The Development Scheme in the Oilfield with Subtle Stratigraphic Trap, a Key to Extend Mature Field Life-span in Sangasanga Field, East Kalimantan, Indonesia*

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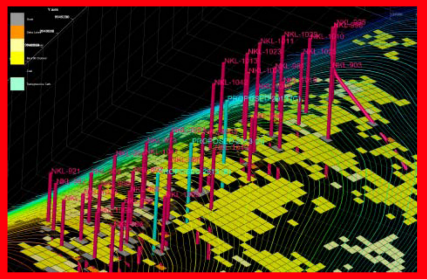
Abstract

The fluvio-deltaic sand of the Balikpapan Group in the Sangasanga Field is one of the most prolific hydrocarbons bearing reservoirs in the East Kalimantan with a cumulative production of 359.25 MMSTB. Most of the past oil production is derived from the structural traps along the Sangasanga anticline axial. However, the likelihood to discover new pools in this area is immense over previously unprognoses stratigraphic traps in the structurally "non-attractive" area. This study was part of a reservoir management effort aimed to extent the mature field life-span. The pilot project consists of two major stages, (1) to execute "semi-exploratory" grid-based drilling program to appraise the subtle stratigraphic traps in the previously untapped area, followed by (2) integrated reservoir characterization scheme dedicated to every individual layer discovered in stage 1. The major task of the study is paleomorphological reconstruction for each identified depositional elements, multi-attribute and neural network analysis of 3D seismic data, and 3D static and dynamic model building, constrained by various reservoir diagnostic data such as SCAL, PVT, IPR and phase envelope studies. This program has proven successful with the discovery of several new significant oil and gas producing sand pools. The paleomorphological based geological modelling offers a high improvement to both thin layer identification and lateral sand net to gross prediction to the outer extent. This integrated study could be used to assist the interpretation of the geometry and dispersal pattern of the reservoir sand (e.g. distributary channel-fill, tidal channel-fill, crevasse splay, mouth-bar or other depositional elements) for the infill and out-step drilling planning purpose.

Selected Reference

Sprague, A.R., P.E. Patterson, R.E. Hill, C.R. Jones, K.M. Campion, J.C. Van Wagoner, M.D. Sullivan, D.K. Larue, H.R. Feldman, T.M. Demko, R.W. Wellner, and J.K. Geslin, 2002, The Physical stratigraphy of Fluvial strata: A Hierarchical Approach to the Analysis of Genetically Related Stratigraphic Elements for Improved Reservoir Prediction: Abstract AAPG Annual Meeting, March 10-13, 2002, Houston, Texas, Official Program, p. A167.





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E. Septama, C. Mustofa Eka Putra, D. Vitri, T. Widiyanto (Pertamina EP Asset-5)

AAPG International conference
Istanbul, Turkey 14-17 September 2014

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PERTAMINA EP

Presenter's notes: Indonesia has a long history of producing oil and gas. In the 1800's the Dutch colonials started to produce oil from some fields in Sumatra, Java, and Kalimantan. Pertamina, as the state owned oil company, has extensive experience to deal with these mature field.
(Presenter's notes continued on next slide)

(Presenter's notes continued from previous slide)

The Sangasanga Field is located in the eastern part of Kalimantan. It lays along the anticlinorium axes with an area of 98 km² almost 30 km in length and 3 km in width. It is adjacent to the modern Mahakam Delta, and is believed to preserve the same sedimentation processes since at least early Miocene. The two yellow areas are the major focus where most of the data comes from to support this presentation.

Historically the field has had several operators since colonial time. Once it was the major source for fuelling during WWII in 1942-1945 during the Japan occupation. Our predecessors have drilled a shallow well in the anticlinal crest and the furthest wells drilled were within 400 meter of the anticlinal crest.

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Subsurface related

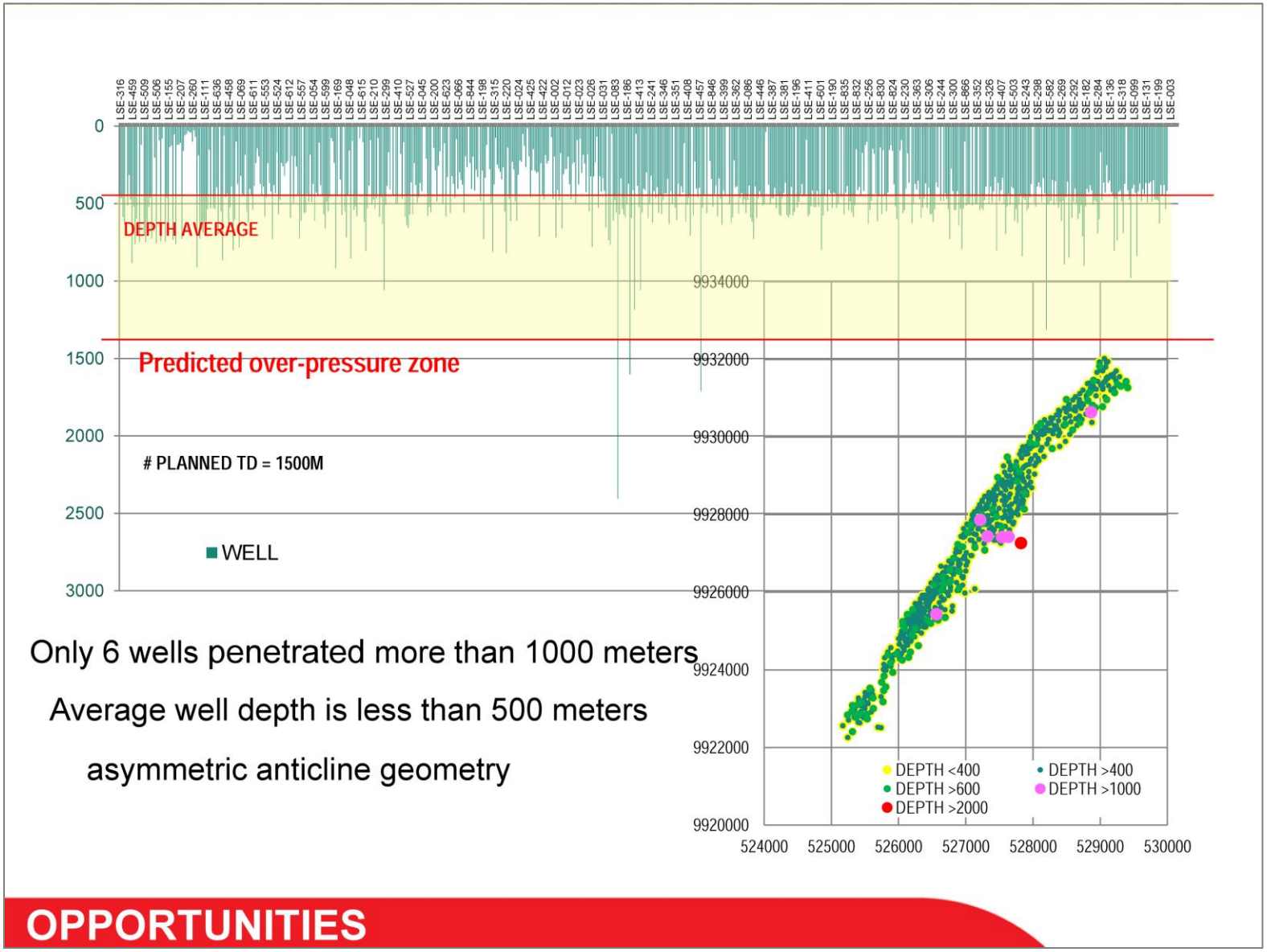
- Predominant Low frequency seismic data
- "*Shoe-lace*" reservoir resolution ➡ below seismic resolution
- Reservoir complexity (size, stacking pattern, orientation)

