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APPLICATION OF INDUCTION LOGGING IN LOUISIANA AND MISSISSIPPI

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In 1951, Induction Logging was started on a commercial scale in "Fresh Muds" in Mississippi, and rapidly became accepted in the shallow Wilcox territory. Steady progress in instrumentation, incorporating vertical and lateral focusing has made it possible to contemplate, at this time, the gradual replacement of conventional electric logging by a combination of the Induction, spontaneous potential, and short-normal resistivity curves.

The basic advantages of Induction over conventional logging are numerous:

A) The focused and symmetrical system permits a greater depth of investigation without the loss of detail usually found with increased spacings in conventional logging - (Fig. 1).

While it was impossible to read the true resistivities of the oil sands at 3250, 3310, 3335, 3360, the Induction log gives a close approximation of this value in spite of the very thin beds. If some accuracy in obtaining Rt is necessary, rather simple proceedings are available to correct for the bed thickness and the effect of the surrounding beds. Obviously, the 64" normal is completely unsuitable for these beds.

B) Considerably greater penetration of the Induction log (Fig. 2) gives a better determination of True Resistivity. In case of very fresh mud and low porosity formations, the effect of invasion is considerable. At 11650 (A), the 64" normal reads 2.6 ohms, as compared to 1.2 on the Induction log. At 11587 (B) the 64" normal reads 5 ohms, instead of 2 on the Induction Log.

While the lateral has an excellent depth of investigation, the nonsymmetrical character of the curve makes true resistivity determinations very difficult. Shadow zones such as 11614-11632 are confusing. To demonstrate the ability of the Induction to look behind invasion, we can see that the Induction Log reads 1.0 at 11660 (C) compared to 0.8 for the lateral. At this same level the 64" normal reads 4.5 ohms. Therefore, the Induction log has the advantage of the deep investigation of the lateral without its numerous disadvantages, and is definitely superior to the 64" normal in showing the true resistivity when dealing with deeply invaded water sands.

(Fig. 3)
On this Lower Cretaceous example, drilled with 1.00 ohms mud (at BHT) we find at 12122 - 24 ohms on the 16" normal, 12 on the 64" normal and 3.8 on the Induction Log. At 12096 the reduction is from 18 to 10 to 2.8. A qualitative interpretation of these zones point to deeply invaded water sands of low porosity. Note, also, the comparison between the Induction and the lateral curve for the entire log. On the average, the reading is close to the same, but the lateral is often distorted by spacing effects.

C) **The Induction Gives High Accuracy of Reading in Low Resistivity Beds**

(Fig. 4).
Due to the use of a conductivity scale, it becomes extremely easy to differentiate between 0.25 and 0.3 ohms—*whereas such readings on the conventional Electric Log are the width of the trace.*
For example, the difference of resistivity between 8133-40 and 8146-50 is 4 large divisions on the conductivity scale of the Induction Log. This high accuracy is necessary in high porosity sands where the difference between 0.6 and 0.7 ohms can mean the difference between water and oil production.

D) **The Drilling Fluid has Negligible Influence on the Induction Log**

(Fig. 5)
The Induction Log, originally designed for oil-base muds, and for cable tool holes (without fluid in the bore hole) is negligibly affected by the resistivity of the drilling fluid. This has a great advantage because nearly identical logs will be obtained in muds of 3.00 or 0.3 ohms resistivity; in such cases the electrical logs may exhibit considerable changes in character.

The Fig. shown here represents actually two off-set wells where the mud was 0.2 ohms in one (on the left) and 0.7 ohms in the other (the SP on this well is deleted for want of space). The apparent resistivities of the normal curves show the effect of the differences in mud resistivity, yet the Induction on the average reads about the same.

