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Development Challenges and Reservoir Evaluation of Bina Bawi Gas Field

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Abstract

The Bina Bawi gas field is located in Sulaymania Province 60 km from Erbil Province, the Kurdistan region of northern Iraq. The Bina Bawi#1 exploration well was drilled in a total depth of 3,355 meters (11,007 feet) for the purpose of testing the hydrocarbon potential of the Triassic-Jurassic carbonate reservoirs of Kurra Chine; Qamchuqa (Primary) and Butmah Sarki (secondary).

A midstream pre-FEED study was completed in early 2017 and the field development plan (FDP) was submitted to the Kurdistan Regional Government (KRG) - Ministry of Natural Resources (MNR) in 2018.

The oil and gas field, is expected to help the Kurdistan Regional Government in meeting the domestic gas demand and for export to Turkey according to the contract agreed with Genel.

The Triassic Kurra Chine and Geli Khana formation is represented in a large anticlinal structure. The oil rim lies in the Jurassic formation. The resources need further appraisal well to turn them into a reserve. The gas is very sour gas and requires specialised technology.

The development of the Bina Bawi field needs further planning to minimize costs and reduce risk. A phased development would allow to gain additional knowledge about the reservoir, control costs and reduce the risk of development. The dispute between KRG and the federal government represented by the Ministry of Oil, and the decision of the supreme court about the validity of any KRG oil and gas contracts poses a risk complicating International Oil Companies (IOC's) investment in Iraqi Kurdistan.

Keywords: Challenge of reservoir evaluation, oil rim, sour gas, cost extensive.

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تحديات التطوير وتقييم المكامن لحقل غاز بينا باوي

الخلاصة:

يقع حقل غاز بينا باوي في محافظة السليمانية على بعد 60 كيلومترًا من محافظة أربيل، إقليم كردستان شمال العراق. حُفرت بئر الاستكشاف بينا باوي رقم 1 على عمق إجمالي يبلغ 3,355 مترًا (11,007 قدمًا) لغرض اختبار إمكانات الهيدروكربون في خزانات الكربونات الثلاثية-الجوراسية في كورا تشاين؛ وقامجوقة (الأساسية) وبطمة سركي (الثانوية). اكتملت دراسة ما قبل التصميم الهندسي الأولي في منتصف عام 2017، وقُدمت خطة تطوير الحقل (FDP) إلى حكومة إقليم كردستان - وزارة الموارد الطبيعية (MNR) في عام 2018. من المتوقع أن يساعد حقل النفط والغاز حكومة إقليم كردستان في تلبية الطلب المحلي على الغاز وتصديره إلى تركيا وفقًا للعقد المتفق عليه مع شركة جينيل. يمثل تكوين كورا تشاين وجيل خانة الثلاثيان في بنية محدبة كبيرة. تقع حافة النفط في التكوين الجوراسي. تحتاج الموارد إلى مزيد من التقييم لتحويلها إلى احتياطي. يتميز الغاز بتركيبة غازية حمضية عالية، ويتطلب تقنيات متخصصة. يتطلب تطوير حقل بينا باوي مزيدًا من التخطيط لتقليل التكاليف والمخاطر. سيسمح التطوير التدريجي باكتساب معرفة إضافية حول المكمن، والتحكم في التكاليف، وتقليل مخاطر التطوير. يُشكل النزاع بين حكومة إقليم كردستان والحكومة الاتحادية ممثلةً بوزارة النفط، وقرار المحكمة العليا بشأن صحة أي عقود نفط وغاز لحكومة إقليم كردستان، خطرًا يُعقّد استثمارات شركات النفط العالمية في كردستان العراق.

1. Introduction

To define the hydrocarbon estimation of the Bina Bawi structure (Figure 1), the stratigraphy from Taq Taq field Well #1 which is close of the structure, was used to analogue the stratigraphy at the Bina Bawi structure. Reservoir and seal rocks, their depth and thicknesses were defined in reference to this well. If the geological model is confirmed by a drilled well then closer understanding the subsurface structural.

