

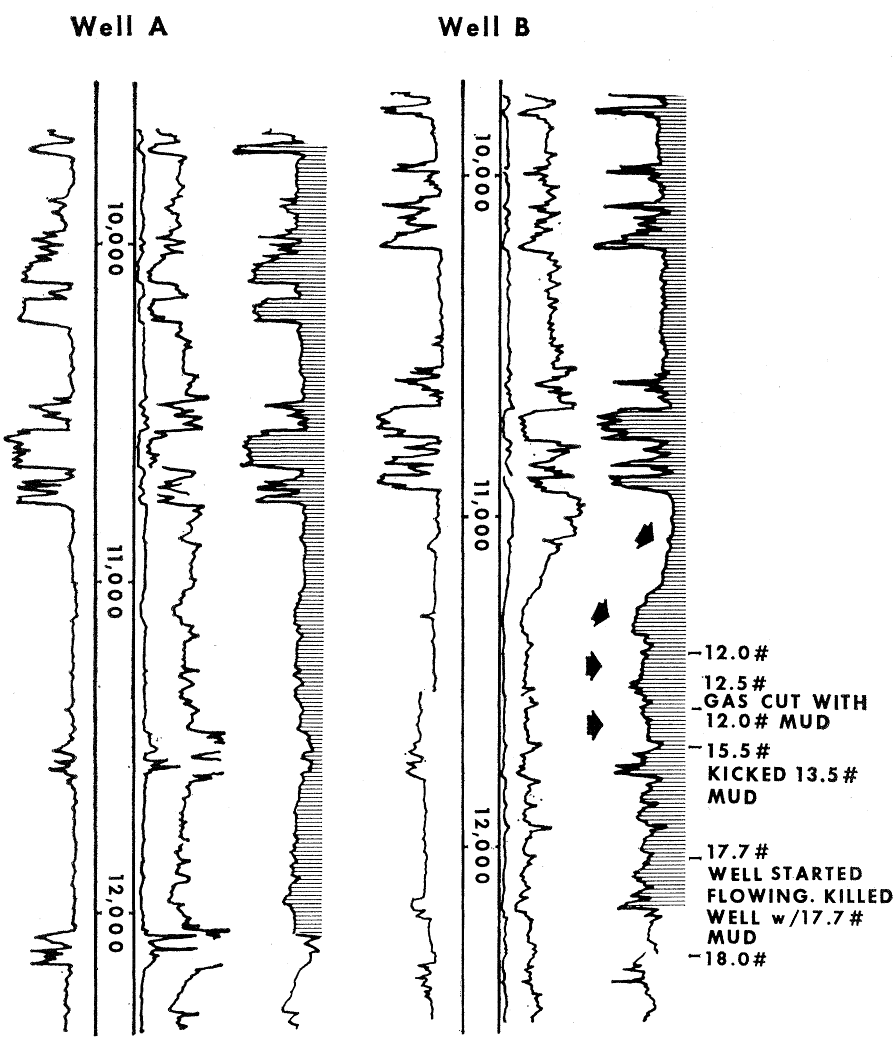

Fig. 5. Electrical logs of two wells, showing (arrows) abnormal increase of shale conductivity with depth at 11,250 feet in well B. The wells are only 2000 feet apart and are separated by a fault. Well B showed evidence of high pressure in the sandstones below about 12,400 feet. The notation "12.0#" means that the well was drilling with mud of density 12.0 pounds per gallon (1.5 grams per cubic centimeter). "Kicked" means that the fluid pressure in the hole exceeded the mud pressure and the well ejected mud at the surface. "Gas cut" means that gas bubbles were noted in the mud returning from the bottom of the hole. [From Wallace (*12*)]

off zones of very high fluid pressures for very long times.

The initial reservoir pressures, as estimated from bottom-hole pressure measurements, were tabulated by the Federal Power Commission (*18*) for several thousand oil and gas reservoirs in Louisiana. The values are identified by field, depth, and stratigraphic horizon, but not by well. Figure 6 shows the pressure values in several fields of the area studied. The depth to the first abnormal pressure determination ranges over a considerable interval even within a single field, because the structures are complex and include many different fault blocks.

