



НЕФТЬ И ГАЗ: ТЕХНОЛОГИИ И ИННОВАЦИИ

Материалы
Международной научно-практической конференции

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В материалах конференции изложены результаты исследовательских и опытно-конструкторских работ по широкому кругу вопросов.

В состав сборника вошли материалы работы секций: «Геология и геофизика месторождений нефти и газа», «Разработка нефтяных и газовых месторождений», «Бурение нефтяных и газовых скважин», «Строительство и обустройство нефтегазопромыслов», «Проектирование, сооружение и эксплуатация систем транспорта углеводородного сырья», «Автоматизация, моделирование и информационные технологии в нефтегазовой отрасли и геологии», «Экология, природопользование и промышленная безопасность в нефтегазовой отрасли», «Современные материалы, технологии и конструкции, используемые в нефтегазовом комплексе», «Химическая технология в нефтяной и газовой промышленности», «Автомобильно-дорожные проблемы нефтегазового комплекса», «Проблемы и инновации в управлении нефтегазовым сектором экономики: макро-, мезо- и микроуровень», «Социально-гуманитарные аспекты развития нефтегазового региона».

Издание предназначено для научных и инженерно-технических работников, руководителей и управленческих работников предприятий нефтегазовой отрасли, а также аспирантов и студентов технических вузов.

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СЕКЦИЯ «Геология и геофизика месторождений нефти и газа»

Overview of non-structural traps distribution in Song Hong basin

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In recent year, the petroleum production rates from structural traps or pre-Tertiary basement have declined quite rapidly. To achieve the goal of sustainable development of Vietnam's oil and gas industry, focusing on the prospecting and exploration of unconventional oil and gas reservoirs, especially stratigraphic traps, will be one of the very urgent tasks.

The aim of this paper is to provide an overview of the non-structural trap distribution in the Song Hong basin. The paper focuses on identifying non-structural traps such as stratigraphic, lithological, and combined traps. Based on the analysis of seismic data, exploration drilling and previous studies, the paper clarifies the distribution rules and formation mechanisms of non-structural traps in the Song Hong basin. Finally, the paper provides detailed directions for exploration, thereby promoting the process of replenishing oil and gas reserves in this area, while expanding the exploration capabilities of new potential oil and gas fields in the future.

On the continental shelf of Vietnam, oil and gas fields are discovered mainly in traditional structural traps with major objects such as: Pre-Tertiary fractured basement, sandstones in Oligocene, Miocene and carbonate sediments. However, the stratigraphic traps (lithological traps, pinch-out traps, turbidite fans, etc.) have not been focused on detailed studies, but only a few small oil and gas reservoirs discovered by chance during the research and prospecting for traditional objects or just seen as a secondary object discovered in combination traps.

Song Hong basin is a Tertiary sedimentary basin (Figure 1) formed from a NW-SE trending pull-apart graben, the flanks of which are bounded by strike-slip and normal fault system. These fault systems were triggered by the collision between the Indian and the Eurasian plates during the Eocene-Early Oligocene. Left lateral strike-slip movement in the Oligocene, right lateral movement in the Late Miocene, and pull-apart extension are the major geodynamic elements that form the Song Hong basin. Immediately following the Middle-Late Miocene tectonic inversion, the basin continued to steadily undergo thermal subsidence until the present. The stratigraphy of the Song Hong basin is relatively complicated. It comprises the Pre-Tertiary basement, as well as Paleogene, Neogene, and Pliocene-Quaternary sediments. Song Hong basin presents source rocks in the Oligocene, Lower Miocene and Middle Miocene sediments, deposited in terrestrial, fluvio-deltaic, and lacustrine environments. Traps formed before or in Early-Mid Miocene are favorable for hydrocarbon accumulations. Traps formed

in the Late Miocene-Pliocene may be gas or condensate accumulations. Prospects formed before and/or syn-deposited in the Late Oligocene to Early Miocene, and tectonically stable through time are probably the most prospective for oil accumulations. Reservoirs there are 3 main reservoirs: Miocene and basement carbonates, Oligocene-Miocene sandstones, Upper Miocene-Pliocene fan and turbidite. On the other hand, the Pliocene and Upper Miocene shales are generally considered as seals.

