Finding New Play Potential in Main Zawtika Development Area, Zawtika Project, Moattama Basin, Offshore Myanmar*

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Abstract

Zawtika gas field is located in block M-9 in Moattama Basin, Gulf of Moattama, Offshore Myanmar (Figure 1). Moattama Basin lies in the inter-arc setting east of the Sunda Trench and east of the elongate N-S trending volcanic ridge. During the Late Cretaceous to Eocene pre-rift stage, the Andaman Sea area included an orthogonal subduction zone and magmatic arc with massive volcanism in response to the subduction of the Indian plate beneath the Sundaland Craton. The rifting continued to early Miocene; a carbonate platform with build-ups, was the dominant feature on the basement high along the northwestern flank of the basin.

Through the Pliocene to Pleistocene, the Moattama Basin was filled with a variety of sediment: mainly from two sources; 1) the Irrawaddy River on the northern side of the basin, and 2) the highlands on the eastern side of the basin. Deltaic deposits that formed during the rapid southward progradation of the Irrawaddy delta are found in the basin depocenter. The Tertiary basin fill exceeds 10 km in thickness and is the prospective section in the eastern half of Block M-9. Extensive development of growth faults was due to the rapid deltaic deposition of 6-8 km thick sediment overlying thick mid-Miocene shale through the Plio-Pleistocene. These faults are restricted to the Sagaing-Shan fault zone and are oriented in an ENE-WSW direction. The larger number of them can be observed in the eastern half of Block M-9, and they represent the normal structural play in this area. Only the structural play of Plio-Pleistocene deltaic sediments, multi-stacked sandstone reservoirs of tidally influenced deltaic environment, is the main contributor to the Zawtika gas field, which has been producing biogenic gas since 2014. They are represented by five main formations in Moattama Basin, as described below.

Formations 4 and 5: Ayeyarwady Formation (Pliocene - Recent), consists of a thick sequence of fluvio-deltaic sediments (sandstones, siltstones and claystones), which were deposited by the Paleo Ayeyarwady River and deltaic system. This formation is the main sediment and contributor in block M9, main Zawtika area.

Formation 3: Kathabaung Formation (? Middle - Late Miocene), is regionally dominated by thick marine shale interbedded with thin-bed fine to very fine-grained sandstone during Miocene transgression.

Formation 2: Kwingyaung Formation I Upper - Lower Burman Limestone (Late Oligocene to Middle Miocene), consists of two carbonate units, Lower and Upper Burman Limestone Members, which underlie the Kathabaung Formation. This formation is directly overlying the volcanic basement. The Upper Burman Limestone Member is the productive reservoir interval, which is characterized by packstone, wackestone, grainstone of shallow marine carbonate, open lagoon, platform rim and fore-reef to slope environments. The Lower Burman Limestone member is characterized as a non-productive reservoir, which was deposited in a shallow marine environment. There are volcanic interbeds with carbonate in some areas, which might be related to volcanic activity during the early Miocene.

Formation 1: Oligocene lacustrine shale is comprised of lacustrine shale, muds and coal fanned during the syn-rift.

Formation 0: Volcanic Basement (Eocene?) was fanned by Pre-Rift stage during the Late Cretaceous to Eocene age. The character of the volcanic basement consists of agglomerate, tuffaceous.

Key sequence stratigraphy of the main Zawtika gas field is limited to Plio-Pleistocene (Formation 4 and 5) stratigraphy that is dominated by deltaic to shoreface environment. Progadation sequence is only observed at the shallowest section. Canyon features are very pronounced and spread all over the study area; Unit 4E-5F (Figure 2). Most of the study area is located on the coastal plain since late Pliocene to present. Delta slope and prodelta area are limited to the western and southern edge of M9 block.

Apart from conventional structural play, there are also potential plays related to a deltaic geological setting such as combination and stratigraphic plays that have not been proven trapping styles by any Zawtika wells. Combination and stratigraphic plays are proposed to be additional potential for exploration in main Zawtika area. Zawtika new resource assessment study is aiming to deliver the potential new play type resources (combination and stratigraphic plays) over existing 3D seismic in main Zawtika area. The study comprises geological setting analysis, play identification, trapping style, seismic special study, prospect and evaluation and proposed potential exploration area that conducted study in 2017. Conceptual of new trapping model from new play study can be summarized as four trapping styles (Figure 3):

