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Crack Obsolete Paradigm: Proven New Petroleum Potential in BPK Area, Sirikit Oil Field, Thailand*

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Abstract

The BPK area was explored by the BPK-A01 well, based on a structural closure concept in 1983. The well objectives were to develop possible fluvio-lacustrine sands in Lan Krabu (LKU) Formation and fluvial sands in the basal Pratu Tao (PTO) Formation. The well discovered oil only from the LKU Formation at 8 mTV, and there was no significant hydrocarbon in the PTO Formation. In 2000, seismic amplitude anomaly was introduced to assist well targeting. Commercial hydrocarbon discovery of oil and gas was developed in both shallow PTO and deep LKU formations.

During 1983-2013, only 8 wells were drilled in BPK with structural trap concept analogue from Sirikit Main Field. The main contributor was from LKU Formation with an average net pay at 26 mTV. All structural closure was introduced at maximum oil production rate of 1,200 STB/d and the production had been declined to lower than 100 bbl/d in 2014. In 2014, the reserves of BPK area were 80 Mbbl and proved mean STOIIP was 2 MMbbl. However, according to a 2013 geological model, there was high discrepancy between dynamic and static STOIIP(s). This leads to a geological and geophysical investigation.

Study Method and Results

The initiative concept integrates two parallel processes in both geology and geophysics. New structural model and play type concept were re-evaluated in 2015 by applying 9 existing wells in BPK and the nearby area according to the process in Figure 1. From the geophysics side, seismic interpretation was then carried out by the application of more complex conjugate faults, along with structural reconstruction of multi-stage fault system. The new compartments were constructed by investigating major event of west dipping fault, which opened up more opportunities in undrilled prospects. Furthermore, the rock physics feasibility study and seismic amplitude anomaly were proved as one of the tools implemented to characterize stratigraphic distribution. This tool was introduced to clearly understand the reservoir properties. Beyond conventional structural interpretation, the amplitude anomalies were calibrated with the hydrocarbon bearing reservoirs. The key steps of the study consist of data quality check (QC), cross plot with various log data, color-coded scatter plots of Vp/Vs and acoustic impedance (AI), fluid substitution, depth trends, and single interface AVO (half-space modelling) to identify classes of lithology (sand/shale) (Figure 2).

After the rock physics feasibility study and seismic amplitude anomaly have been applied, there are some uncertainties in sand presence for well targeting, and this could not be fully identified. In 2016, unsupervised seismic facies classification (the hybrid clustering method) was utilized to improve sand direction images. First, the most representative seismic attributes in the other domains, apart from amplitude, were selected to generate seismic facies maps. Then, log motif interpretation, channel width-thickness ratio and modern analogue have been integrated with the result from seismic facies maps to calibrate for interpretation. The calibrated facies maps were used to optimize well targeting as shown in Figure 3.

From the geological point of view, reservoir geometry modeling of channel width versus thickness, channel direction, sand distribution, and lateral seal were studied. From the 2015 well results, the log character of channel in PTO Formation has an average thickness of 8-10 mTV, which is then converted to channel width as shown in Figure 4. The average channel width in PTO formation is around 200-250 m.

In the channel geometry study, Nan River (Phitsanulok province) and Chao Praya River (Nakornsawan province) are analogized to illustrate the northeast to southwest direction fairways with channel width 150-200 m and 300-550 m, respectively. According to the integrated interpretation of well log and seismic amplitude anomaly, the channel width in PTO averages 200-250 m and the channel direction is north to south and northeast to southwest; this corresponds to the modern analogues. Moreover, the analysed channel direction is cross-ways against the main fault trend (Fault azimuth: north-south, fault dipping: west) in BPK area. This structural configuration and channel distribution indicated a large remaining potential in BPK (Figure 5). However, the lateral seal is the key risk to be assessed in the area, so shale-gouge ratio and juxtaposition are closely studied.

Conclusions

From the success of drilled wells, mean proved STOIIP and OGIP volumes with the new concept are 64 MMSTB and 4 Bscf, respectively, with that, the shallow play target is more incredibly majority potential in BPK area. Undrilled prospects in BPK with mean STOIIP at 11 MMSTB and mean OGIP at 0.19 Bscf have been planned to be proved in the near future. Moreover, an opportunity of using this new play concept and approach will be applied to the other areas in Sirikit Oil Field.

