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Performance of High Resolution Induction Tool (HRI) in WRBC

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ABSTRACT

High resolution induction tool (HRI) was purchased from M/s. Halliburton alongwith state of art logging unit EXCELL - 2000 and was inducted into the suite of in-house logging tools in early 1997.

Fourteen wells have been logged with this tool so far, which have been studied herein to assess the performance of this tool in the area under Ankleshwar project e.g. Gandhar, Kosamba, Kim etc., vis-a-vis environment under which recording was done.

This study brings out that for generating resistivity data of reliable quality from HRI tool, it should be run against the zones where Rm is above 0.1 ohm.m at formation temperature. This is corroborating with limit of Rm as suggested by the manufacturer.

It has been observed that not only the limit of Rm value at formation temperature but the ratio Rmf/Rw also has a bearing on the performance of this tool. Preferable value of this ratio should exceed 0.3. This limit of Rmf/Rw is the out come of this study.

The wells where Rm < 0.1 ohm.m. at F.T. and Rmf/Rw < 0.3 HDRS responses become spiky which is not corroborated by porosity response and shows poor repeatability. The spikes do not appear to relate to the formation attributes.

It has also been observed that the HDRS value appears to outstrip RLLD value on both low and high end of resistivity in some of the wells.

INTRODUCTION

The basic objective of running a resistivity tool is to define bed boundaries and the measurement of uninvaded resistivity (Rt), the flushed/invaded zone resistivity (Rxo/Ri), the drilling fluid invasion diameter (Di) profile and identification of movable oil.

Halliburton's, High Resolution Induction (HRI) is one of such resistivity tools and has a vertical resolution of 24". It is claimed to be based on True Resolution Focus, where the deep measurements are not synthetically 'sharpened' by combining shallow measurements (which are drastically affected by borehole, mud, invasion) with deep measurements (supposed to directly measure uninvaded zone resistivities).

This tool was inducted into the suite of in-house logging tools along with a state of the art logging unit EXCELL 2000 in early 1997.

Fourteen wells have been logged with this tool so far, which have been studied herein to assess, the performance of this tool in the area under Ankleshwar Project e.g. Gandhar, Kosamba, Kim etc, vis-a-vis environment under which recording was done.

INDICATED ADVANTAGES

The HRI tool can resolve beds as thin as 2′ and is accurate in beds thicker than 3′ while reading 40 % deeper than the conventional Induction log.

HRI may be run in place of the standard DIL. In principle, the HRI accommodates slightly more saline muds (Rm = 0.1 ohm-m at F.T.) and larger bore hole diameters (dh = 14″ with 1.5″ stand off).

HRI may be run instead of the DLLT in the following cases.

1. Fresh mud and /or low resistivity formations where the DLL was run for achieving a higher vertical resolution.
2. When the Groningen gradient affects the RLLD. An improved response in the low resistive zones and a degraded response in overlying salt or anhydrite cap rock may be apparent.

INDICATED LIMITATIONS

With saline muds and very resistive formations, there is no advantage of using the HRI over the DLL, except possibly the depth of investigation. It is recommended to use the DLL whenever Rm < 0.1 ohm.m at formation temp., and/or Rt/Rm > 1000.

CASE STUDY

Out of the studied fourteen wells, the figures and descriptions of 5 representative wells are given below :

◊ **WELL # A (FIG : 1) :**

Both HRI and DLL are recorded. The formation is Trap.
Character wise HDRS matches with RLLD. Value wise HDRS in general reads lower than RLLD. There are spikes/noise in three places in the HRI log which appear to correlate with boundary effect.

◊ **WELL # B (FIG : 2) :**

Both HRI and DLL are recorded in the interval 3070 - 3270 m. The HDRS appears spiky which is more pronounced against 3240 - 3270 m. These spikes do not appear commensurate with that on N - D combination. Hole is in general not smooth.

◊ **WELL # C (FIG : 3) :**

Both HRI and LLD are recorded. HRI is matching with RLLD keeping in view of N - D response. However HDRS reads slightly lower value than RLLD in lower end of resistivity.

◊ **WELL # D (FIG : 4) :**

HRI resistivity (HDRS) tends to out strip that of laterolog (RLLD) particularly on lower end and marginally on higher end of resistivity. Laterolog being resistivity measuring type tool may read higher on lower end of resistivity than HRI.
Resistivity responses correlate well with N - D response.

◊ **WELL # E (FIG : 5) :**

The logs are displayed alongwith its near by well no. X. The dotted curves are of well no. E and the continuous curves are for the well no. X.

