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Evaluate uncertainty form Basin to Prospect scale to improve exploration success

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Summary

Evaluating the key parameters of the petroleum system elements (Trap, Reservoir, Charge, and Seal) is always challenging. Explorations being a high risk business need an integrated analysis of all the elements. Petroleum system modeling and understanding of Play to prospect with uncertainty analysis will help in reducing the exploration risk.

Keywords: *Exploration, Petroleum system, Play to Prospect risk, Petrel*

Introduction

Selecting an exploration target is very critical and always started with the understanding of basinal information. Petroleum system elements play a major role for any exploration success. They behave differently from one part of the basin to another depending on various parameters involved during basin evolution.

Screening an initial target and understanding the potential prospect failures in the basin will lead to a cost effective exploration campaign. To represent the holistic workflow various information available on the Cambay basin was used.

Method

Stepwise workflow procedure for integrated petroleum system analysis in Petrel was described in Fig. 1

1. Collect Information: Various available information such as Basin cross-sections, well information, available maps, basin evolution details, geochemical information etc. was collected for the analysis. Present day available structural information and interpretations also added for the basin understanding.

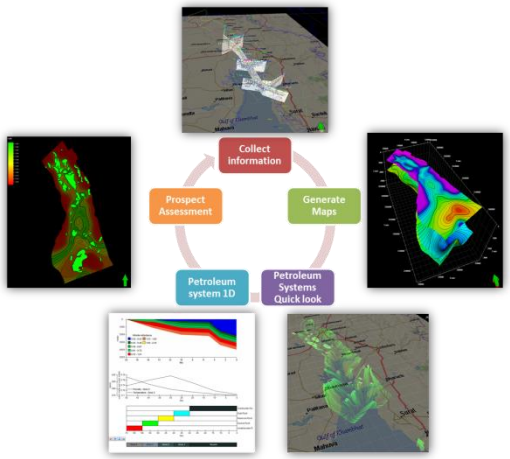

Fig. 1: Integrated petroleum system analysis

2. Generate Maps: Available scanned maps were loaded and georeferenced. Then they were digitized to generate appropriate map for the basin. Various basin scale maps like Top of the reservoir, Top of source rock, seal, vitrinite reflectance etc. were generated to be used during future evaluation.

Structural framework of the cambay basin was generated using the major stratigraphic units. Three units/blocks were captured for the study namely Mehsana Ahmedabad block, Cambay Tarapur Block and Jambusar-Broach block as shown in Fig. 2

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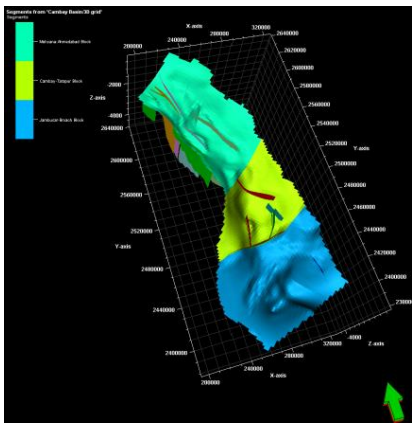


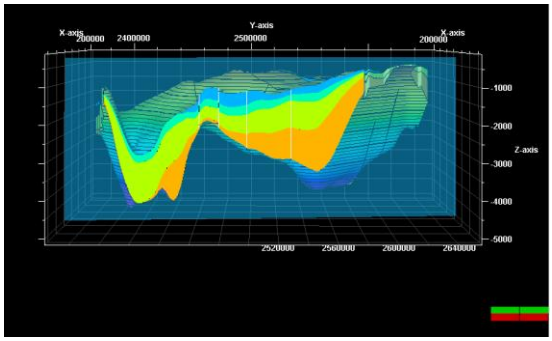


Fig. 2: Cambay basin representing three tectonic units

Major facies boundaries were identified and lithology was interpreted for the available wells. (Fig. 3)

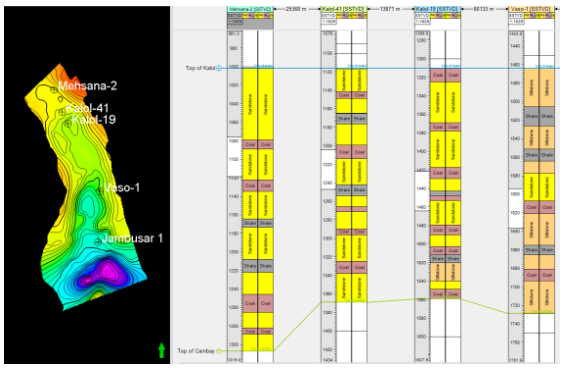


Fig. 3: Facies boundaries identification

Facies model was interpreted with available well lithology information to capture the variation of lithology in the entire basin. (Fig. 4)

