Uncertainty and Risk Analysis of 3D Geological Model for Syn Rift HP-HT Reservoir of Krishna–Godavari Basin, India*

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Abstract

Geo-cellular modelling has long been used to understand lithology extent and petrophysical property distribution within the geological body. In case of Syn rift HP-HT green field, uncertainty in modelling parameters, initial gas in place and risk related to well locations optimization within Geo-cellular model. The quality of 3D geological model strongly depends on the type of integration geological data, their integration and associated uncertainty analysis to improve an existing geological model and effectively plan further site of investigation. Therefore, this paper aim to identify and quantify uncertainties and obtain more accurate geo-cellular model to be used in reservoir simulation. The methodology intends to evaluate geo-cellular model, GIIP and risk analysis. The study was divided into generation of flow stream line, S-curve, sensitivity analysis and uncertainty map. Uncertainty range was applied to variable of facies modelling, petrophysical modelling and input data series. Variables ranges from these data were used by Monte Carlo simulation method to generate random values to be input uncertainty in geo-cellular model. We generated 500 models using the Monte Carlo simulation method. We cross plotted GIIP vs. connected pore volume to find out the S-curves and array of variability approach to select P10, P50 and P90 cases of the model distribution. The connected pore volume was estimated for each of the model using streamline simulation technique to further rank these models based on dynamic connectivity. Connectivity was qualitatively ascertained by visualizing streamlines and was quantified by estimating connected pore volumes. Based on ranking, model having better dynamic connectivity was simulated. In conclusion, all cases GIIP of P10, P50 and P90 not showing more variation to base model. It means input data and geo-cellular parameter has been taken for base case is robust. The uncertainty maps of mean and variance is showing well A position is falling in low risk area and well B is having very high risk. Key Words: Uncertainties, Risk, Syn rift HP-HT reservoir, Geo-cellular model, GIIP.

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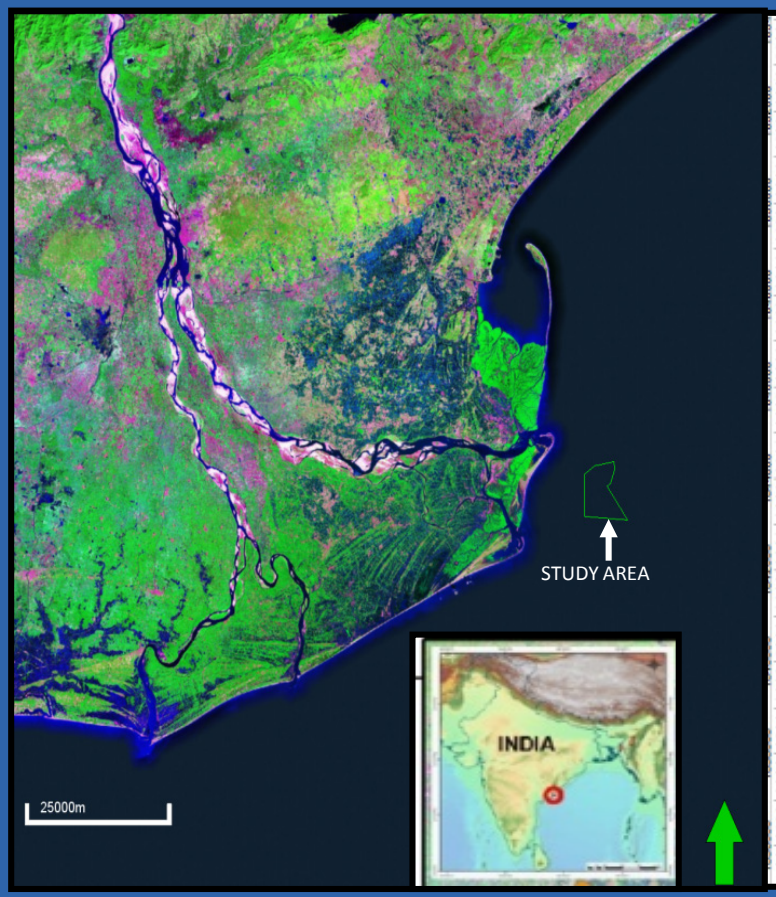
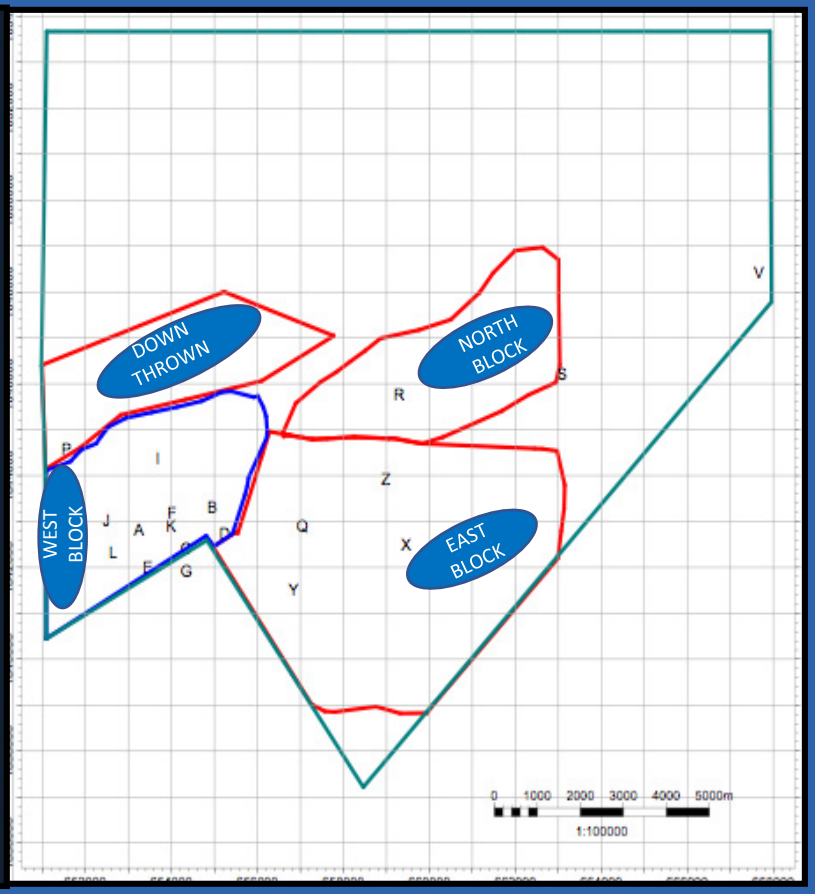
PRESENTATION OUTLINE

- Introduction
- Regional Geology of Study Area
- Problem Statement
- Modeling workflow
- Conclusions
- Acknowledgements

