

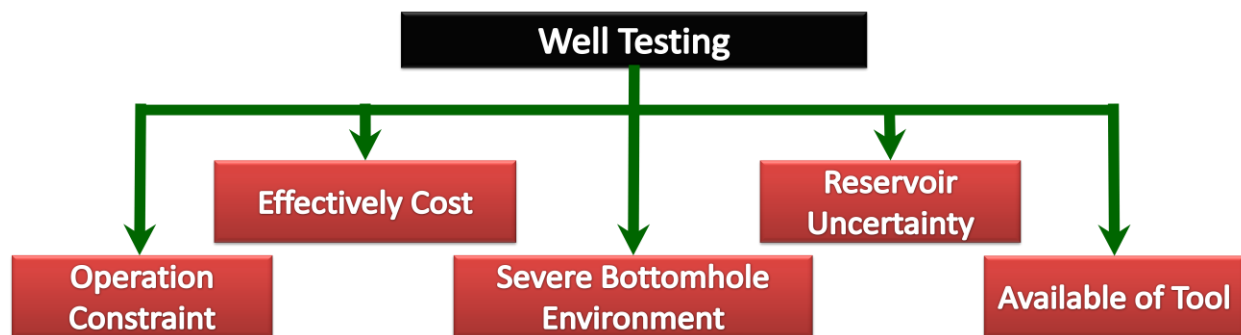
## **“Ton Rang-3: Thailand First Successful High Temperature PLT Logging”**

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### ***Innovation feature***

The objective of this document is to share challenges in data acquisition program on Ton Rang-3 well by High Temperature Production Services Platform (HT-PSP), mainly focus on well test operation in crucial bottom-hole environment. The Ton Rang-3 well is an exploration well which was drilled in March 2011. The well is located in the west border of Bongkot concession. This well was TD at 3,452 m TVDBRT or 4,180 m MDBRT in Oligocene section which is the unexplored interval. In addition, this well is the deepest well that PTTEP has ever drilled in the gulf of Thailand. The temperature was anticipated up to 227 degree Celsius while the pressure was estimated approximately 8,000 psi at a bottom-hole. Thus, this well is characterized to be a high temperature and high pressure well.

Data acquisition plays incredibly important roles in identifying deliverability of reservoirs and also quantifying hydrocarbon reserves contained in this kind of reservoirs. The success of this deep section will be important for guiding further exploration and also to support the economic analysis of next the development plan. Information is extremely valuable; therefore, the special specification tool must be carefully selected based on the anticipated high temperature environment expected.

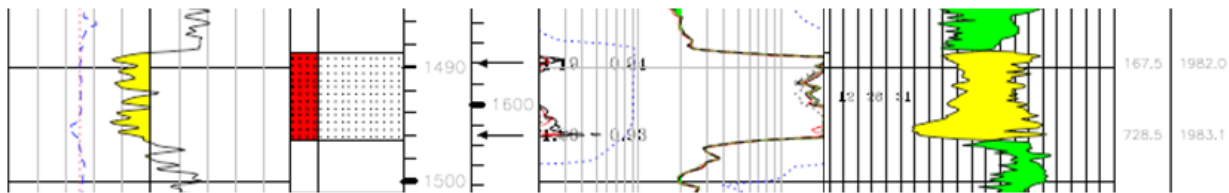


**Ton Rang 3: Challenges in well testing**

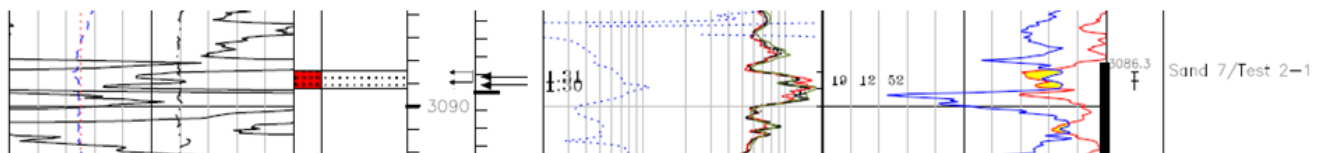
In terms of data acquisition program in both 8-1/2” and 6-1/8” sections, the reservoir evaluation, especially SRFT and HXPT, could not clearly identify the properties of the discovered sands in the deep section. Thus, well testing combined with high-temp PLT is initiated to acquire more information to meet well objectives.