1) Canyon-fill trap
2) Combination trap of deltaic sediment against canyon
3) Combination trap of channel and
4) Invisible channel trap (using channel model)

1) Canyon fill trap: The canyon-fill play was identified inside the canyon bodies that consider the individual channel and stacked channel levee as individual prospect. The sediment of the channel fills inside canyon may be transported from upstream river from the hinterland. These channel fills were sealed by the shaly sequence deposited inside canyon body. Many seismic attributes e.g. RMS, Maximum amplitude, spectral decomposition attribute have been generated to help outline the channel fills bodies inside the canyon. Many canyons in Asia have been used as analogous model for Zawtika canyons e.g. canyon found from Indus Fan from Pakistan and Bengal Fan from Bangladesh. Canyons found in Main Zawtika Area are about 5-12 km wide and 300-500 m thick, that is smaller than that of lndus and Bengal fan (Figure 4).

2) Combination trap of deltaic sediment against canyon: Combination trap against canyon play has been identified over Main Zawtika area. This play has been defined by potential highstand reservoir that has been indented by Canyon as demonstrated in Figure 5. The potential prospects were represented by strong amplitude reflector that against the edge of the canyon body which may be sealed by shaly sequence inside the canyon body. The chance of reservoir presence is quite high as canyon scoured at the high stand potential reservoir. However, the key geological risk may associate to the capacity of lateral seal.

3) Combination trap of channel: This play is identified based on anomaly apparent on various seismic attributes. The Zawtika core area is interpreted as tidal-influenced deltaic environment. The isolated channel sand is expected to creating combination trap over structural closure. The play is dominantly biogenic gas accumulating in Plio-Pleistocene section, focusing in Formation 5 due to biogenic gas window. Channel geometry and orientation is studied by integrating of seismic anomaly and well log characters. Anomaly is extracted from various seismic attributes, including of RMS amplitude, Maximum amplitude, General Spectral Decomposition (GSD). Gamma ray log character, sharp bedding and fining upward or blocky shape, is integrated to determine channel width, thickness and orientation in each particular reservoir unit. Combination trap of isolated channel, that has been proven in Arthit and Bongkot Fields, is generally created by channel orientates perpendicular to structural contour and up dip to fault. Trapping mechanism has to be considered in both of fault seal and lateral facies change seal. Typical trapping model of combination trap is illustrated in Figure 6.

4) Invisible channel trap (using channel model): This play is introduced after amplitude statistics study suggests some gas bearing sands are not related to amplitude and vice versa. In general, in Zawtika gas field, only some channel gas sand related to anomaly while the most is not. The potential area is determined based on promising trapping model only as mentioned in Figure 7. This kind of prospect identification is widely applied in the Gulf of Thailand where channel sand is unlikely to be detected by seismic. Principle of combination trap identification is applied from Arthit Field. The area of gas accumulation is justified from hydrocarbon column height; channel direction and average channel width are from studied. The un-detected channel play is not proven in Block M9 area, but already proven in Arthit and Bongkot areas of which the EOD are similar.

The main potential traps for new play study are Canyon fill trap and Combination trap of deltaic sediment against canyon. The first main trapping style is Canyon fill trap, which has been interpreted, based on geological setting model and using differences in seismic signatures in vertical seismic profile. The contrast of seismic shows lithology differentiation composed of sand-rich, shale-rich and/or alternative sand shale sediment in canyon body. The calibration from offset well result and seismic special study such seismic attribute, delineating the trending of sand-rich sediment are also using to expected to be reservoir potential within body of canyon. The second main trapping style is combination trap of deltaic sediment against canyon body. In this trapping style, muddy units within canyon body can act as lateral seal to trap gas in deltaic sediment that against to canyon body. The hydrocarbon exploration related to canyon also requires insight understanding of trapping styles of Canyon fill trap and Combination trap of deltaic sediment against canyon by using geological model, seismic feature and attribute and AVO study to increase the level of confidence for interpretation and evaluation.

Eventually, two new play prospects are planned to test and evaluate in the near future. Both Canyon fill trap and Combination trap of deltaic sediment against canyon while other two additional traps related to channel will be ranked and realized. The new play potentials in the main Zawtika area with economic findings will potentially support sustainability and future growth of Zawtika development field.