LOCATION MAP OF KG BASIN

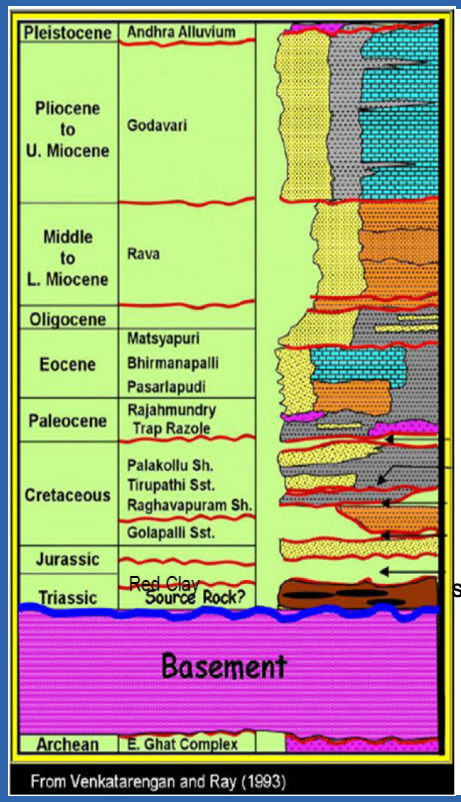


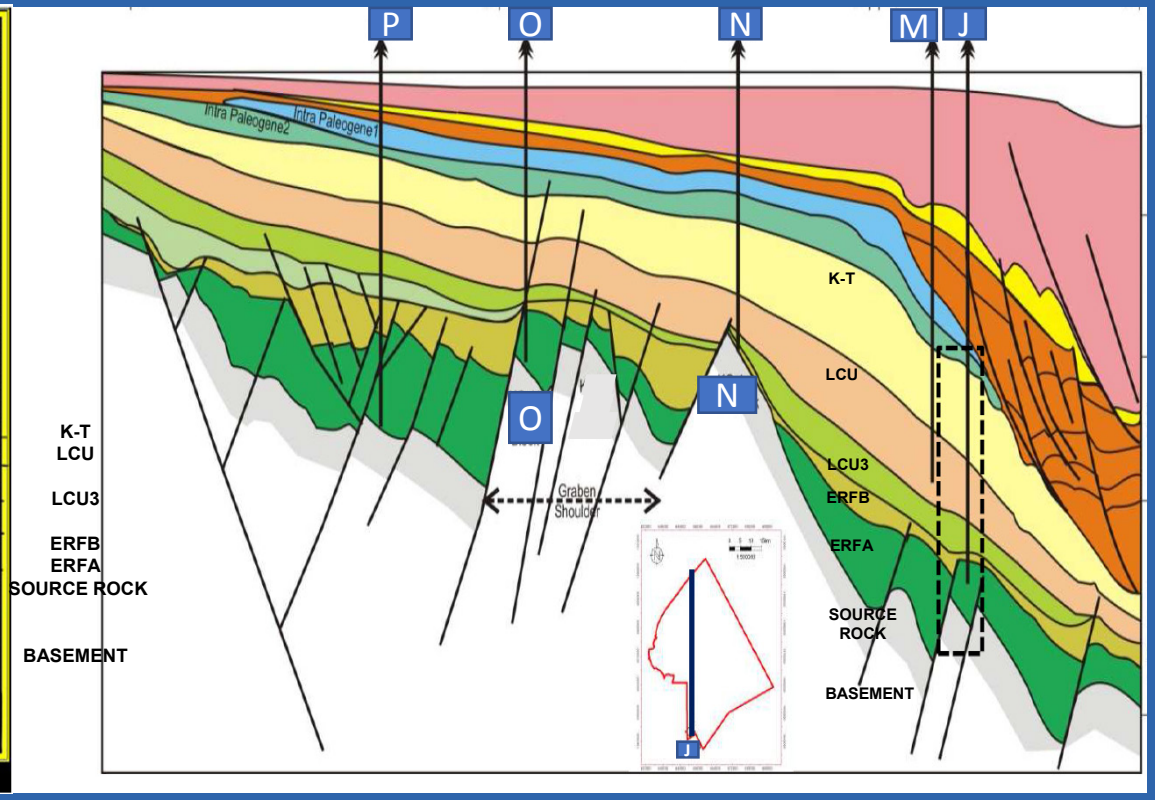
(A) LOCATION MAP OF STUDY AREA



(B) LOCATION MAP OF STUDIED BLOCK

REGIONAL STRATIGRAPHY AND CROSS SECTION OF KG BASIN SHOWING STRUCTURAL FRAMEWORK OF THE BASIN





Ref: Shenai & Rao, 1982; Rao, 2001; Gupta, 2006; Bastia and Nayak, 2006; Lal et al, 2009

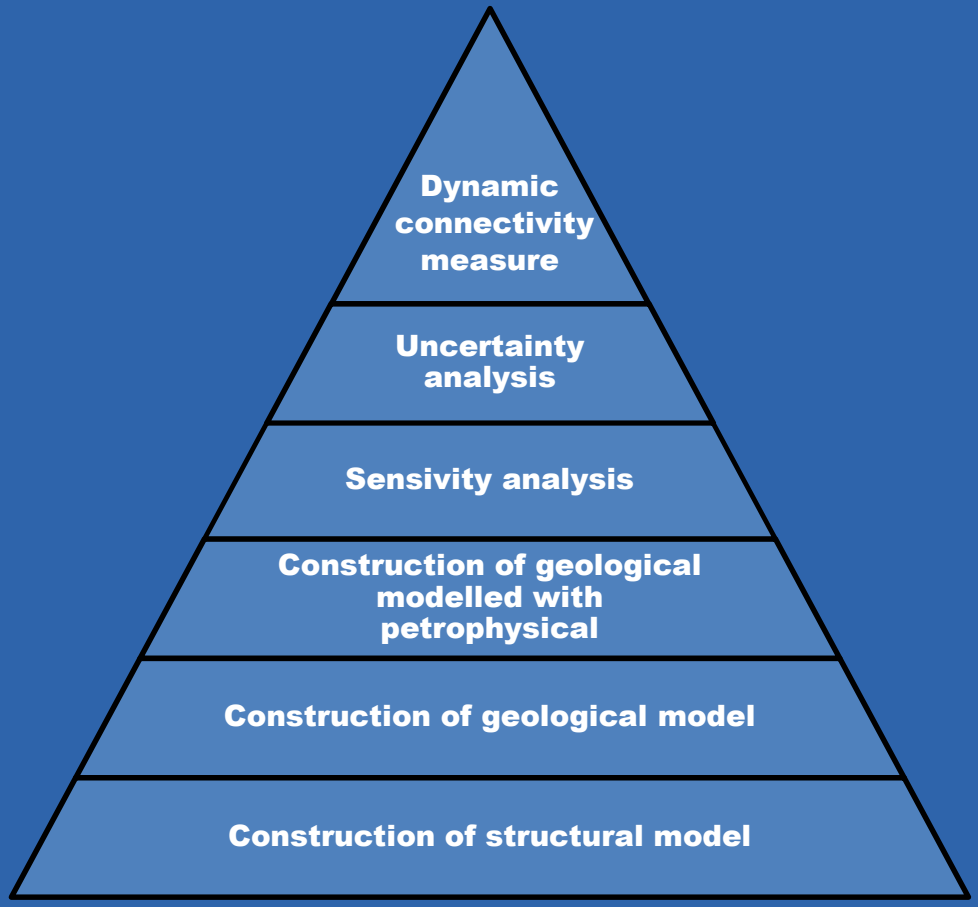
PROBLEM STATEMENT

The Syn-rift HP-HT reservoirs in Krishna Godavari basin Block West has been described as a highly heterogeneous mixed clastic system that yields complex yet prolific reservoirs, for which rock quality is challenging to predict.