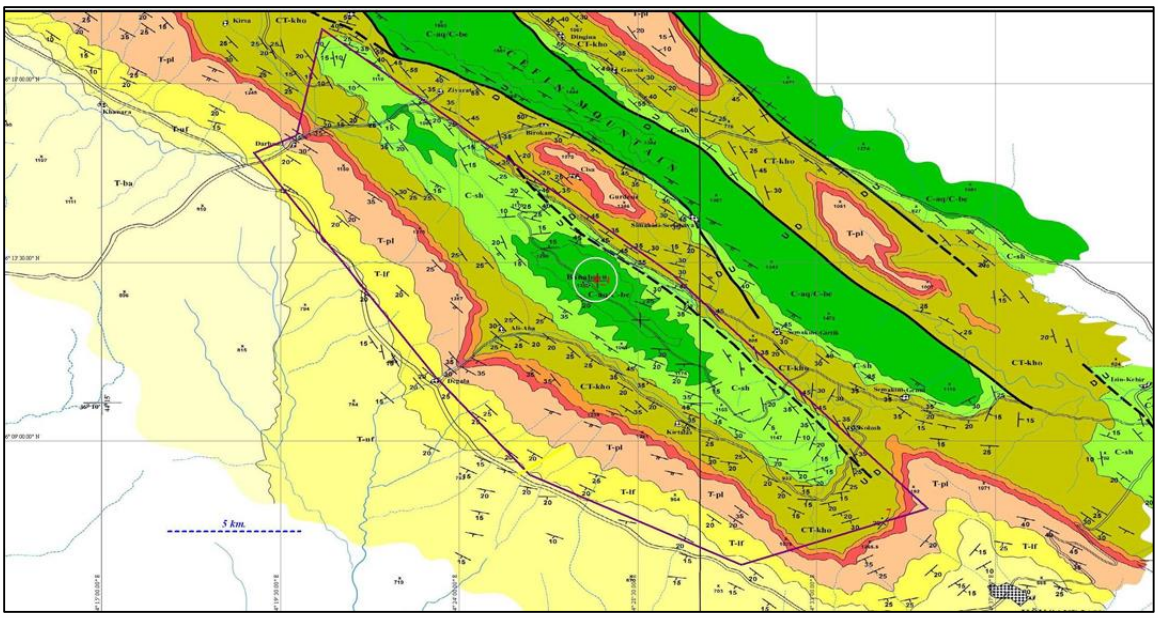

Fig. (1): Bina Bawi structure [1].

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The Bina Bawi # 1 is located 50 km NE of Erbil city, between Shaklawa, Selahaddin and Koy Sandjak cities. The well tested six million (SCF/d) in the Triassic formation, while the Cretaceous yielded shows of light oil 35° API. The Bina Bawi-3, Jurassic formation contains an 800 m column of hydrocarbon shows at Bina Bawi-3 well, which produced during test more than 4,000 (bbl/d) barrels of light oil a day. The hydrocarbon specification showing 190,000 ppm of hydrogen sulphide (H_2S) and 50,000 ppm of carbon dioxide (CO_2). The fourth appraisal well, Bina Bawi-4, focused on testing the Jurassic, Triassic and Permian formation. The Bina Bawi 5 focussed on the Jurassic and Triassic formation. Furthermore, additional test was executed the closure of the structure to the North West. A well tests confirmed the presence of a 1,500m gas column, which confirmed the field to be a gas discovery [2, 3, 4].

The field was declared commercial in March 2013, following completion of the extended well test (EWT). The extended well tests which confirmed small oil rims and significant increase of source gas. Extended well tests on Bina Bawi 4, 5, and 6 wells were completed in 2014, which resulted in substantially lower oil rims, but a significant increase in sour gas shows and sour gas potential. No H_2S content and rate of flow at this level has been measured as all the tests were unsuccessful The gas quality within Triassic could very similar to the quality of Jurassic discovery at 190,000ppm of hydrogen sulphide (H_2S) and 50,000ppm of carbon dioxide (CO_2).