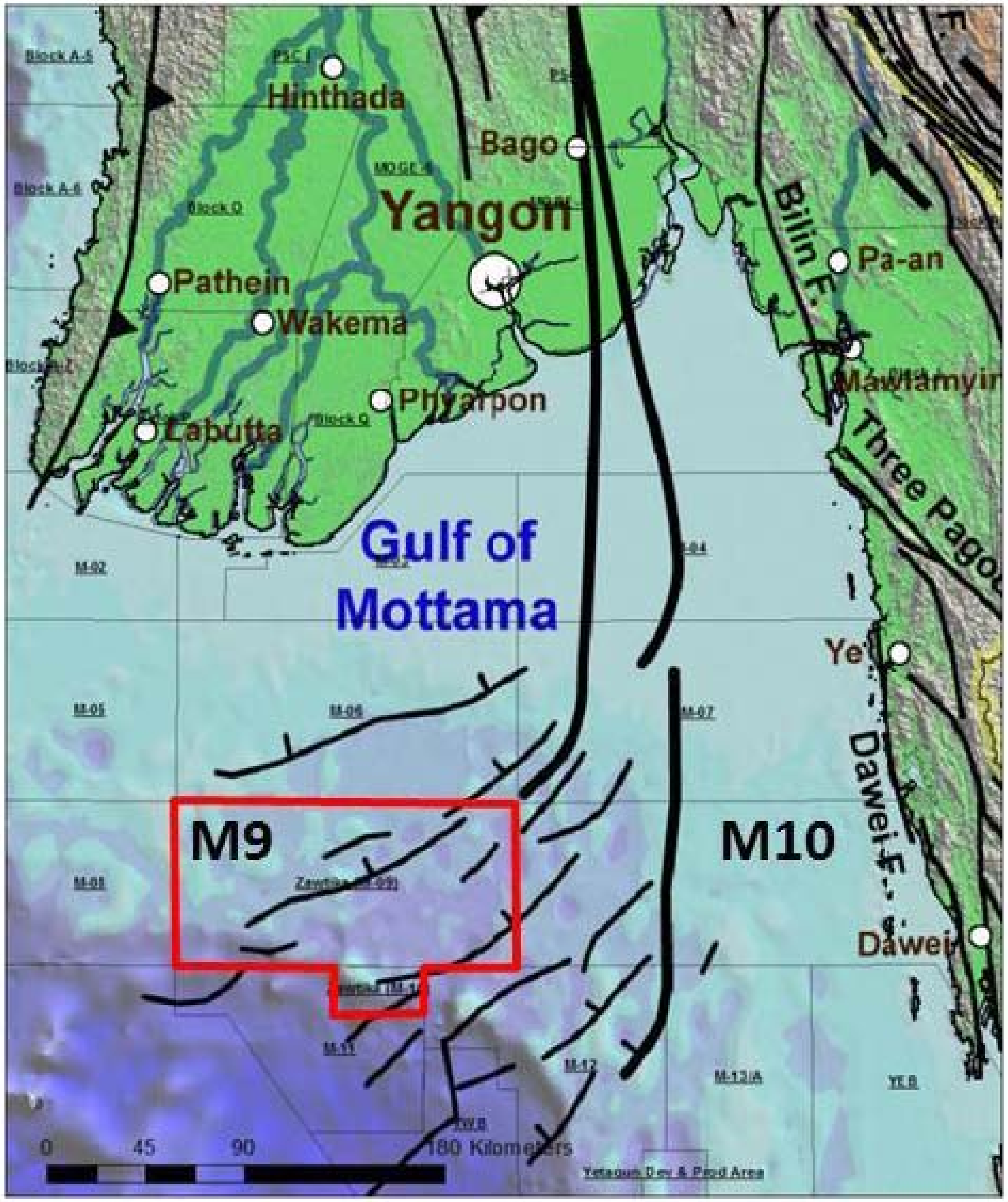

Figure 1. Location of Block M-9 in Moattama Basin, Gulf of Moattama, Offshore Myanmar.

