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# 2023 LICENSING ROUND REPUBLIC OF ANGOLA

ONSHORE  
KWANZA BASIN

ONSHORE KWANZA BASIN

Portfolio  
**OPPORTUNITIES**

Bloco  
**KON13**

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# 1. Introduction

The portfolio opportunities describe the general characteristics of **Block KON 13**, presenting the main geological and geophysical aspects from the exploration history, petroleum system, and a series of opportunities identified in the block. This characterization results from the survey and framing of existing data that allowed the seismic interpretation and the elaboration of the geological model by the ANPG/DEX team.

**Block KON 13** is in the central-eastern part of the Onshore Kwanza Basin. In 1969 the exploration companies Purfina, Petrangol, and Total drilled two (2) exploration wells, Chio-1 and Quembaxi-1. In 2009 - 2012, the Geokinectics Company conducted a 2D seismic survey, acquisition, and processing.

Sonangol conducted recent geological mapping and well geochemistry data survey studies in partnership with Obrangol and Previsão Oil companies from 2010-2015 and 2012- 2015, respectively.

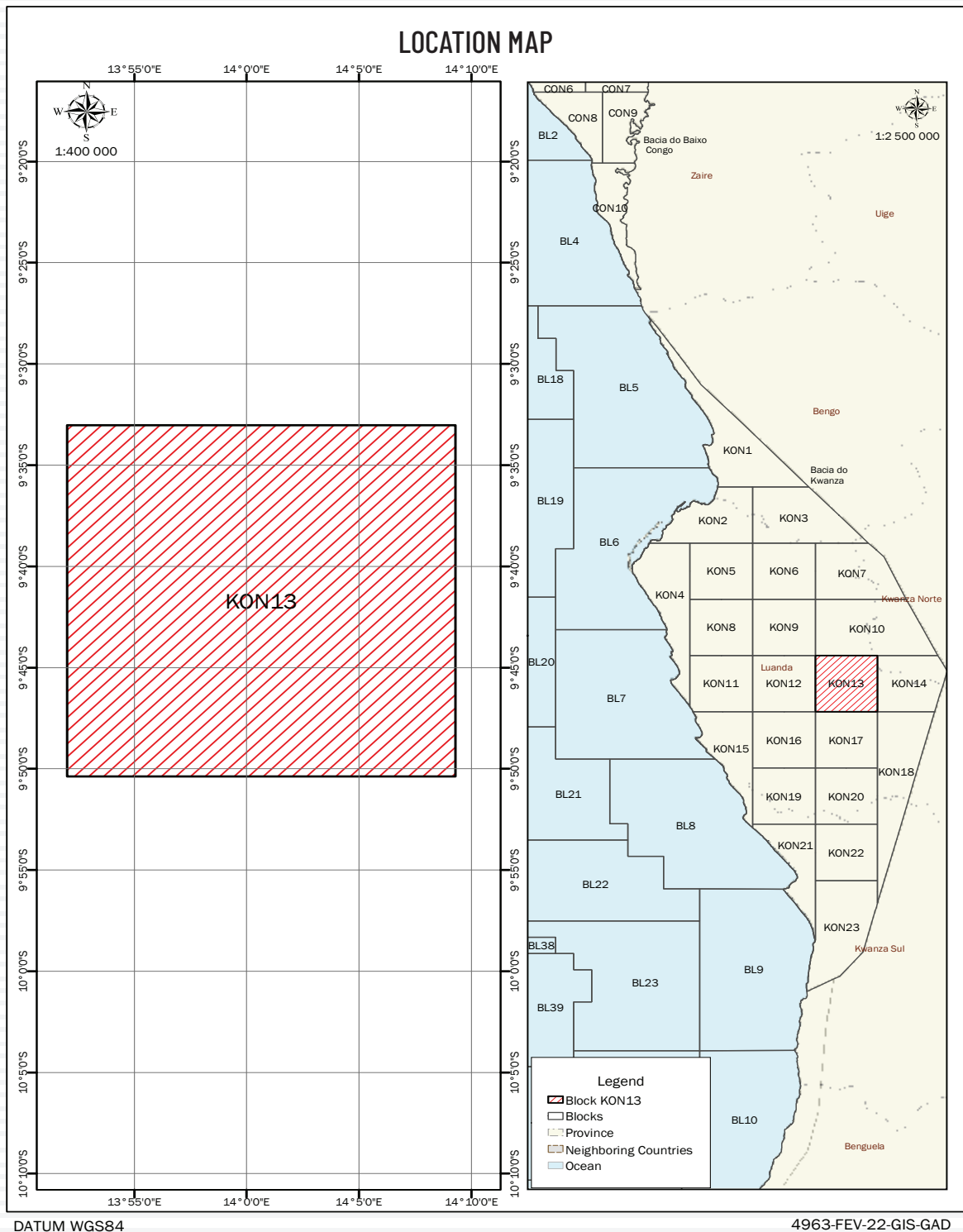
The Kwanza Basin is known for its onshore and offshore exploration history of two significant plays, Pre-salt and Post-salt (Albian and Tertiary). The pre-salt petroleum system comprises the shales from Cuvo Formation as source rock, the sands from Cuvo and carbonates from Toca equivalent Formations are the mains reservoirs, and the seal consists of the massive salt. In the post-salt, the Binga Albian source rock comprises carbonate facies with significant quantities of organic-rich matter. As a reservoir, the carbonates of the same Formation are sealed by the shales from Cabo Ledo Formation. Tertiary trough formation occurred progressively from east to west. The onset of salt-raft tectonism at this time created the accommodation space for the deposition of black-colored organic-rich shales (Cunga Gratidão Fm.) that formed an important source rock in the grabens that feed the sandstone channels from the Quifangondo Formation sealed by the intraformational shale of the same Formation. The trap mechanisms for all plays are structural, stratigraphic, and combined.

Structures with possible accumulation of hydrocarbons in the pre-salt and post-salt were identified. The leads identified from integrating geological and geophysical data present prospective resources estimated from 770 - 1 100 MMBO.



## 2. GEOGRAPHIC Location

Block KON 13 is in the northern part of the Kwanza Basin. It is bordered by Block KON 10 to the north, KON 17 to the south, KON 12 to the west, and KON 14 to the East, defined by the geographic coordinates  $9^{\circ}32'58''$  and  $9^{\circ}50'19''$  S and meridians  $13^{\circ}52'11''$  and  $14^{\circ}09'28''$  E, having a total area of approximately 1010.73 km<sup>2</sup> (Figure 1).



**Figure 1:** Location map of Block KON13, ANPG 2022

### 3. GEOLOGICAL Setting

The outcrops of Block KON 13 are represented by sediments of Precambrian to Eocene age, according to the geological chart of the Onshore Kwanza Basin (Figure 2). The sedimentary history is characterized by paleoenvironmental variations between continental, transitional, and marine environments, in which two (2) lithostratigraphic units are evident: Pre-salt and Post-salt play.