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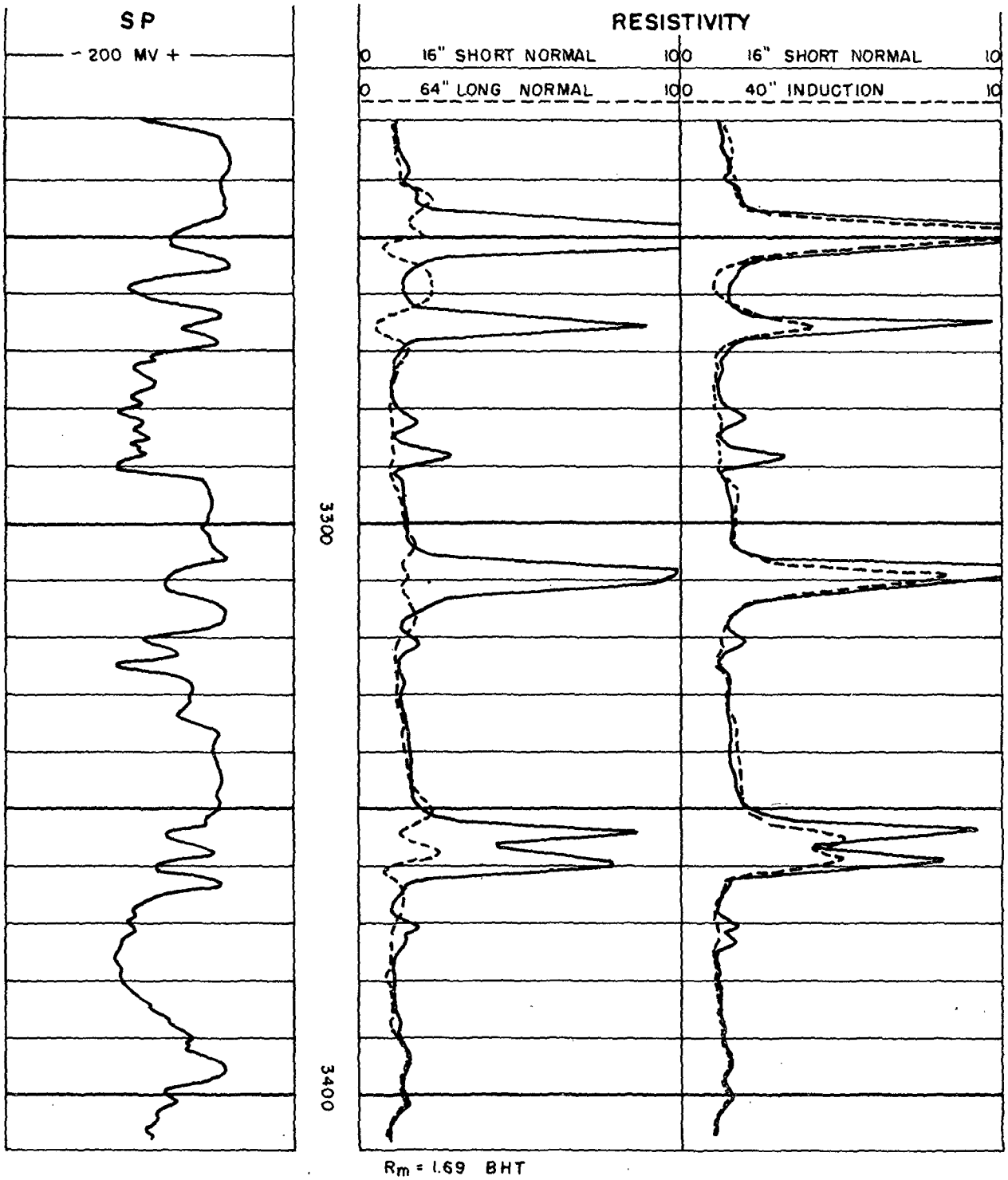
SP
- 200 MV +
RESISTIVITY
0 16" SHORT NORMAL 100 16" SHORT NORMAL 10
0 64" LONG NORMAL 100 40" INDUCTION 10
3300
3400
Rm = 1.69 BHT