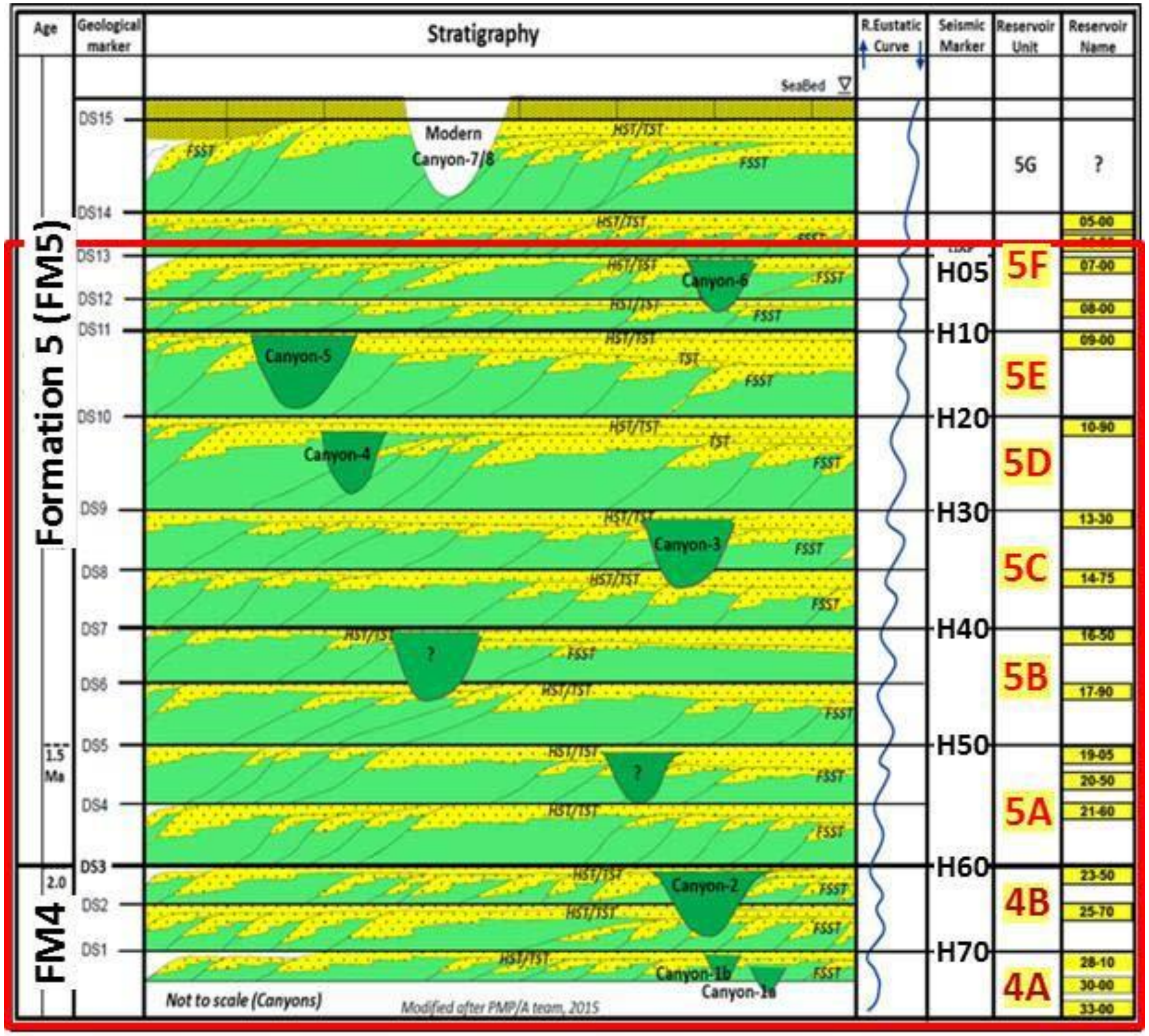

Figure 2. Sequence Stratigraphy of Formation 4 and 5, Moattama Basin.