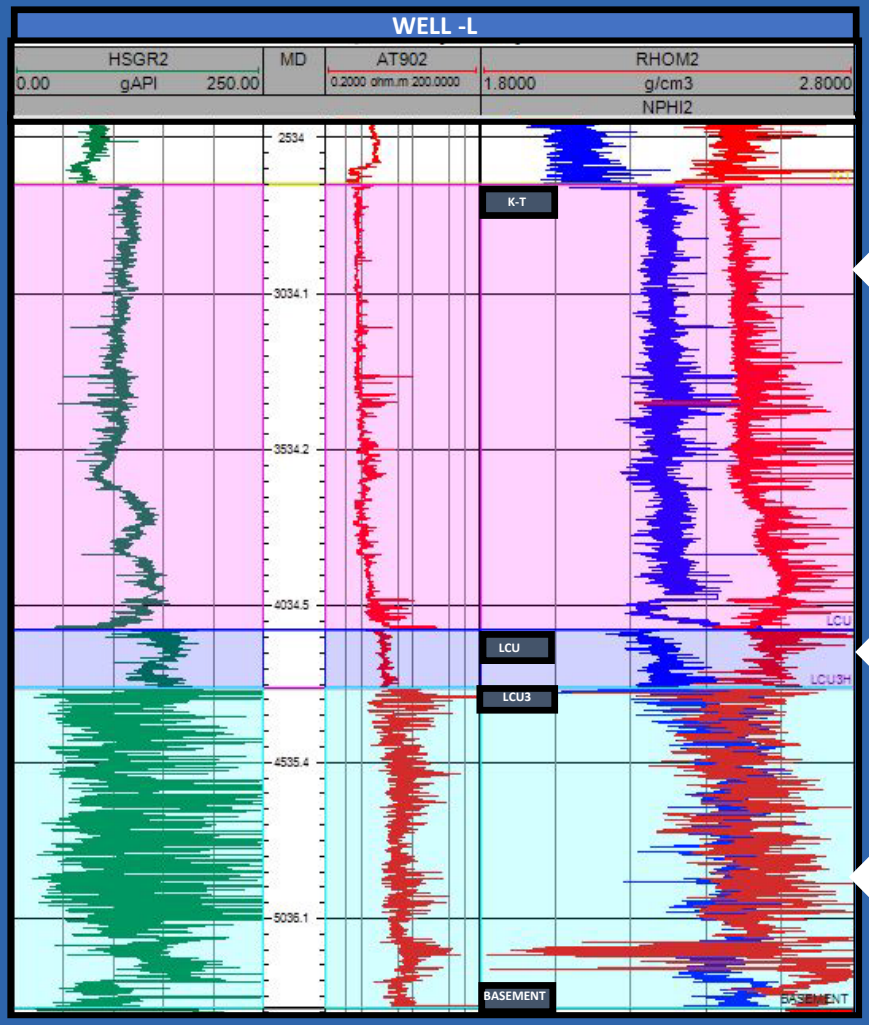
Key static subsurface uncertainties associated with Syn-rift HP-HT reservoirs in Block West have been identified and can be summarized into three questions:

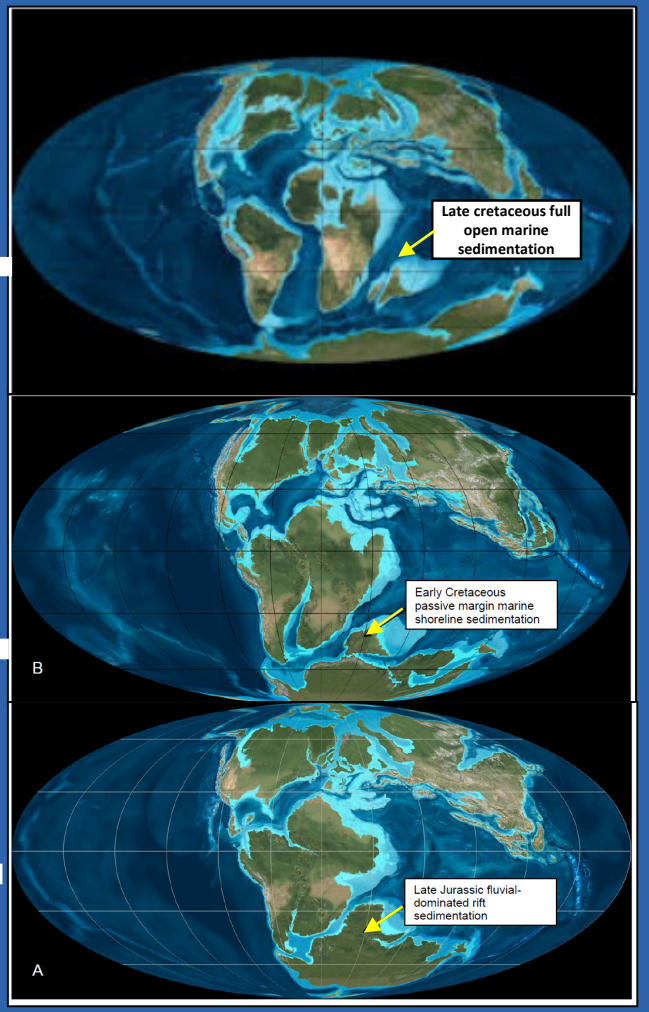
- How much Gas is there? (Original Gas in Place)
- How easily will it move around? (Reservoir Connectivity)
- Risk related to well location optimization within Geo-cellular model

SOLVING SUBSURFACE UNCERTAINTY : MODELLING WORKFLOW



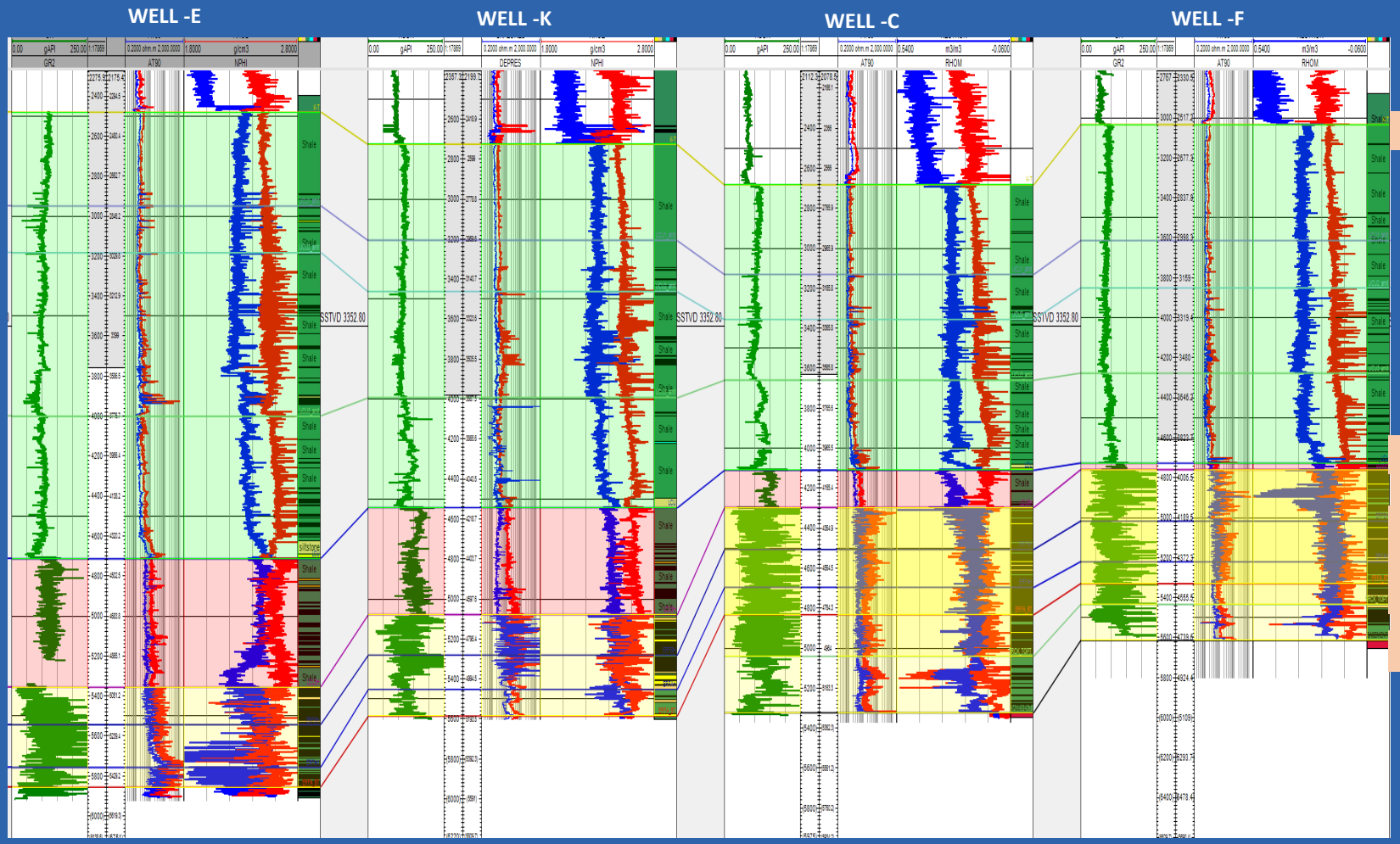
PALEOGEOGRAPHIC MAP (MOLLWEIDE PROJECTION)SHOWING THE LOCATION OF INDIA DURING THE SEPERATION OF PLATES