Based on improvement of process by cracking an obsolete paradigm in BPK, the large volumetric of STOIIP 64 MMstb and OGIP 4 Bcf from initiative concept of structural-stratigraphic combination trap (PTO Formation) has been successfully discovered, comparing to only STOIIP at 13 MMstb from the past structural closure concept. Additional, BPK oil production potential was 2500 bbl/d from the combination trap concept, while the structural concept gave only 1200 bbl/d. Total additional reserves is 4.1 MMbbl and projected NPV increased to 70 MMUSD. With this approach, the new opportunities, in terms of the well numbers and production potential, are increased. Furthermore, the concept will be applied to other areas in exploring the Sirikit Oil Field area.

Selected Reference

Sutter, A., 2008, Channel-belt width prediction and connected sandbody volumes from preserved sandstone thickness in wells. Website accessed October 17, 2017.
http://www.seddepseq.co.uk/Fluvial_Modelling/CBW_Prediction.htm

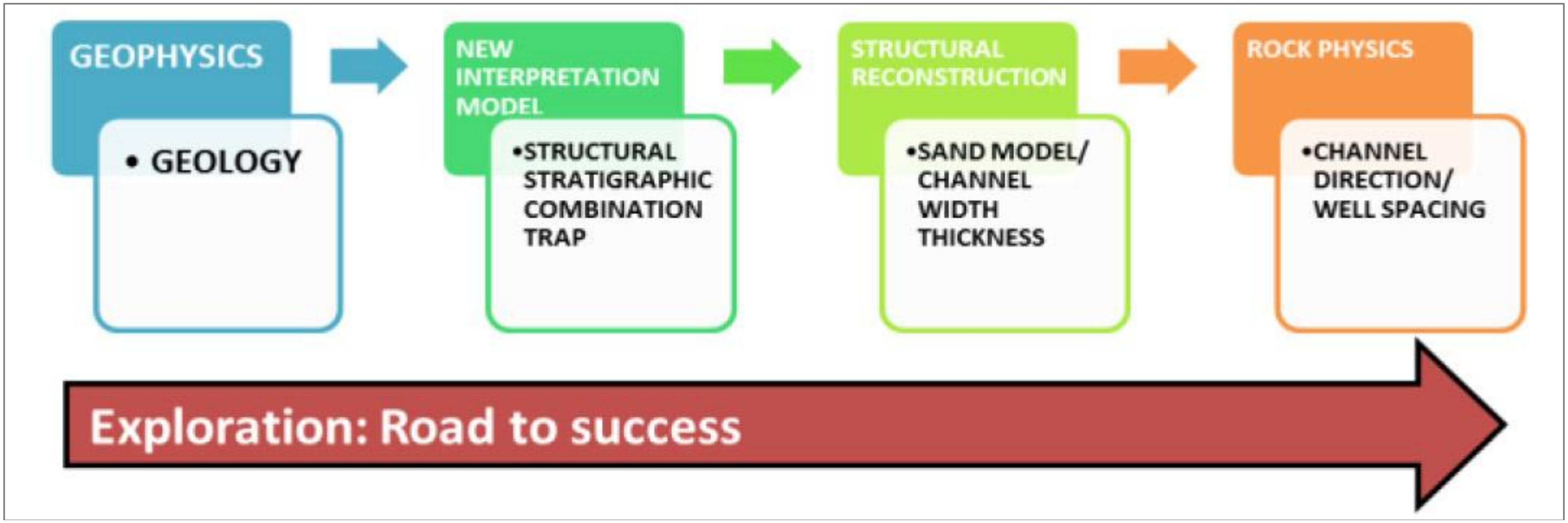


Figure 1. Geophysics and geology concepts used in BPK study.