The HRI (HDRS) and DIL (RILD) are matching reasonably in the interval 2960 - 3120 m. holding compatibility with respective N - D combination. Interval 2976 - 2987 m shows HDRS >> RILD which may be due to discernible hydrocarbon presence in well no. E.

The HRI in the in 3120 - 3185 m becomes more spiky. The Bore hole is also not smooth.

In the interval 3150 - 3175 m stratigraphic units are vertically off set.

DISCUSSION

HDRS appears to out strip RLLD on both low and high end of resistivity in some of the wells.

Bar diagram of Rm value & vis-a-vis quality of log (Fig : 6) indicates the value of Rm at formation temperature should be more than 0.1 ohm.m for acceptable log.

Bar diagram of Rmf/Rw value (Fig : 7) vis-a-vis log quality shows that well no. J with Rm = 0.16 ohm.m, Rmf/Rw = 0.17, the log is spiky. In well no. E, the log of upper section (2960 - 3120 m) with Rmf/Rw = 0.687 is acceptable and the log of lower section (3120 - 3185 m) with Rmf/Rw = 0.18 is spiky. Rm (0.08 ohm.m) is same for both the section (Fig. 5). Similar situation is also seen in other wells also. These observations suggest that not only the Rm value, Rmf/Rw has also important influence on the log quality.

It is seen that the lower limit of Rmf/Rw ratio can be taken as 0.30 for generating reliable HRI data in combination with Rm > 0.1 ohm.m.

Bar diagram of Rt/Rm values (Fig : 8) however does not yield any definite correlation with log quality to assess its critical value. It appears that Rt/Rm can not be seen in isolation but is to be judged along with Rmf/Rw value.

Spiky response present in some of the wells is not corroborated by porosity log and show poor repeatability and not related to formation attributes.

CONCLUSIONS

1. This study brings out that HRI should not be run against the zones where Rm goes below 0.1
   ohm.m at Formation Temperature, which is in agreement with that quoted by M/s. Halliburtion.
2. Rmf/Rw should be more than 0.30. This is a new criteria emerged from this study.
3. Spiky response may not be related to formation attributes as shown in some of the wells where in it is not corroborated by porosity log and show poor repeatability.

REFERENCES

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2. 'High resolution Induction Logging - A comparison with conventional Induction as used in thin sands in the Texas Gulf Coast region' - by carlos Silva and David Spooner (SPWLA 91 WW).
3. "Summary sheet on the HRI" - By Halliburton (un published).

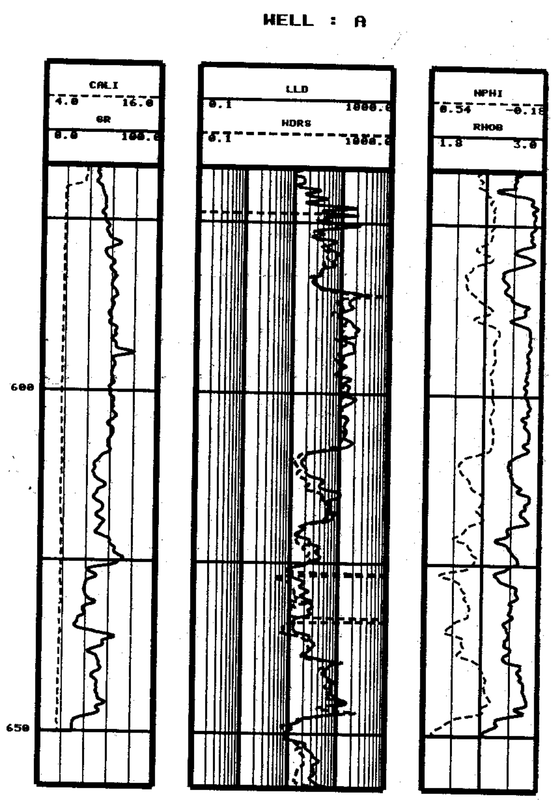
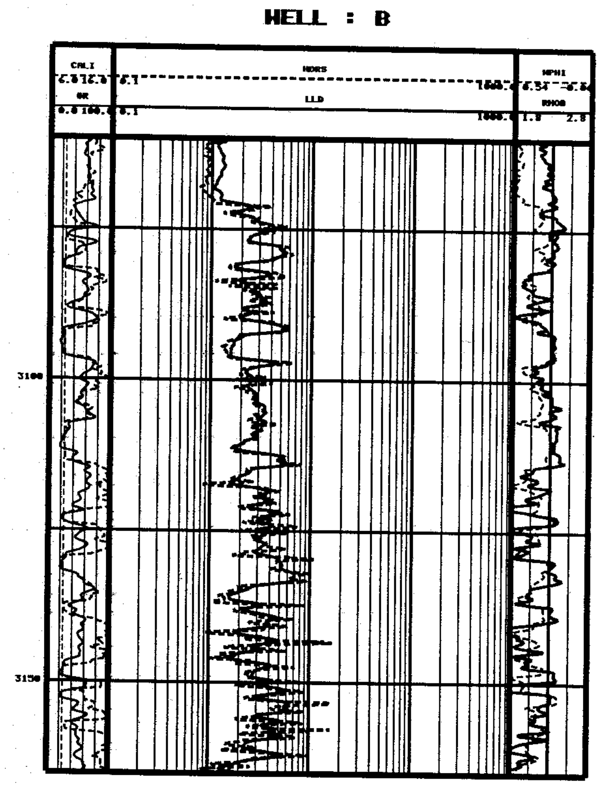