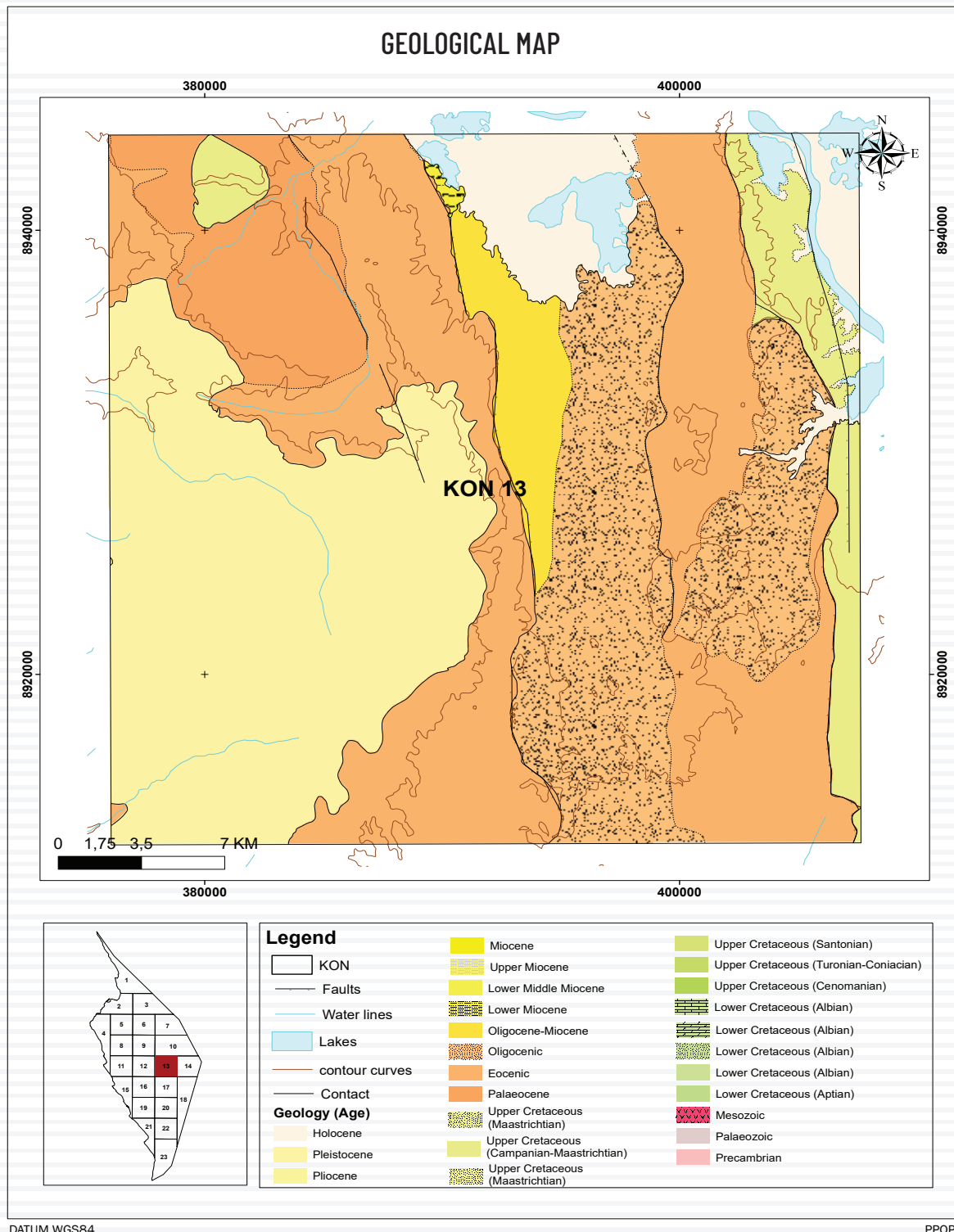


Figure 2: Geological map of Block KON 13, ANPG 2022



## Pre-salt Unit

The deeper structural zone has a more outstanding sedimentary contribution and potential for organic matter accumulation. When subjected to high temperatures and pressures, it results in the generation of hydrocarbons. The faults are used as migration paths to the horsts. The sandstone of the Sag basin has a good reservoir characteristic, as well as the pinch-out sands deposited on the flanks of the horsts.

In the early Aptian, a lagoon depositional system developed with the influence of the first marine incursions and high temperatures. The salt layer constitutes the seal at the level where this unit was deposited.

## Post-salt

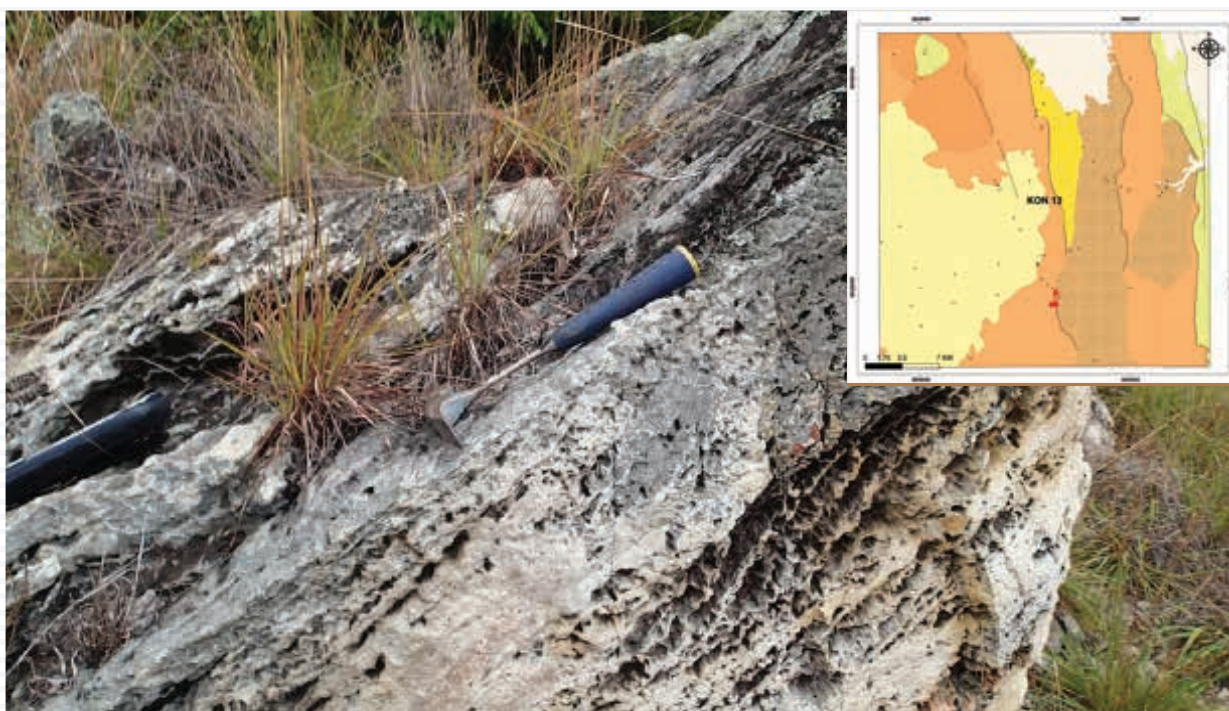
The post-salt unit is represented by extensional structures resulting from salt tectonics, marked by a series of listric normal faults and a very clear structuring at the Albian level.