Old Field related

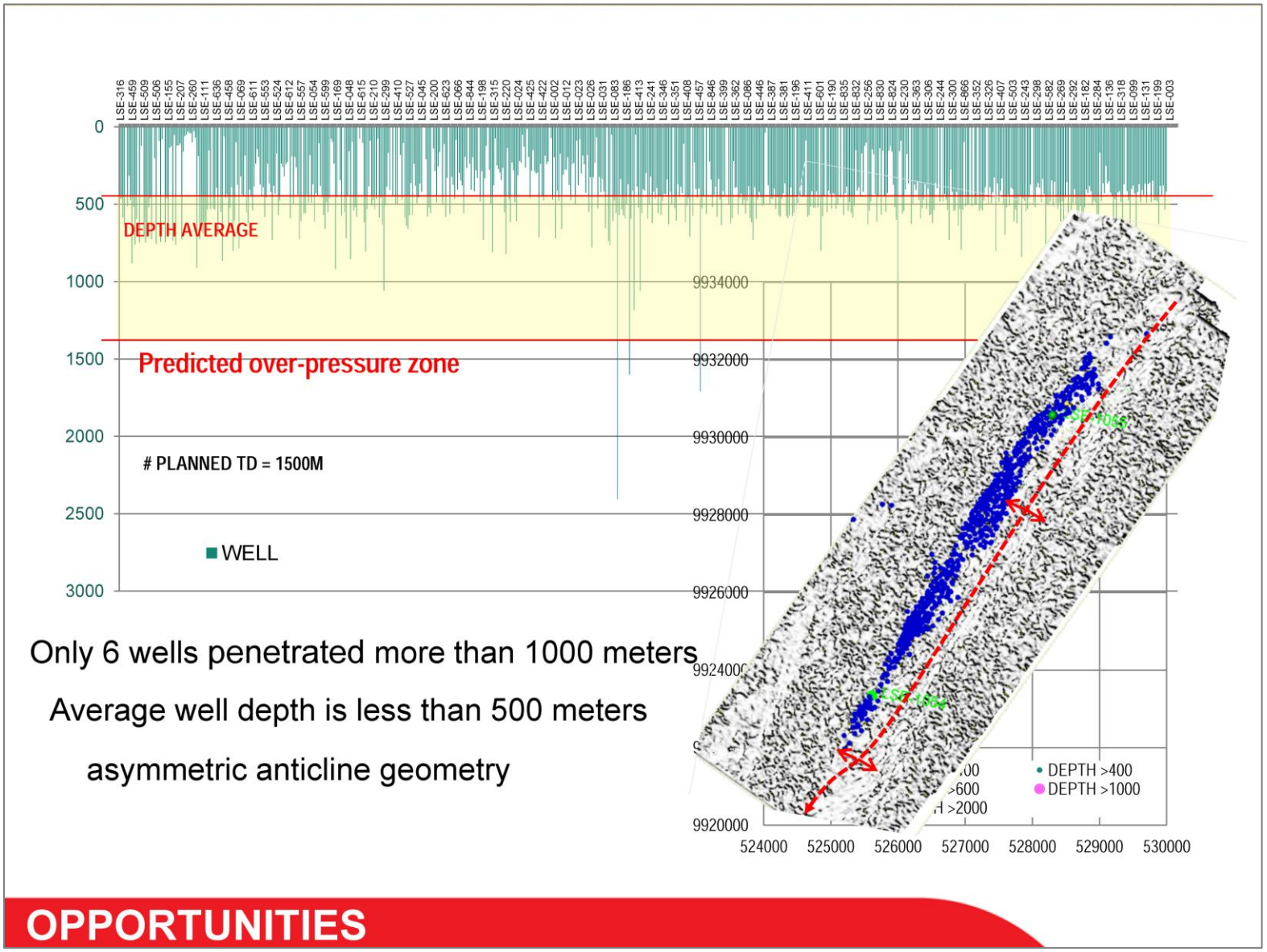
- Scarcity of well data (cores, well logs, pressure, production)
- Mechanical problems (need replacement)

CHALLENGES

Presenter's notes: The major challenges that we face in Sangasanga are as follow:
Predominance of low frequency seismic date so the stratigraphic interpretations ae not possible.
Most of reservoir is below the seismic resolution.
The complexity of the reservoir distribution pattern.
Scarcity of well data.



Presenter's notes: Despite those inhibiting factors, opportunity still arise as we wish to develop the field. It is noted that some of the structures are prematurely drilled into only less than 500-600 meters. We have the opportunity to drill deeper. Also the anticline is asymmetric, it is laterally shifted 300 meters to the east which mean more area to explore.