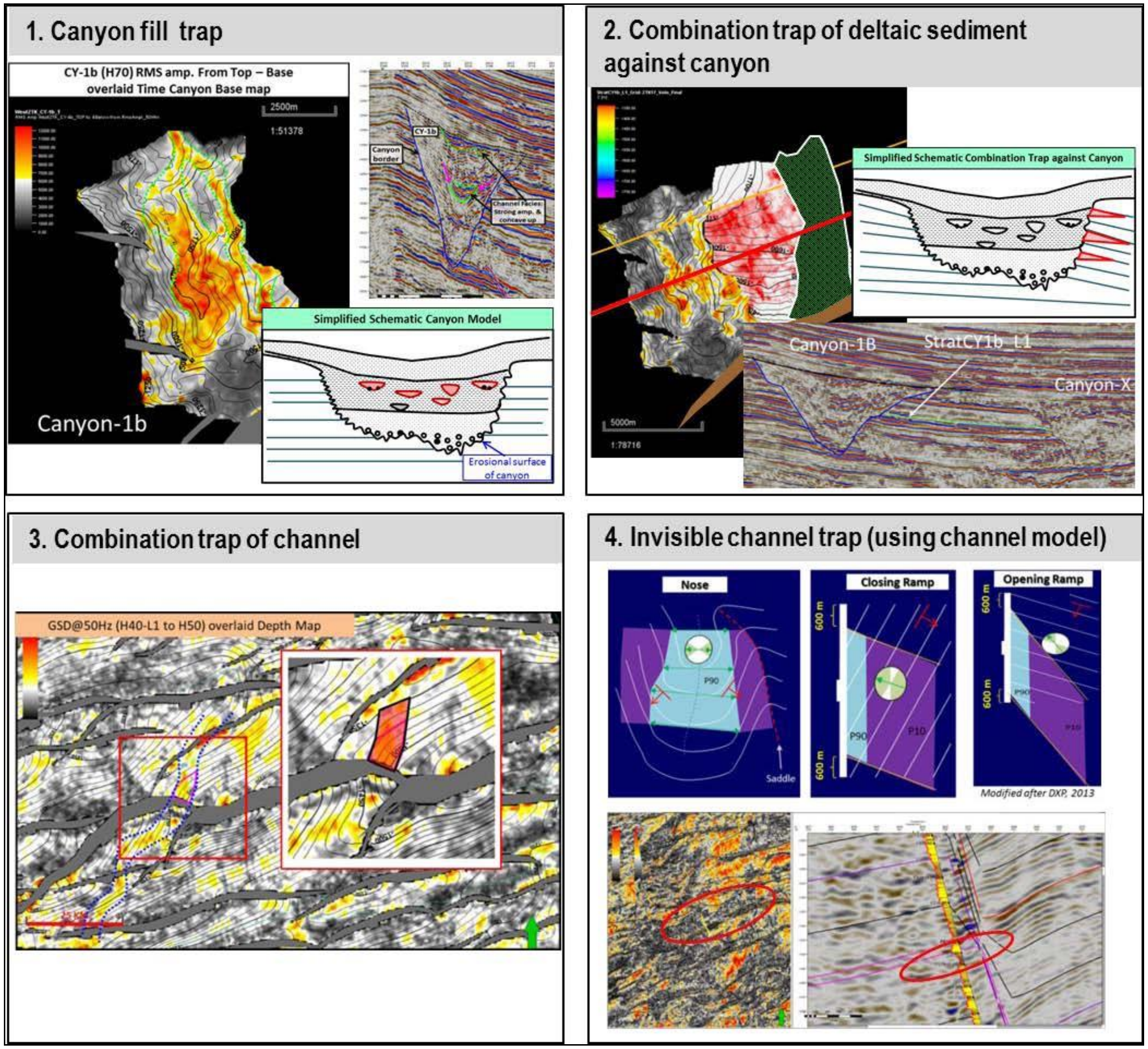

Figure 3. Conceptual of New Trapping Model in Main Zawtika development Area.