The determination, from the shale conductivity, of the first abnormal pressure makes it possible to relate the top of the higher-than-normal pressure intervals to the local structure in some detail. Figure 2 is a portion of a longer section drawn to determine this relation in the area studied. The original logs showing electrical properties of the rocks plotted against depth have been greatly reduced. The left-hand curve is the self-potential, and its jagged character indicates that there is a large amount of sand above the *Heterostegina* horizon. The amount of sand decreases with depth, and the lower parts of the section are mostly shale with a low and smooth self-potential curve. In Fig. 2, to the right of each well is plotted a graph of the shale conductivity (in millimhos), calculated from either the resistivity log (R) or the induction log (I). Where the shale conductivity begins to increase downward, the porosity of the shale becomes abnormally high, and the shale is, therefore, undercompacted for the depth to which it is buried. At this point the fluid pressures in the associated porous sandstone reservoirs become abnormally high.

The top of the undercompacted shale is approximately at the stratigraphic horizon where the next large growth fault to the north—that is, in the up-dip direction—dies out upward. From this it is concluded that the horizon of the shallowest abnormal pressures is controlled by the growth fault. Occasionally the growth faults continue upward into shallower horizons as normal faults, but they do not cause abnormal pressures down-dip unless they have growth characteristics—that is, disparity in thickness on either side of the fault plane.

The depths to the first abnormal reservoir pressures were determined from the Federal Power Commission data for all the fields in southwest Louisiana for which geological information has been published. The values for the area discussed here are shown in Table 1. As far as could be determined, the first abnormal pressures were encountered approximately at the stratigraphic horizon, where considerable thickening occurred across the adjacent growth fault up-dip. There were certain exceptions and ambiguities which could

