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Depositional Environment Prediction of Ingoli Field of Cambay Basin using Natural Gamma Ray Log

Gaurav Siddharth Gairola,
Department of Earth Science,
Indian Institute of Technology,
Bombay.

Abstract- The natural gamma ray spectrometry can be used effectively and efficiently to predict the depositional environment. The natural gamma ray log measures the natural gamma radiation emanating from a formation split into contributions from each of the major radio-isotopic sources. Analysis of the sources of the natural gamma radiation gives us added information concerning the composition and likely lithology of the formation. In this paper the depositional environment of Ingoli Field, Cambay Basin is predicted using natural gamma ray log. Based upon the elemental composition of the uranium and thorium it was found that natural gamma ray log not only helps in determining the depositional environment but also helps in distinguishing the areas proximal and distal from the sea. The natural gamma ray log data was studied for two wells and the analysis are made on them which reveals the marine depositional cycle and the proximity of one well with respect to the second from the sea.

Keywords—NGS log, Depositional Environment Prediction, Cambay basin

INTRODUCTION

The conventional gamma ray log measures a composite gamma ray which in fact emitted by three main types of source elements (^{40}K, ^{232}Th and ^{238}U) and their decay products. The radioactivity due to individual element cannot be calculated from the gamma ray log. The natural gamma ray log is based upon the principle that the amplitude of the output from the gamma ray sensor is proportional to the energy of the incident gamma ray. This information can be used to measure the proportion of the total gamma radiation coming from each of potassium-40, the uranium-radium series, and the thorium series for a particular formation.

Radioactive element	Detected by peak of element	Energy value of the peak
K (potassium)	K	1.46Mev
U (Uranium)	Tl (thalium)	1.76Mev
Th (Thorium)	Bi (bismuth)	2.62Mev

Table 1: Peak study for analyzing individual characteristic spectra from U, Th and K.

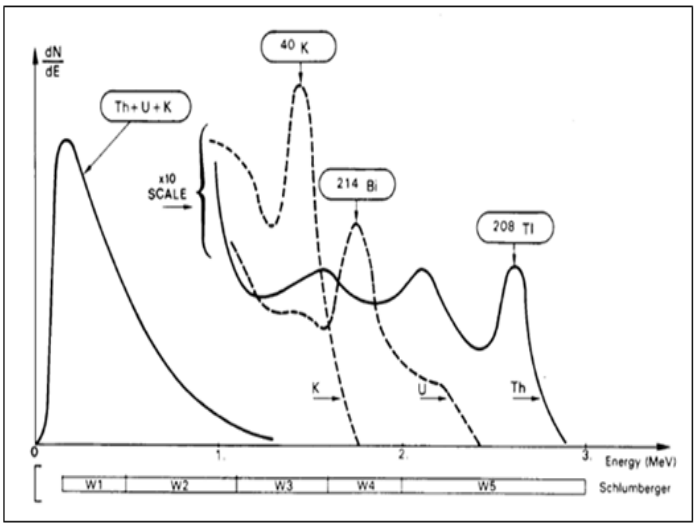

Fig 1: Potassium, Uranium and Thorium spectra obtained using crystal detector.

Location of study area

The southern part of exploratory block CB-ONN- 2000/1 is located along the western margin of Mehsana- Ahmedabad tectonic bock. It extends from Longitude 72^0 17' 44'' to 72^0 30' 11'' and Latitude 23^0 00' 59" to 23^0 01' 42". The total block area is 1424 Km² (DGH, 2011).

The study area (Ingoli : 14.03 sq.km.) is located in southern part of CB-ONN-2000/1 which is limited to the south by the Nawagam – Wasana basement uplift. The NW-SE marginal fault located in SW portion of the block. The block is segmented longitudinally (NNW- SSE) into two major half grabens each associated with prominent faults **(DGH, 2011).**

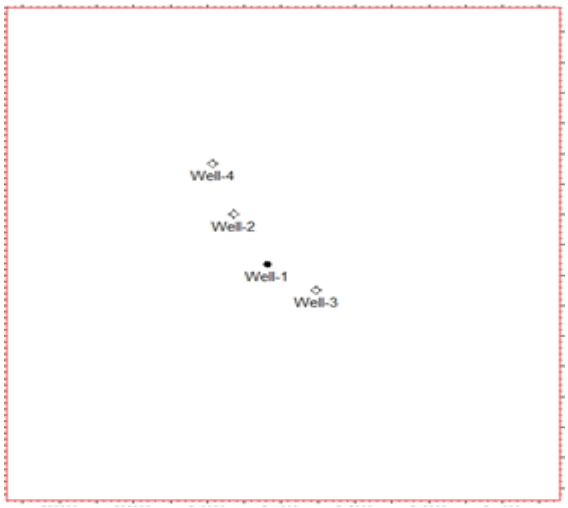

Fig 2: Map view of study area with well locations.

Methodology

The natural gamma ray log data for two wells are studied and concentration of each element was calculated after certain interval of depth. The thorium by uranium ratio is calculated for each of the well and also the uranium concentration across the depth was plotted for one of the well. The histogram for the thorium by uranium ratio is plotted for the analysis.

