## Paper B5

## Sepat Barat Deep-2: The Deepest and Hottest HPHT Well in North Malay Basin

S. Osman\* (PETRONAS), M. F. Nianamuthu (PETRONAS), F. A. Ismail (PETRONAS), J. J. M. Idris (PETRONAS) & J. Ping (PETRONAS)

Since the late 60s, exploration activities had started in the North Malay Basin region which resulted in the discoveries of Jerneh, Lawit, Bintang, Damar, Noring, Guling and Tujoh by several operators (Figure 1). Most of the exploration target is the conventional play type; Upper Miocene clastics of Groups D, E and Top F (Figure 2). The play is generally located within the hydrostatic to slightly over pressured zone (upper zone of pressure ramp up). The play is characterized by siliclastics prone of Group E where most of the hydrocarbon accumulations are trapped within the east to west faulted anticlines. The hydrocarbon types are generally gas with condensates and some of the structure also had discovered oil rims (Sepat, Dulang, Semangkok and Bujang). This play is also characterized by having variable CO2 concentrations. Given the pressure range at the groups F, H, I and J depths as well as temperature gradient in the North Malay Basin, only complex architecture HPHT type of wells could successfully allow the exploration of the deeper prospects.

Malay Basin had undergone three major structure movements; extension, thermal subsidence and basin inversion. The important result of the inversion is the compressional anticline, which includes the low relief structure. The possible low relief traps lies between high relief structures or beneath the major gas fields which may be overlooked because they are not obvious in the time domain and affected by gas sagging (Ji Ping, 2010). Hence a comprehensive seismic analysis is required, especially to generate the correct velocity model. The seismic data in the Sepat Barat area is poorer in the deeper levels and also effected by the gas cloud from shallower reservoir. The reservoirs are consists of fluvial and coastal reservoirs most often fluvial meandering channel. Traps associated with this play are 4 way-dips anticline (Figure 3).

The Middle to Lower Miocene HPHT play of Group F, H, I and J is characterized by the simultaneous occurrence of high pressure and high temperature. Most of the previous exploration wells had penetrated until top of Group F, due to inability to drill through high temperature and pressure region.

In addition, as experienced in Sepat Barat Deep-2 well, expected less than 1 ppg drilling margin (margin between formation pressure and fracture gradient) and possible to encounter another pore pressure ramp in F and H groups. High mud weight was used, up to 18.2 ppg with bottom hole temperature reaching 360 degree Fahrenheit and challenges of the presence of shallow gas that required surface casing to



Figure 1: Sepat Barat Deep-2 well location in the North Malay Basin Region.

be set shallower (resulted in a very long 17-1/2" section up to 1850 meters).

Sepat Barat Deep-2 well was the only well which successfully evaluates the deeper reservoir of Group F and H in the North Malay Basin area with a total drilled depth of 2768mss. The reservoir pressure system is over-pressured starting at depth 1748mss, penetrated steep pressure ramp which is 3 ppg pressure increments for 200 meters until lower of Group F sand. The maximum recorded formation pressure was 7826psi at 2623mss and maximum bottom hole static temperature recorded was 340 degree F (Figure 4).

Based on the new well data, depositional environment for Group F is interpreted as delta front to shallow marine while Group H is interpreted as delta plain. A total of 8 new hydrocarbon bearing sands were encountered with gross thickness of 69 meters. The well had proved that Group F and H have significantly good porosity and permeability. F sands which are over-pressured reservoirs had preservation of its porosity up to 24% and this resulted had challenged the previous hypothesis of reservoir porosity quality decreases with depth. Minimum CO2 content (11%) was recorded in H80 and H90 sands concluded that there is no CO2 trend with depth in the area (Figure 5).

The Sepat Barat Deep-2 well had recorded a milestone as the first successful HPHT well in North Malay Basin region. Advanced tools and technologies were applied such as Manage



Figure 2: NW-SE Well to Well Correlation from Noring-1 to Melor-2.

Warta Geologi, Vol. 38, No. 2, April – June 2012



## PERTEMUAN PERSATUAN (MEETINGS OF THE SOCIETY)



Figure 3: Low relief structure at the deeper reservoir of Sepat Barat.





Figure 5: CO2 trend in Sepat Barat Field is non depth dependent.

Pressure Drilling (MPD), high temperature wireline tools, StethoScope and Insitu Fluid Analyser (IFA). With the same technologies and well design, all the others deeper prospect could be explored.

Discovery of Sepat Barat Deep-2 well will open up the deeper reservoir of Sepat Complex and similar plays within surrounding area i.e Bujang, Inas and Guling. North Malay Basin region had proved to be highly prospective with the current available facilities. With thorough well-planning and application of relevant technologies had not only ensured the well objectives was meet but importantly drilling operations was optimized and safely conducted.