Fig No. 1



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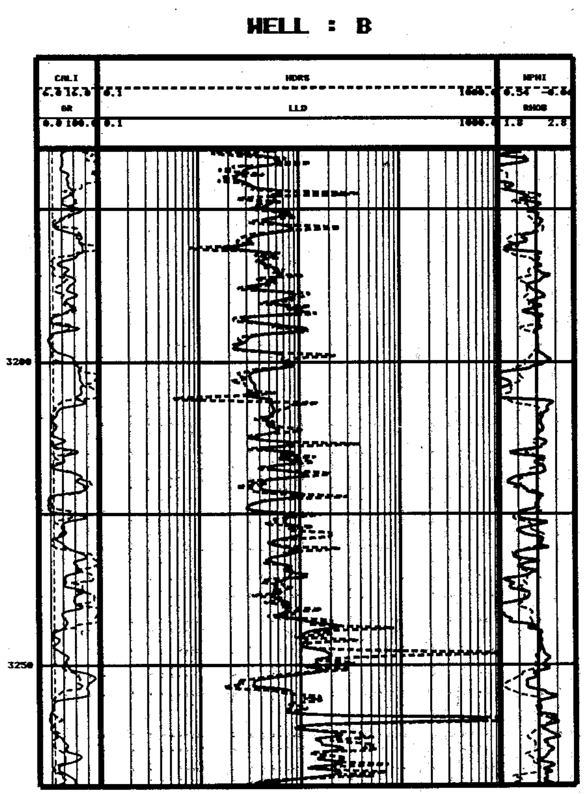

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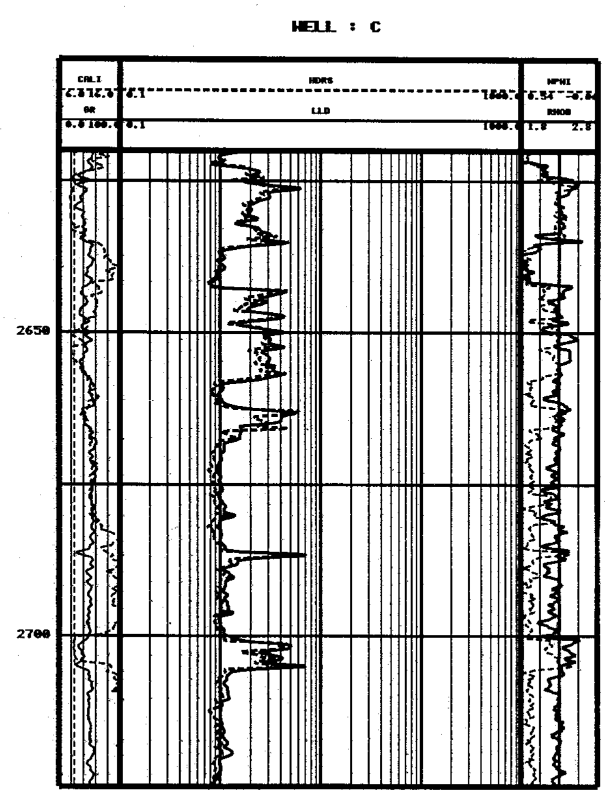

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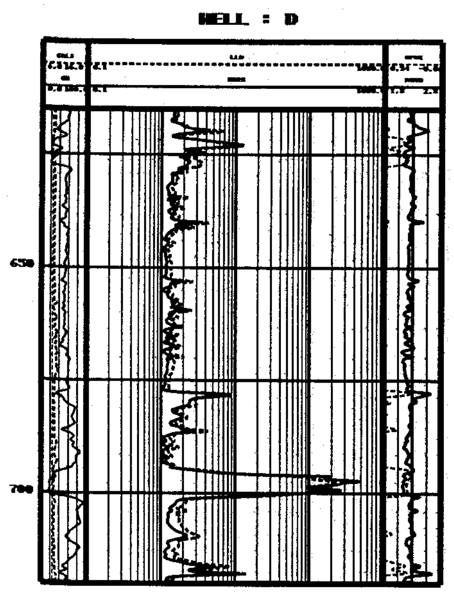