Since Ton Rang-3 was planned to drill in Oligocene section which the thin layer sands and/or tight reservoirs are expected to be found. The conventional well test will not practical for this kind of

reservoir. Only small tight sand obviously cannot lift up completion fluid during clean up period, more sands have to be perforated and flow commingles. As a result, the conventional well test interpretation results cannot represent the reservoir characteristic precisely. The production logging tool (PLT) was brought into consideration, it will help identifying the contribution of each reservoir which had been perforated along the well. The reservoir properties such as permeability of each reservoir can then be calculated. The problem is the original PLT temperature rating is just only 150 degree Celsius which cannot withstand the temperature of this well. Thus, **the - Temperature Production Services Platform (HT-PSP) or high-temp PLT** was selected to be run the first time in Gulf of Thailand (Bongkot Field) for preventing risk and limitation which can occur during the operation. With modification on Dewar flask around the tool, it can withstand higher temperature at 220 degree Celsius. However, its internal temperature of the electronics cannot exceed 177 degree Celsius. Therefore, in term of operations, the strategic plan and monitoring while operation is really important. During operation, job planning, extensive prevention and mitigation plan have been prepared and reviewed. The flask will prevent heat to transfer into the internal tool, but heat generated from inside electronics cannot transfer out of the tool either. In effort to maintain internal temperature, the tool needs to be powered down whenever possible. The cartridge temperature is also has to be monitored closely, then decision can be made to mitigate tool failure, i.e. increase speed pass or cancel bottom sand which has high temperature.

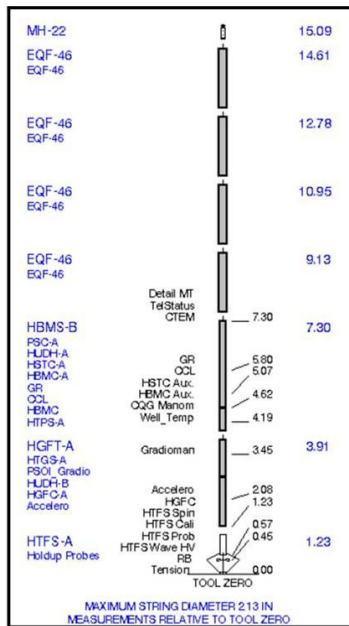


**Porous sand in Formation 2**



**Tight sand in Formation 0**

Apart from the success of this project mention above, it's not only because the special tool we used in order to get a good result, but also due to the efficient teamwork among multidiscipline which are geophysicists, geologists and reservoir engineers cooperation.



### High Temperature Production Services Platform (HT-PSP) Wire Line Assembly

#### **Thai E&P Industry Impact and Value**

In today's world, energy is regarded as one of the main factors to prove national security in terms of economic competitiveness. Considered as one of the major role players in E&P industry in Thailand, PTTEP's growth is therefore highly significant. In order to enhance the company's growth, exploration plan cannot rely only on conventional resources but innovative ideas are needed towards unconventional plays such as deep formation. According to long-term gas production prediction of Bongkot field, more than 200 Bscf/year of gas reserves is needed in order to prolong production plateau at the rate of 600 MMscf/day. The ability to prove the productivity of the new structure is extremely significant in terms of reserves addition

Ton Rang-3 exploration project is considered as a play opener in the gulf of Thailand as the main target focuses on the deeper reservoirs with questionable sealing capacity which has never been explored. Data acquisition, therefore, played an important role in identifying geological structure, as well as, quantifying hydrocarbon reserves in order to prove the economic feasibility for further development plan. The fact that the well penetrated to the deepest stratigraphic in Bongkot field, reservoir conditions remained rather doubtful. Reservoir conditions were expected to be severe with extreme temperature and abnormal pressure. Data acquisition plan, therefore, had to be readily adaptable at hand to gain extensive forms of information while remaining cost-effective. Several forms of techniques were implemented including formation testing, open-hole logging and well testing.