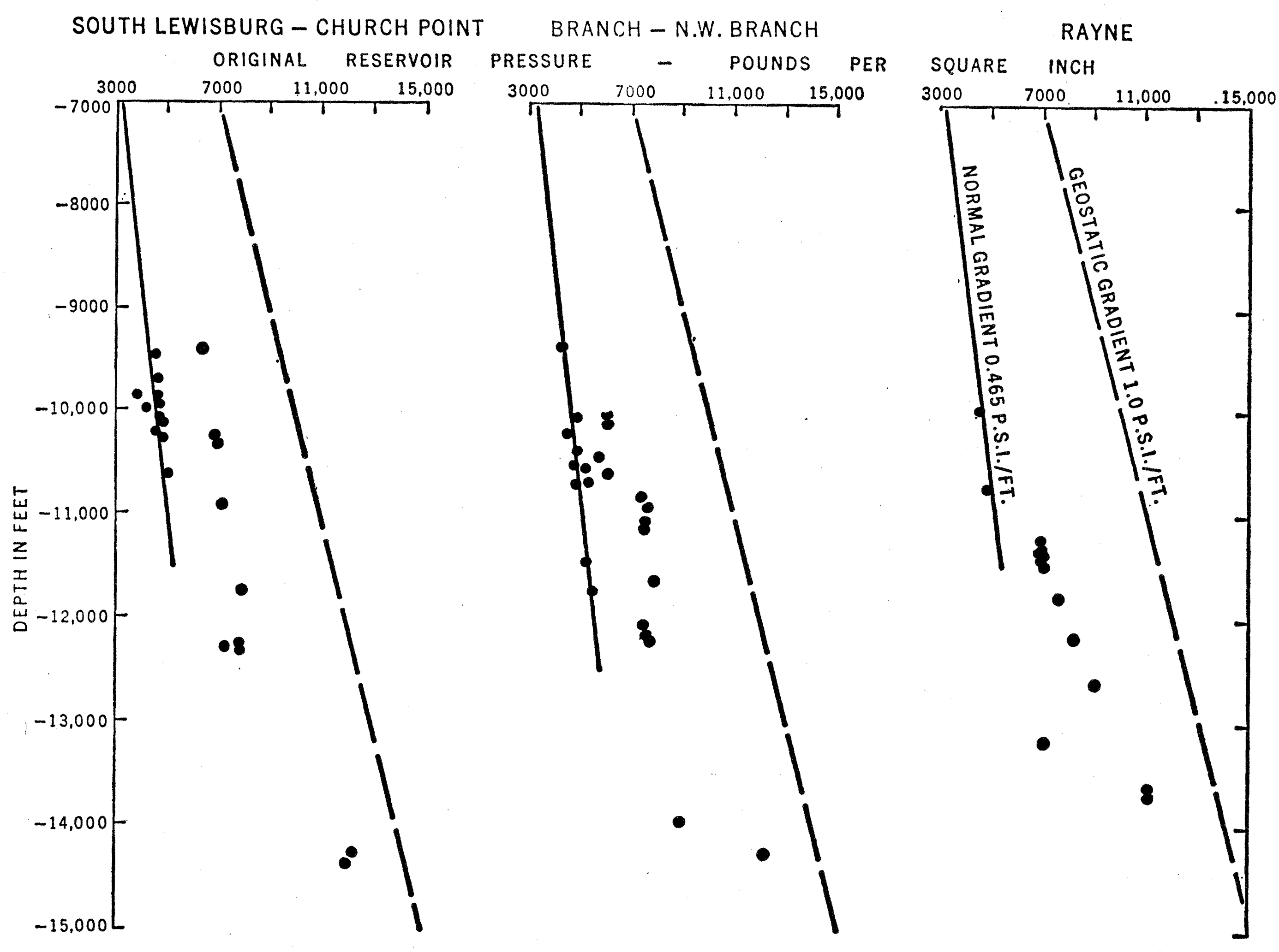

Fig. 6. Original reservoir pressure plotted against depth for a number of reservoirs in the Nodosaria embayment. The shallowest depth at which abnormally high pressure is encountered at South Lewisburg is 9400 feet; at Rayne, about 11,200 feet. The wells are scattered and are not identified; the depths differ from those for the shallowest undercompacted shales shown in Fig. 2.

Table 1. Fields in southwestern Louisiana having abnormally high pressures of fluids in the pores of the sands. [Data from Federal Power Commission]

Field	Depth (ft) to first abnormal pressure	Pressure (lb/in.^{2})	Geological horizon
South Lewisburg–Church Point	9,401	6,417	*Cibicides hazzardi-2*
Branch-Northwest Branch	10,050	6,165	*Marginulina texana*
Rayne-West Rayne	11,250	6,855	Klumpp D Sand
Duson and South Duson	10,498	7,204	*Marginulina-1* Sand
Ridge	11,050	7,500	*Marginulina idiomorpha-1,* 11,000-foot Sand
North Leroy and Leroy	12,055	9,950	*Marginulina howei* 12,250-foot Manes Sand
Abbeville	11,920	10,474	11,900-foot Sand (*Heterostegina* zone)
Savoy	10,460	6,307	Upper Cockfield
Veltin	10,900	6,500	Upper Cockfield
South Bosco	11,006	5,983	Klumpp A
North Crowley	11,100	7,500	Frio Stringer
Southeast Rayne	10,683	8,967	*Marginulina-7*
North Scott	11,245	7,987	Arceneaux (*Cibicides hazzardi*)
Leleux	14,368	12,932	14,350-foot Sand

not be worked out because the wells in which the high pressures were encountered were not identified, so their structural position could not be determined. Many other fields in Louisiana show the same relationship of abnormal pressures to faults—that is, the first abnormal pressure occurs at about the horizon where the controlling growth fault terminates upward.

In a few cases normal pressures are found in horizons below those in which the next growth fault up-dip terminates. In some of them the section includes well-developed sandstones. These may have provided drainage to the surface through some connection which is not obvious. Because the faults have dip angles of 50 degrees or less, wells frequently cross fault planes. It is possible for a well to encounter the zone of abnormal pressures and then cross a fault plane and enter a different fault block where pressures are normal. This results in an abrupt decrease in shale conductivity as the well crosses the fault.

A possible explanation for this pattern of abnormally high pressures is as follows. Immediately after the deposition of muds on the outer shelf, compaction started and the interstitial water must have migrated vertically upward to the sea bottom. As compaction progressed, however, the vertical permeability of the muds decreased rapidly, and most of the water soon had to travel parallel to the bedding. If growth faulting occurred when there was still a lot of water in the shales, the routes of up-dip migration parallel to the bedding were shut off by the fault plane. The water remained in the pores, where it had to sustain a heavier load of overburden as sedimentation proceeded. If the faulting occurred after most of the water had been expelled, when the shales were already compacted, the abnormal pressures were much smaller, or pressures were normal.