Figure 1

C. A. Doh, Induction Logging in La. & Miss.

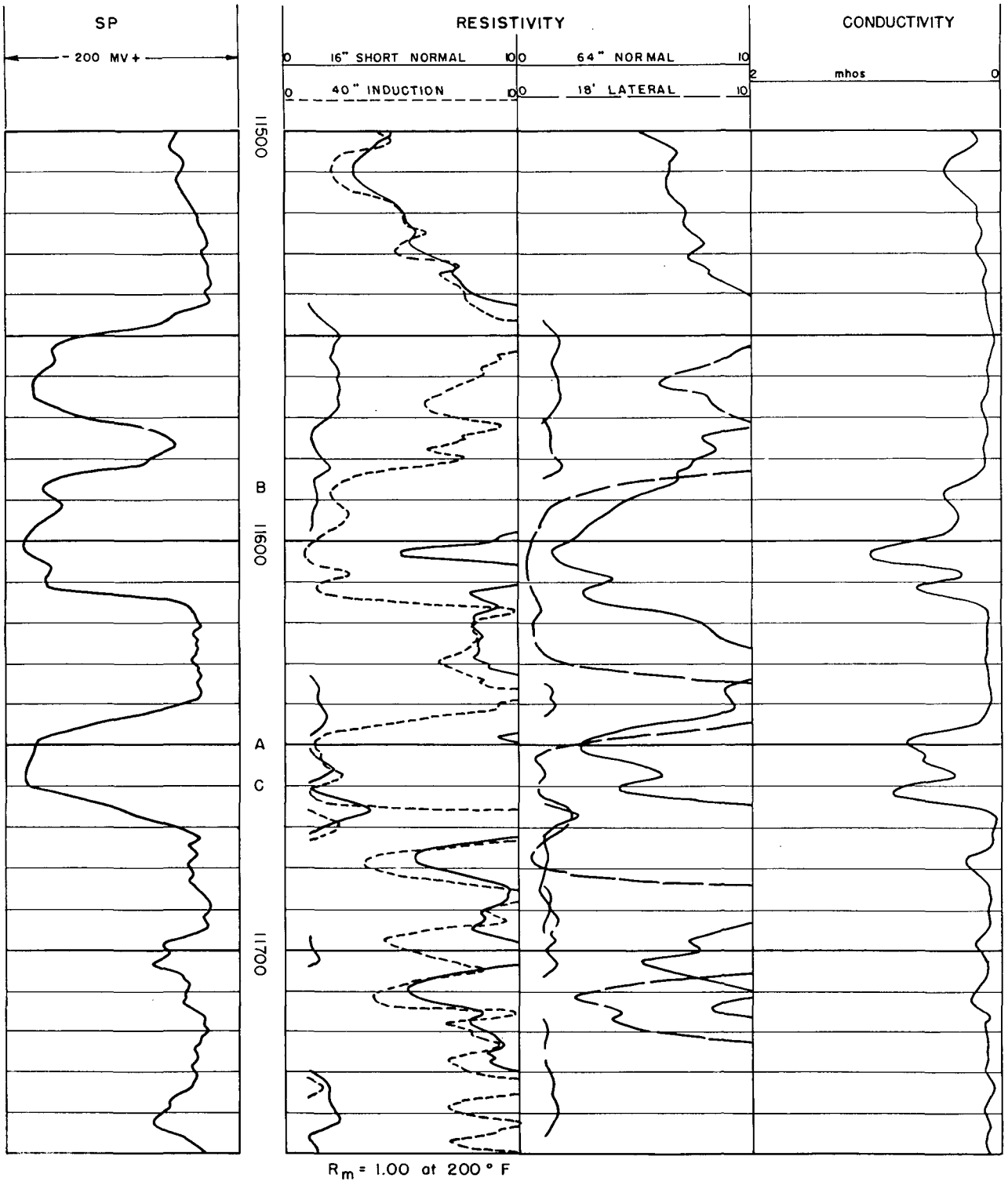

Figure 2

C. A. Doh, Induction