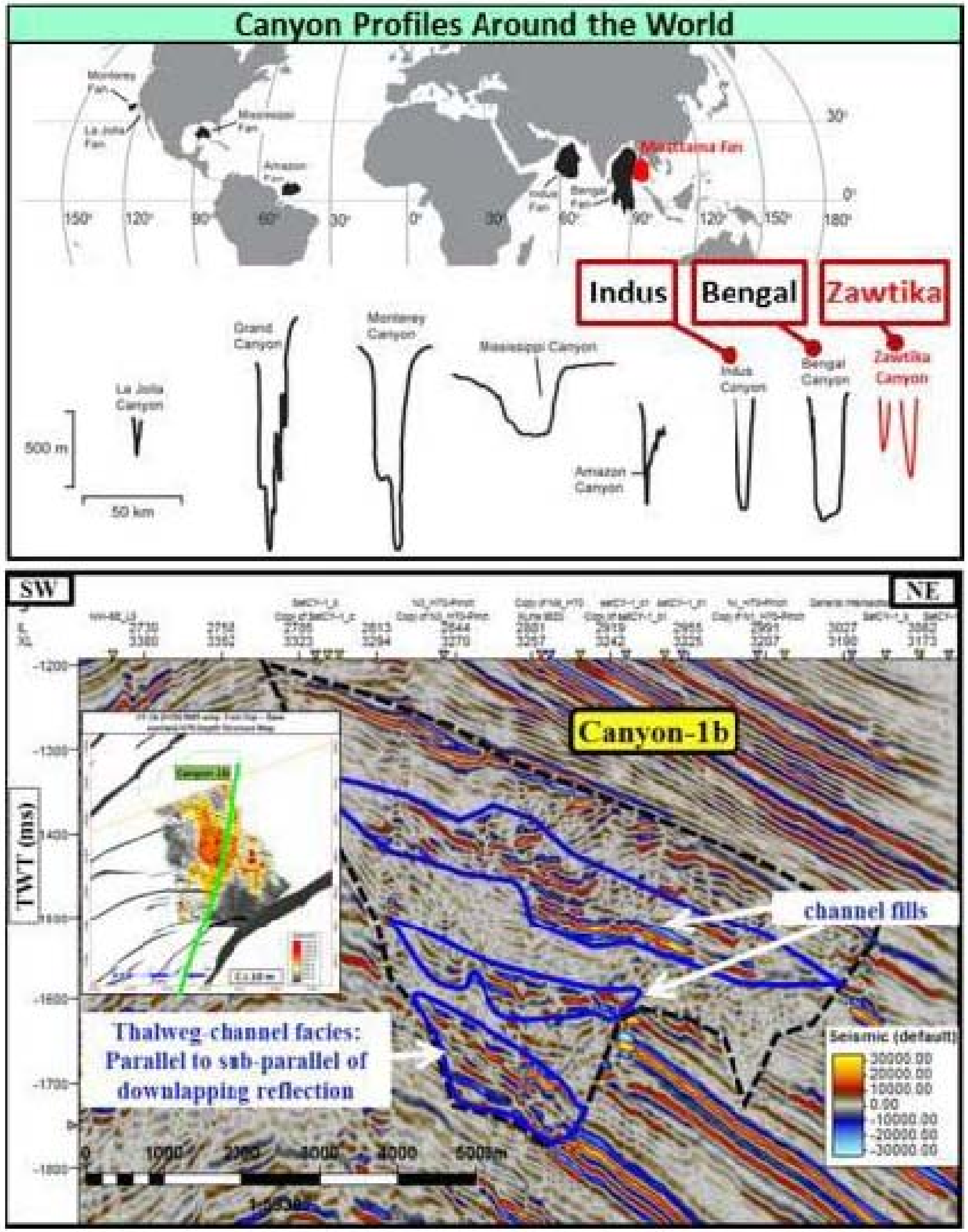

Figure 4. Conceptual Model of Canyon Fill Trap.