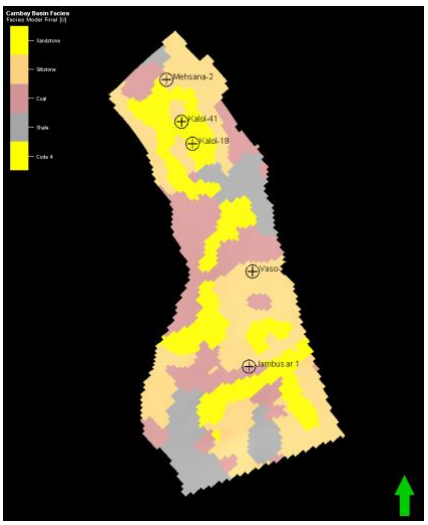


Fig. 4: Facies model for entire Basin

Various other critical maps like vitrinitie reflectance, porosity distribution of reservoir and pressure variation of the seal rock were prepared as shown in Fig. 5

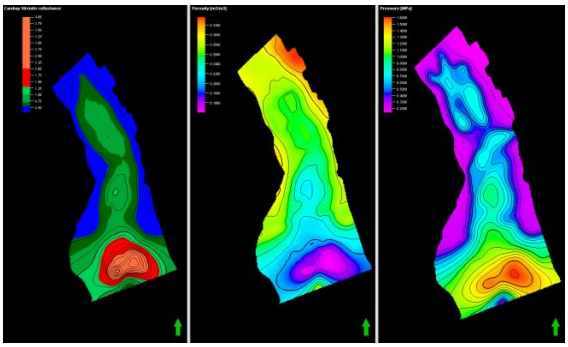


Fig. 5: Vitrinite reflectance, porosity distribution and pressure maps

3. Petroleum System quick look: An initial rapid screening of the hydrocarbon source and reservoir with simulation of maturation, migration and accumulation was performed to understand the elements of the petroleum systems. Quickly simulated results can be compared with geological scenarios through maps of source rock maturation, hydrocarbon generation, location of accumulations, and hydrocarbon migration pathways. (Fig. 6)

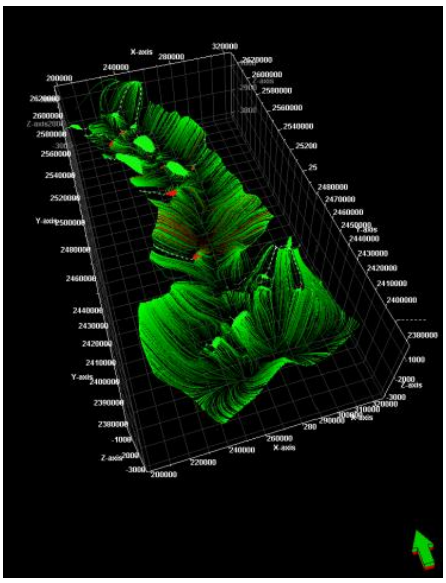


Fig. 6: Hydrocarbon accumulations in Cambay basin

4. Petroleum system 1D: Dynamic forward modeling of geological processes in the sedimentary basin over geological time spans was analyzed using detailed stratigraphic tables, lithology, and source rock kinetics with petroleum systems 1D simulation. The results support greater understanding of source rock and hydrocarbon flow-path migration process. Each accumulations generated during Quick look method can be calibrated with the 1D simulation of nearby well information (Fig. 7). Source rock presence, Maturity of the source rock can confirm the accumulations and can make them a suitable area for exploration.

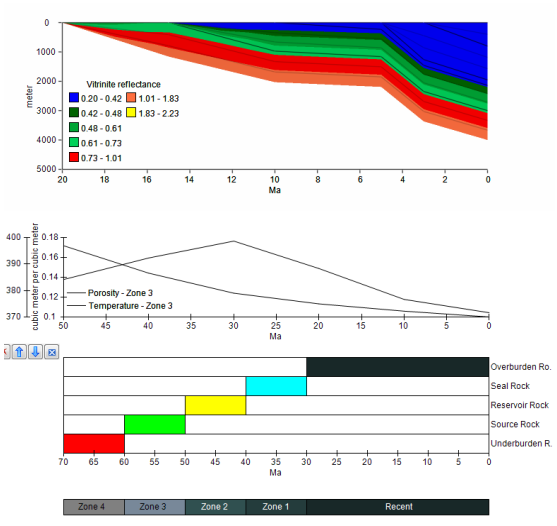


Fig. 7: Simulation results for Kalol 19 well

5. Prospect assessment: Physical property maps of play elements are transformed to chance-of-success maps, and combined to provide an overall chance of success. Play chance and prospect volume results are linked to data and interpretations—throughout play assessment and prospect generation.