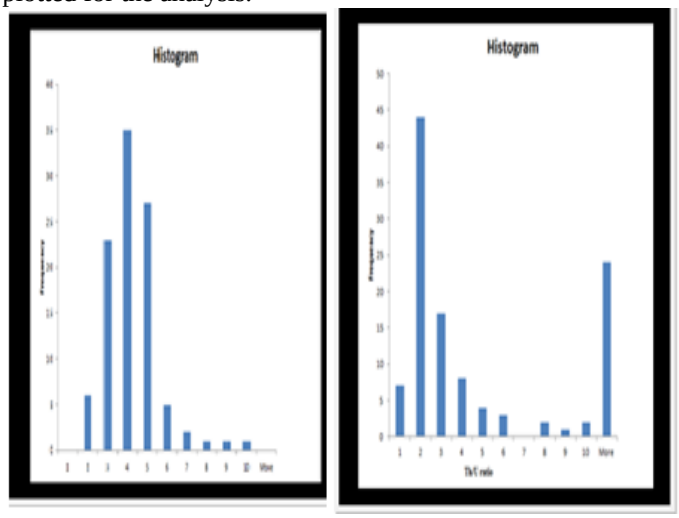

Fig 3: Th/U ratio for two wells Well-4 and Well-1 respectively.

The depth variation of the uranium concentration is also analysed for one of the well for understanding the signature change in that across the depth.

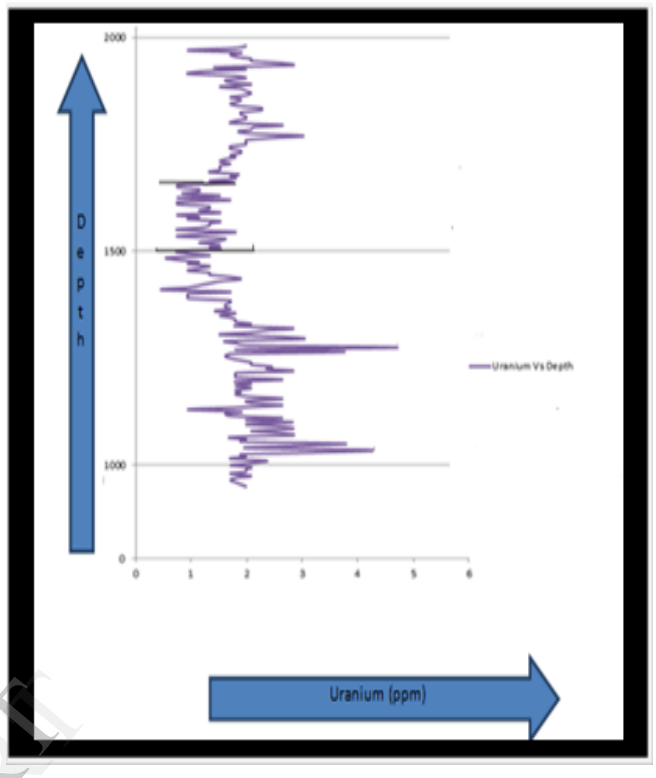

Fig 4 -Uranium Vs Depth plot for Well-4

Interpretation

Depositional environment can be predicted from the NGS log using variation in uranium concentration in the sub surface formations. The more mobile nature of uranium than thorium (**SLB_1982**) has resulted in more uranium concentration in sea water as compared to the river water. The thorium-to-uranium ratios in sedimentary rocks range from less than 0.02 to more than 21. Ratios in many oxidized continental deposits are above 7, whereas most marine deposits have ratios much below 7(**Dr. Orion Berryman**). Thus, the Uranium vs Thorium plot can reveal the types of deposits while the uranium concentration variation along the depth can be used to predict the transgression and regression marine cycles.

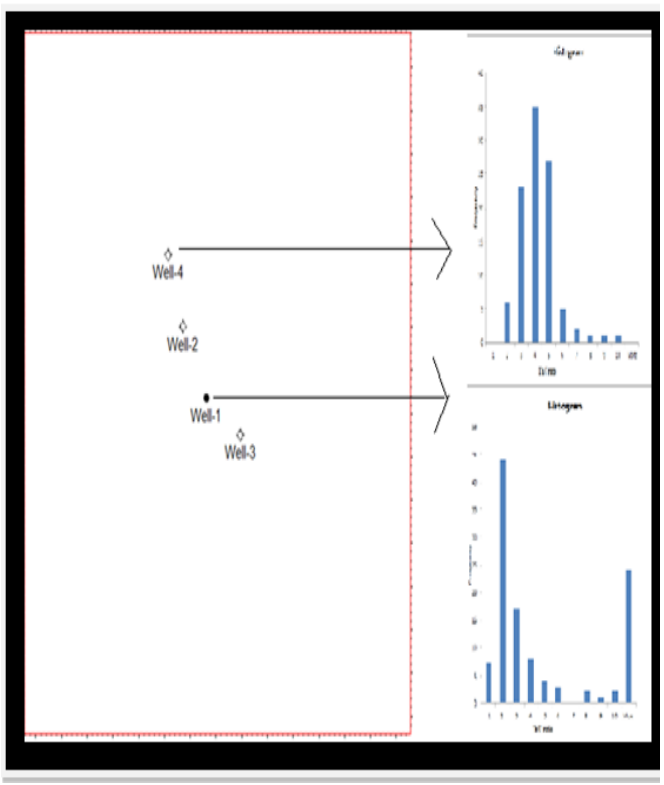

Fig 5: Th/U ratio histogram along with the well location on the map.