The Albian limestone sediments are rich in the organic matter "calcilutites," with more significant predominance in this unit, present high potential for generation, with lateral facies migration that feeds the fractured oolitic limestone reservoirs. As a seal, the salt of the Tuenza Formation and the Cenomanian clays of the Cabo Ledo Formation, with mixed trapping.

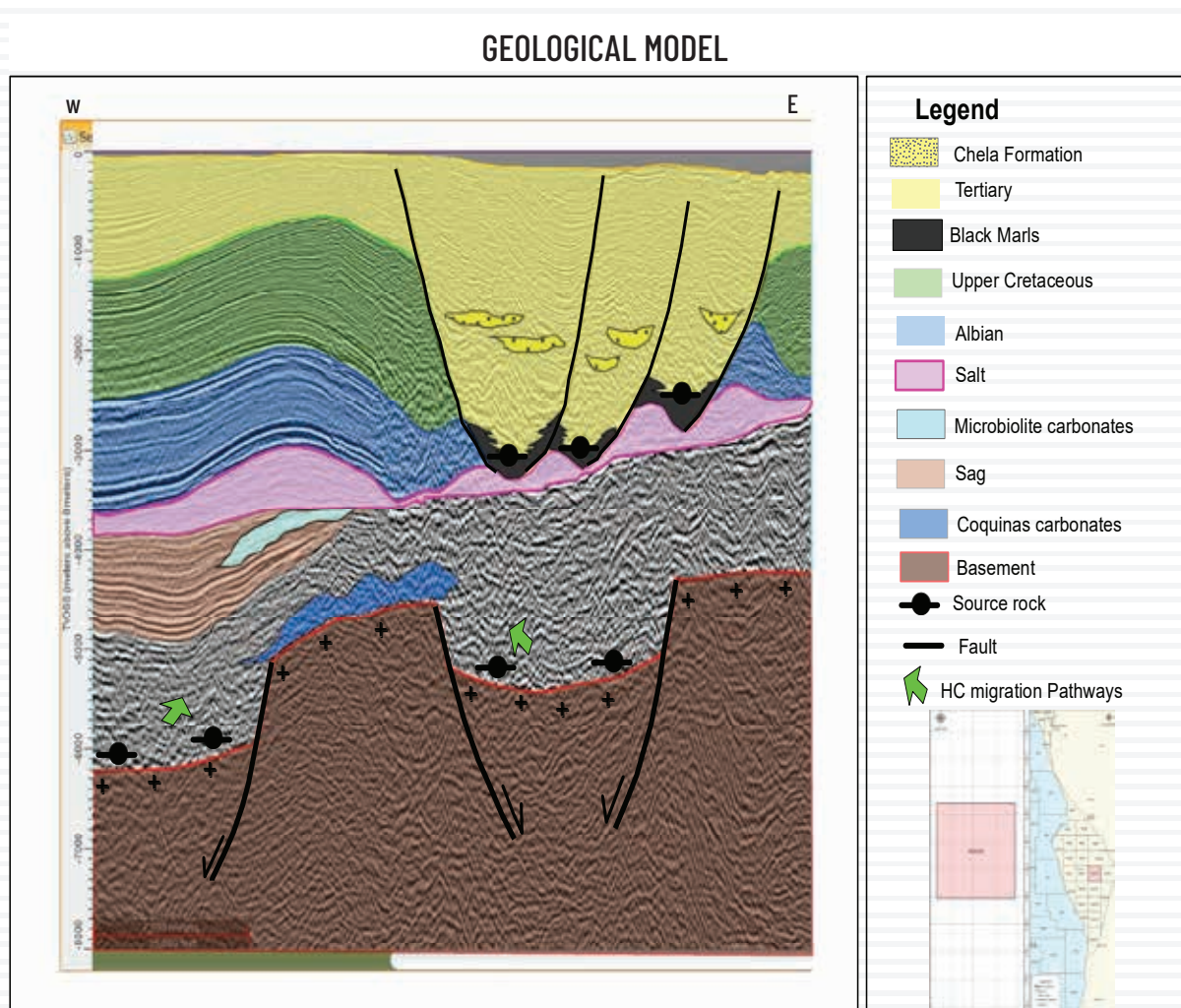
The Upper Cretaceous preserved in the west of the Block, represented by pelagic sediments such as marls, gray clays, and micaceous siltstones, are potential sources in this unit. At the same time, the regressive sandstones of the Itombe and Teba Formations have reservoir potential. The clays of the same formations constitute the seal.

At the Tertiary, because of sedimentary overburden, the formation of the Tertiary Chio Trough to the west, with predominantly potential reservoir sands in the Quifangondo Formation. The shale of the Cunha-Gratidao Formation is a source rock, with the recent shales being potential cover rocks.





**Figure 3:** Sandstones Bed - Chio Formation from Oligocene | Muxima



**Figure 4:** Geological Model of the Block KON 13, SKB 224, ANPG 2022

## 4. **EXPLORATION** History

The first commercial discovery of oil in the Kwanza Basin occurred in 1955, resulting from the drilling of the Benfica-1 well, known as the Benfica field. Other findings followed, represented by the Luanda, Cacuaco, and Galinda fields.

In July 1961, in the continuation of the work started by the Research Mission, the then-operating company Petrangol discovered the first significant field, the Tobias field, in the Cabo Ledo region, which guaranteed Angola's self-sufficiency in terms of crude oil and also contributed to ending the skepticism regarding the existence of the precious 'black gold' in the Angolan subsoil. The peak of exploration activity was primarily driven by the discovery of the Quenguela Norte field, which represents the new play of the Tertiary. In that same decade, the Mulenvos field was also discovered.

By the end of the 1970s, the Légua and Bento fields had been added to the Inner Kwanza Basin discoveries. The first exploration work on the Block dates to 1969, carried out by the Purfina, Petrangol, and Total companies. Two (2) wells, Chio-1 and Quembaixi-1, were drilled, with the Chio-1 showing evidence of oil at the Cuvo Formation level of the lower Cretaceous in the Pre-salt. A total of 135.7 line km of seismic was acquired.

The objective of Chio-1 was the recognition of a depocentre connected to the Eocene salt tectonics, reaching 3079.5 m and completed in 1970.

ENI company conducted the aero gravimetry and magnetometry survey in 1988. In addition, recent geological mapping and well geochemistry studies were carried out by Sonangol in partnership with the companies Obrangol 2010-2015 and Previsão Oil 2012-2015 (Figures 5, 6, and 7).