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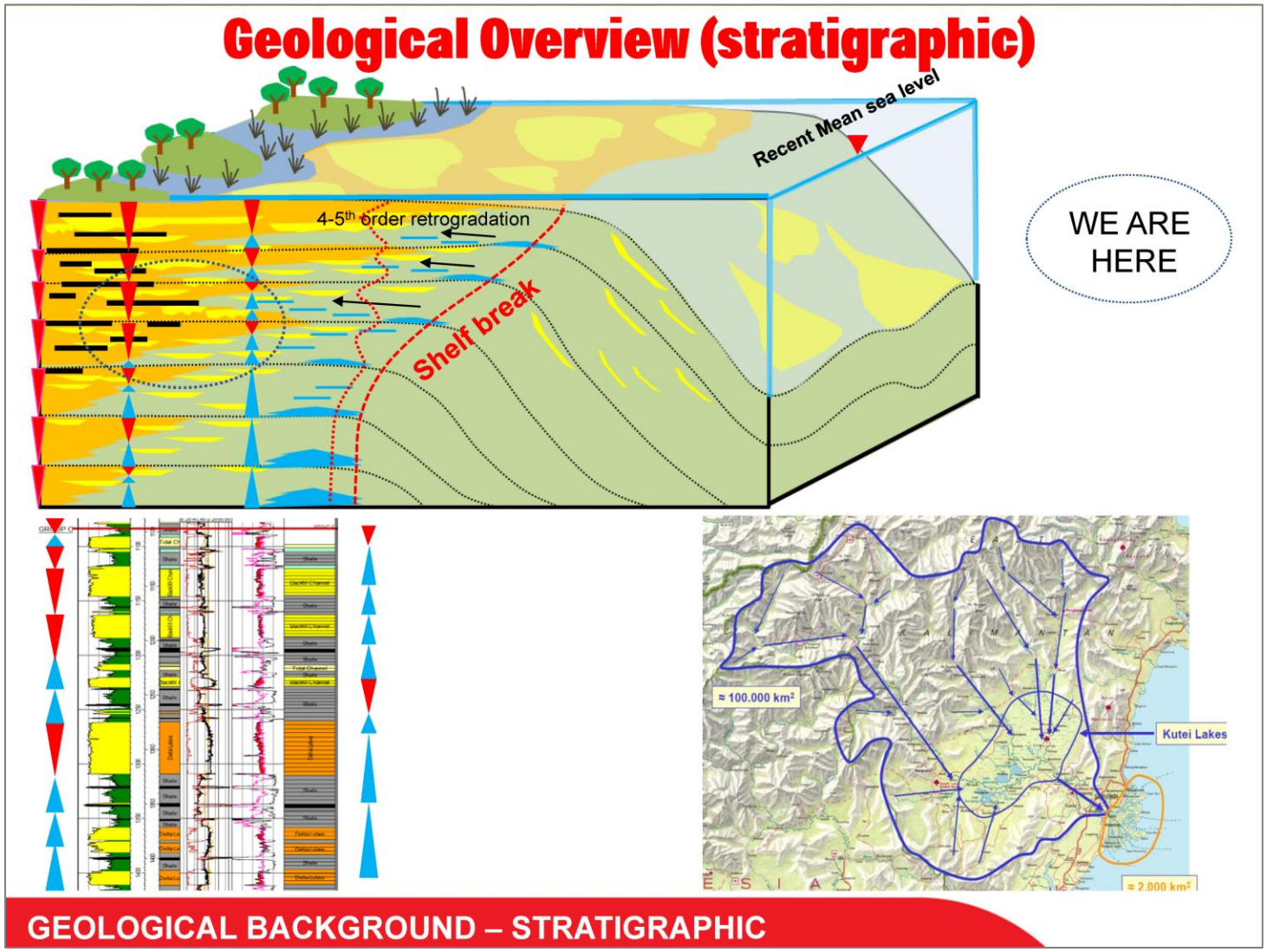