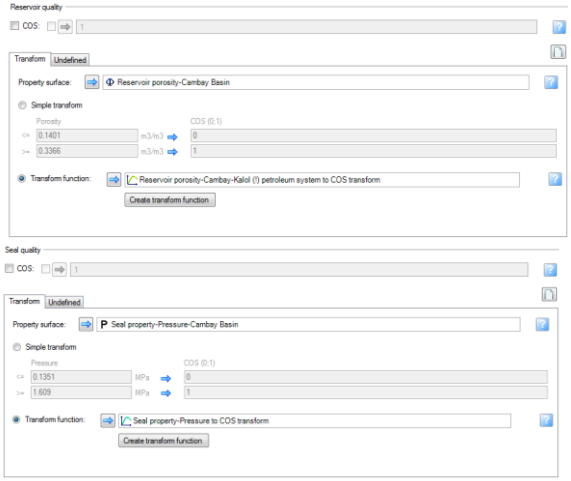


Fig. 8: Chance of success set up for Reservoir and Seal map

Combined COS (Chance of success) map can be used to finalize the prospect locations. Green color denotes the high chance of success as compared to red areas. COS map overlay with already discovered data provides a good match, which further can be improved by incorporating more data. (Fig. 8, 9 and 10)

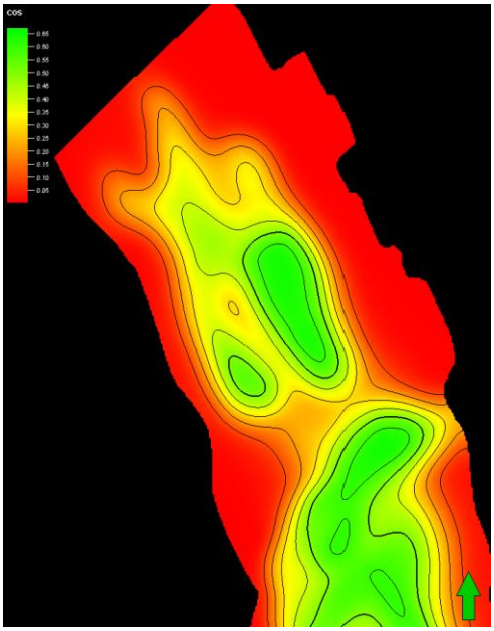


Fig. 9: Chance of success Map for North Cambay field

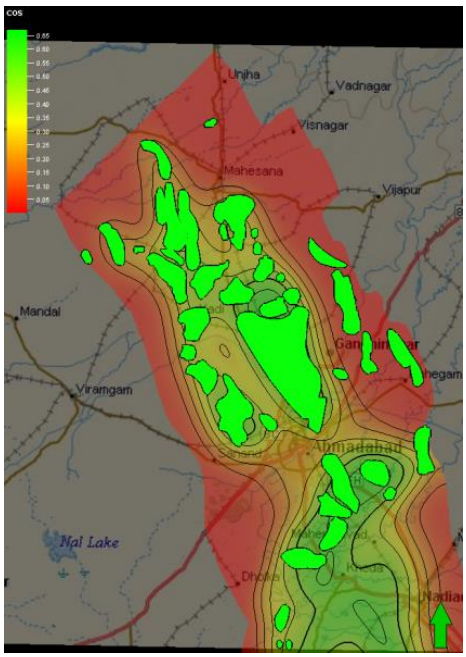
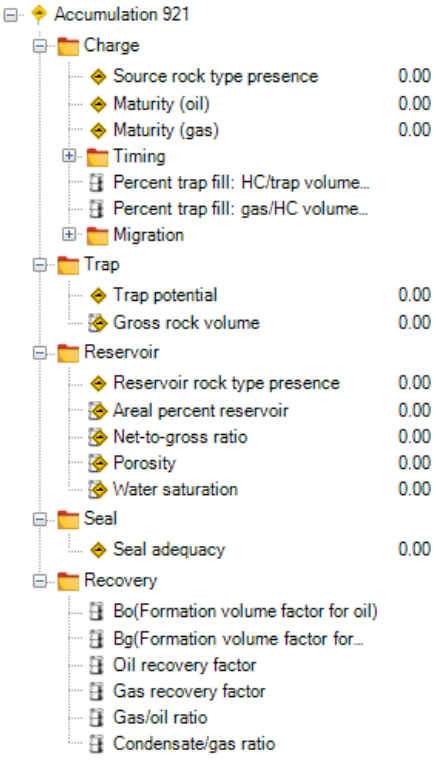


Fig. 10: Chance of success Map overlay with proved hydrocarbon prospects of Cambay Basin

Further uncertainity analysis can be done with each accumulations. Various parameters as shown below can be analysed with an range of values to generate the P10, P50 & P90 values of the hrdrocarbon.



Integrated analysis from basin to prospect level like this will definitely provide us more insight and understanding of the basin and results in ranking of the prospect and help us in more successful drilling campaign.

Conclusions

1. An improved understanding of the combined risk elements of trap, reservoir, charge and seal will help in locationg the hydrocarbon in the basin.
2. Play chance maps and risked volumes can be of help to choose prospects for the exploration drilling program.
3. Prospect assessment using Monte Carlo simulation for in-place and recoverable hydrocarbon volumes factors with geological and economic success chance can provide the range of values to decide for.
4. Decision makers can dive deeper into prospect evaluations to understand factors that cause prospects to fail and which parameters give rise to uncertainty in potential reward volumes

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