1.1. Formation Tops

The actual stratigraphy penetrated at Bina Bawi #1 is as follows in Table (1):

Table (1): Formation tops [5]

Formation	Measured Depth (m)	Subsea Depth (m)	Thickness (m)
Kometan	Surface	+1348	215
Gulneri/Dokan	222	+1133	20
Qamchuka	242	+1113	317
Upper Sarmord	559	+796	140
Garagu	699	+656	78
Lower Sarmord	777	+578	79
Chia Gara	1015	+340	122
Barsarin	1137	+218	196
Naokelekan	1211	+141	69
Sargelu	1270	+85	141
Sehkanian	1411	-56	129

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Vol. 15, No. 2, June 2025, pp. 33-43
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Butmah/Sarki	1540	-185	295
Baluti	1835	-479	116
Kurra Chine + Geli Khana	1951	-596	1404 p.
T. D.	3355	-2000	

1.2. Formation Evaluation

Visual examination of core and cuttings samples, paleontological analysis, cores, evaluation of wireline logs, drill-stem tests and deviation surveys.

1.3. Wireline Logging

PNN logs were taken to fulfill the requirements met usually by Density and Neutron logs. However, the results of PNN logs were not conclusive by themselves and needed to be justified by other means [5].

1.4. Stratigraphy at Bina Bawi #1

The stratigraphic sequence of the Bina Bawi structure presented here is based on the information from the field study and the data gathered from nearby Taq Taq-1 well. Bina Bawi-1 well completed at Kurra Chine - Geli Khana formations reaching the final depth of 3355 meters [1,6,7].

1.5. Lithology

Figure (2) illustrate the formation contacts and columnar section of BB-1

Kometan Formation: (surface – 222m.)

Dokan Formation : (222m – 242m)

Qamchuka Formation: (242m – 559m)

Upper Sarmord Formation: (559m – 669m)

Garagu Formation: (669m – 777m)

Lower Sarmord Formation: (777m – 1015m)

Chia Gara Formation: (1015m – 1137m)

Barsarin Formation: (1137m – 1211m)

Naokelakan Formation: (1211m – 1270m)

Sargelu Formation: (1270m – 1411m)

Sehkanian Formation: (1411m – 1540m)

Butmah/Sarki Formation: (1540m – 1835m)

Open Access
Vol. 15, No. 2, June 2025, pp. 33-43

P- ISSN: 2220-5381
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Baluti Formation: (1835m – 1931m)

Kurrachine-Gelikhana Formation: (1931m – 3355m)