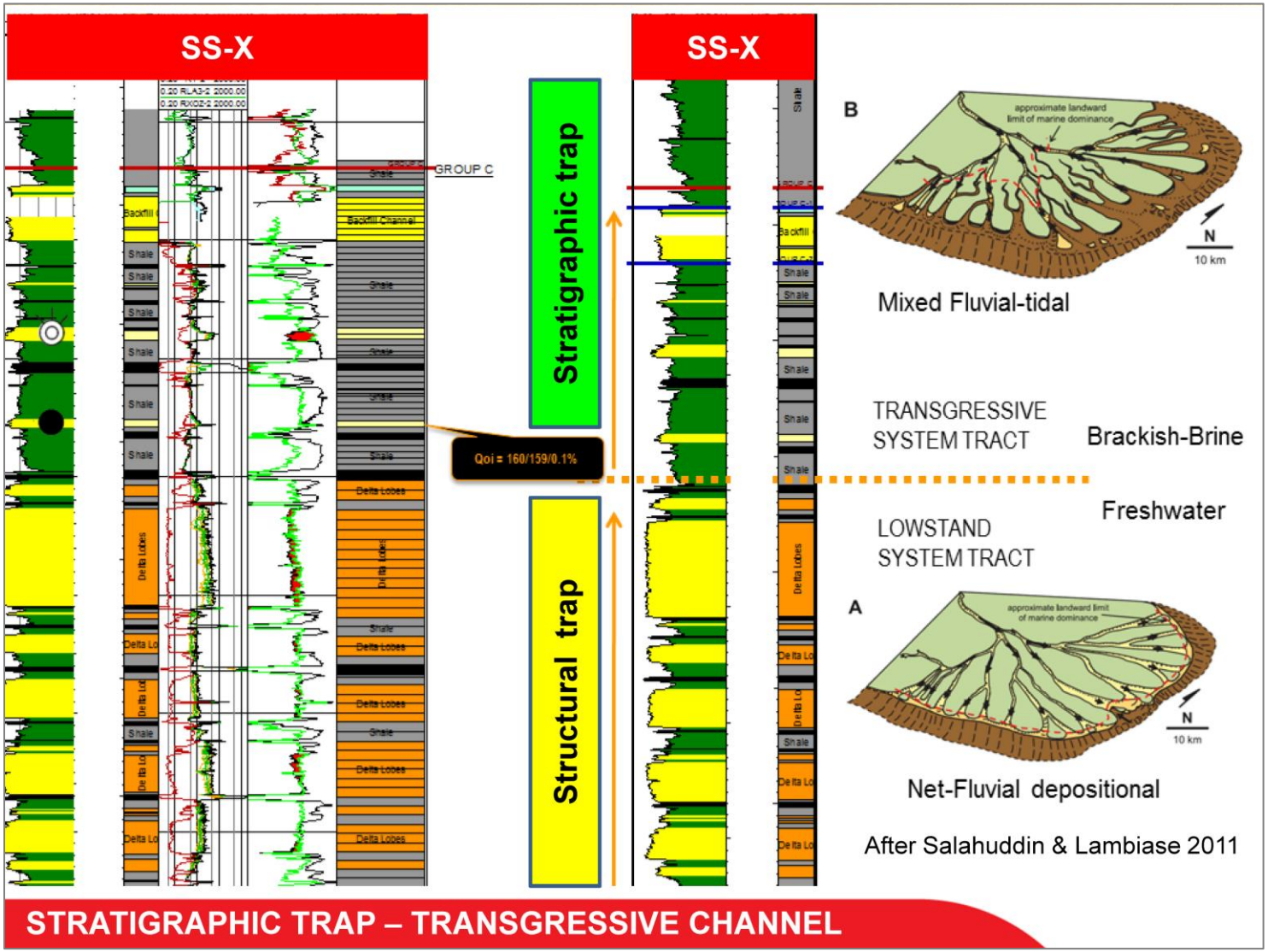
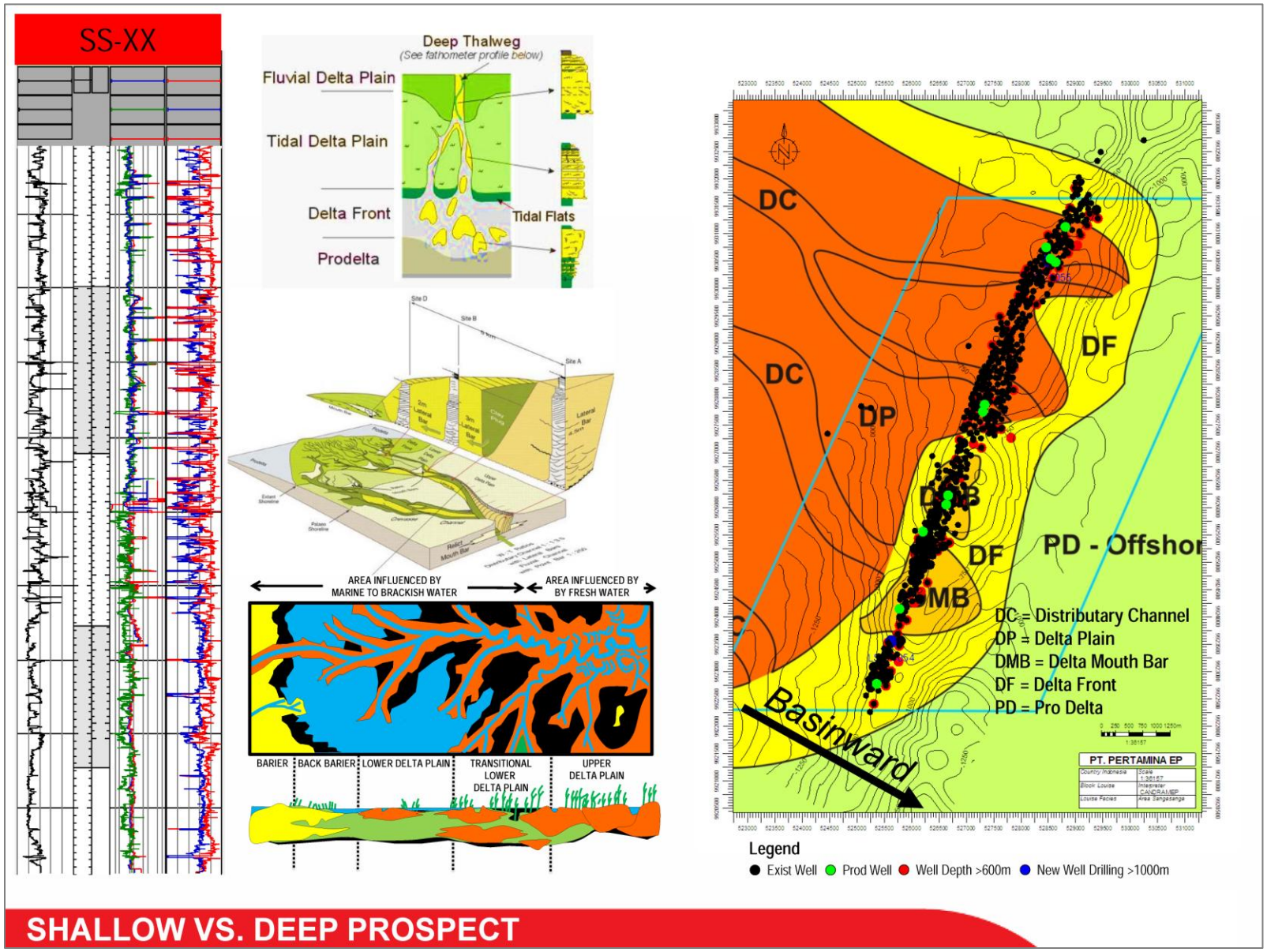