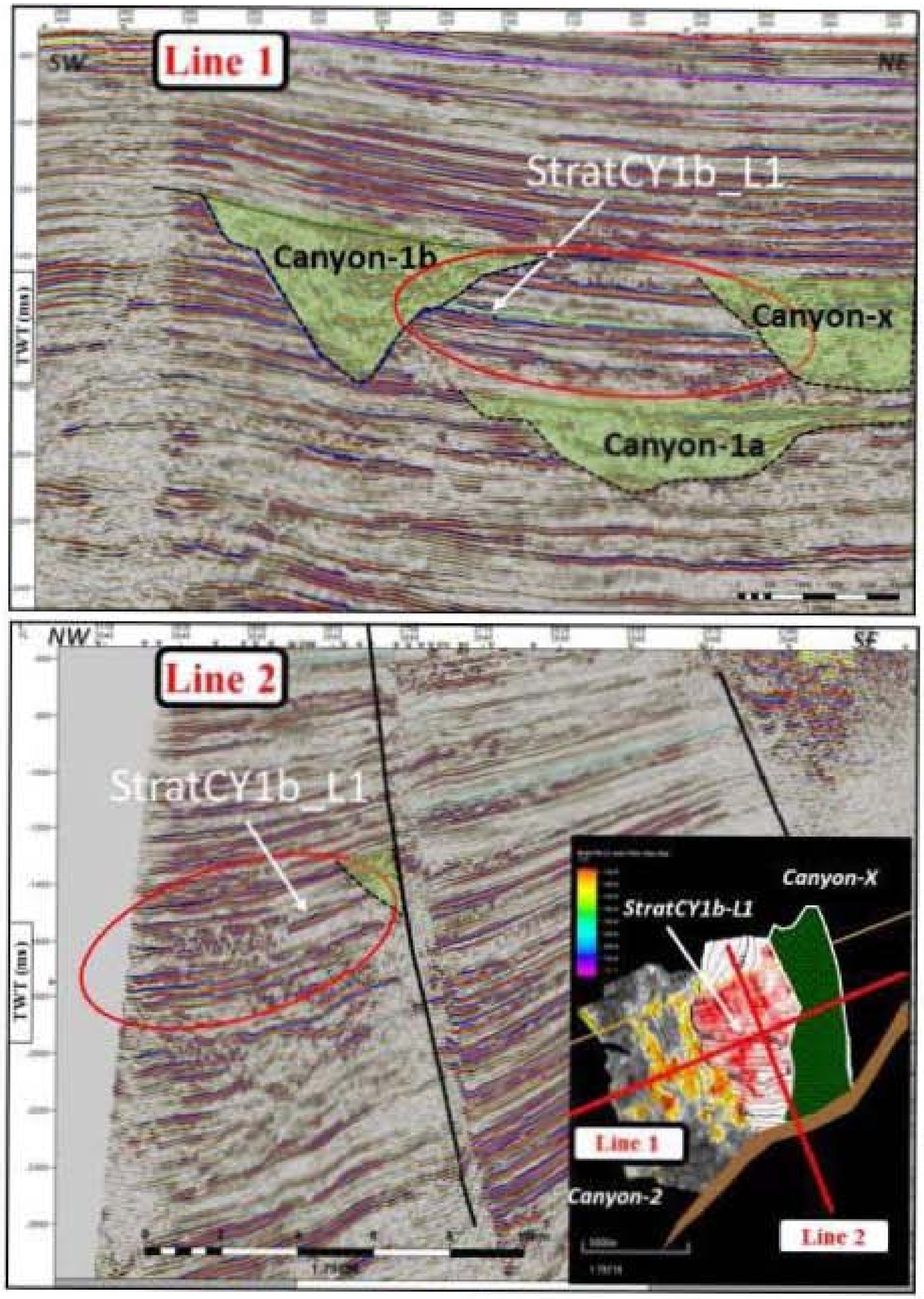

Figure 5. Conceptual Model of Combination Trap of Deltaic Sediment against Canyon.