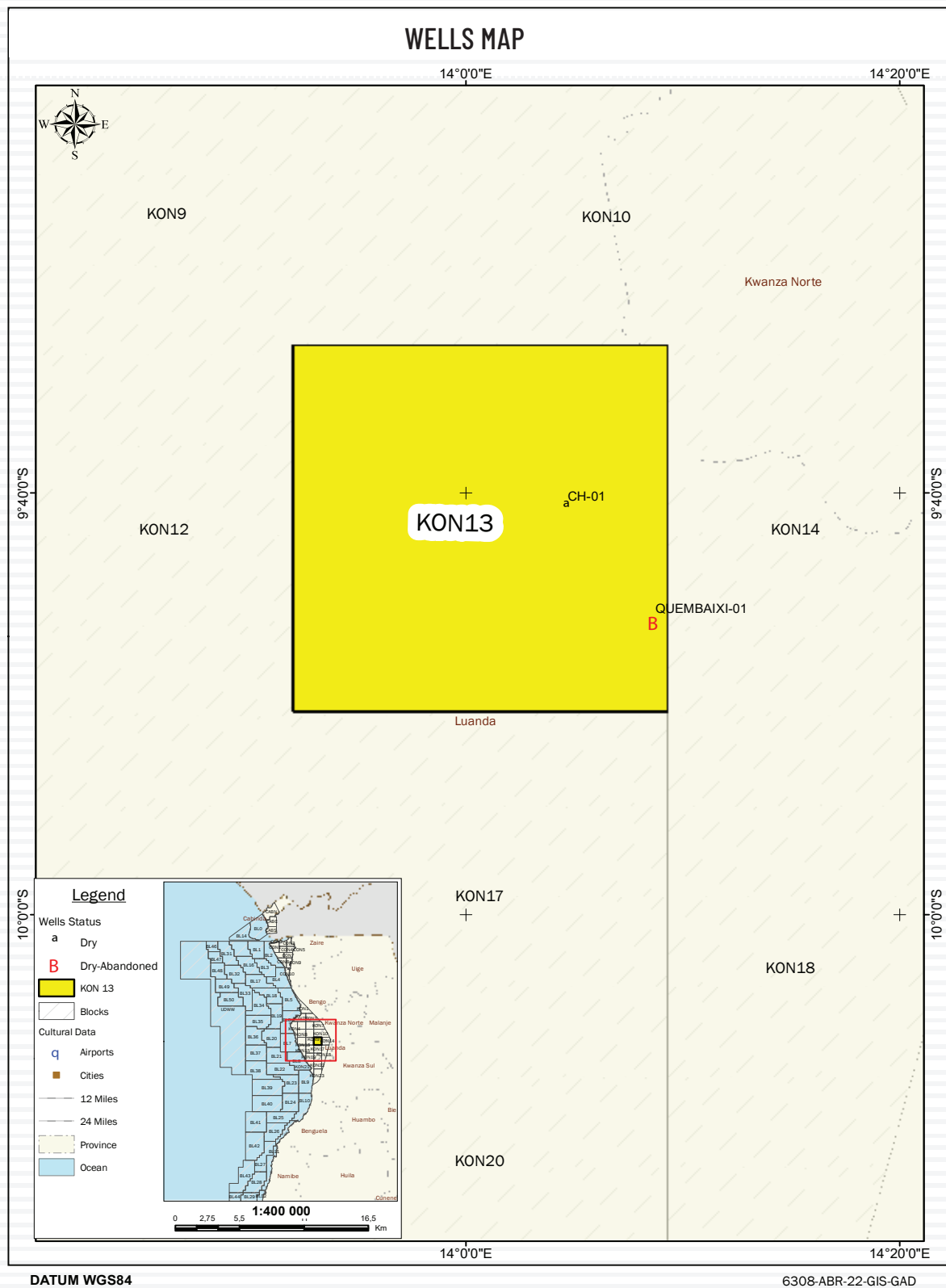
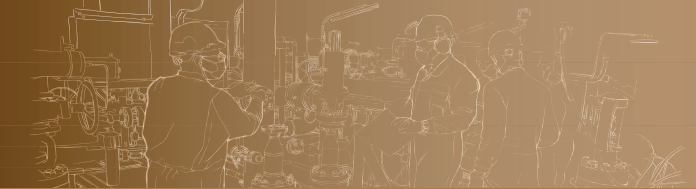
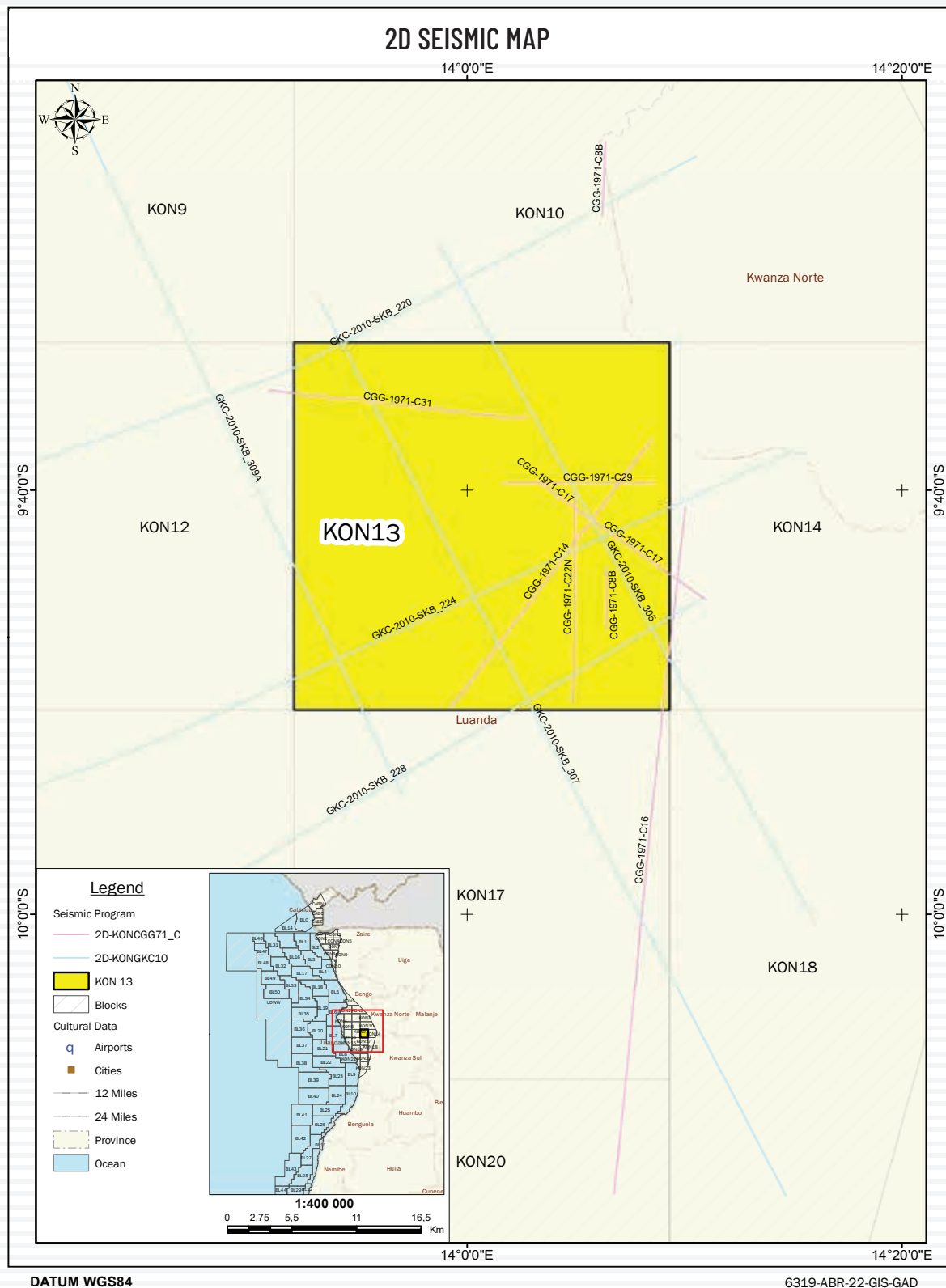