Severe reservoir conditions and economic feasibility in terms of rig time saving inhibited conventional acquisition techniques, particularly on formation test and reservoir deliverability. In terms of formation test, different kinds of tools were used including conventional formation pressure test; however, the information could not clearly identify the properties of the discovered

sands. Reservoir test, therefore, became extremely critical. Conventional deliverability test relies on individual reservoir test which needs extended amount of rig time. However, the technique used in the project was to perforate several sands and test commingly, then, each sand's productivity was identified by high-temperature endurance PLT tool. This technique can help save rig time while ensuring proved hydrocarbon pay zones.

Ton Rang-3 has generated new phase of exploration plan to go beyond the previous deep section which has been avoided due to temperature limit. The feasibility of data acquisition techniques in challenging environment establishes new standards of technology within the company. Also, lesson learnt helps support future development plan of similar exploration campaign.

As a result of Ton Rang-3 operation, production logging descents were successfully commenced in two separate testing zones. Fluid type as hold up and flow contribution of each perforation sand have been clarified with E-probe, Fullbore spinner, Gradiomanometer, Temperature and Pressure sensors. Moreover, the engineer on the job was able to perform the wellsite quicklook providing turnaround result in realtime manner. The preliminary results of the PLT match very well with the surface production test and open hole data. This tool can prove successful for identifying the flow contribution in deep section which makes values to PTTEP as following;

- Reduce the isolation and safe rig cost by comingle test (Cost saving).
- Allowing each perforation comingle zone to be evaluated and prove possible sand that doubt by conventional log (Increase net pay).
- Reducing uncertainty in hold up condition for better development phase planning (Economic evaluation).
- Ability to test the flow contribution high temperature zone which technology was not previously exists (New play opener). At least 350 Bscf of mean OGIP has been evaluated from this interval
- Avoiding the use of explosive setting tool at temperature reducing potential failure and HSE concern (Safety and cost saving).

Based on the successful of high-temp PLT in this well, this tool became the proven solutions for PTTEP and is considered to be continuously used for further well testing operation in next exploration campaign.

### **Essay, Why this project should win the award**

More than a century, Exploration and Production is a highly capital intensive sector. In Thailand, E & P business has become a major contribution to the national energy component. A large number of money was spent in this business sector in Thailand. PTTEP is Thailand based Oil Company who has been supplied a huge rise in the energy use. Regarding to this demand, efforts are being made by PTTEP to discover new plays and enhance hydrocarbon reserves using new and more powerful technologies.

Bongkot asset is the main contributor to PTTEP for more than a decade, mainly producing gas. Same as nearby areas, a significant play type widespread in the Gulf of Thailand is clastic play. It is

obvious that the conventional plays in Bongkot are Miocene post rift of Miocene section. A tremendous change has become since we considered investigating in Oligocene syn-rift. Targeting in the deep section seems to be very challenging for the team as Oligocene section typically has high temperature and abnormal pressure. Consequently, Ton Rang-3 was planned after been studied in detail, it is also being a deepest well testing its stratigraphic trap. The significant challenges in drilling this well will impact to the conventional play concept of asset. It comprises both during drilling activity issue and its result.

According to the high temperature condition, HPLT (high-temp PLT) was designed to use. Previously, in the deeper section, we can perforate only large sands causing missing many thin reservoirs. Although HPLT seems to be more functional, the more concerns were taken into account as this tool will be the first run in the Gulf of Thailand. However, the result shows that the tool can be able to prove potential contributors at deep section. Also a large interval of sands was perforated include thin layer reservoirs.

Although a few of exploration wells have already proven hydrocarbon but deeper section still remains unexplored. Ton Rang-3 result shows a success targeted reservoir deposited as a fan delta in 3 ways dip closure as modeled. From core data, it can be interpreted that the well located in the distal setting along the bounding fault, lateral to the fan delta. Thus, this would represent a play opener for Bongkot.

As has been shown, a new discovery, new concepts are growing continuously among our subsurface team. The latest technology allows us to prove a larger number of unconventional reserves which have been previously neglected. Also, the creative and innovative methods of thinking have leaded us to discover the new plays in order to support the company's target and the country's increasing demands.