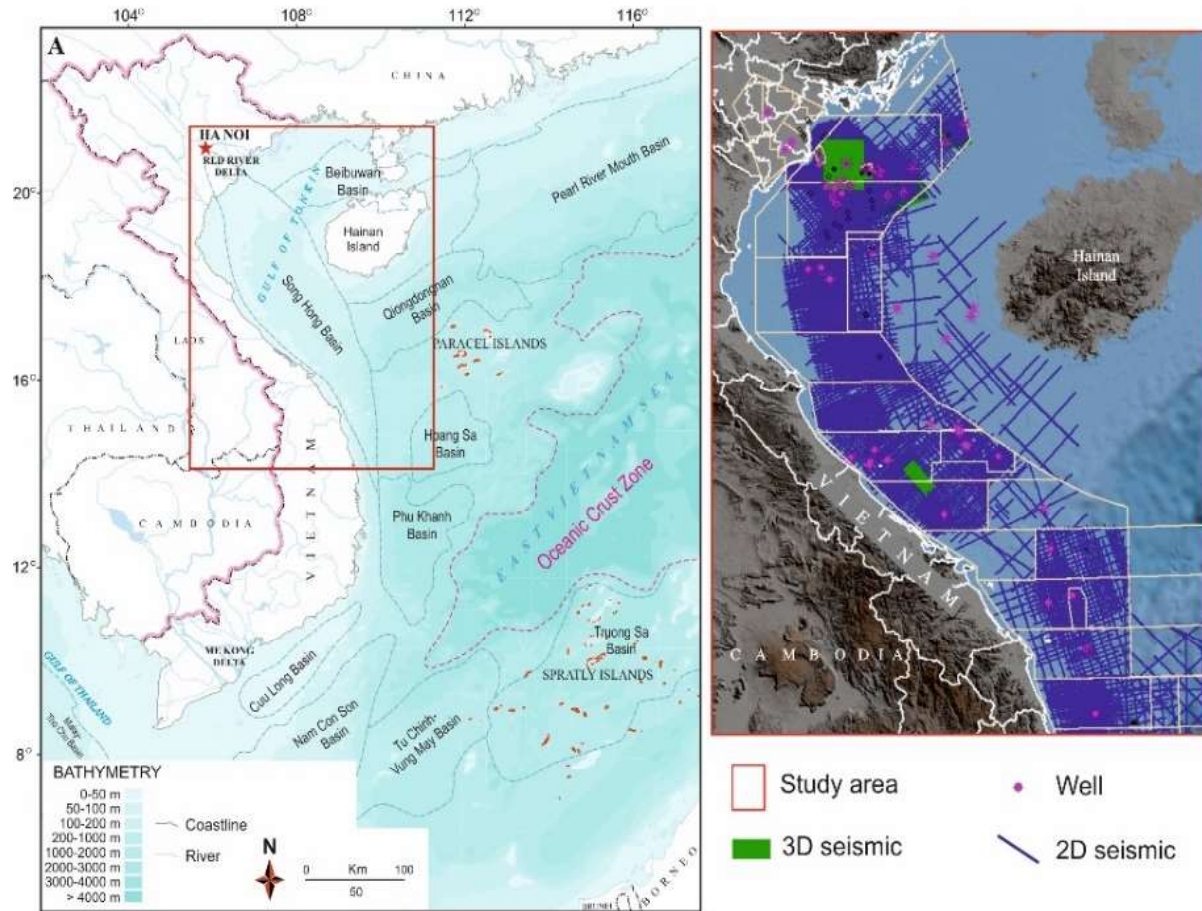


Figure 1. Map of location of Tertiary basins on the continental shelf of Vietnam and seismic and well database available in the Song Hong Basin

The Song Hong basin has a very thick sediments, deeply deposited up to approximately 14 km, formed by strong subsidence in the central part of the basin. This is a favorable condition for the formation of stratigraphic traps, turbidites in Lower Pliocene, Upper Miocene in the blocks 105, 108, 109, 110, 111, 112, 113&115, and Quang Ngai graben (block 118). In the central part of the basin, many turbidites traps were discovered adjacent to diapirs with petroleum potential such as Bao Vang, Bao Trang prospects.

In the research of Nguyen The Hung (2008) [1], 8 stratigraphic traps (turbidite) were discovered North of Song Hong basin (blocks 110 to 113) and these traps have high petroleum prospect related to 4 objects in Late Miocene

and Pliocene formations, other 4 objects in Oligocene - Middle Miocene formations (Figure 2a).