Figure 5: Well map of KON 13, ANPG 2022





**Figure 6:** 2D Seismic Data Acquired on Block KON 13, ANPG 2022

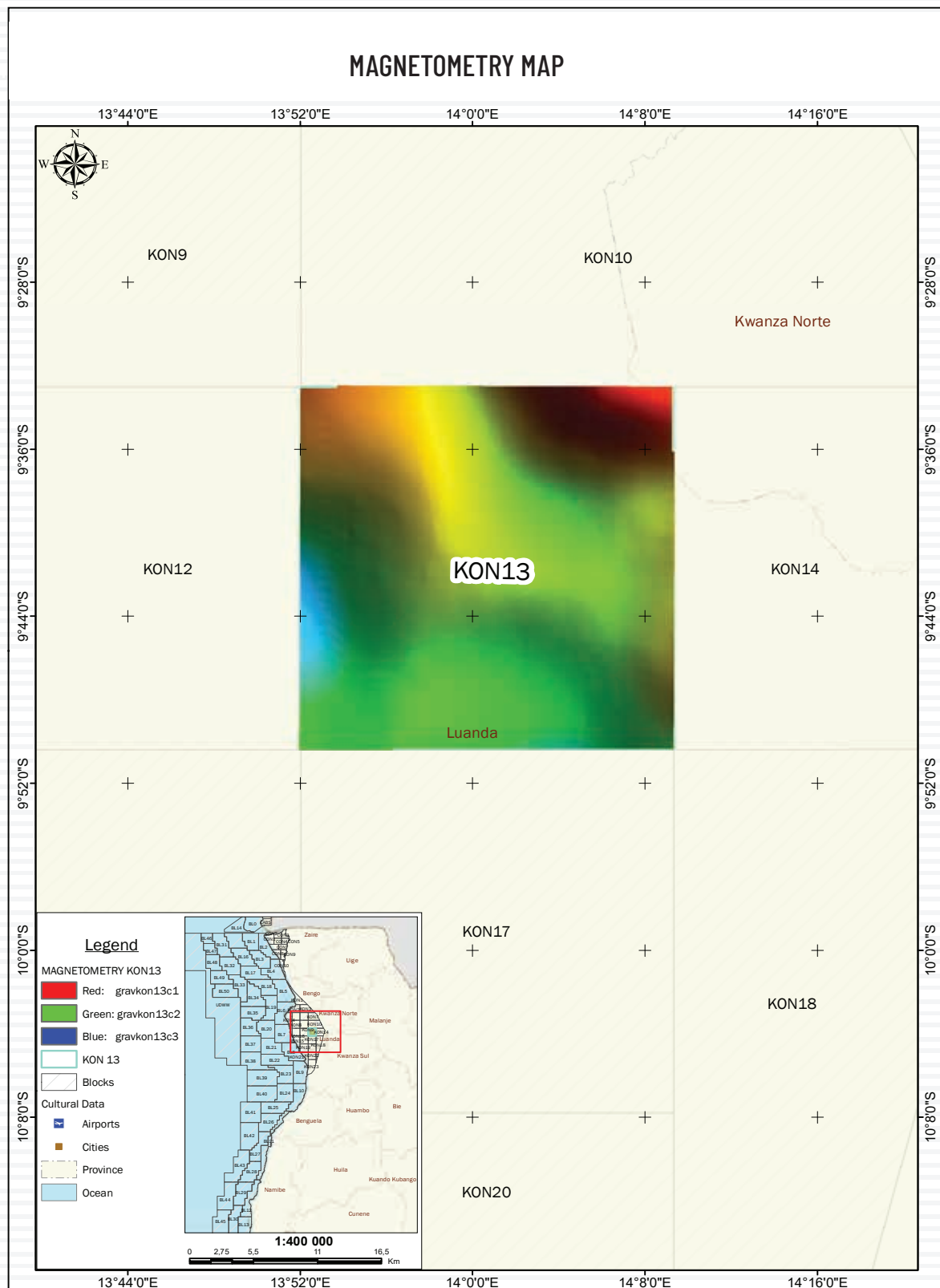
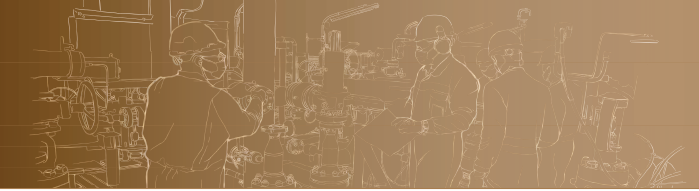


Figure 7: Magnetometry map of the KON 13, ANPG 2022



## 5. PETROLEUM System

With the integration of geological e geophysical data, it was possible to determine the lithostratigraphy and the description of the petroleum system of the two mega-sequences (Pre-salt and Post-salt).