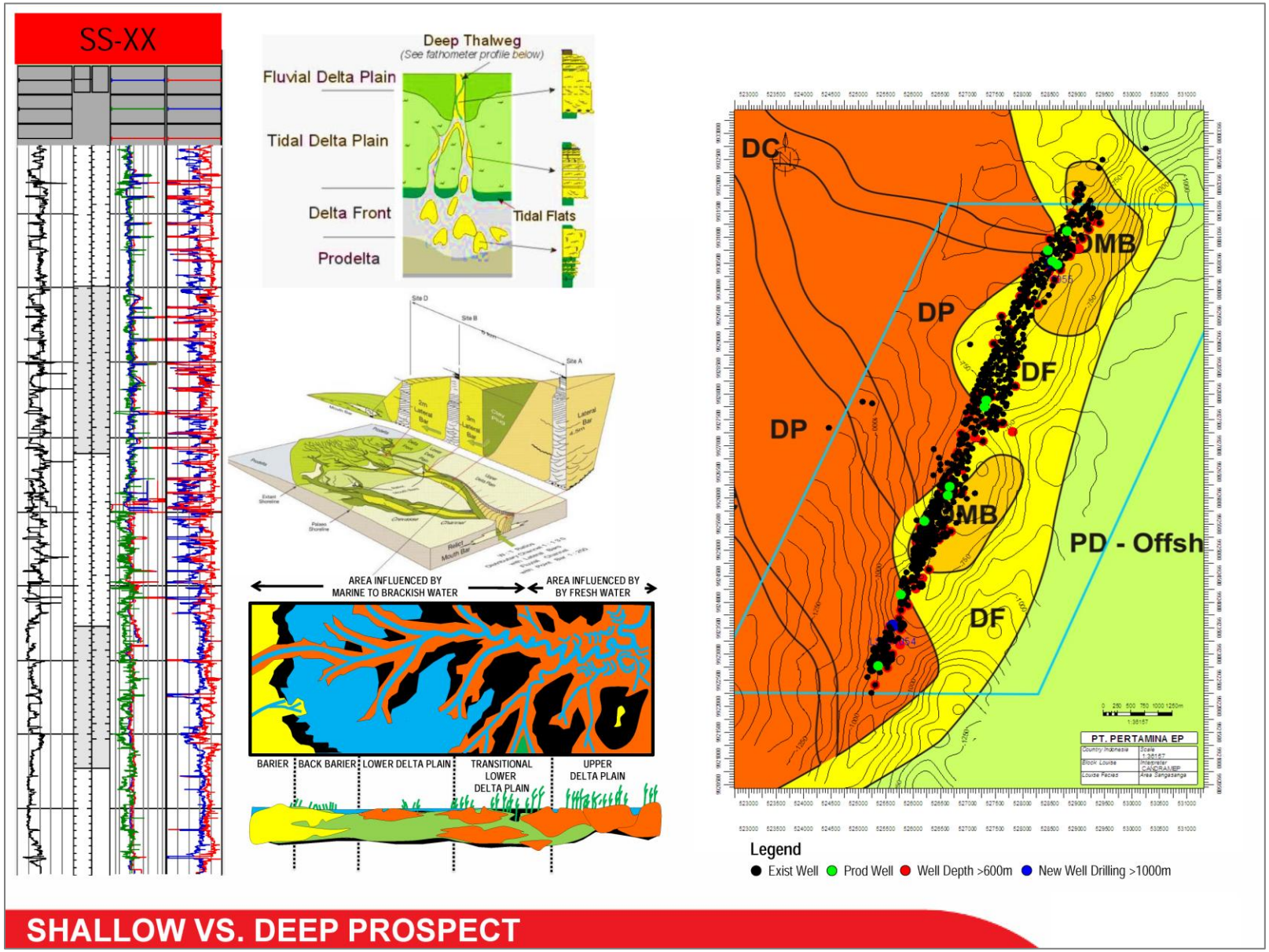
Presenter's notes: This map shows the major sedimentation direction in the Mahakam Delta is Northwest-Southeast. The long dash line shows the large progradational event of the delta as believed by many previous researcher. However, our new data from the wells log, outcrop studies, and biostratigraphy shows there is a small transgressive event in the scale of 4-5th order in the top of each progradational event. As this event brought mud, it will enhance the seal capacity and of course will give a good chance to develop a stratigraphic trap.