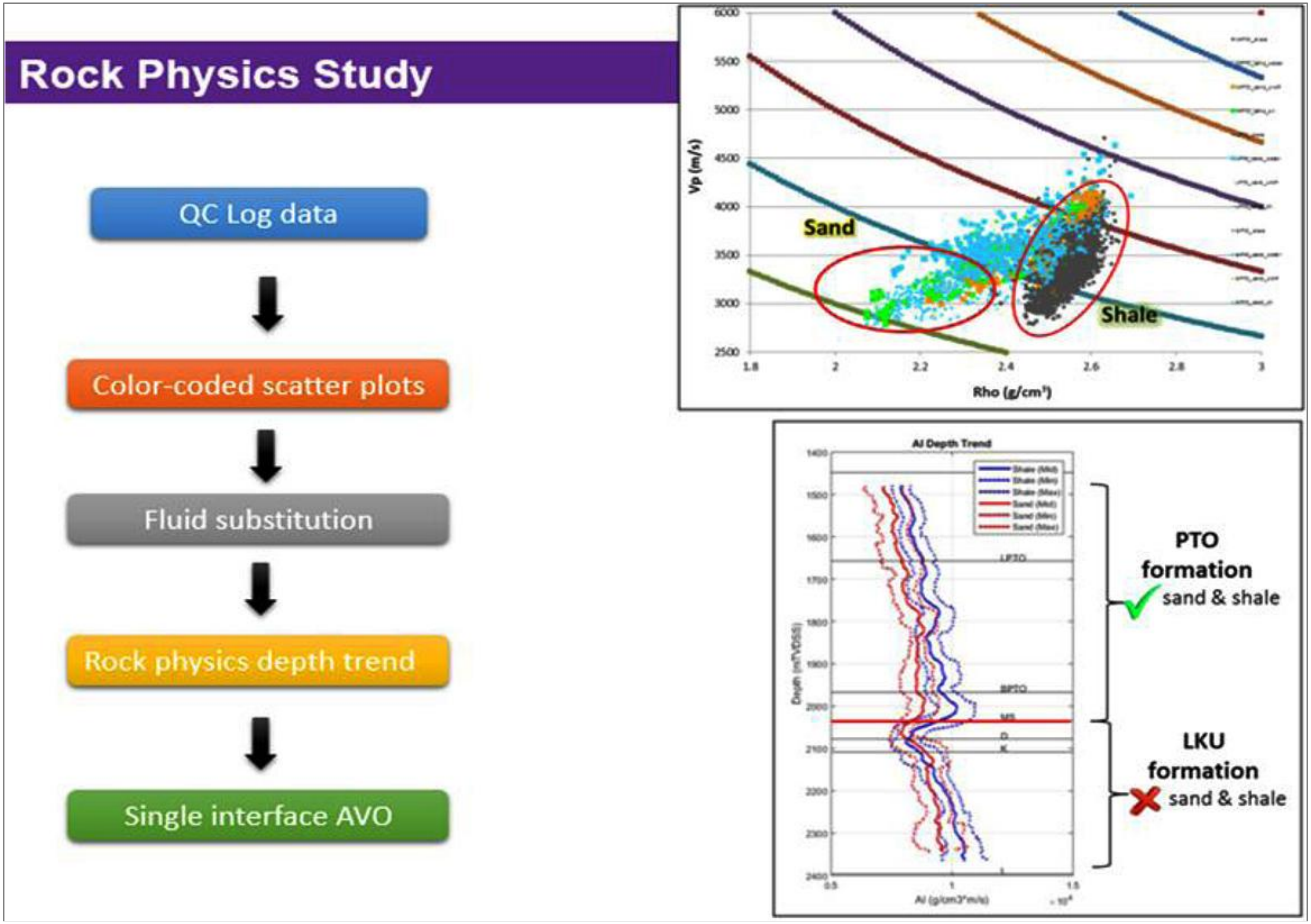


Figure 2. Rock physics feasibility study in PTO and LKU formations.