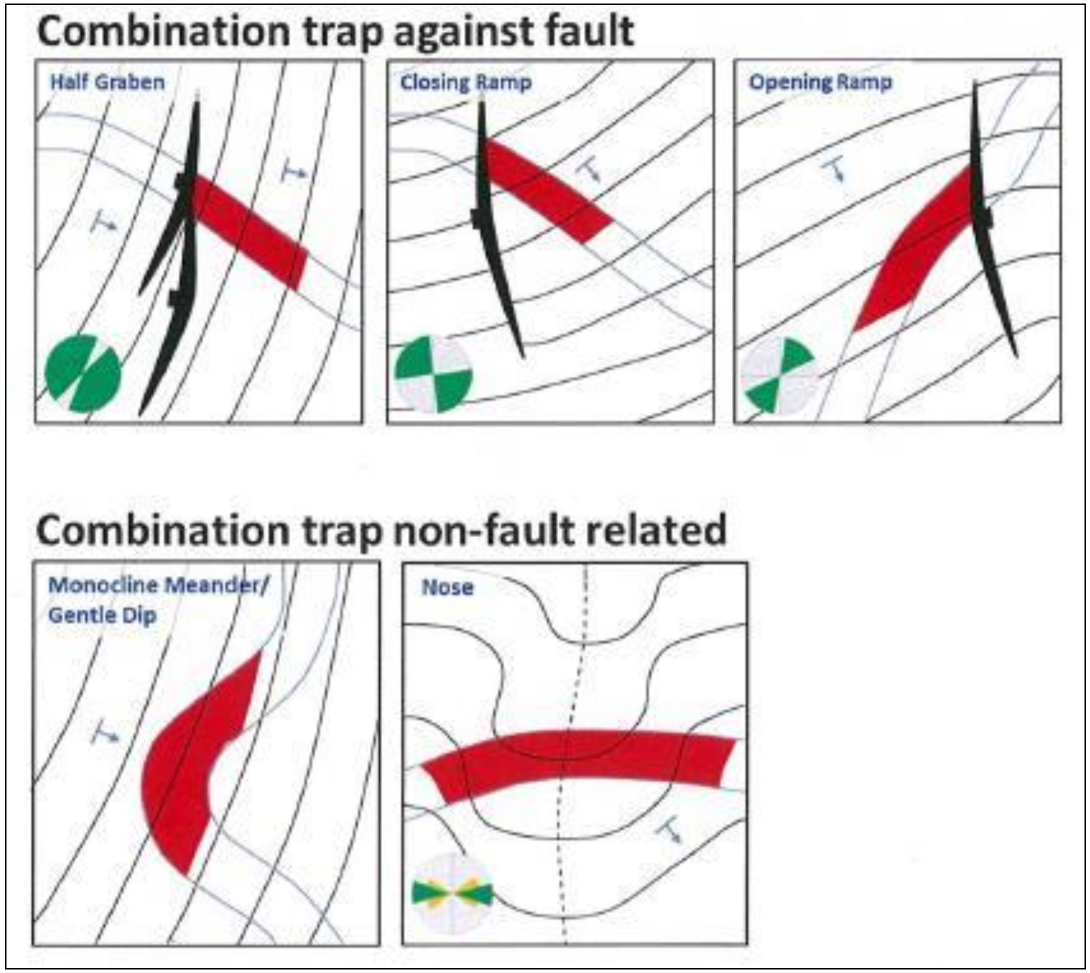

Figure 6. Typical Trapping Model of Combination Trap of Channel.

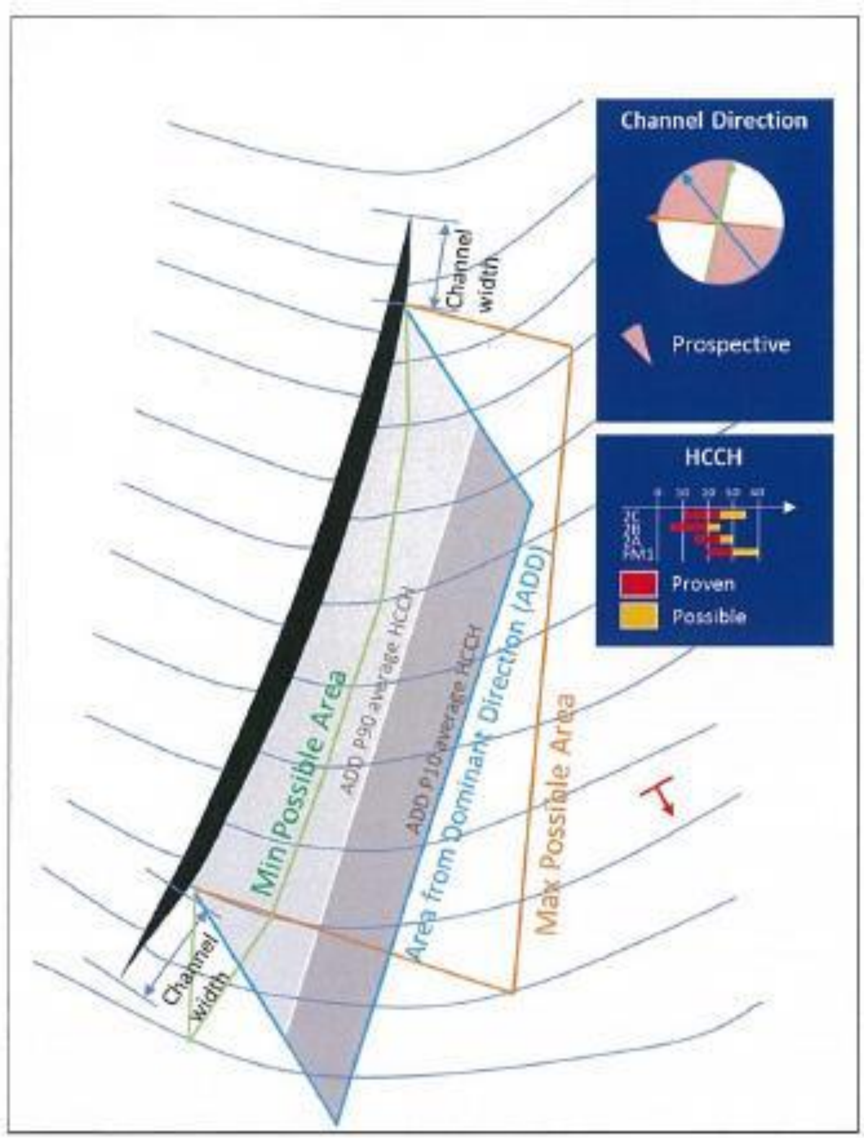

Figure 7. Invisible Channel Trap Area Identification (Using Channel Model).