Presenter's notes: If we zoom in to the area we could see there is a cycle that shows the gradual changes between fluvial to tidal processes. The illustration is taken from Salahuddin and Lambiase, 2011 shows that the fluvial system is diminished upward and changes into the mix processes. We found that both reservoirs are potential but the bottom part will develop a structural trap whereas the upper part will develop a stratigraphic trap.



Presenter's notes: This paleogeography map is built from integrated biostratigraphy data. From this map we could predict the variation between the shallow zone and the deep zone where the coast line has moved east.



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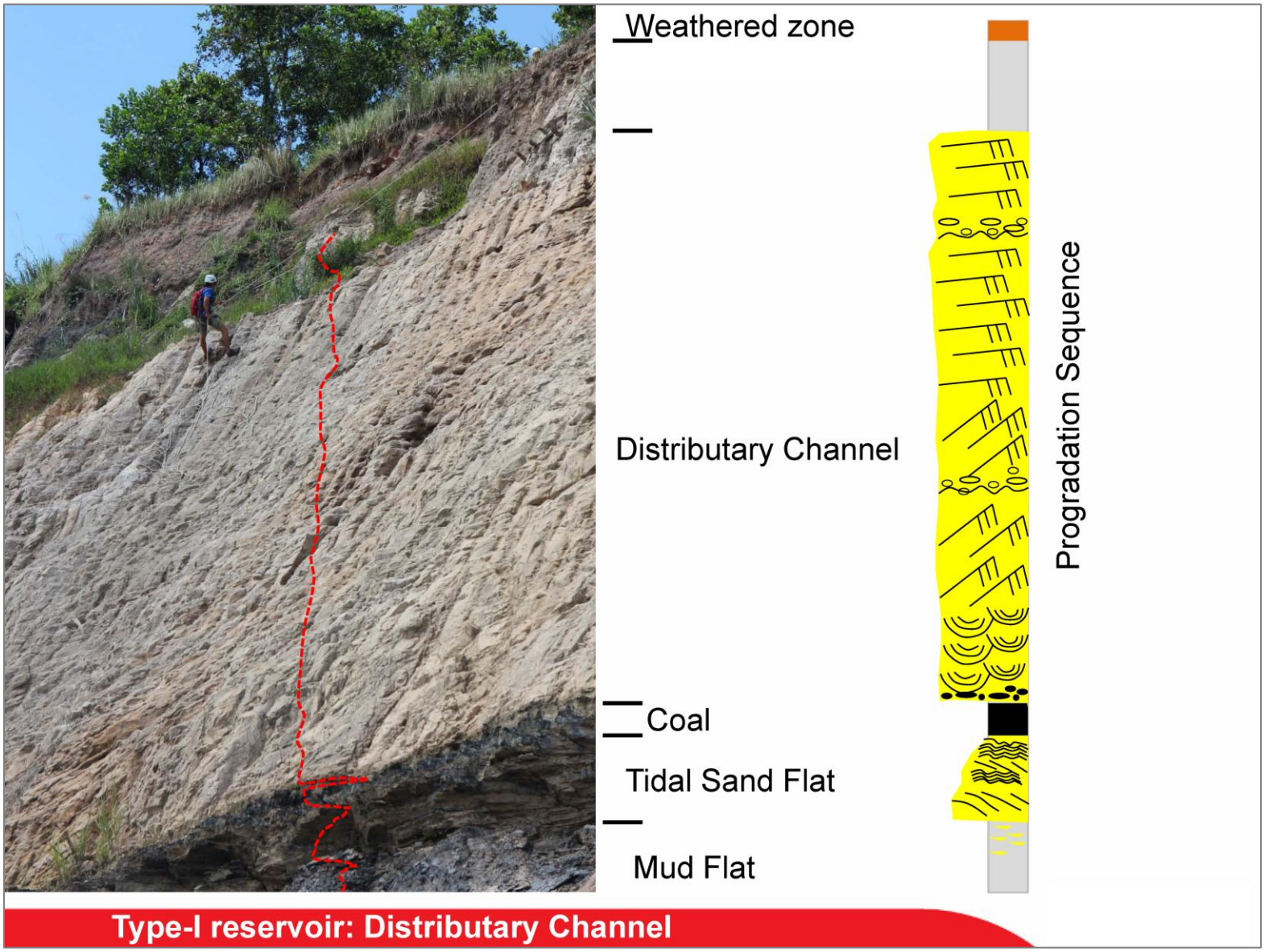
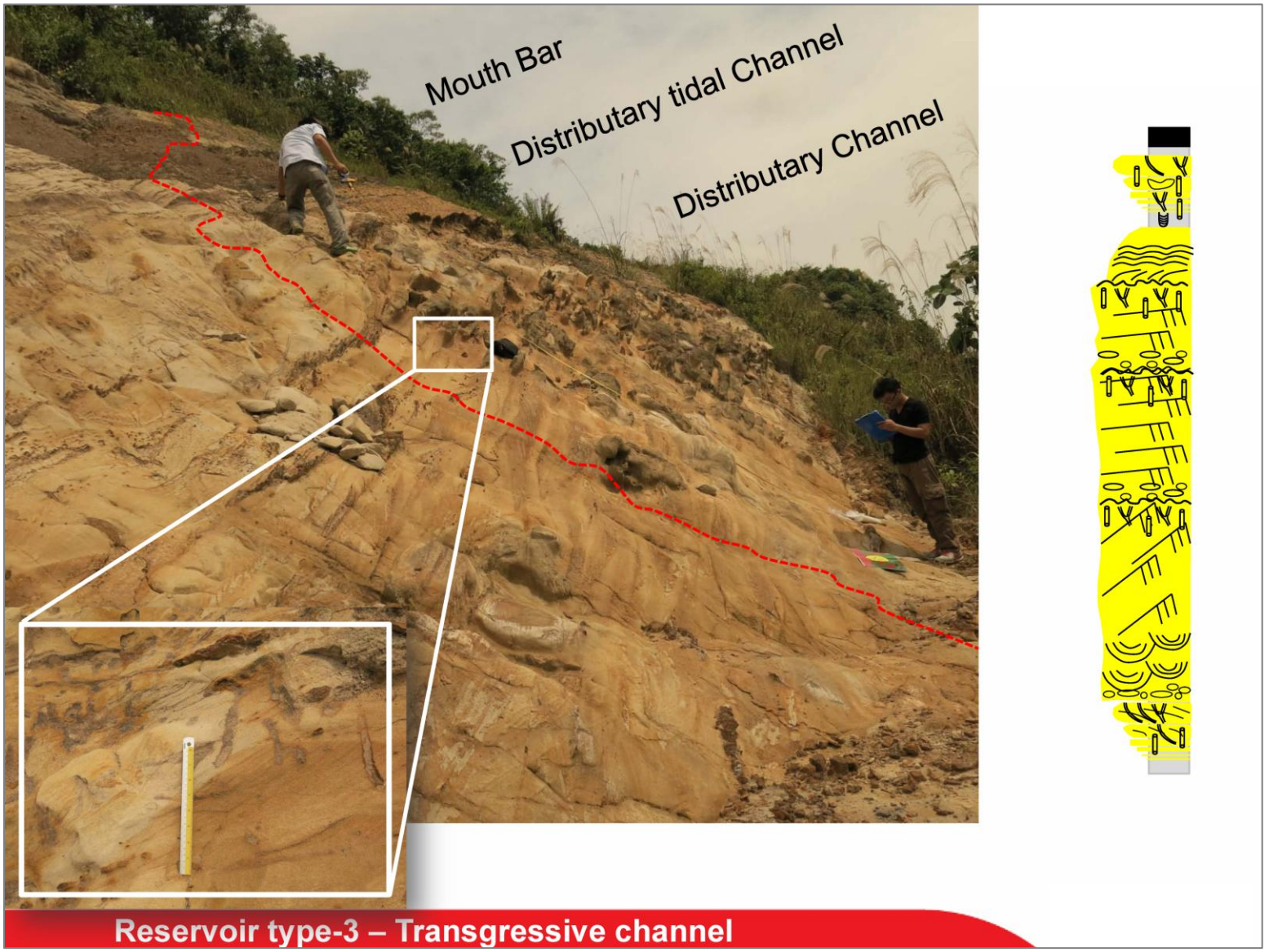


Presenter's notes: To enhance our knowledge about the channel geometry, we did an outcrop survey and measurement. Some are high angle and this example shows the classic progradational depositional system in the delta, purely fluvial processes result in the thick distributary channel fill deposit.