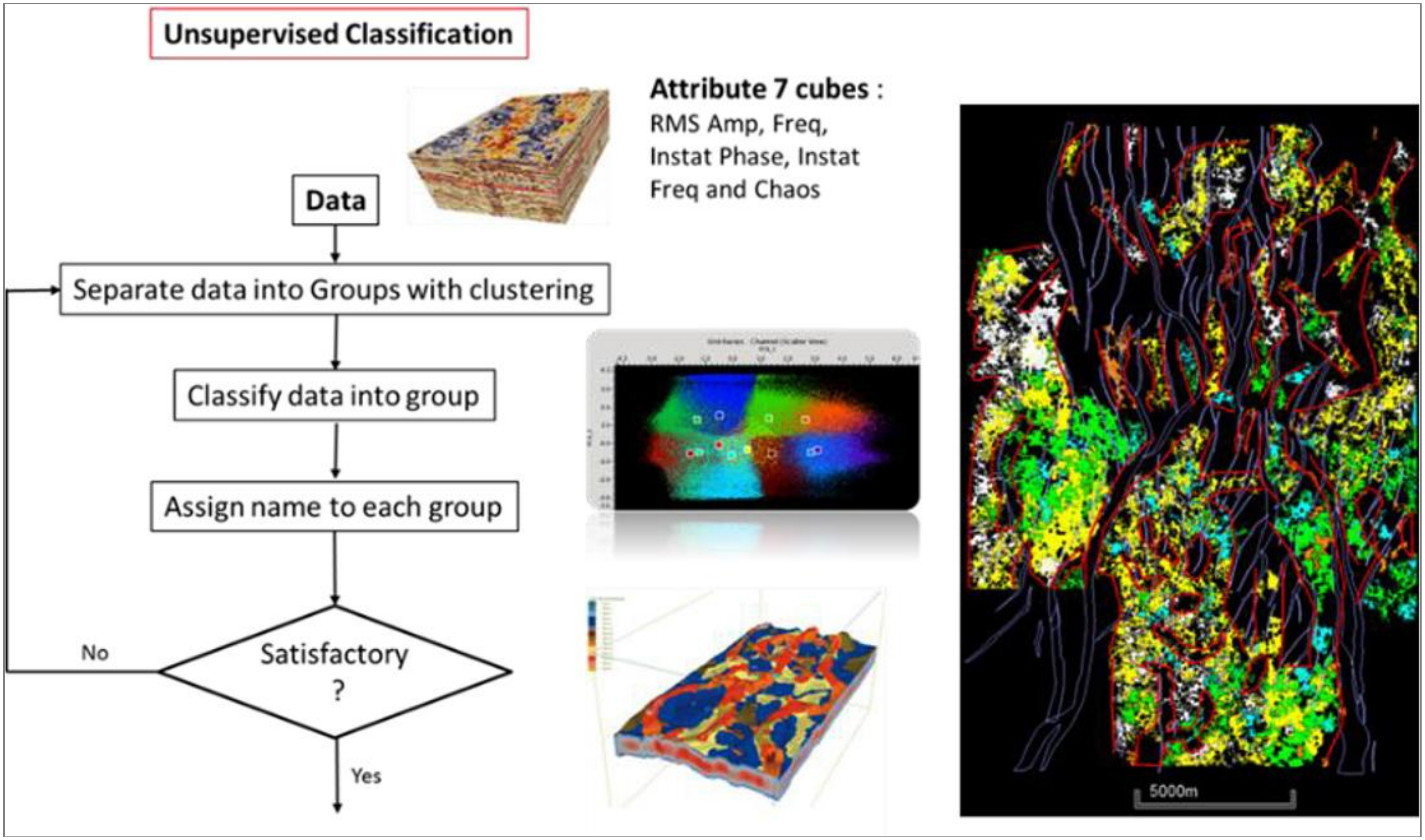
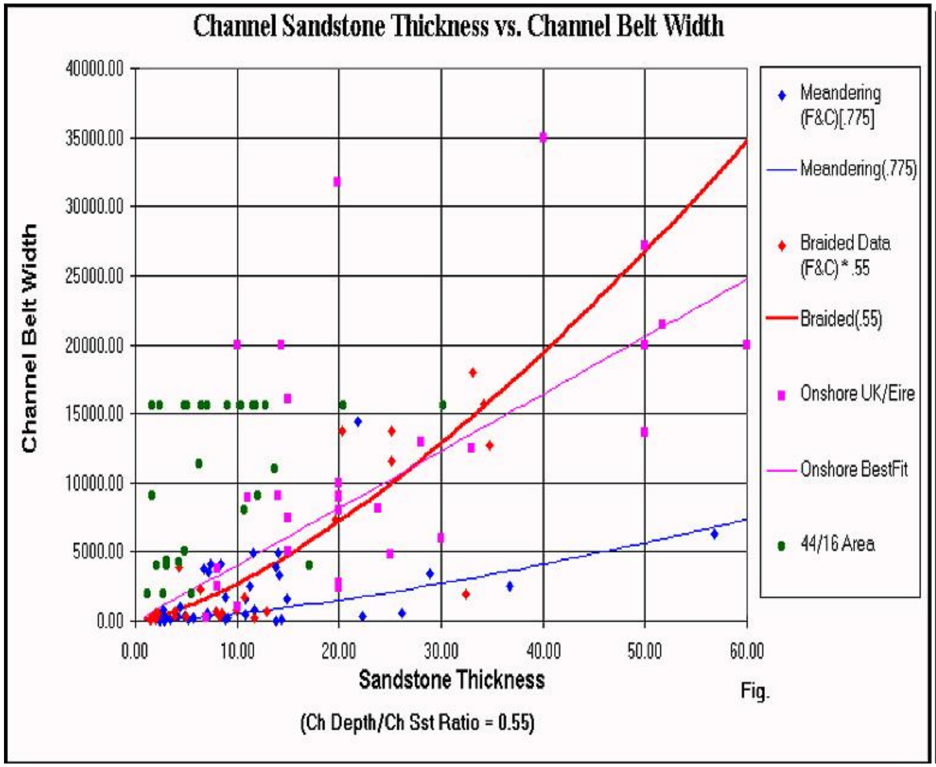