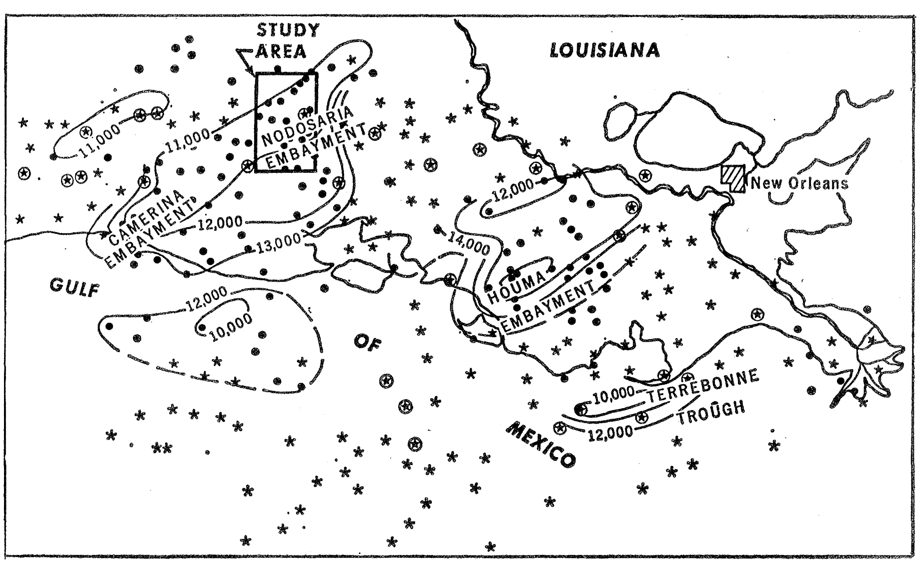

Fig. 7. Map of southwestern Louisiana, showing (solid circles) the location of fields with abnormally high reservoir pressures. The approximate depths at which abnormally high pressure is first encountered are shown by highly generalized contours. (Stars) Salt domes; (circled stars) salt domes with abnormally high pressure. Salt domes are scarce in the embayments where the abnormal pressures are most abundant.

Tectonic Implications

The fields for which abnormally high pressures were reported to the Federal Power Commission are shown as solid circles in Fig. 7. The depth to the first abnormal pressure is shown by contours in a very approximate and generalized way. The detailed pattern of the top of the zone of abnormal pressure is much too complex to show on a map of this scale. One could work it out from well logs by noting the first abnormally conductive shales.

The abnormal pressures seem to be more common in the embayment areas. In these embayments there is a corresponding scarcity of salt domes, as noted by Sloane (*19*) in the Houma area. Perhaps in the embayment areas the shales never compacted properly and still have abnormally low densities, less or only slightly greater than the density of salt. It may be that only when the density of the rocks overlying the salt exceeded the density of the salt by an unknown but probably substantial amount was there a tendency for the salt to rise and form domes.

The high pore pressures in the shale facilitate the sliding, and it is hard to tell whether the growth faults cause the abnormal pressures or vice versa. It is certain that at the present time large areas of the Gulf Coast are underlain by zones containing water under pressure almost high enough to float the overlying rocks. Only a small increase in southward tilting, such as subsidence of the shelf edge, might cause large slabs of the continental-shelf sediments to go sliding down the slope into the Gulf of Mexico. Here they would pile up on each other like thrust sheets and nappes, as suggested by Hubbert and Rubey (*20*).

Conclusions

The complex down-to-the-basin growth faults of southern Louisiana appear to have been caused by slumping along the edge of the continental shelf during sedimentation. The toes of the slides must resemble low-angle overthrusts, with repetition of section. Although such repetition has never been reported, one may expect to find it in drilling deep, off-shore wells.

The growth faults seal the flow of fluids, and, down-dip from them, abnormally high pressures are found. The shales in these intervals are less compacted than is usual at the depth at which they are buried. The normal processes of compaction and diagenesis were arrested by the faulting. The pore water has remained in the sediments, where it has to support part of the weight of the overburden, and its hydrostatic pressure is, therefore, much above normal. The high pressures show that these shales have extremely low permeability to water, perhaps because their interstitial water is non-Newtonian.

In a few areas, called embayments, the growth faulting caused certain stratigraphic units to be abnormally thick, and the abnormal pressures are found at particularly shallow depths. Salt domes are notably scarce in the embayments, probably because the shales never became dense enough to make the salt rise and form domes.