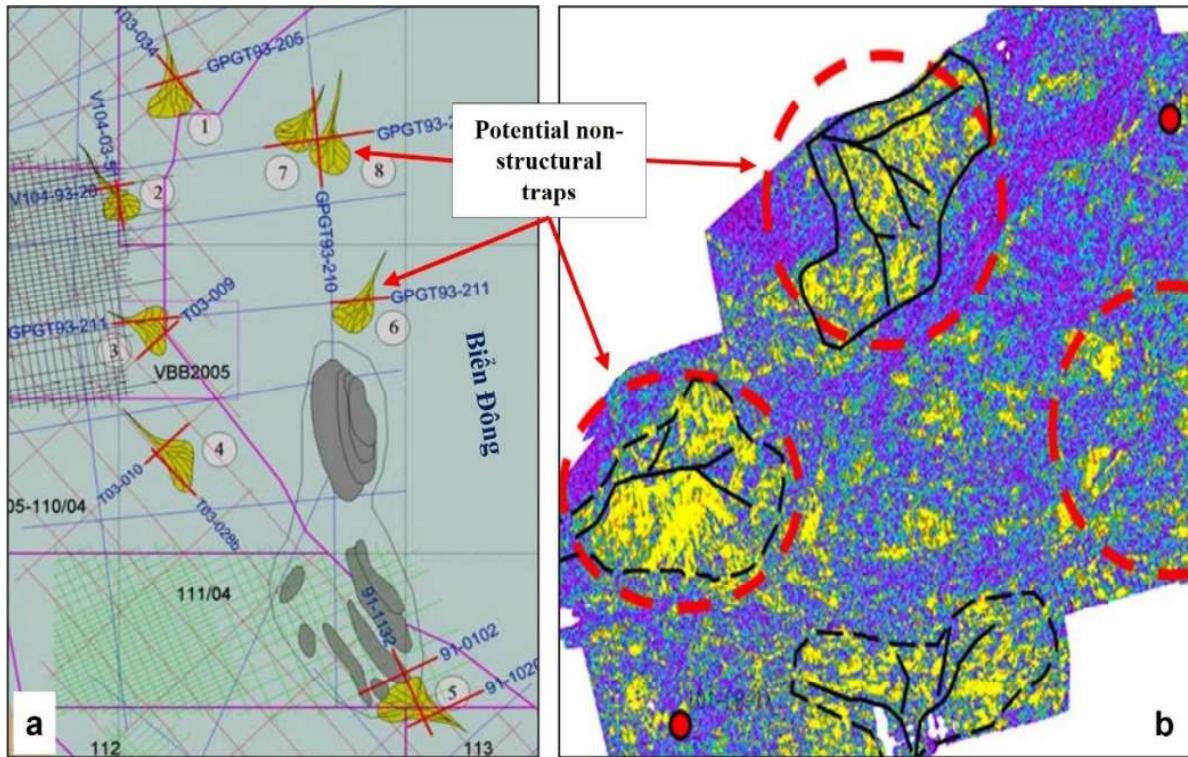


Figure 2. a) Location of stratigraphic traps in the Song Hong basin [1];
b) Prediction of non-structural traps location in the block 100-101 based on the Spectral Decomposition seismic attribute

Some special seismic methods were applied in the block 100-101 based on seismic attribute analysis and sequence stratigraphy to delineate the location and distribution of 3 submarine-fans in the lacustrine environment (Figure 2b) and at the same time assess the oil and gas potential and geological risks of these objects.

In 2012, on the basis of statistics of different stratigraphic traps, Truong Minh showed that about 110 stratigraphic traps were discovered with potential oil and gas in the continental shelf of Vietnam [2]. In the Song Hong basin, fan traps in Oligocene at depths of 4500-4700m, many lithological traps discovered in Lower Miocene limestone, pinch-out traps in Oligocene, Lower Miocene and Middle Miocene with different sizes at depths from 2500-2600m to 3400-3600m. In the Song Hong basin, lithological traps in carbonate rocks and stratigraphic traps in clastic sediments were discovered with sizes from $6 \times 2 \text{ km}^2$ to $20 \times 8 \text{ km}^2$ at depths 1,4-1,8 km and 7,6 -8 km.

In the northern area of basin (within blocks 102-106, and 103-107), potential stratigraphic traps were discovered such as onlap or incised channel (Figure 3).

In 2017, Le H.A. applied Spectral decomposition analysis combined of sequence stratigraphy, well logs, and seismic attribute to identify non-structural

traps in Oligocene, Miocene sediments in blocks 103 to 110 [3]. The results have identified several of non-structural traps such as onlap, pinch-out, or canyon fill sands in the coastal and shelf facies, submarine fan and turbidites in the shelf facies. These traps are distributed in shelf strips extending perpendicular to the direction of sedimentary material from west to east.