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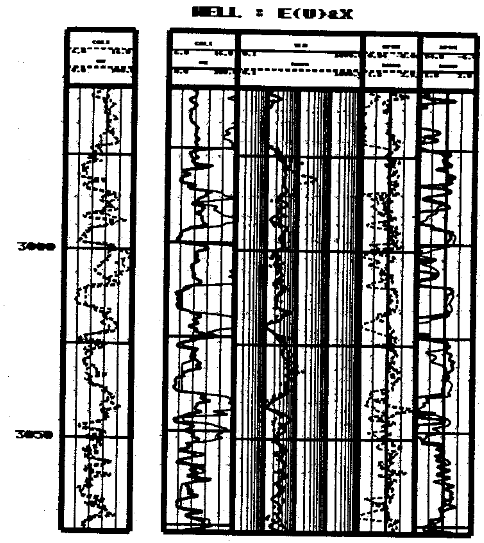

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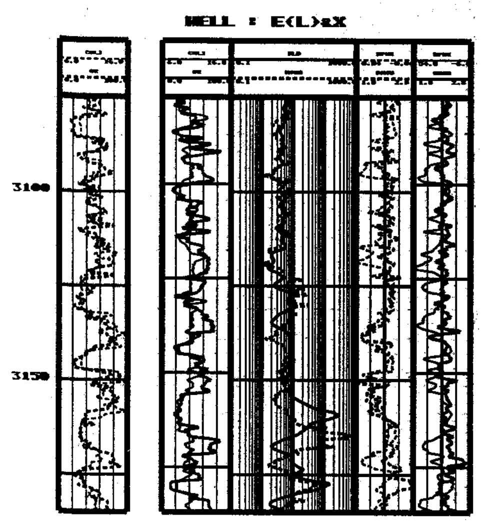

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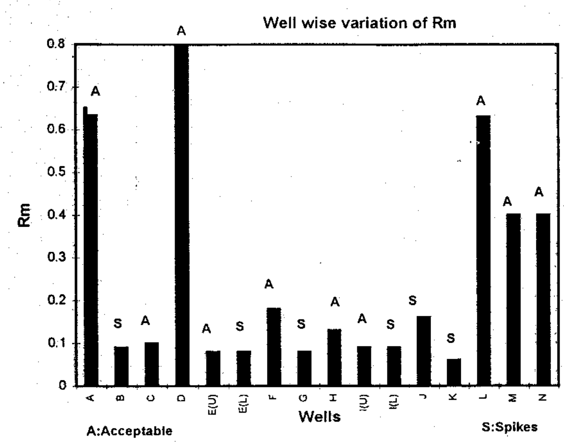
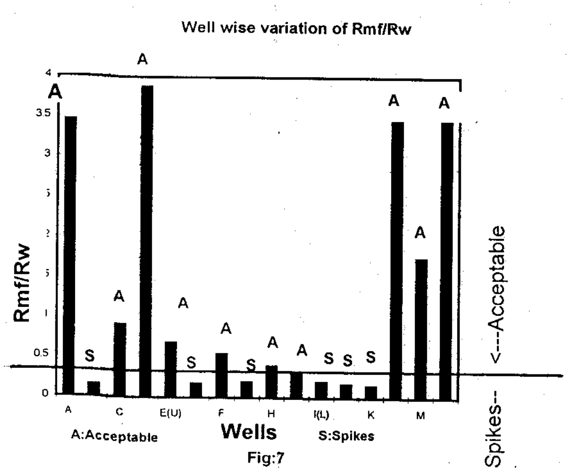


Fig:6



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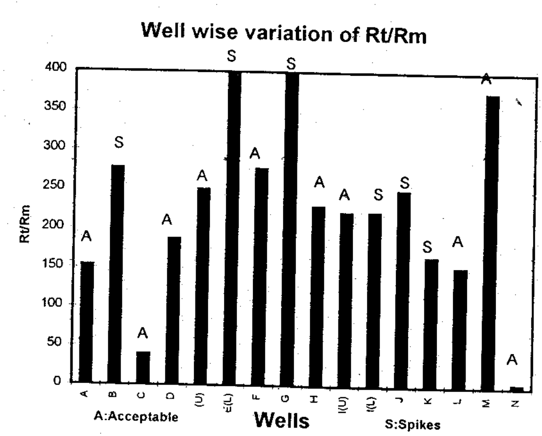

Fig:8