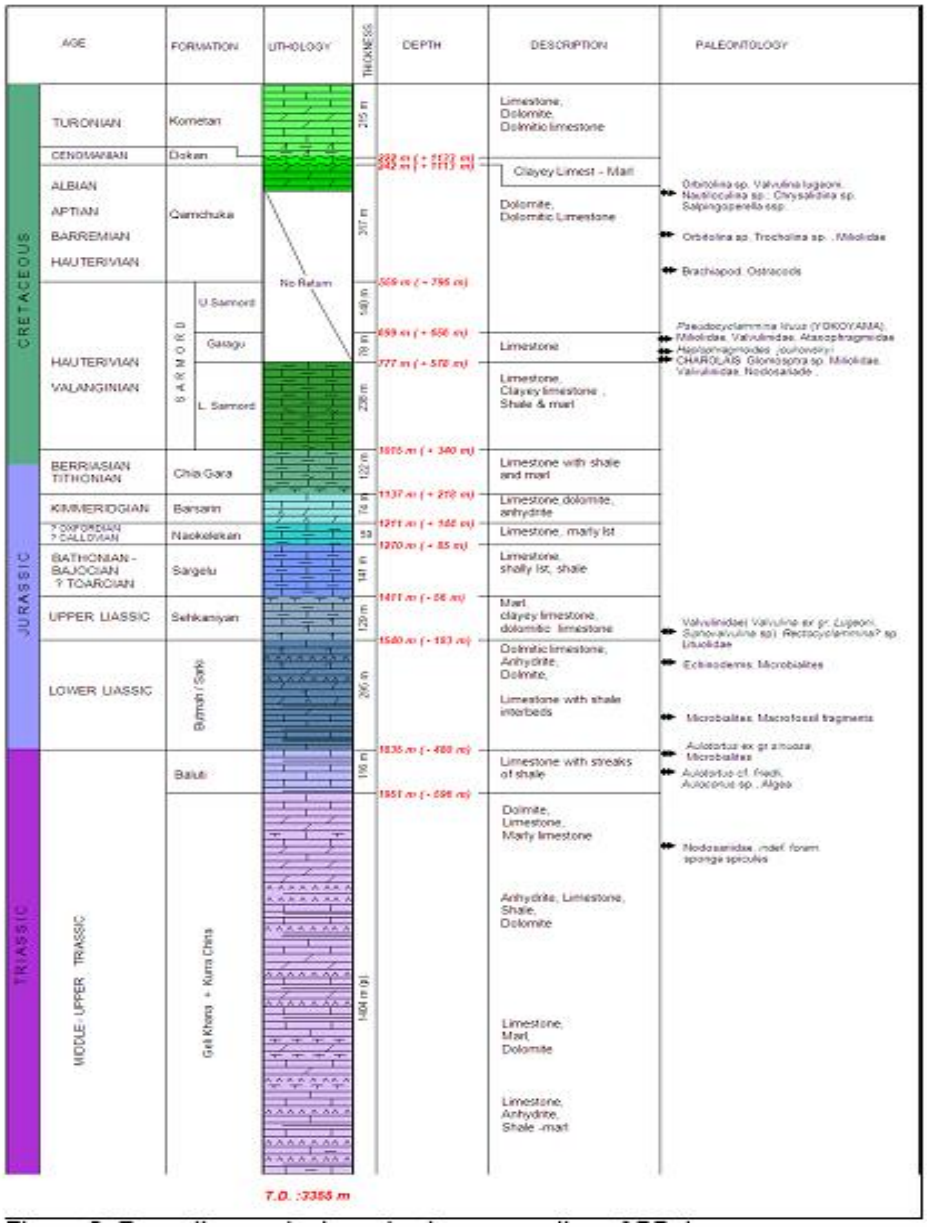

Fig. (2): Formation contacts and columnar section of BB-1 [2].

1.6. Resources

The early published estimation by Genel was approximately C2 3900 Bscf with the upside reaching up to C2 5 Tscf. The oil rim is around 30 million barrels of light oil.

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Vol. 15, No. 2, June 2025, pp. 33-43
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The last estimation by RPS for Bina Bawi 2 C contingent resources (BSCF) is 6472 and revised is 8230. Those numbers don't match with the Geology and geophysics (G&G) analysis worked out by PRDPC.

MNR consultant summary of Contingent Resources – Development unclarified (Gross 100% working interest basis) attributable to the Bina Bawi are:

1C 4651 Bscf, 2C 8230 Bscf, 3C 13036 Bscf the amount of condensate accordingly is 34, 62 and 99 MMstb as mentioned by the consultant.

A revised 2C gross contingent resource of the field was assessed by the Petroleum Research and Development Centre (PRDC), which was compared to the previously published numbers.

We believe that the updated reservoir simulation modelling has not precise input. As a consequence, the development risk likely increases during. Further appraisal, could help to refine the reservoir understanding.