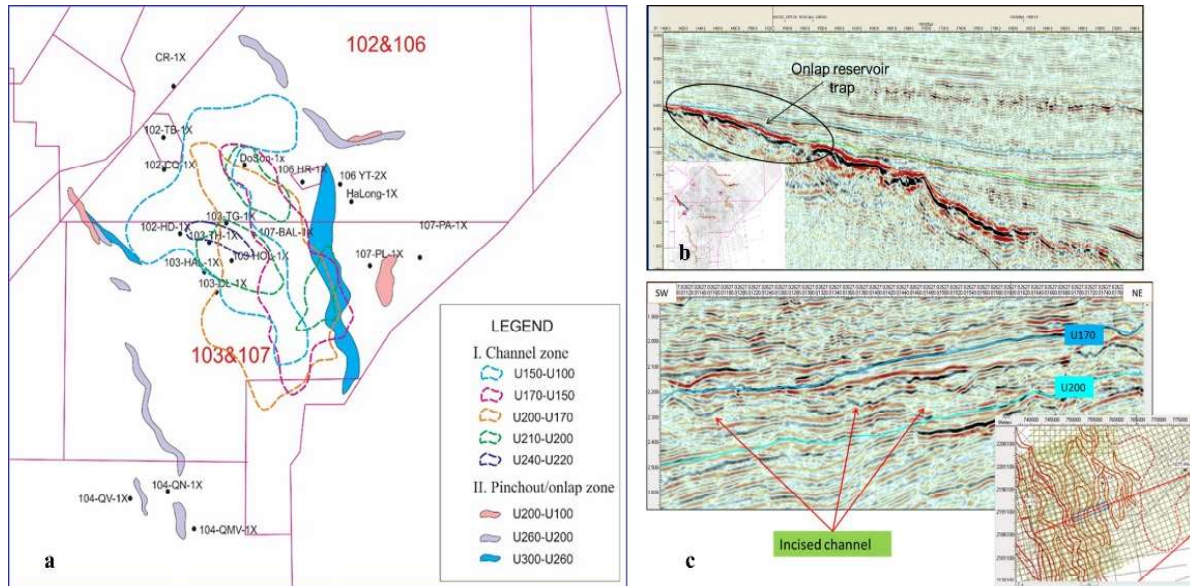


Figure 3. a) Map of potential non-structural trap distribution in the Northern Song Hong basin; b) Onlap reservoir trap; c) Incised channel

Within block 103-107, northern Song Hong basin, Ho T.T. (2017) has shown a number of potential reservoirs [4]. Slope apron systems, and turbidite systems are distributed within the Middle Miocene section in the Eastern area. Canyon-fill sands at the base of the lower Upper Miocene in Northwest area.

Cua Lo gas prospect located on the eastern side of the block 105-110/04 of Song Hong basin. Sandstone reservoirs are deposited within the Mio/Pliocene submarine fan system, and encased in shales to form stratigraphic traps. The sedimentary systems consist of Mio/Pliocene slope fan complex, and Pliocene channels. Amplitude Versus Offset (AVO) analysis on 3D seismic data has shown that non-structural traps in the Cua Lo prospect can be identified through amplitude anomalies. The seismic section (Figure 4) shows Mio/Pliocene fan systems and channels. Cua Lo has prospective recoverable resources of up to 13.9 TCF.

In 2019, ENI has confirmed a considerable hydrocarbon accumulation in the Ken Bau discovery, further expanding its potential in Song Hong basin with the first exploration well, drilled to a total depth of 3606 m, discovered gas and condensate in several intervals of Miocene sandstones interbedded with shales [6]. One year later, the second exploration well drilled 2 km apart from the first well, encountered a pay about 110 m in several intervals of Miocene sandstones. The results obtained at the Ken Bau wells were confirmed a considerable hydro-

carbon accumulation in deep-water sediments and opened up further direction of exploration of the southern region of the Song Hong basin.