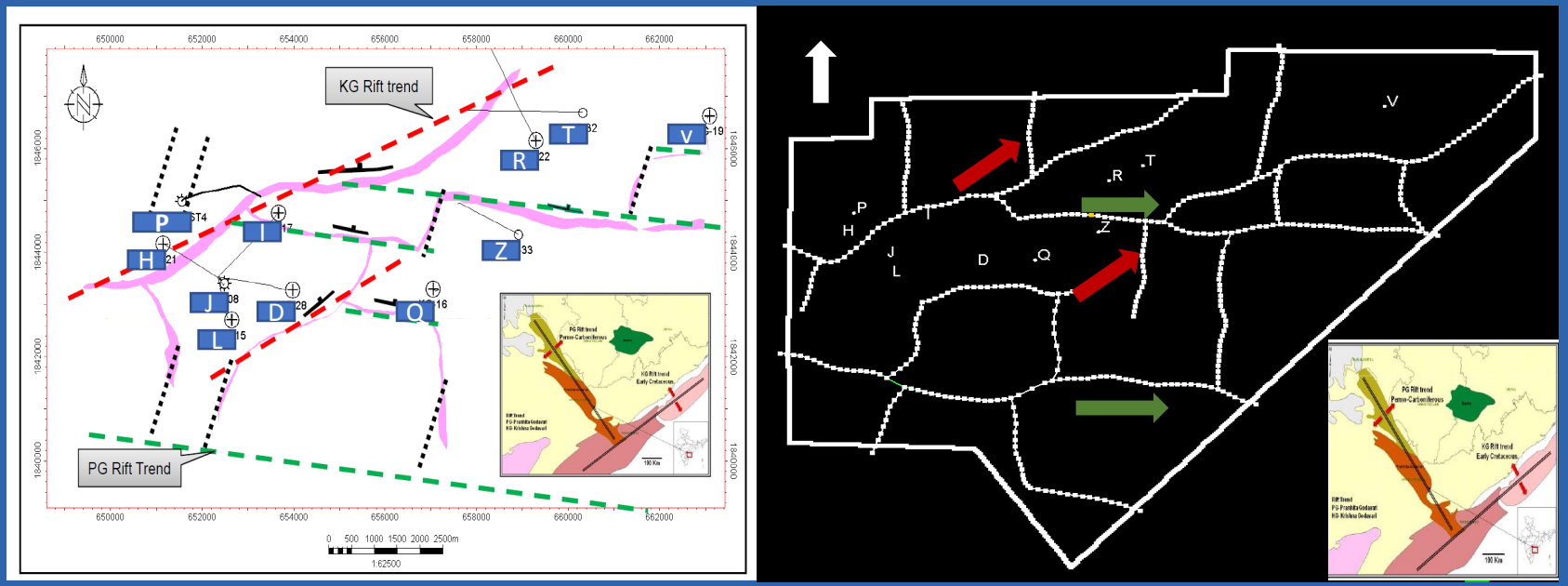


Ref: Blakey, Ron, http://jan.ucc.nau.edu/~rcb7/globaltext2.html

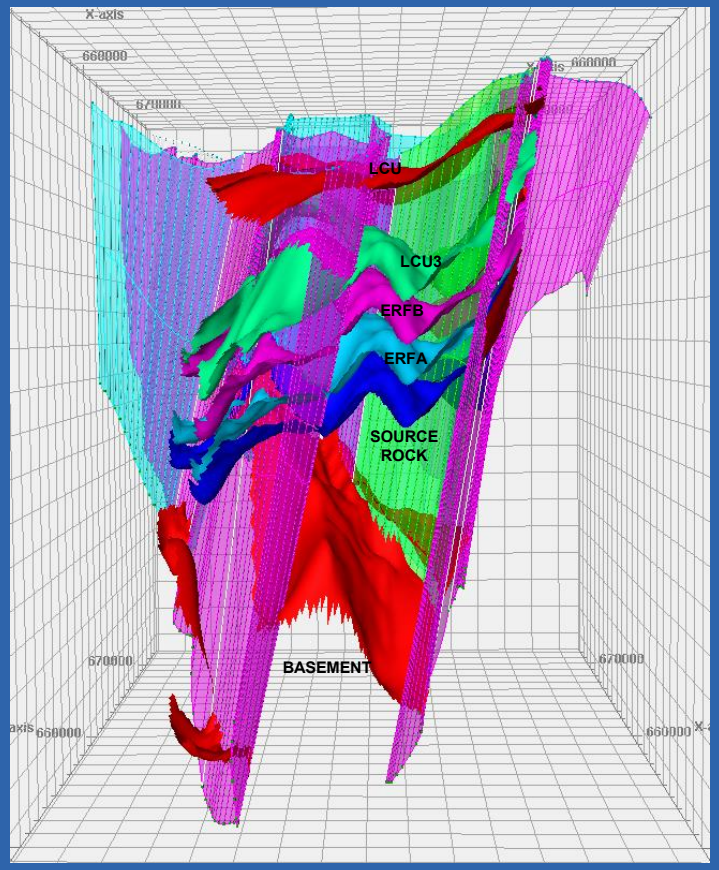
WELL LOG CORRELATION



FAULT PATTERN FROM SEISMIC INTERPRETATION

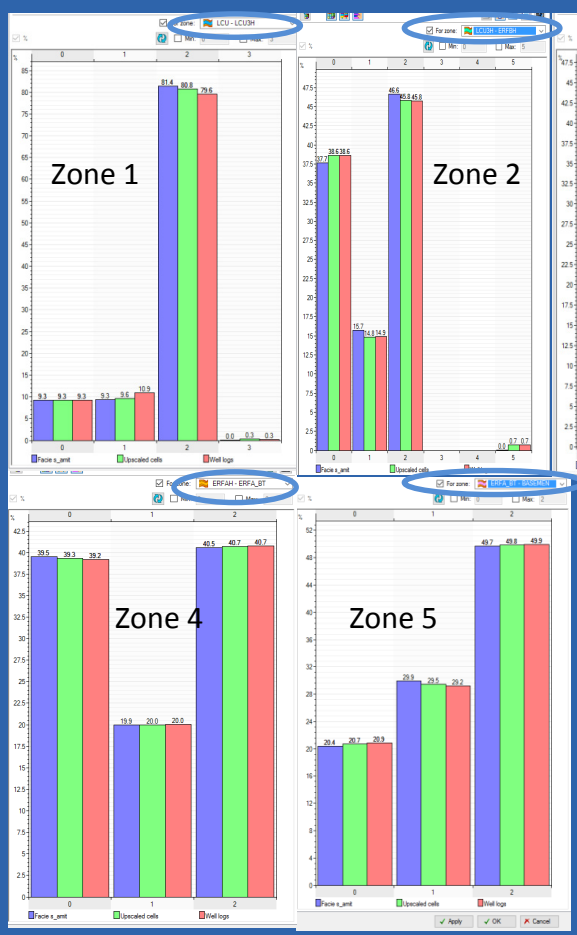


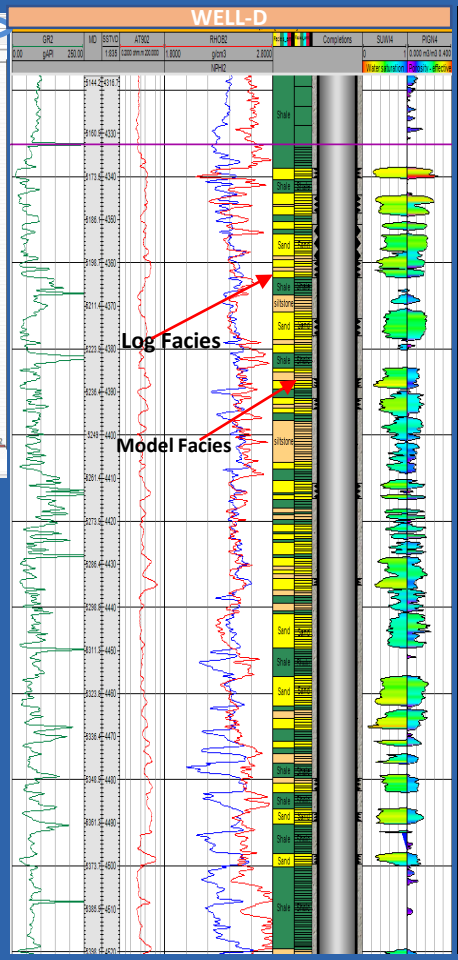
CONSTRUCTION OF STRUCTURAL MODEL

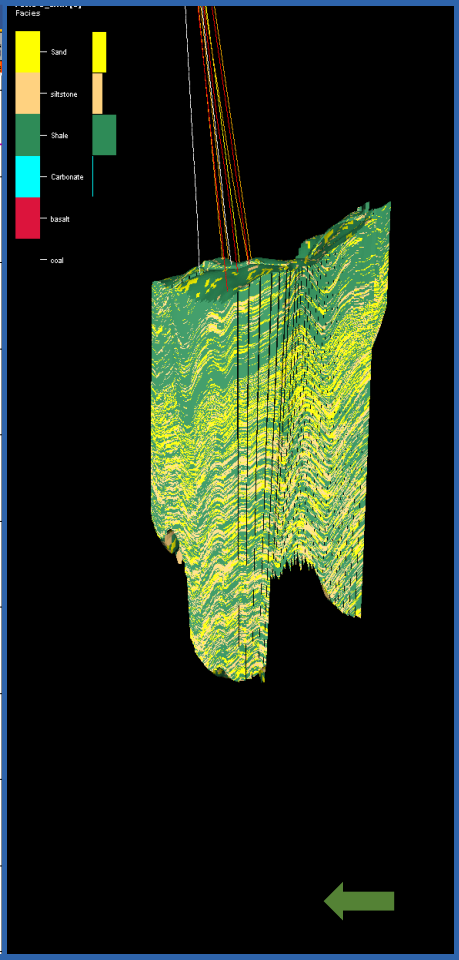


- Three seismic interpreted horizons
- Three proportional stratigraphic horizons
- Network of fourteen faults