References and Notes

1. S. W. Lowman, *Bull. Amer. Assoc. Petrol. Geologists* **33**, 1939 (1949); L. L. Limes and J. C. Stipe, *Trans. Gulf Coast Assoc. Geol. Soc.* **9**, 77 (1959); W. R. Paine, "Geology of Acadia and Jefferson Davis Parishes," *Geol. Surv. Louisiana Bull. No. 36* (1962).
2. W. R. Paine, *Trans. Gulf Coast Assoc. Geol. Soc.* **16**, 261 (1966).
3. R. D. Ocamb, *ibid.* **11**, 139 (1961).
4. C. E. Thorsen, *ibid.* **13**, 103 (1963).
5. The stratigraphic horizons shown on the cross section are not the first appearance of foraminifera species, as might be supposed from the name. They are recognizable and well-established features of the electrical log commonly used for correlation. They are probably close to true time horizons.
6. E. B. Eckel, Ed., "Landslides and Engineering Practice," *Nat. Acad. Sci.–Nat. Res. Council Pub. 544* (1958), p. 40.
7. D. G. Moore and J. R. Curray, *J. Geophys. Res.* **68**, 1725 (1963).
8. M. Ewing and J. Antoine, *Bull. Amer. Assoc. Petrol. Geologists* **50**, 479 (1966).
9. For example, the Eocene Jackson fauna appeared immediately below the upper Oligocene (or lower Miocene) *Marginulina texana* zone of the Frio in the J. P. Owen Fontenot No. 1 (Sec. 12, T 12S, R 1E). The whole Vicksburg formation was absent.
10. G. E. Cannon and R. C. Craze, *Trans. AIME* **127**, 29 (1938).
11. G. Dickinson, *Bull. Amer. Assoc. Petrol. Geologists* **37**, 410 (1953).
12. W. E. Wallace, *The Log Analyst* **6**, 3 (1965).
13. C. E. Hottman and R. K. Johnson, *J. Petrol. Technol.* **1965**, 717 (1965).
14. L. F. Athy, *Bull. Amer. Assoc. Petrol. Geologists* **14**, 1 (1930); H. D. Hedburg, *Amer. J. Sci.* **31**, 241 (1936).
15. D. G. Williams, W. O. Brown, J. J. Wood, *Oil Gas J.* **63**, No. 41, 145 (1965).
16. G. A. Hill, W. A. Colburn, J. W. Knight, in *Economics of Petroleum Exploration and Property Evaluation* (Prentice-Hall, New York, 1961), pp. 38–69.
17. P. F. Low, in *Proceedings 8th National Conference on Clays and Clay Minerals* (Pergamon, Oxford, 1960), pp. 170–182.
18. Many other characteristics of the reservoirs were tabulated, and the data were stored on a digital magnetic tape together with other data on basic reservoir factors supplied by interstate pipelines purchasing gas in southern Louisiana. Copies of the tape may be obtained from the Federal Power Commission, Washington, D.C.
19. B. J. Sloane, Jr., *Trans. Gulf Coast Assoc. Geol. Soc.* **16**, 249 (1966).
20. M. K. Hubbert and W. W. Rubey, *Bull. Geol. Soc. Amer.* **70**, 115 (1959).
21. R. O. Steinhoff, *Oil Gas J.* **65**, 178 (1967).

22. The work discussed here was supported in part by National Science Foundation grant No. GP 5051.

Intelligence Has Three Facets

There are numerous intellectual abilities, but they fall neatly into a rational system.

J. P. Guilford

Many a layman who has taken a psychologist's intelligence test, especially if he did not do as well as he thought he should, has the conviction that a score, such as an IQ, does not tell the whole story regarding intelligence. In thinking so, he is absolutely right; traditional intelligence tests fall far short of indicating fully an individual's intellectual status. Just how far short and in what respects have not been well realized until very recent years during which the whole scope of human intelligence has been intensively investigated.

This is not to say that IQ tests are not useful, for they definitely are, as years of experience have demonstrated. Intelligence-quotient tests were originated more than 60 years ago for the purpose of determining which children could not learn at normal rates. This meant that the content of IQ tests weights heavily those intellectual abilities that are pertinent to school learning in the key subjects of reading and arithmetic, and other subjects that depend directly upon them or are of similar nature psychologically. IQ tests (and also academic-aptitude tests, which are essentially similar) predict less well at educational levels higher than the elementary grades, for at higher levels subject matter becomes more varied. Even at the elementary level, predictions of achievement have been poor in connection with the *initial* stages of learning to read, in spelling, and in the arts. The defender of the IQ test might say that intelligence is not involved in such subjects. But he would not only be wrong, he would also be dodging problems.

One Intelligence, or Many Abilities?

The father of IQ tests, Alfred Binet, believed firmly that intelligence is a very complex affair, comprising a number of different abilities, and he manifested this conviction by introducing tests of many kinds into his composite scale. He did not know what the component abilities are, although he suggested that there are several different kinds of memory, for example. He went along with the idea of using a single, overall score, since the immediate practical goal was to make a single administrative decision regarding each child.

Test-makers following Binet were mostly unconcerned about having a basic psychological theory for intelligence tests, another example of technology running far in advance of theory.

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