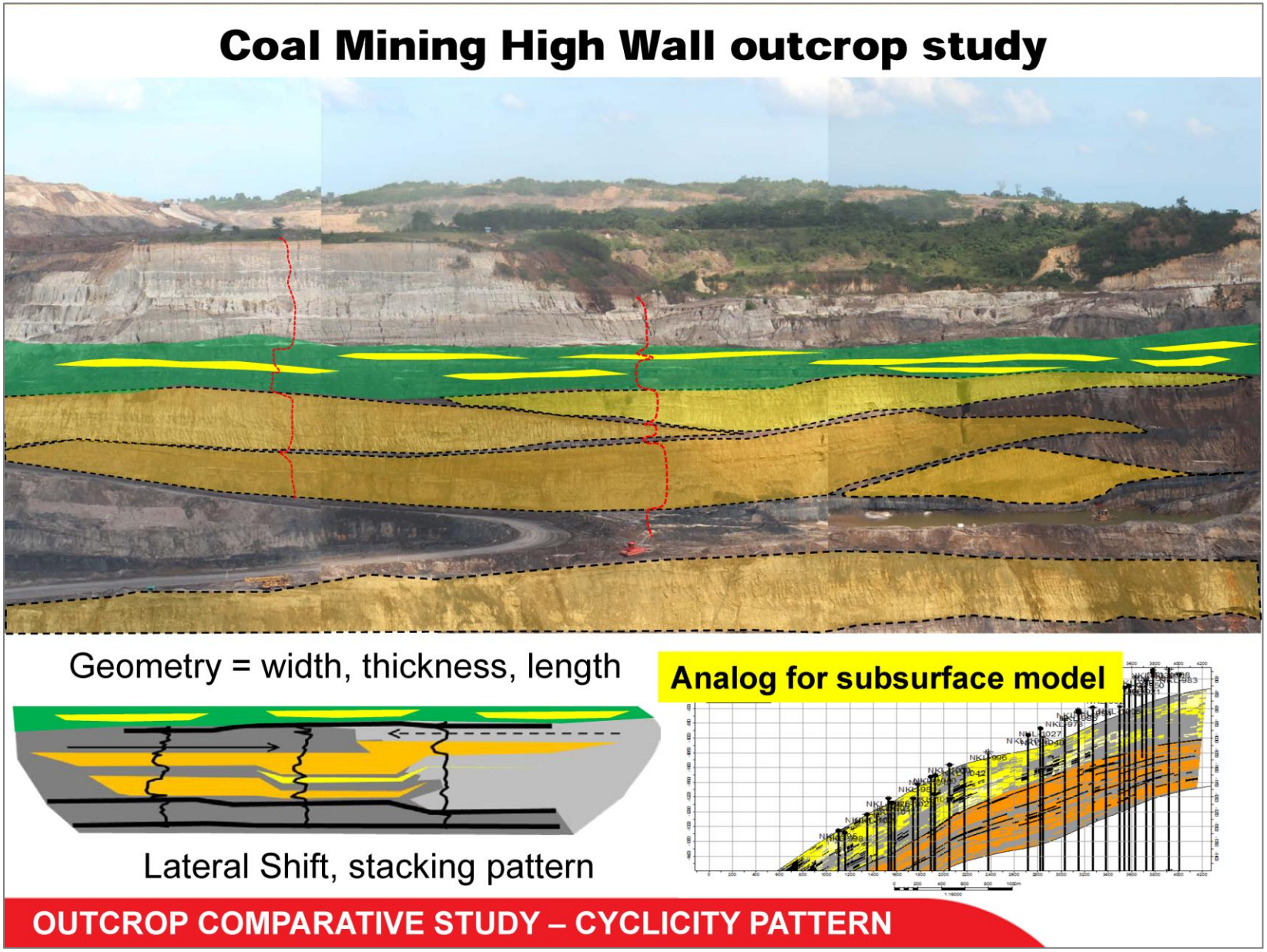


Presenter's notes: In contrast with this outcrop, it shows a typical terrigenous sediment, dominated by river processes. But it tends to be more tide dominated and burrowed by marine organism. On a few cycles upward, it shows a good example of the drowned river system which will become our new reservoir target.

Coal Mining High Wall outcrop study

OUTCROP COMPARATIVE STUDY – CYCLICITY PATTERN

Presenter's notes: In a greater extent we also use outcrop data to extract some of the morphometric parameters such as channel width, thickness, length, stacking pattern and use it as an analog for the subsurface geological model.