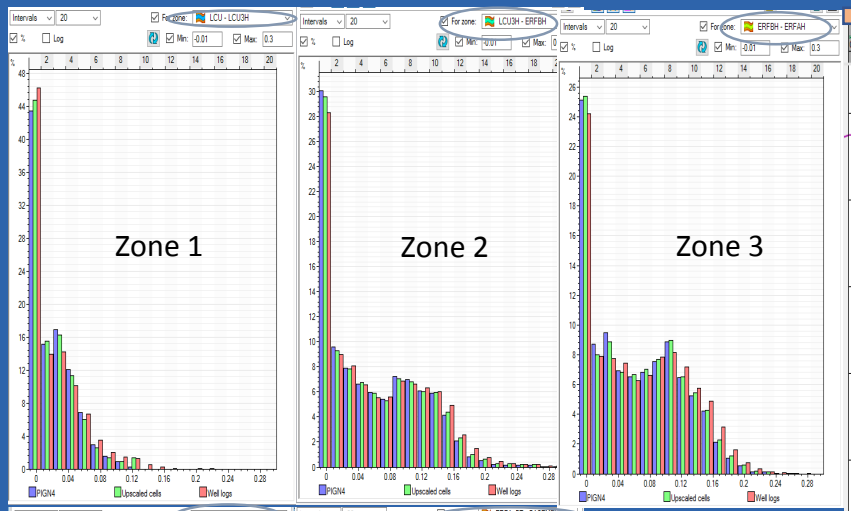
FACIES MODELING : FACIES DISTRIBUTION IN ZONES, WELLS AND MODEL

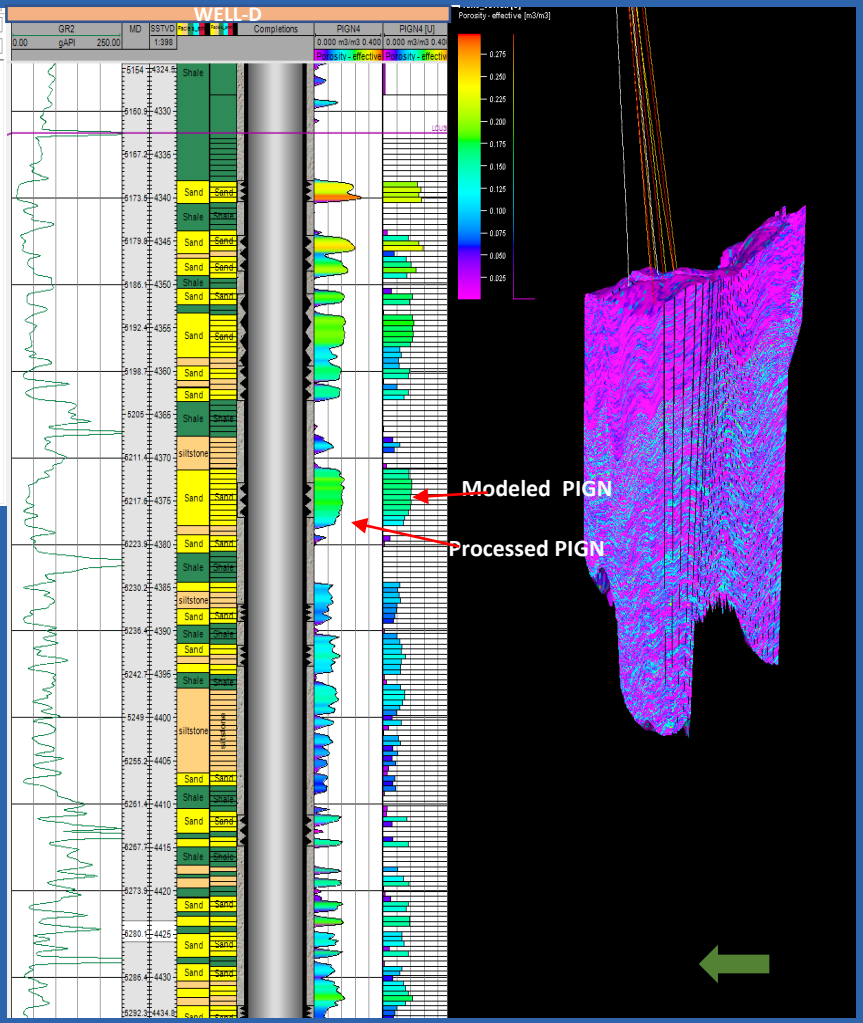




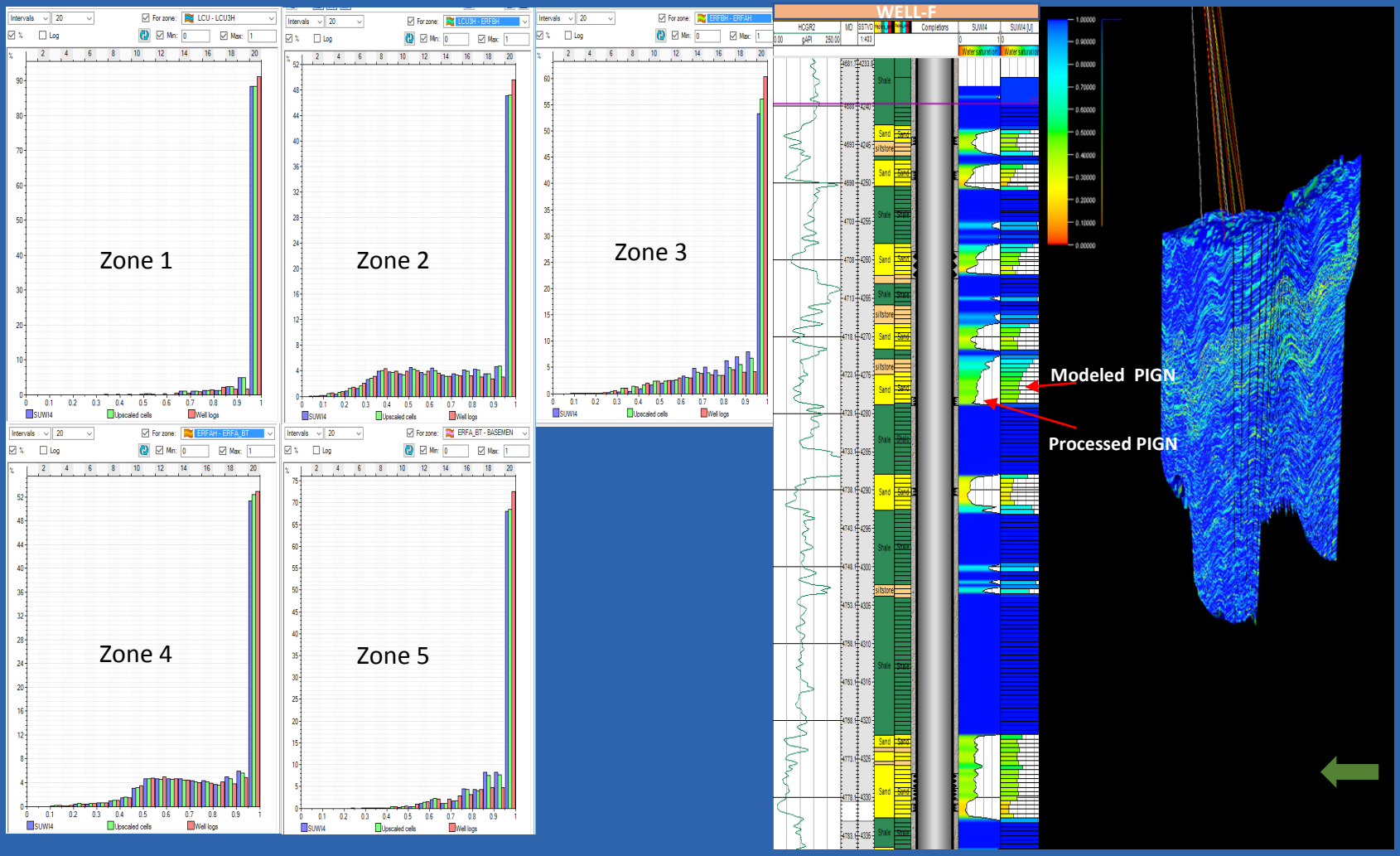