Logging in La. & Miss.

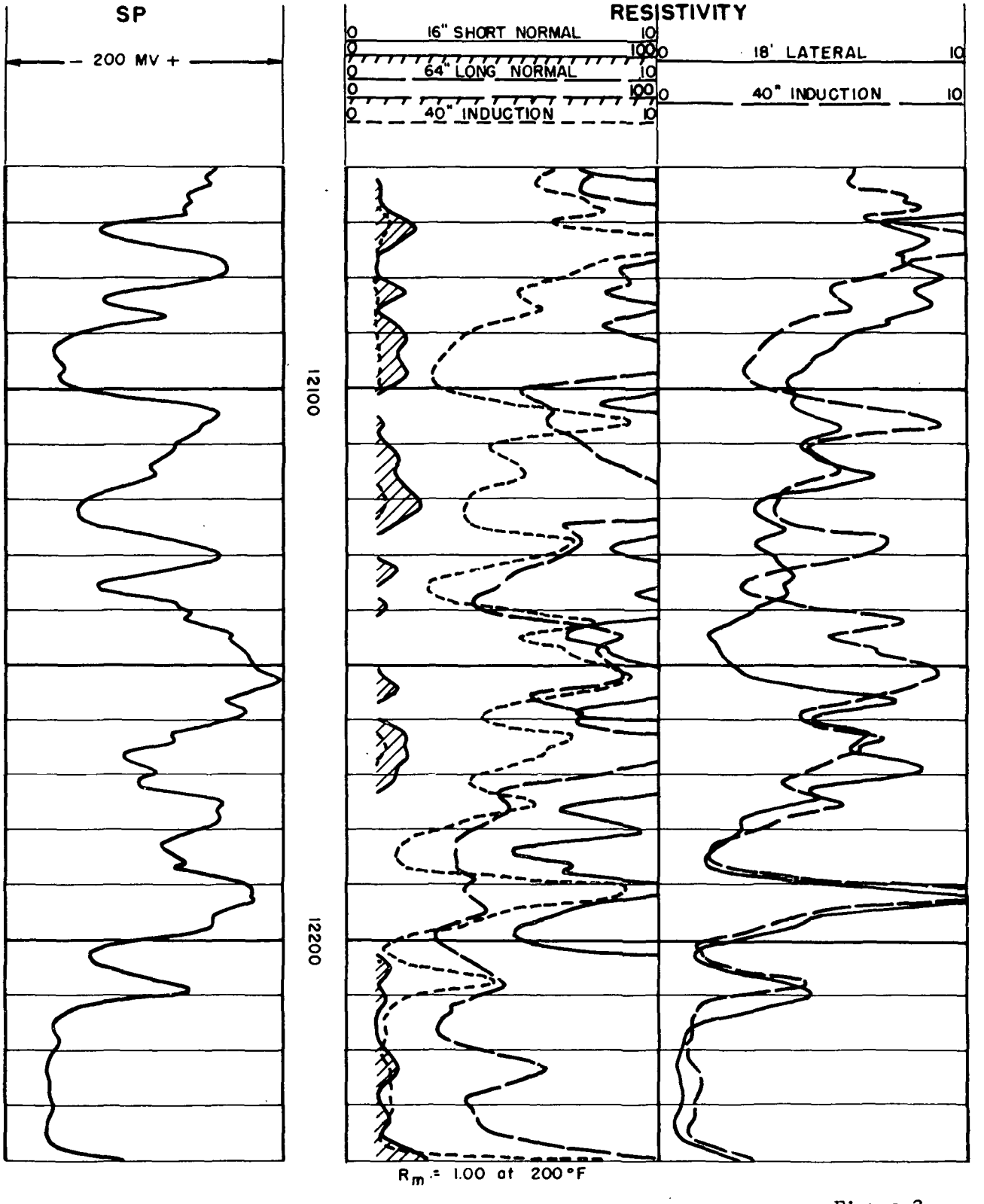

Figure 3

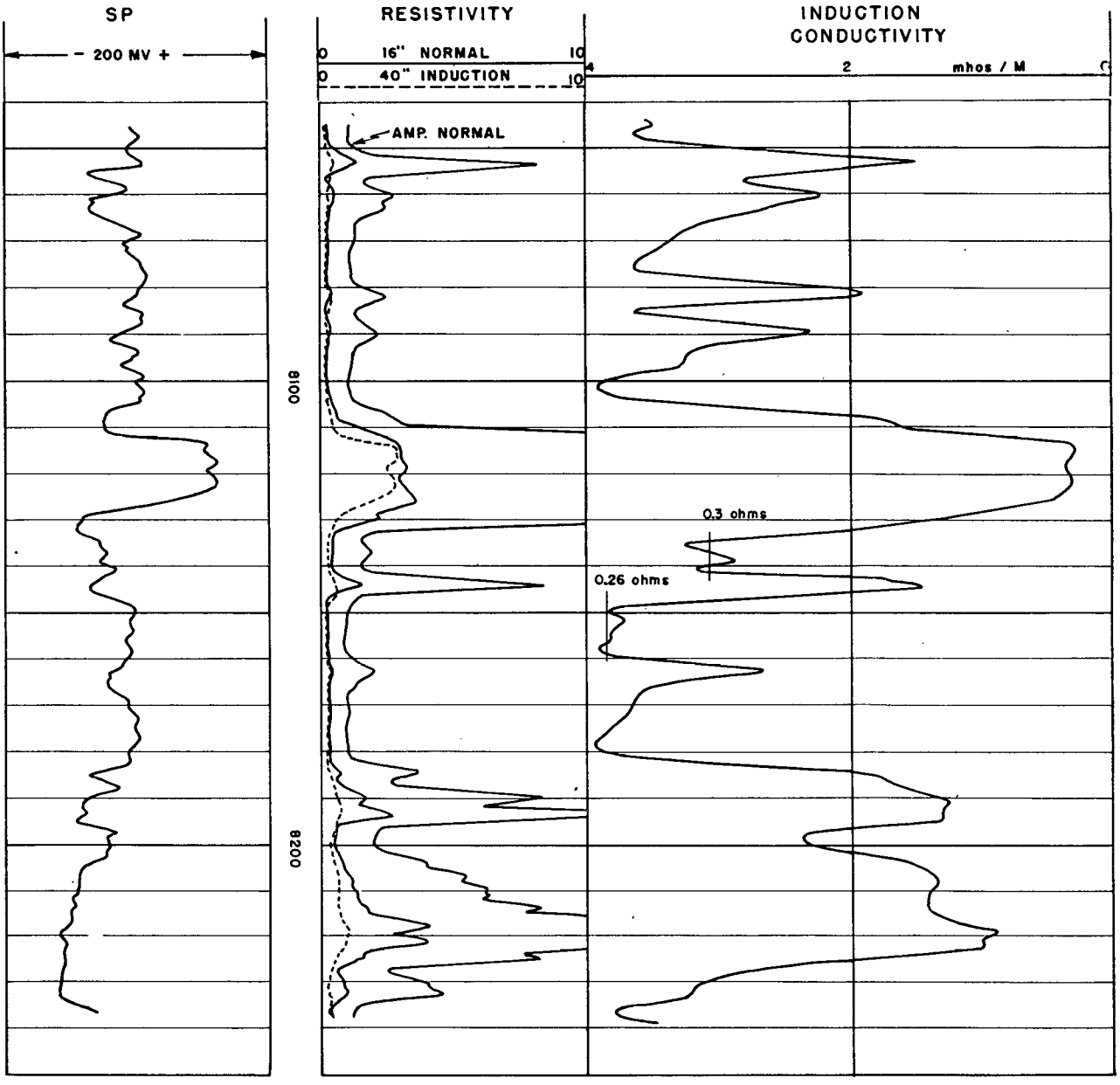
SP
– 200 MV +
RESISTIVITY
0 16" NORMAL 10
0 40" INDUCTION 10
AMP. NORMAL
INDUCTION CONDUCTIVITY
4 2 mhos / M 0
8100
8200
0.3 ohms
0.26 ohms