The PRDPC numbers are: 1C 2607 Bscf, 2C 4420 Bscf, 3C 5610 Bscf. Our numbers need more appraisal well to understand the delineation of the reservoir and to confirm the resources and convert them to reserves [8,9].

2. Method

2.1. Well tests

Test was held in Kurra Chine + Geli Khana Formations [2].

1. Test 1: Interval 2190-2217m open hole. Water with mud and mixed gas, the measured gas values are: H_2S: 8-10 ppm; C2: 9 ppm; C3: 450 ppm).
2. Test 2: Interval 3200-3210m. Gas and water reach to surface. Salinity of water was reported as 286,000 ppm based on mud engineer analysis; this is regarded as unreliable (refer to "BINA BAWI-1 Well Testing Report).
3. Test 3: Interval 3200-3210m. Gas and brine.
4. Test 4: Interval 3200-3210m. Gas and H_2S and brine
5. Test 5: Interval 3200-3210m. Gas and H_2S and brine.
6. Test 6: Interval 3200-3210m. Gas and H_2S and brine.
7. Test 7: Interval 3200-3220m. Gas and H_2S.
8. Test 8: Interval 2232-2254m. Gas and H_2S. Until test 11 still have gas and H2S [10,11].

Open Access
Vol. 15, No. 2, June 2025, pp. 33-43
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2.2. Hydrocarbon Shows

Kometan Formation: rare dead oil

Dokan Formation: dead oil

Qamchuqa Formation dead oil

Upper Sarmord Formation: No hydrocarbon shows

Garagu Formation: dead oil or asphalt.

Lower Sarmord Formation: dead oil or asphalt

Ghia Gara Formations: No hydrocarbon shows

Barsarin Formation: No hydrocarbon shows

Naokelekhan Formation: No hydrocarbon shows

Sargalu Formation: No hydrocarbon shows

Sehkaniyan Formation: No hydrocarbon shows

Butmah / Sarki Formation: No hydrocarbon shows

Baluti Formation: No hydrocarbon shows

Kurra Chine / Geli Khana Formation : Strong hydrocarbon odour and gas.

3. Result and Discussion

3.1. Production Profile

The production profile (Figure 3) is forecast based on the available data, can be changed either way after further appraisal program and more wells drilled in the area. This is the best possible forecast that can be done at this point in time. Producing source gas is a challenge and needs special measures and surface facilities. The production profile below shows the plateau of 13 years above the 500 mmscf/d. In order to achieve the mentioned production, the field needs 88 vertical wells or less horizontal wells. Until depletion, a total condensate production 53 mmbbl [12, 13,14].

The oil rim production (Figure 4) is very low and could be produced simultaneously with gas production.