PROPERTY MODELING: POROSITY DISTRIBUTION IN ZONES, WELLS AND MODEL





PROPERTY MODELING: SATURATION DISTRIBUTION IN ZONES, WELLS AND MODEL



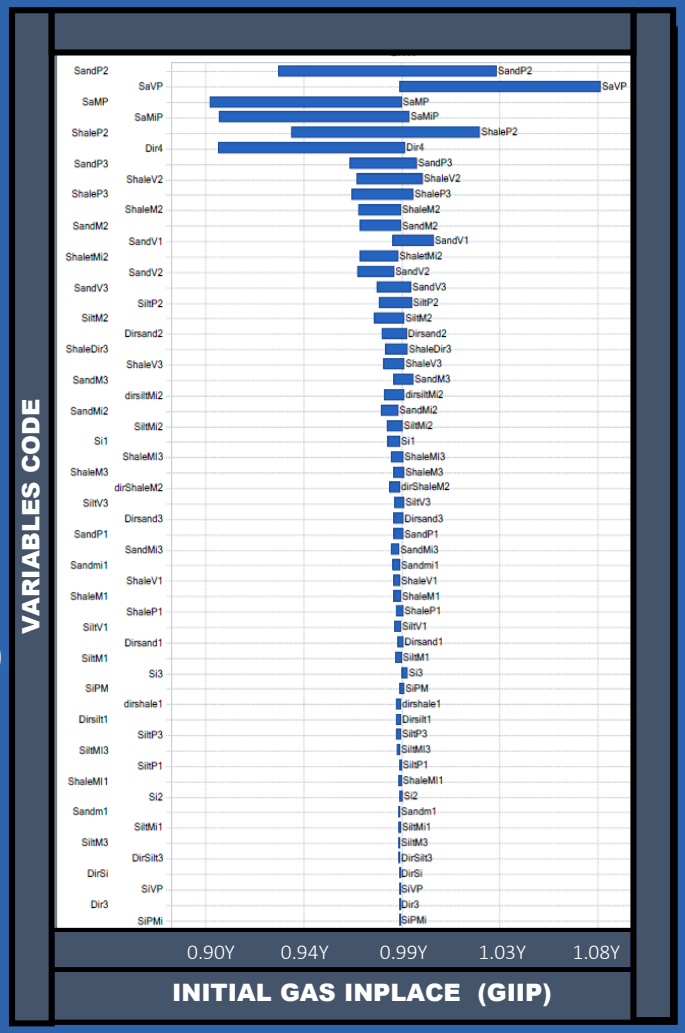
SENSIVITY ANALYSIS

Selected Variables Affecting GIIP :