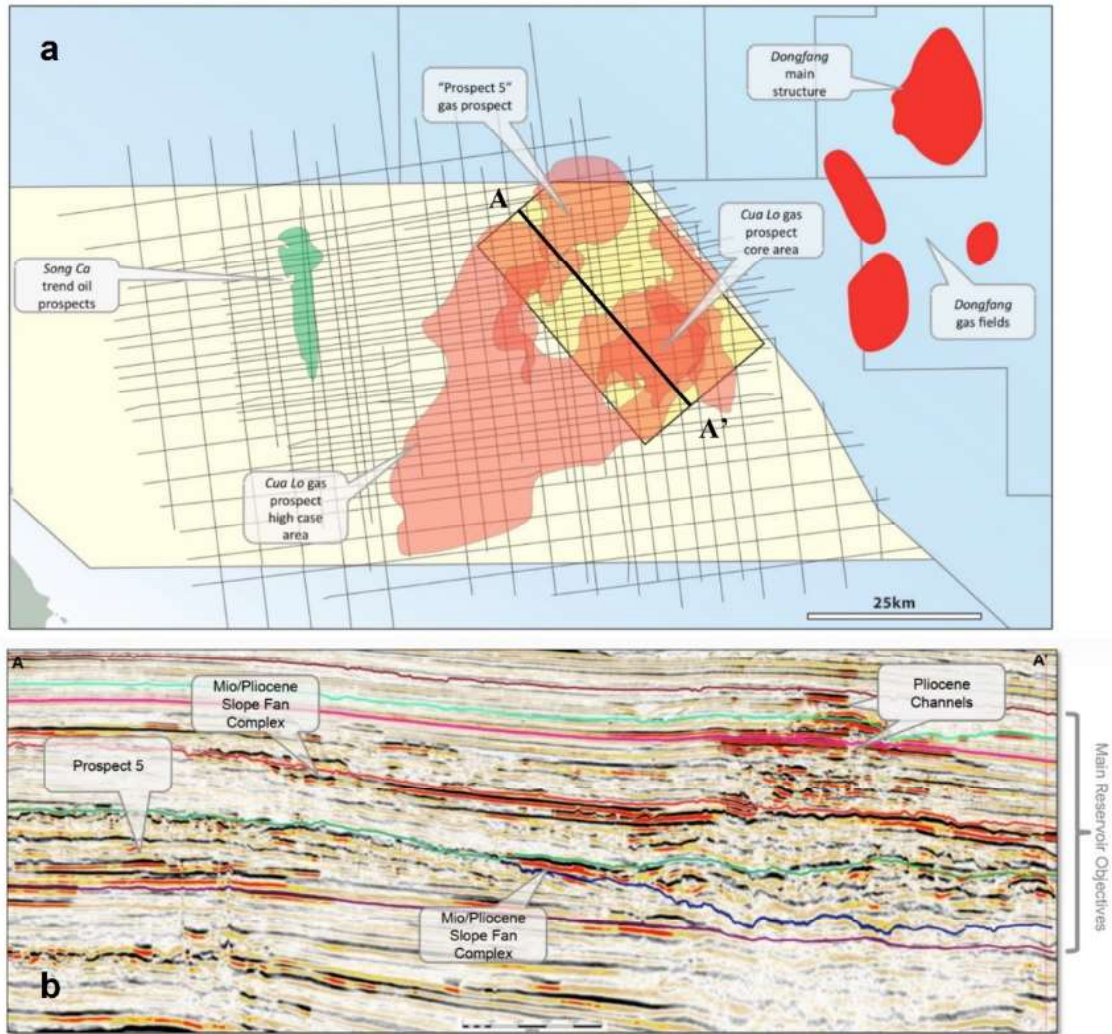


Figure 4. a) Map of block 105-110/04 showing location of Cua Lo prospect;
b) Several Mio/Pliocene non-structural traps identified on seismic data [5]

In general, the researches on stratigraphic traps in sedimentary basins on the continental shelf of Vietnam in general and Song Hong basin in particular are still preliminary and have only focused on a specific object without comprehensive and systematic studies on the mechanism of formation, development and distribution of stratigraphic traps.

From the research results conducted in the Song Hong basin, it is possible to select several potential non-structural trap areas in the Ham Rong area, as well as ancient channel systems in the Miocene sediments of blocks 102-106, and shallow marine and pre-deltaic Miocene sediments in block 103-107, Cua Lo prospect in block 105-110/04. To expand search and exploration efforts, evaluate petroleum potential, and predict the risks for new geological targets, it is crucial to apply new methods technologies. These advancements will help

in studying the characteristics, formations mechanisms, and distribution of these non-structural traps in general detail.

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Permeability forecast for carbonate oil gas reservoir based on hydraulic flow unit division

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Carbonate reservoir are important in oil and gas exploration and exploitation. According to statistics, it is estimated that about 60% of the world's oil and gas reserves are in carbonate reservoir rocks and a lot of researchs suggested that 70% of conventional oil and gas reserves in the Middle East are in carbonate reservoir rocks. Because of the importance of discoveries in carbonate reservoir and the complexity of this type of reservoir, studies related to carbonate reservoir abroad, especially related to the description of carbonate reservoir properties, have long been highly valued. Studies by Archie (1952), Dunham (1962), Lucia (1987), G.V. Chilingarian (1992, 1996), Pittman (1971, 1992), Amaefule (1993) ... all emphasized the heterogeneity of carbonate reservoir and the need to classify rock types in carbonate reservoir. The distinction of carbonate-bearing rocks is closely related to the distinction