The above Th/U ratio plots depicts that the deposits are marine deposits because Th/U ratio for both the wells is less than 7 and on moving from Well-4 to Well-1 the uranium concentration has increased which may be due to the fact that the Well-1 is more closer (proximal) to marine depositional environment as compared to Well-4 because sea water has more uranium concentration compared to river water.

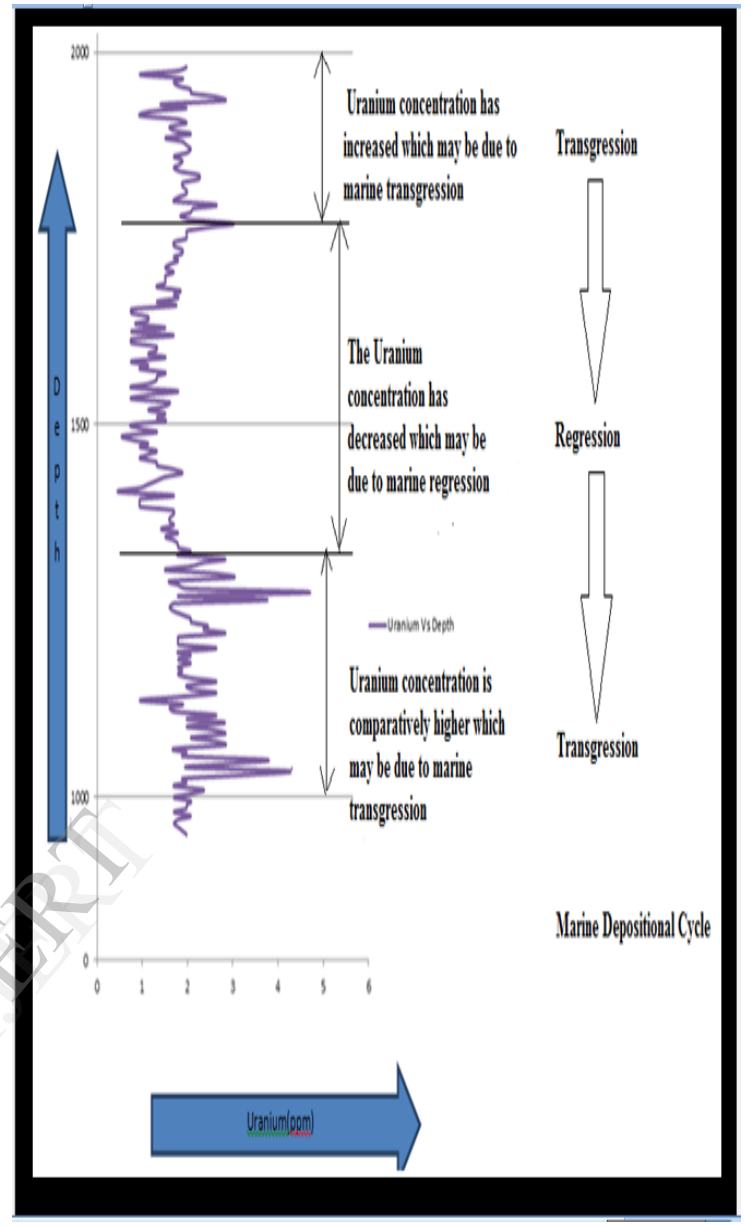

Fig 6- Interpretation of marine depositional cycle from Uranium Vs Depth plot for Well-4

RESULT

The depositional environment of the Ingoli field was predicted using the natural gamma ray log which shows there is a deposition of marine sediments. The alternate cycle of transgression, regression and then again transgression occurred there which has characteristic deposition of cambay shale, kalol formation and tarapur shale respectively.

CONCLUSIONS AND FINDINGS

The study shows that the natural gamma ray log (NGS) can act as an impotant tool for prediction of depositional environment. The depositional pattern shows different Th/U ratio for continental and marine deposited sediments. In addition to that the marine depostional cycle can also be predicted by analyzing the concentration variation of uranium along the depth.

REFERENCES

- DGH: Cambay Basin Information Docket
- SLB 1982: Essential of Natural Gamma Ray spectrometry interpretation
- O. Serra, Elsevier (1984), Fundamentals of well-log interpretation.

Tables and Figures

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- Fig 6- Interpretation of marine depositional cycle from Uranium Vs Depth plot for Well-4.

About the author

Gaurav Siddharth Gairola is currently pursuing M.Tech in Petroleum Geoscience from Indian Institute of Technology, Bombay. The author was awarded the University Silver Medal for his excellence in academics (B.Tech Geoscience Engineering) from University of Petroleum and Energy Studies.