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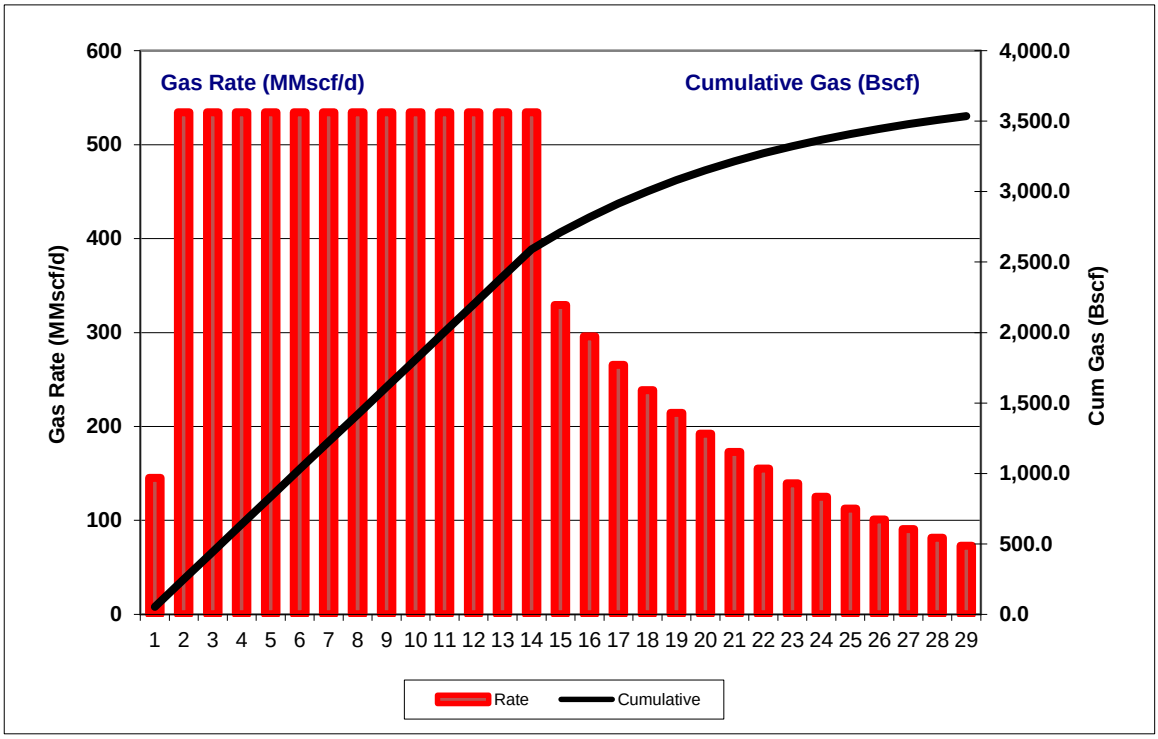

Fig. (3): Proposed gas production profile

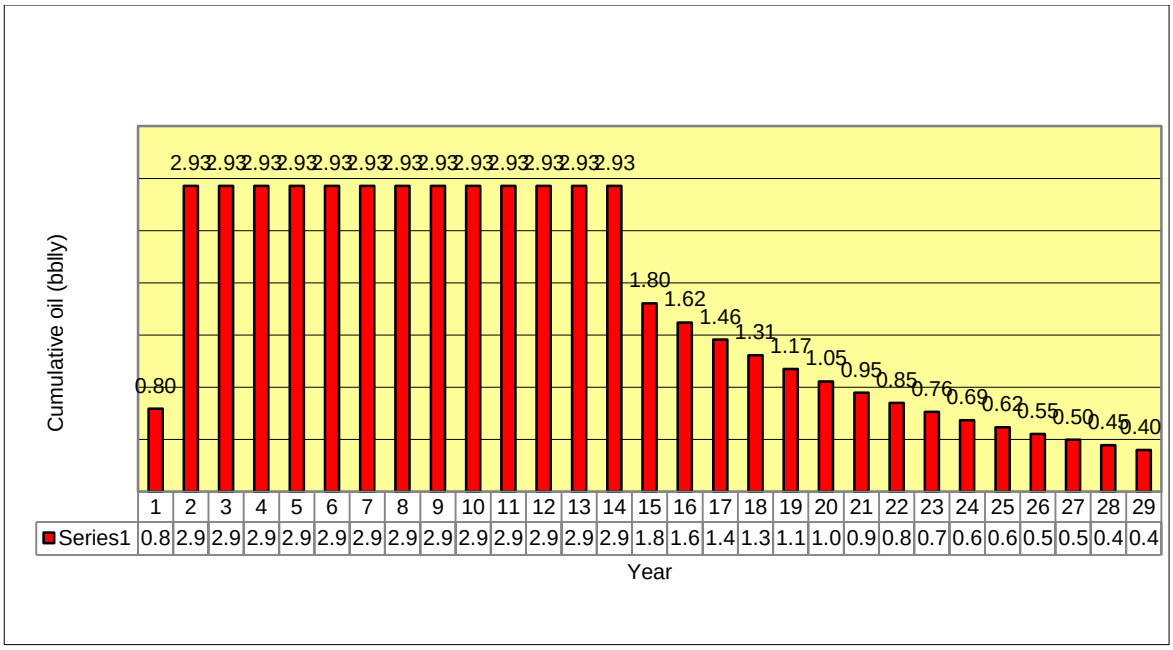

Fig. (4): Proposed condensate production profile

Open Access
Vol. 15, No. 2, June 2025, pp. 33-43
P- ISSN: 2220-5381
E- ISSN: 2710-1096