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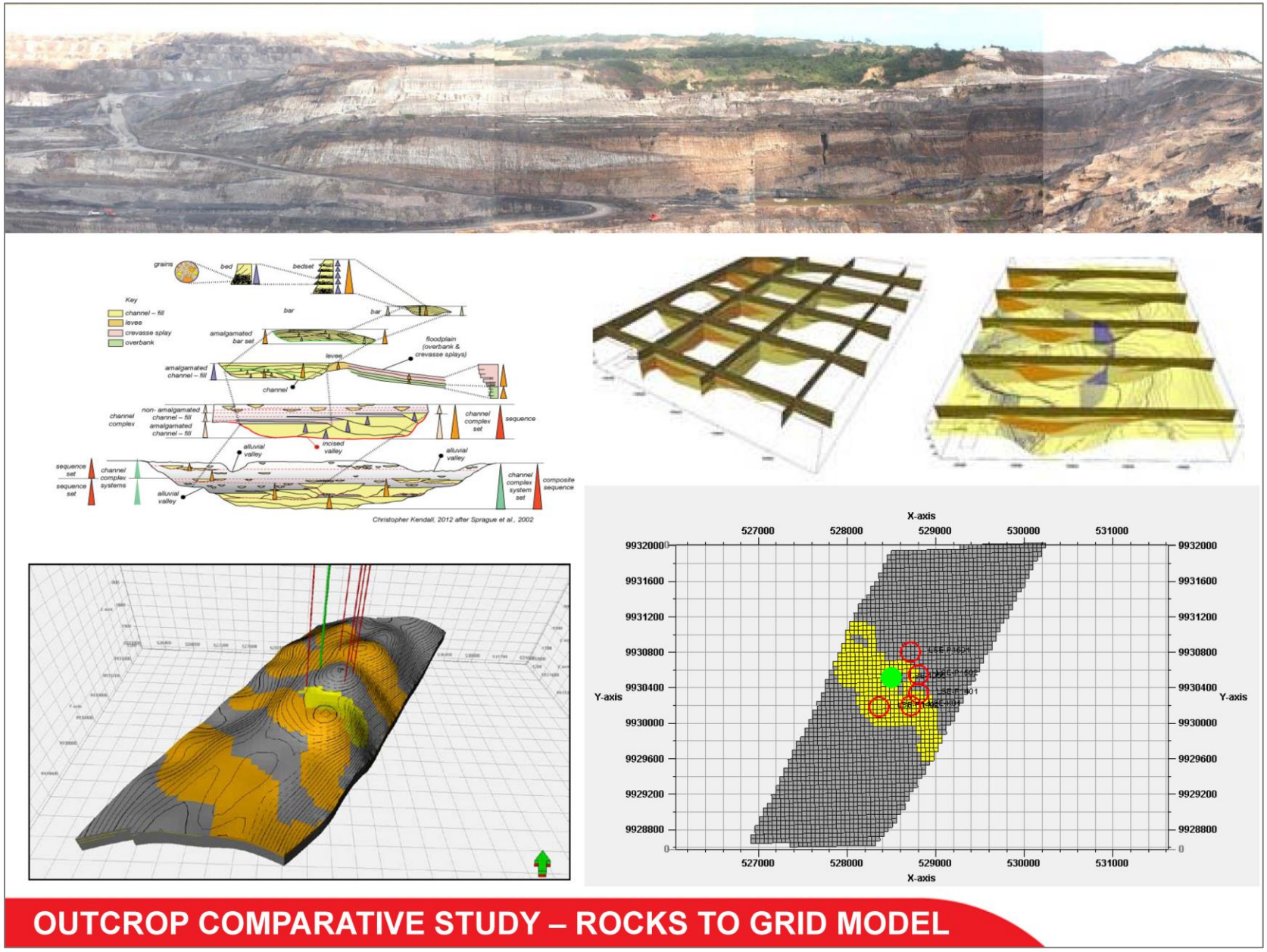
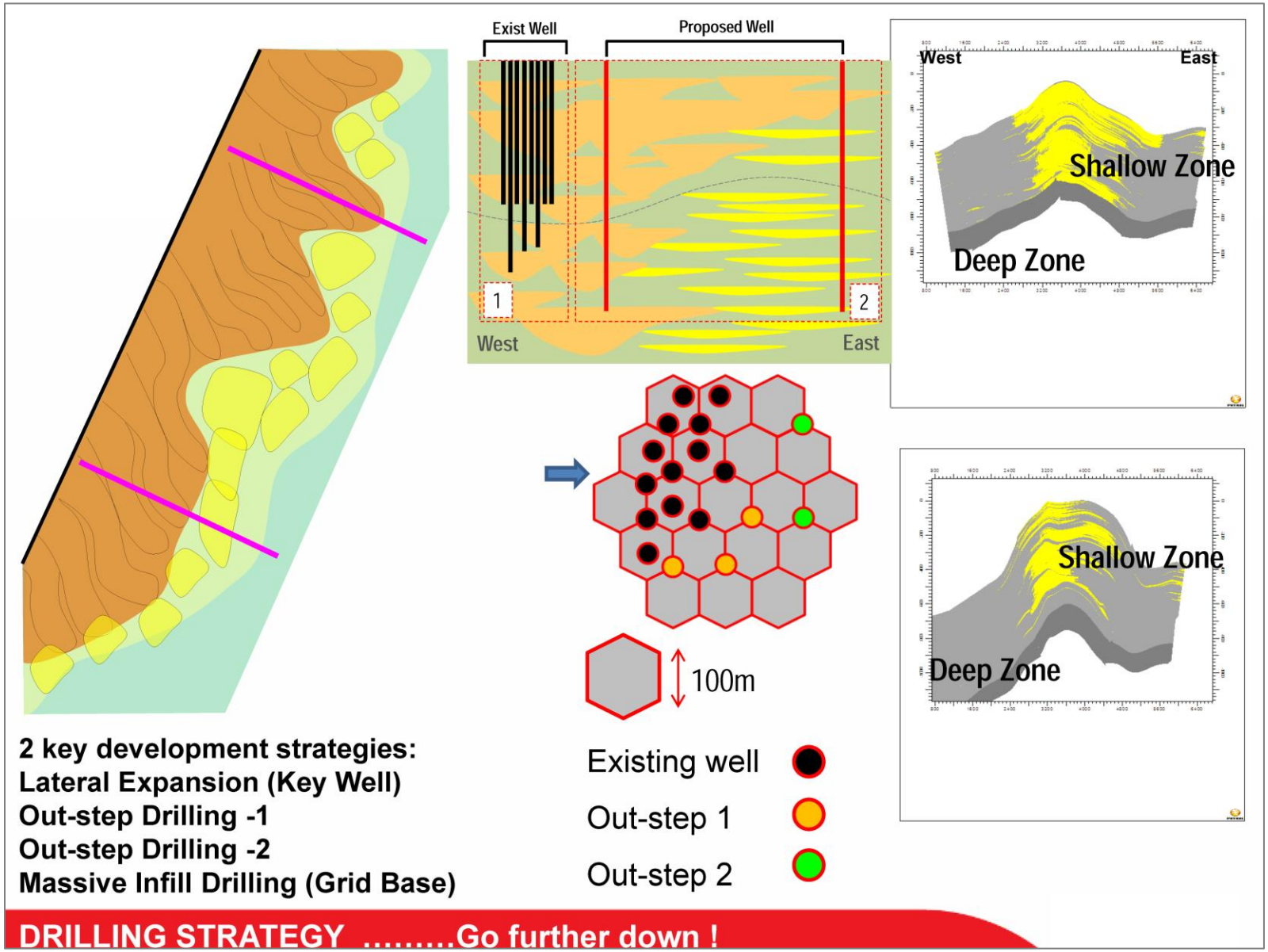


Presenter's notes: This is a typical workflow to build a deterministic geological model. The outcrop measurements are translated into a 3D fence diagram using Walther's Law correlation. We also accommodated the lateral facies changes concept into the 3D grid model.



Presenter's notes: Based on our knowledge we could predict the overall shallow to deep prospect reservoir distribution. In this current model we expect to find stratigraphic traps in the east flank of the anticline and based on their morphometrical parameters we could enlarge the well spacing toward the east.

Reservoir Geology

- 3 Major potential reservoir sands identified :
  - distributary channel-fill system
  - estuarine tidal channel and mouth bar
  - Transgressive/back filled channel

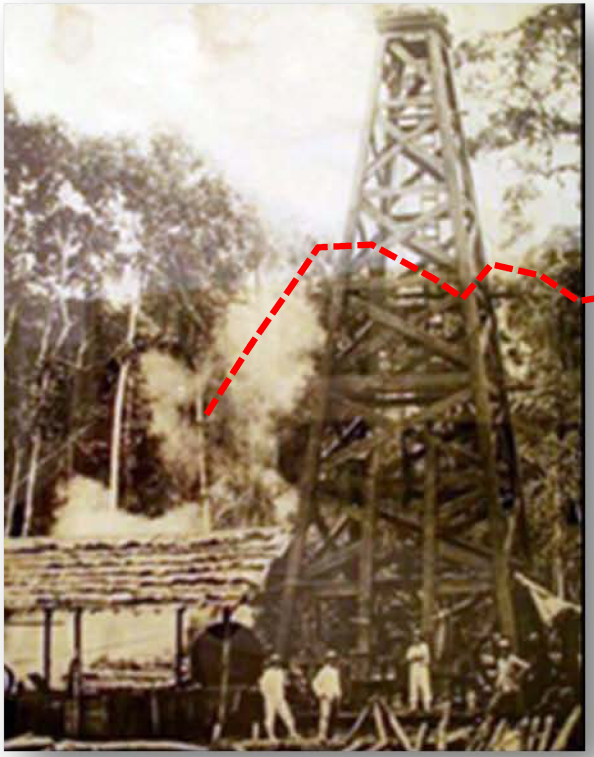
- The transgressive channel fill is a potential **giant reservoir**:
  > Thicker > Coarser Grain size than tidal channel/mouth bar
  → **> Storage Capacity**

  - Stratigraphic successions provide a predictable trends

Field Development

- New stratigraphic trap in the eastern anticline flank

- The massive drilling program is needed to optimize the withdrawal area (isolated reservoir)



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Terima kasih