Figure 4

C. A. Doh, Induction Logging in La. & Miss.

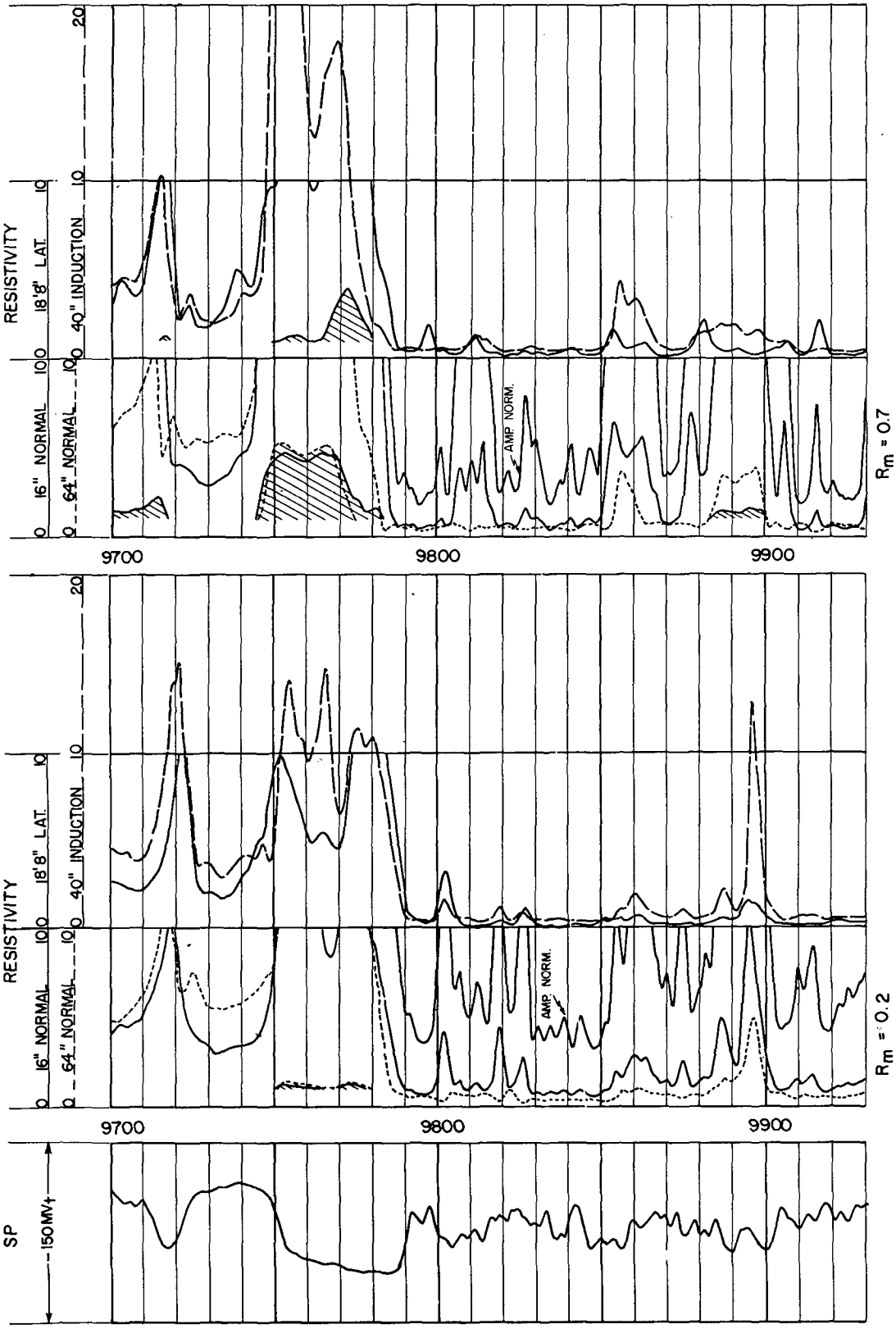

Figure 5

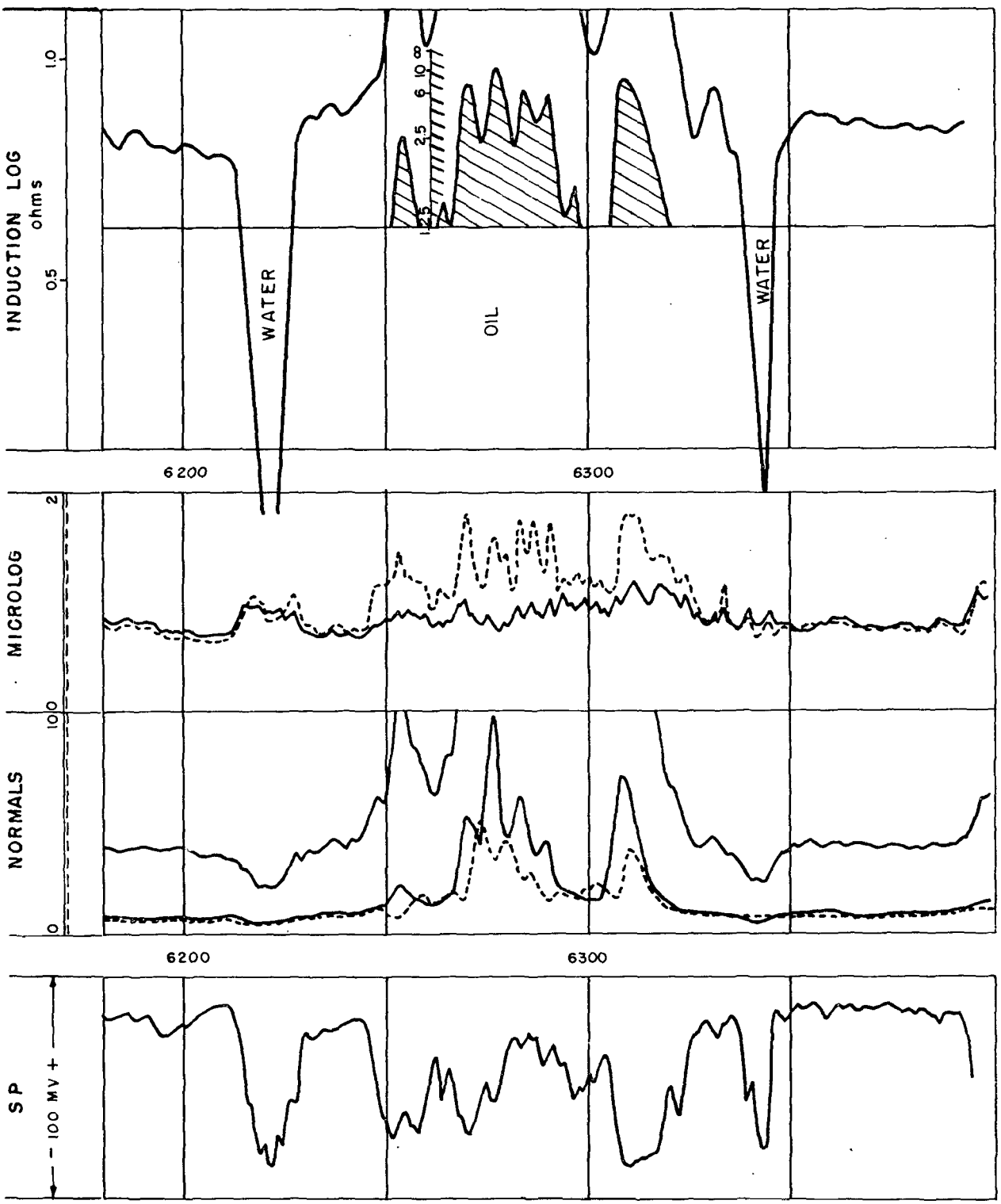
INDUCTION LOG
ohms
1.0
0.5
2.5
6
8
10
WATER
OIL
WATER
6200
6300
MICROLOG
2
0
NORMALS
100
0
Rm 0.67 at 141°F
6200
6300
SP
100 MV

