Abstract

Pore Pressures in the Nam Con Son Basin, Offshore Vietnam – Observations, Characteristics and Solutions

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A number of sedimentary basins of various ages are located offshore Vietnam. These basins include; in the south, Cuu Long Basin and Nam Con Son basins, the latter a major gas production province in Vietnam; and in the north, the Song Hong Basin.

Exploration plays in these Vietnamese basins are focused on either (a) oil-bearing fractured granite basement which now accounts for 80% of Vietnam’s total annual production or (b) clastic, consisting of reservoirs both, above and below the MMU horizon, which is a substantial regional unconformity. Examples of the clastics in the Nam Son Con are sandstones from the Dua Thong and Mang Cau Thong Formations.

A particular challenge to developing these clastic plays has been to understand the pore pressure regime. For example, in the Song Hong Basin, the Cua Lo 1 ST-1 well is a side-track well to the original Cua Lo-1 exploration well, which commenced drilling on 11 August 2013 and was then subsequently plugged back from a depth of -2,531 TVDSS and side-tracked due to an unexpectedly high pressure kick. In the Nam Con Son Basin high pressure-high temperature conditions have been reported in the Hai Thach and Moc Tinh gas fields in Blocks 05-2 and 05-3.

So what are the reasons for this abnormal (or unexpected) pore pressure causing such well control/drilling problems? The simple answer is, of course, inaccurate pre-drill prediction; however, there are a series of factors that do make pressure prediction in these basins very difficult. A major contributing factor is complex geology and this is highlighted in Figure 1, by a cross-section of Block 06/94, Nam Con Son.

In reference to Figure 1, below we highlight four structural/stratigraphic areas of focus. In each setting, there are a set of pressure characteristics that have to be understood.

1. Basin fill consists of syn-rift and post-rift sequences, separated by a regional Middle Miocene unconformity (MMU). The syn-rift comprises tilted fault blocks, whereas the post-rift consists of undeformed prograding sets. The variable depth of the MMU varies across the basin causing differential loading. Higher rates of sedimentation will result in higher syn-rift pressures as the overburden is thicker. These are predictable using the “Swarbrick Method” (Swarbrick, 2012).
2. Regional unconformities such as the MMU event, can also allow pressure to escape but this is difficult to quantify as this dissipation is controlled by the age gap represented by the unconformity as well as by seal thickness and permeability of the shales. If the unconformity has allowed pressure to escape, then sediments underneath can re-compact and have no porosity anomaly, despite being over-pressured a second time.

3. In the Nam Con Son Basin, carbonates are present but global analogues demonstrate that typical pore pressure algorithms are not suitable for direct pressure prediction in such lithologies as they are typically stress-invariant. These carbonates often have structural relief and so can be prone to elevated crestal pore pressure as a result of pressure transfer from beneath or down-dip. An example is shown in Figure 2 where Miocene pinnacle reef structures offshore Sarawak have relief up to 1,000m and are overlain by rapidly deposited clastics with sedimentation rates of 500m/My.
A similar process can occur in association with faults. Fractured carbonates are also often associated with loss zones due to fractures.

4. Lastly, and perhaps most importantly, geothermal gradients tend to be high such that HP/HT conditions are common. These high gradients result in relatively shallow shale diagenesis and maturation, and can generate substantial additional over-pressure i.e. in excess of that generated by simple loading and ineffective dewatering (a process termed disequilibrium compaction).

![Figure 2: shows the effect of lateral transfer using the Centroid Concept of Traugott (1997). Pressure has been transferred from down-dip (higher) over-pressured shales (blue line) into the inclined reservoir, which results in elevated pore pressure at the crest (see text for explanation). Note how the kick taken at Top Carbonate is matched using the Centroid Concept and the ‘silty’ “Swarbrick Method” profile (straight red line) (Heller et al, 2014).](image)

This presentation reviews observations from the literature on pressure and drilling in the Vietnamese basins and in the region. We will then highlight some of the characteristics of drilling in this type of setting, and offer some solutions (e.g. MPD drilling, geological model construction, understanding overpressure mechanisms etc). Analogues from SE Asia (Malay Basin, Central Luconia, Brunei etc) as well as more globally (Mid-Norway, North Sea) will be shown.
Heller, J; Basuki, D; Choo, M; O’Connor, S and Swarbrick, R 2014. Using simple loading models to predict crestal pore pressures in Miocene carbonate exploration targets, Luconia, Sarawak. IPA Conference, Jakarta, Proceedings.