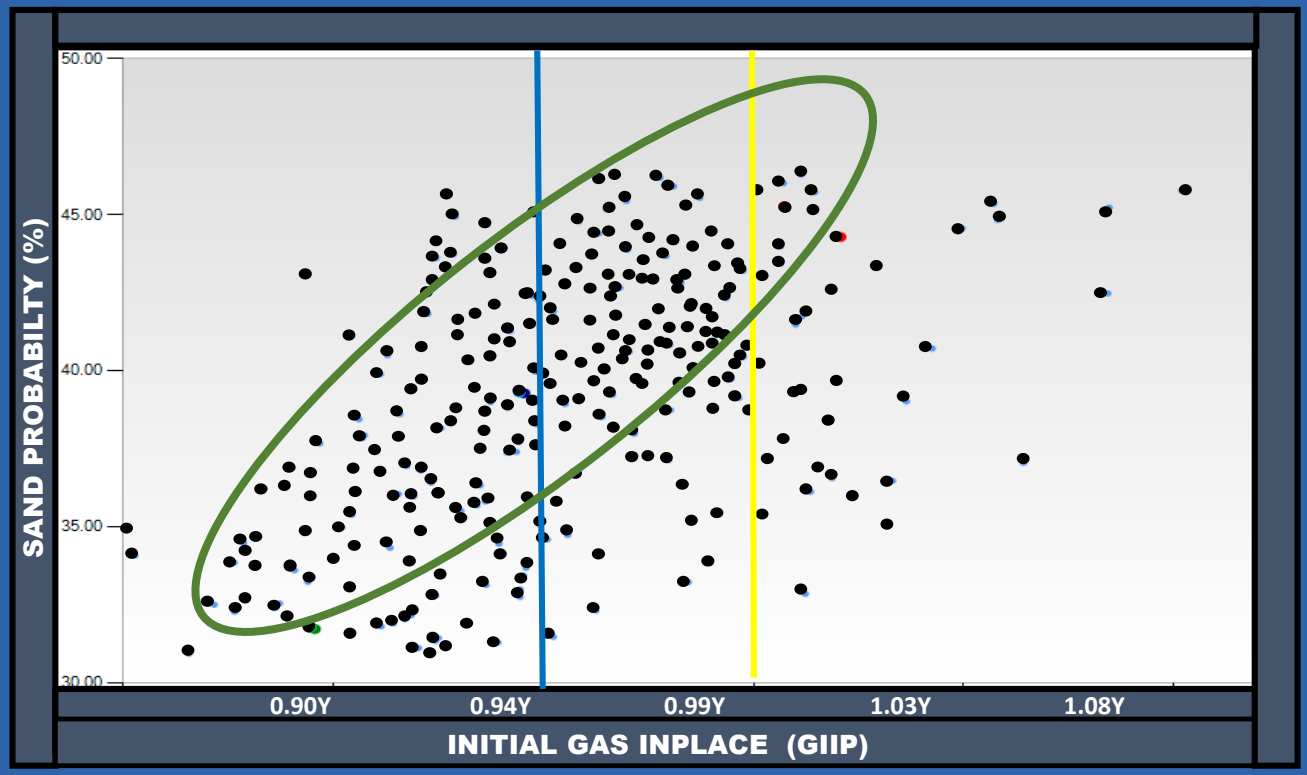
- Facies Proportions
- Average Porosity
- Sand Direction

Selected Reservoir Connectivity Variables

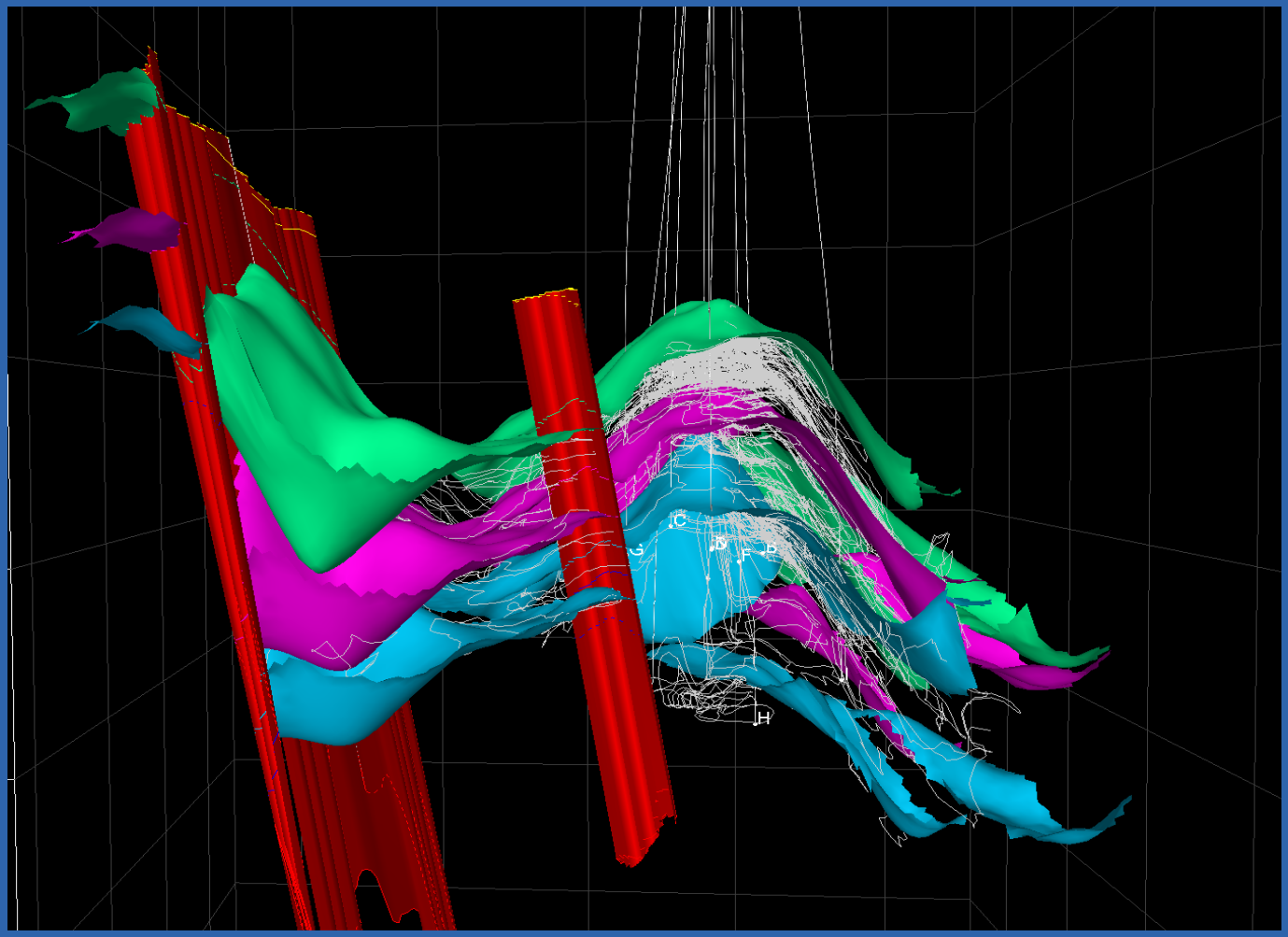
- Variogram Length (Vertical, Major, Minor)