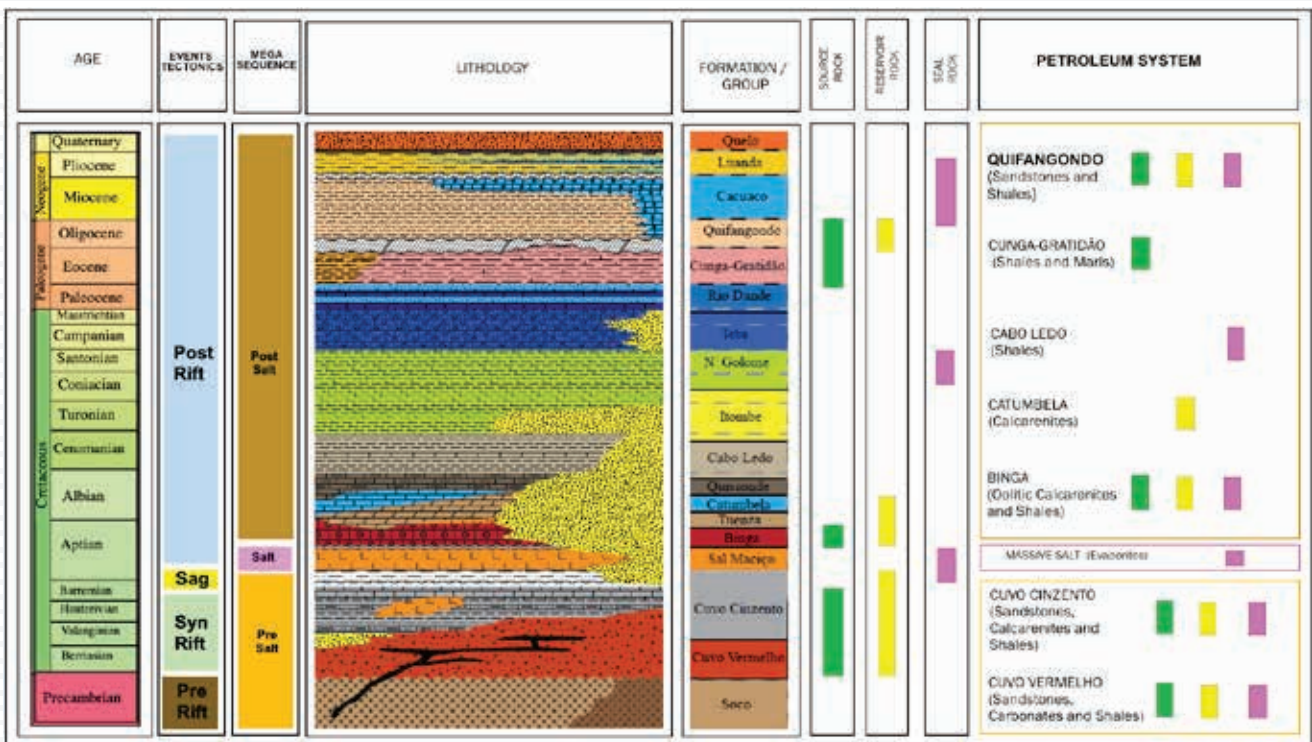


Figure 8: Lithostratigraphic Column of the Onshore Kwanza Basin, ANPG 2022

## 5.1 Generation and Migration

The source rock consists of organic-rich lacustrine shale of the Cuvo Formation in the Pre-salt, carbonates from Binga Formation in the Albian, and black marls of the Cunga-Gratitude Formation in the Tertiary. Migration pathways occur from faulting, salt window, and facies contact.

## 5.2 Reservoir Rock

Block KON 13 shows reservoir potential in the pre-and post-salt units. The coquina carbonates on top of the horst, sands on the flanks, and sands on top of the Barremian are the potential reservoirs at the pre-salt level.

In the post-salt, the oolitic and dolomitic limestones of the Binga Formation, the sandstones of the Itombe Formation, and the clastic of the Teba Formation of the middle Cretaceous.

## 5.3 Seal Rock

The seal rock for the Pre-salt is the Massive Salt of the Aptian age. The Albian Formations are the overlying saliferous Tuenza and the Cabo Ledo Formation shales. The seal rock of the Upper Cretaceous reservoirs in the Itombe and Teba Formations are the shales of the same formations. And for the Quifangondo Formation corresponds to the overlying intraformational shales.

## 5.4 Trap

Potential trap types in the pre-salt include tilted fault blocks, stratigraphic pinch-out against horst flanks, and truncations in overlying salt layers. In contrast, post-salt traps are generally controlled by a salt movement that results in raft-like and turtle-back structures. Stratigraphic traps are also possible in zones of lateral facies variations.

## 5.5 Source Rock Occurrence

The primary source rocks identified in the Kwanza Basin are the clays of the Cuvo Vermelho and Cinzento Formations in the pre-salt and the carbonates of the Binga Formations in the post-salt. The geochemical data from Blocks KON 4, KON 11, and KON 12 allowed us to assess the potential of the source rocks. The Chio-1 well revealed good Total Organic Content (TOC) results at the mature stage in the Pre-salt unit. At the Post-salt level, source rock characterization was based on inferences from data from wells Galinda-1, Galinda-4, and Tobias-6 of Blocks KON 11 and KON 12 (Tables 2, 3, and 4), suggesting good mature stage organic content.

## Cuvo Vermelho Source

The clays of the Cuvo Vermelho Formation identified in-depth 2869,9 m, show good values of total organic content (TOC) 1.5%; HI values 175 mgHC/gCOT indicate type III kerogen, the parameter indicating maturity Tmax 441 °C shows that the rock is at the beginning of the maturation stage.