Figure 3. Unsupervised seismic facies classification study in PTO formation.



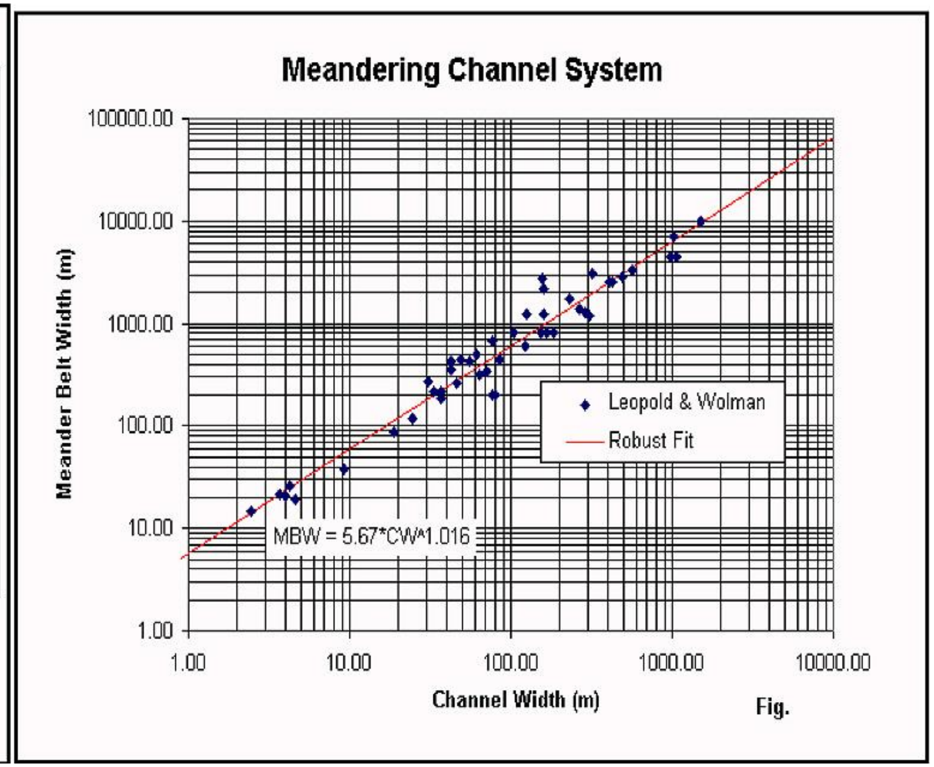


Figure 4. Channel-width prediction from the channel thickness study analogue from the fluvial environment (Left: Net pay-channel belt correlation, Right: Channel belt-channel width correlation).