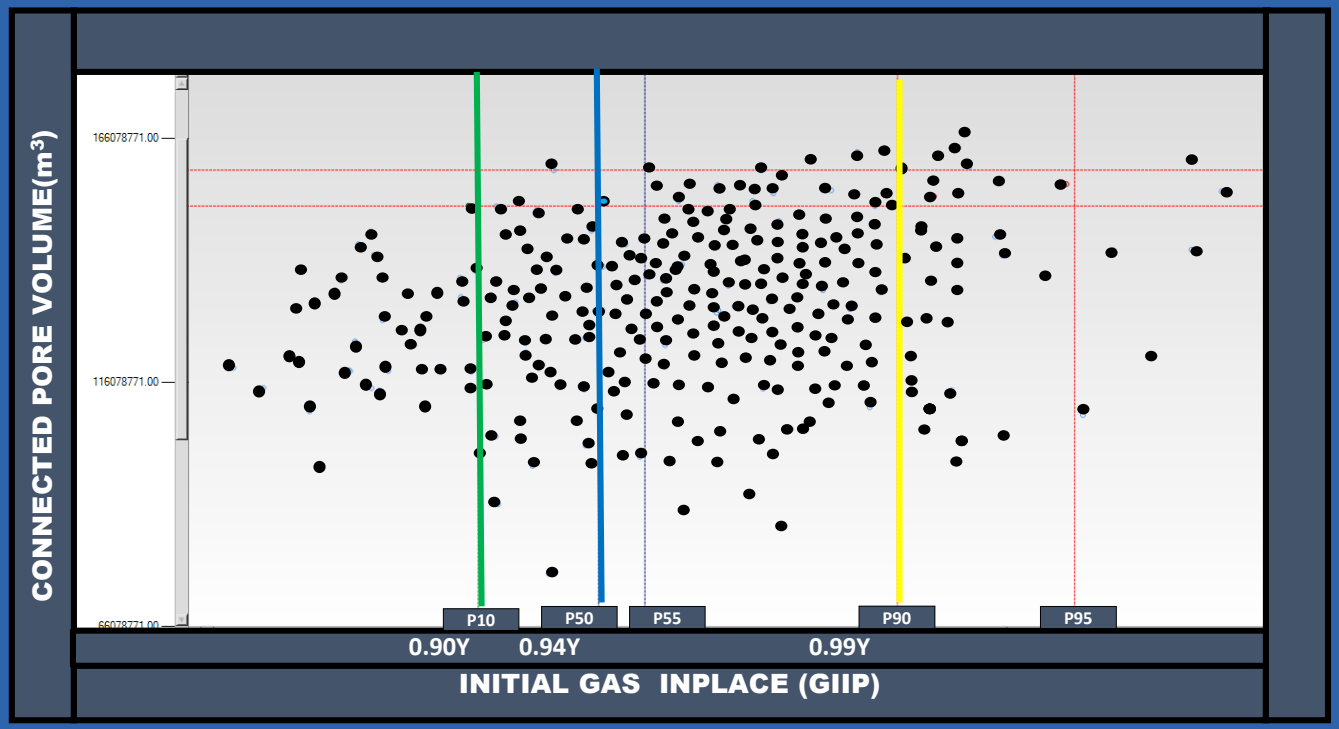
CROSS PLOT OF SAND PROBABILITY VS UNCERTAINTY RANGE IN GIIP



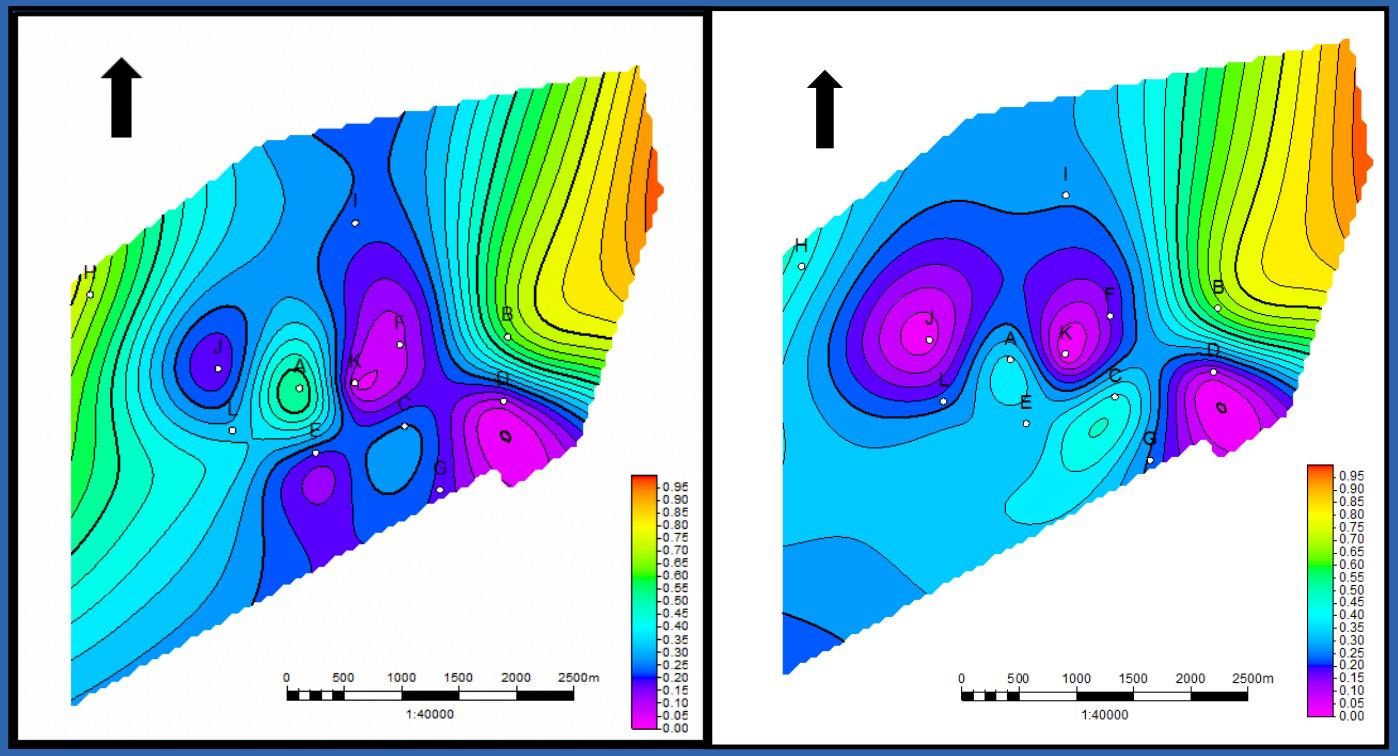
DYNAMIC CONNECTIVITY



GIIP VS CONNECTED PORE VOLUME



UNCERTAINTY MAPS OF CONNECTED PORE VOLUME MEAN VS VARIANCE



CONCULSIONS

- The result of sensitivity analysis on various case model using uncertain parameter described in tornado chart ,where it is confirmed that facies modelling (sand probability range) has largest impact on Initial Gas Inplace.
- The GIIP obtained after the all iteration was: 0.99Y for P90, 0.94Y for P50 and 0.90Y for P10 scenarios. P90 and P50 scenarios did not show much variation of Initial Gas Inplace with respect to deterministic volume of base model is assumed to be Y
- The uncertainty maps of connected pore volume mean and variance are showing that well A is falling in low risk area because the connected pore volume mean is high and variance is low compared to well B, where as well B is having very high risk area because the connected pore volume mean and variance is very high

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