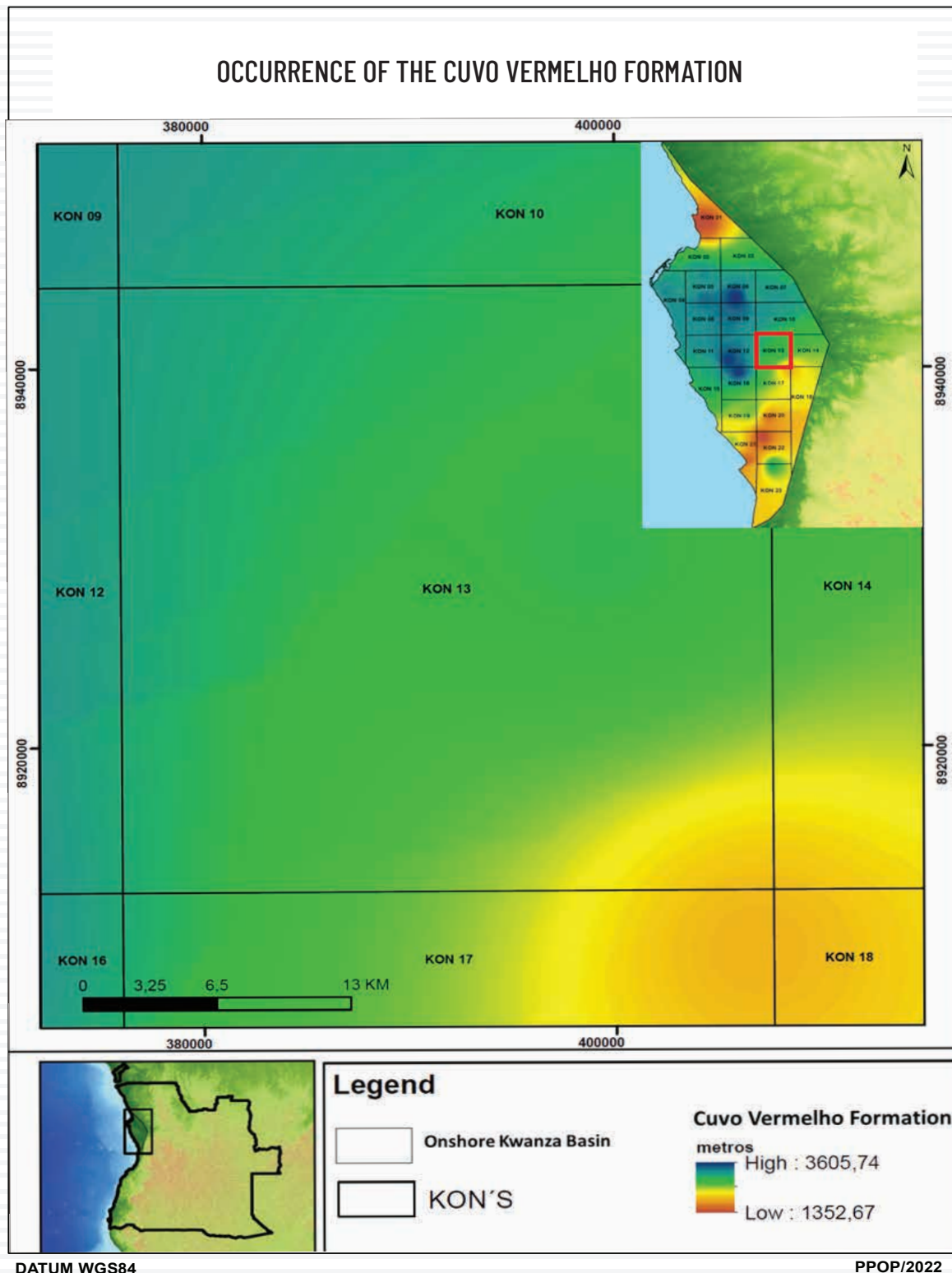


Figure 9: Occurrence map of Cuvo Vermelho Fm. Source rock

## Cuvo Cinzento Source

The clays at the level of this formation identified in the depth of 2829,1 – 2829,9 m show good values of total organic content (TOC) 1,06- 1.83%, HI values mgHC/gCOT indicate kerogen type III, the parameter indicative of maturity Tmax 458-465 °C suggesting that the rock is at the peak of the maturation window.

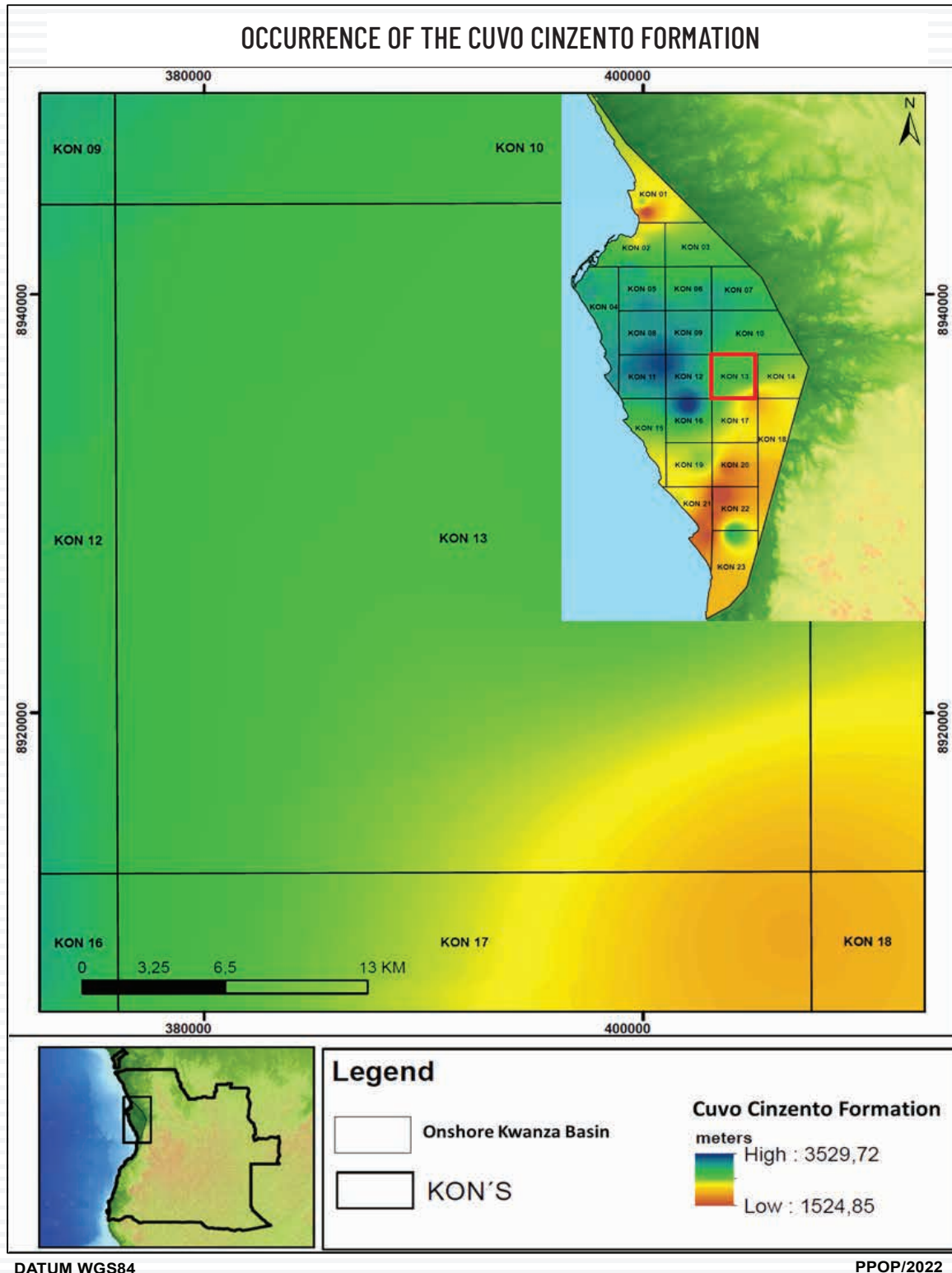


Figure 10: Occurrence map of Cuvo Cinzento Fm. Source rock



## Binga Source

The carbonates of the Binga Formation proven Albian level source rock, with good geochemical characteristics, confirmed by exudation indicating hydrocarbon generation in the block.