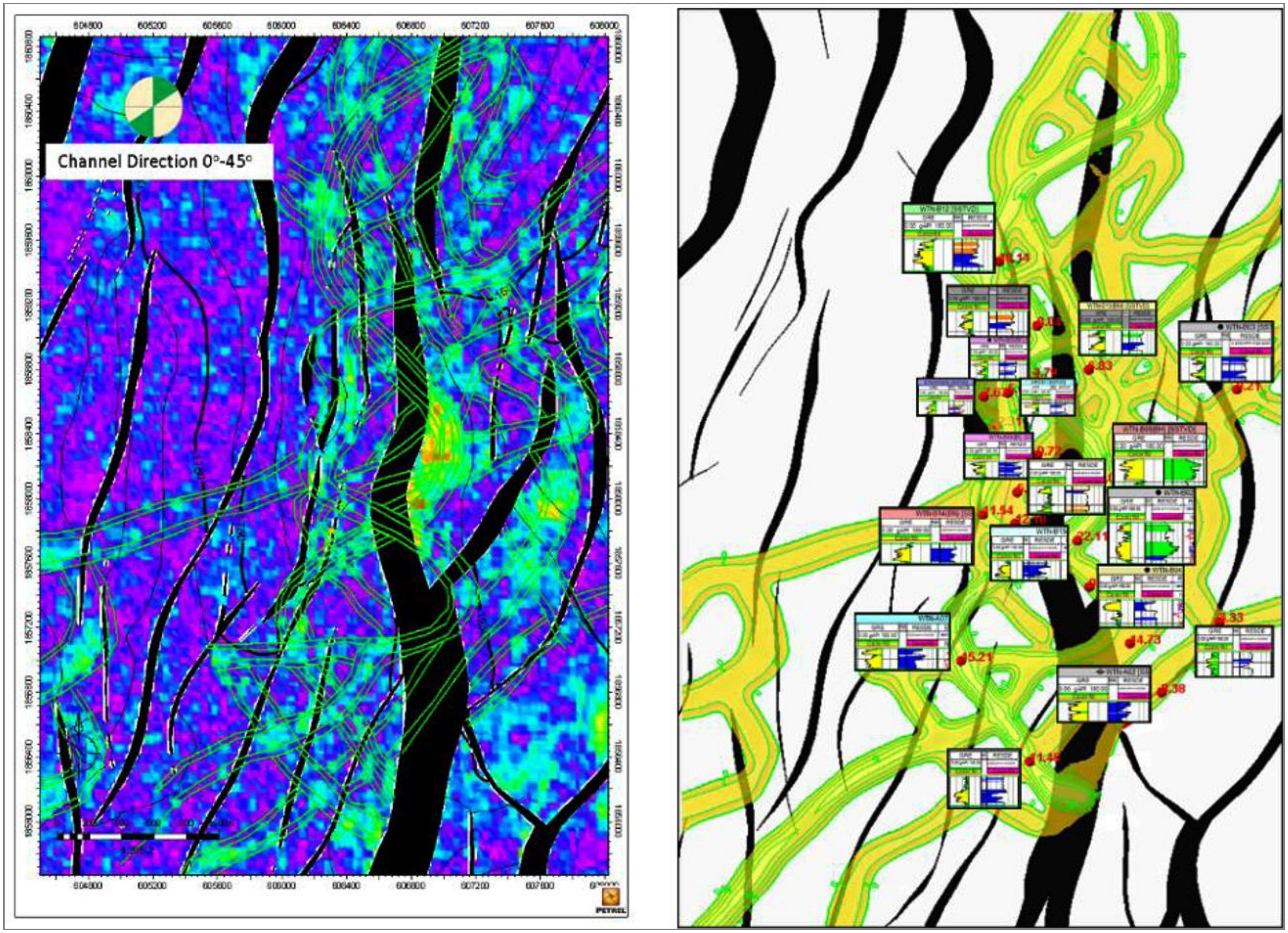


Figure 5. Channel fairway in BPK (Left: Amplitude anomaly, Right: Log character).