Figure 6

C. A. Doh, Induction Logging in La. & Miss.

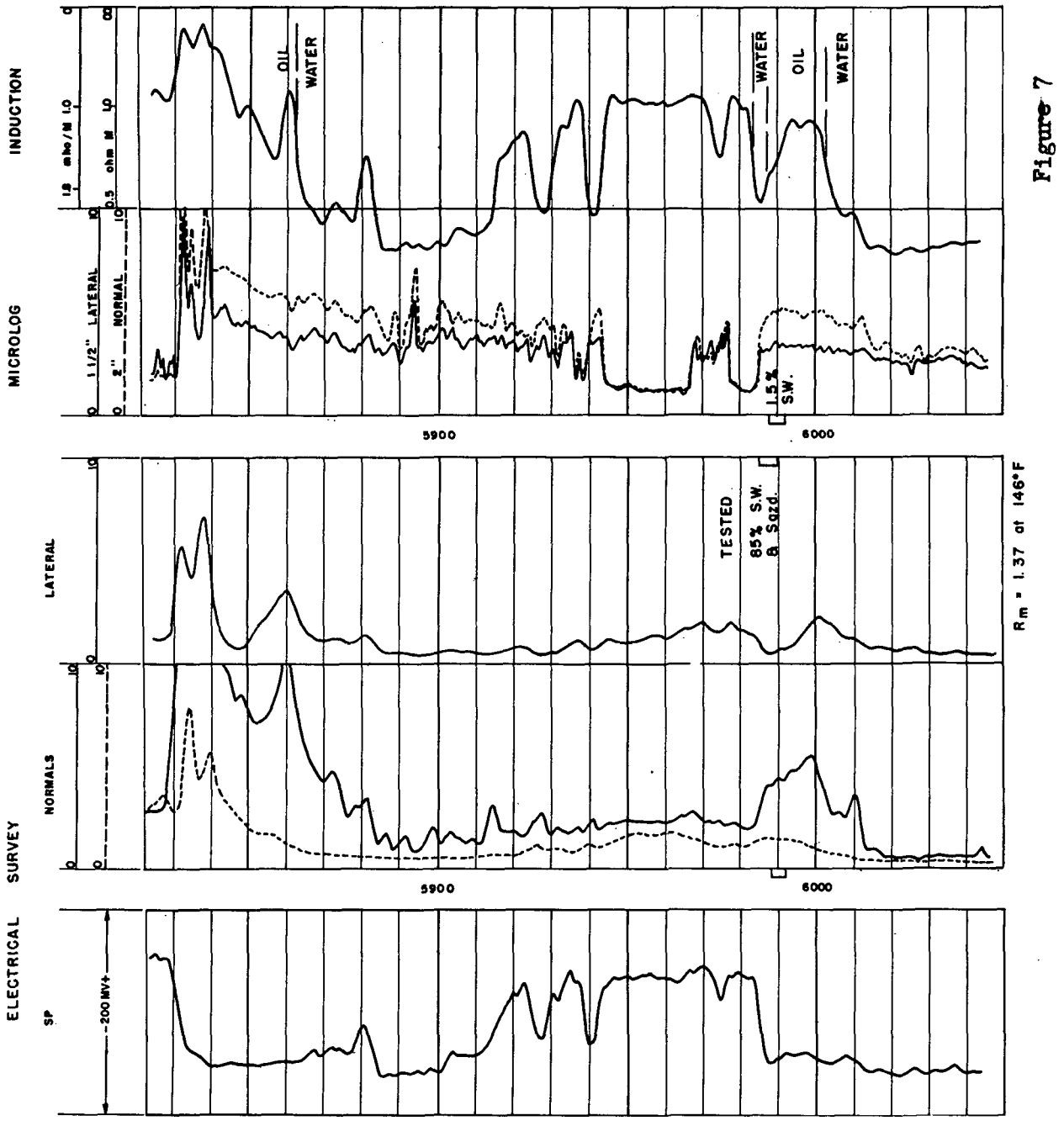

Figure 7

E) **Induction Log has a "Great Affinity" for Water Sands**

(Fig. 6)

The two water sands above and below the oil zone are very clearly shown on the Induction log. This reduces the uncertainity, and, therefore, the number of side-wall cores required. Any sand in the Gulf Coast of Louisiana with less than 0.5 ohms can confidently be classified as a water sand. Clean water sands are, therefore, always positively identified. Shaly sands may also show quite low resistivities even when oil bearing, and a very accurate determination of their true resistivity is essential for log analysis. These sands should always be side-wall sampled.

Special Problem Solved by Induction only

(Figure 7)

A thin-water sand on top of an oil sand was detected by the Induction Log on several wells in Brewton, Alabama. The example shown was tested between 5985 and 5990 and made 85% water. This interval was squeezed and perforated from 5988 to 5992, and produced with 1.5% water cut.

We have shown that Induction Logging can be used to provide more detailed and more accurate information on true resistivity determinations than we can often get from the conventional electrical log. Moreover, the Induction Log is the best answer to thin-bed and thin-oil column problems. When used with other basic curves, such as the Spontaneous Potential, 16" normal, and MicroLog, this combination provides essential information for detailed log analyses.

REFERENCES

1. Introduction To Induction Logging and Application To Logging of Wells Drilled with Oil Base Mud. By H. G. Doll—JOURNAL OF PETROLEUM TECHNOLOGY, June, 1949.
2. Interpretation of Induction Logs—Schlumberger Well Surveying Corporation—Copyright 1951.