3.2. Proposed Development Plan

The most suitable way of development is a phased development plan. The oil rims are secondary and could be produce simultaneously during the production of gas.

Sour gas will be treated and sent to use for electricity power plants and any increase in production, could convert it to gas to power.

PDRC proposed gas production planned to supply 500 million standard cubic feet a day (mmscfd) [2].

3.3. Sale of Raw Gas

Genel Energy gas lifting agreements (GLAs) with the Kurdistan Regional Government (KRG) in February 2017, for supplying gas from the Bina Bawi and Miran fields. KRG will purchase gas under a take-or-pay arrangement from both the fields, at a price of $1.20 per thousand cubic feet. Genel has agreed to supply gas for a duration of 12 years, which includes a two-year build-up period and a ten-year plateau period.

KRG has agreed to provide 20 billion cubic metres (bcm), (706) Bscf, 164 (mmscf/d) of gas from the two gas fields to Turkey, under the KRI-Turkey Gas Sales Agreement entered in 2013. The agreement confirms the availability of regular gas supply to Turkey at a cheaper price than current imports.

3.4. Contractors Involved

The surface facilities pre-front-end engineering design (FEED) was awarded to Flour, the development plan to Baker Hughes. The fire and gas dispersion studies for Xodus. RPS Energy Consultants for evaluating and determining the oil-bearing reservoirs at the field [3].

4. Conclusions

The location of the BB-1 well was defined according to surface geology. There was no seismic data. The stratigraphic succession established for the well prognosis is based mainly on the general geology of Northern Iraq and the subsurface data of Taq Taq-1 well. An obvious fault repetition in the succession has not been observed on the logs but it needs further investigation, especially after seismic interpretation. A combination of the stratigraphical and structural causes of thickening might be the more likely case.

Open Access
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Most of the tests were unsuccessful due to technical reasons. DST#7 and DSTs #11 and 12 were thought to be successful, and DST#7 yielded approximately 5 to 6 mmscf/day probable gas production rate at 3200-3220m interval. Although flow tests were performed at this interval, the flow periods were not sufficient to get a proper result, due to mechanical problems caused by the presence of H_2S and other technical reasons.

Cretaceous reservoirs were considered to be primary target of BB-1 well. In fact, many live and dead oil shows have been observed in cuttings, cores and junk basket samples belonging to the Cretaceous rocks, starting from 268m. However, no tests were performed in the Cretaceous interval. Therefore, due to the condition of the well it was decided to drill a shallow well, BB-2, close to BB-1 for testing Cretaceous targets only [1].

On 10 December 2021, the Kurdistan Regional Government received a letter from a subsidiary of Genel Energy plc ("Genel"). In this letter, Genel confirmed that it did not intend to continue to perform its obligations under the Bina Bawi and Miran PSCs, and purported to terminate the PSCs with immediate effect. Genel has sought to justify its termination of the PSCs by asserting that the Government is in repudiatory breach. The Government strongly denies that it is in repudiatory breach of the PSCs. The complexity of the reservoir, the commerciality risk, supreme court decision are another reason for withdrawn of Genel from the field.

The efficient way to develop a challengeable gas field is to cooperate with the central government – Ministry of Oil (MoO) using private small-medium firms for development in phasing steps for domestic use only.

Open Access
Vol. 15, No. 2, June 2025, pp. 33-43
P- ISSN: 2220-5381
E- ISSN: 2710-1096

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