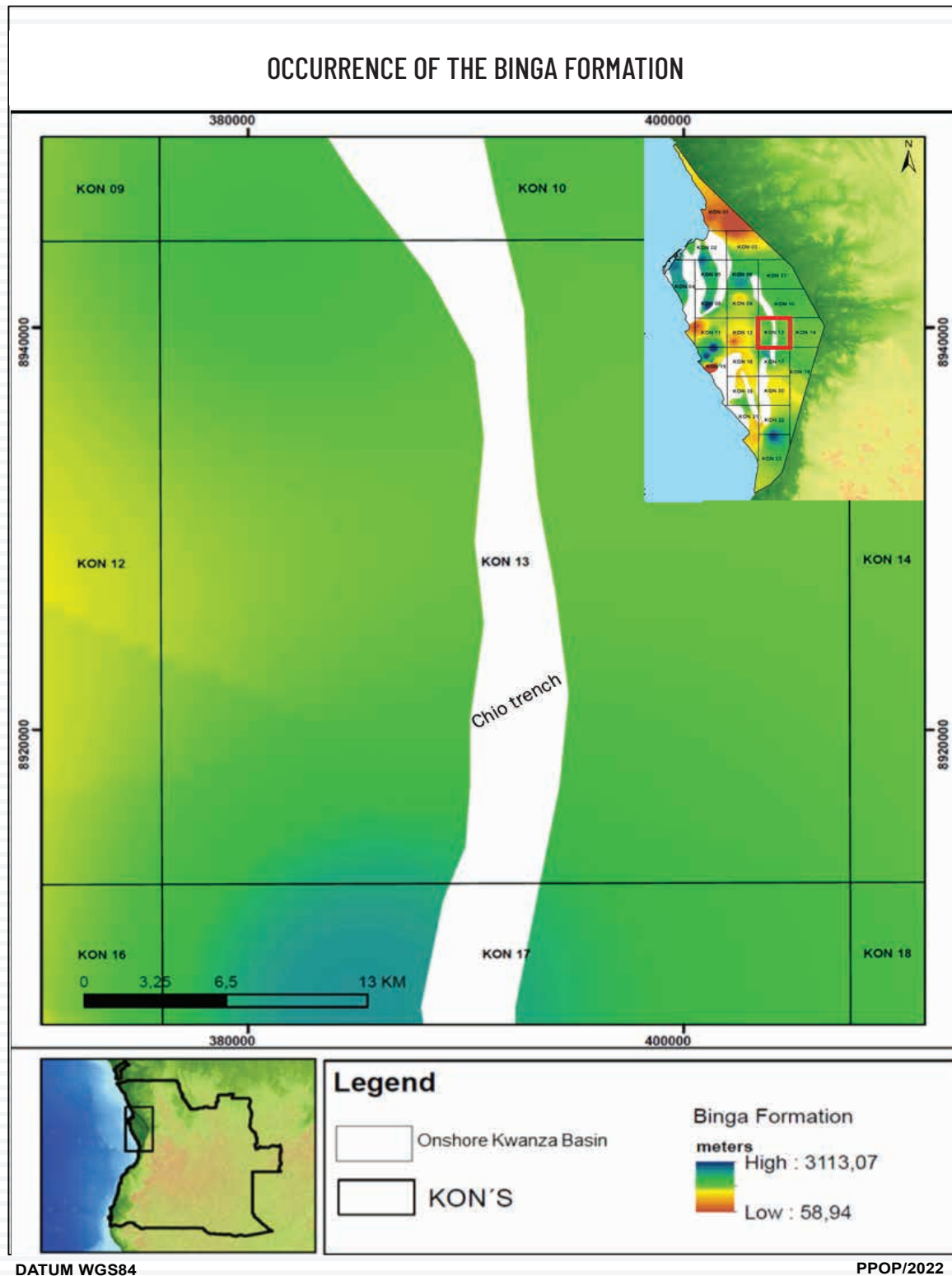
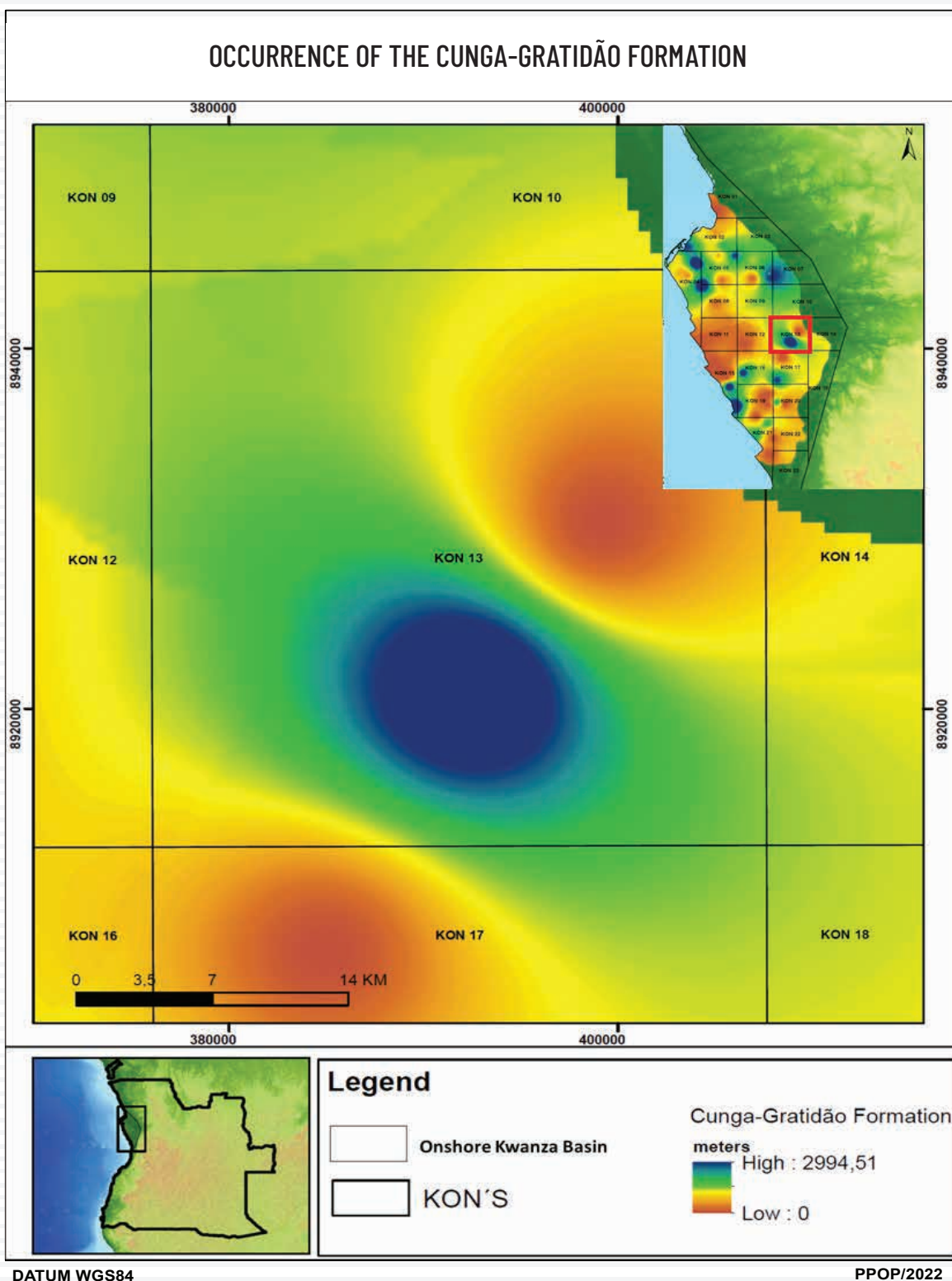


Figure 11: Occurrence map of Binga Fm. Source rock

## Cunga-Gratidão Source

The black marls of the Cunha-Gratidão Formation are a proven Tertiary source rock distributed in the Chio Trench and have good geochemical characteristics for hydrocarbon generation in the block.



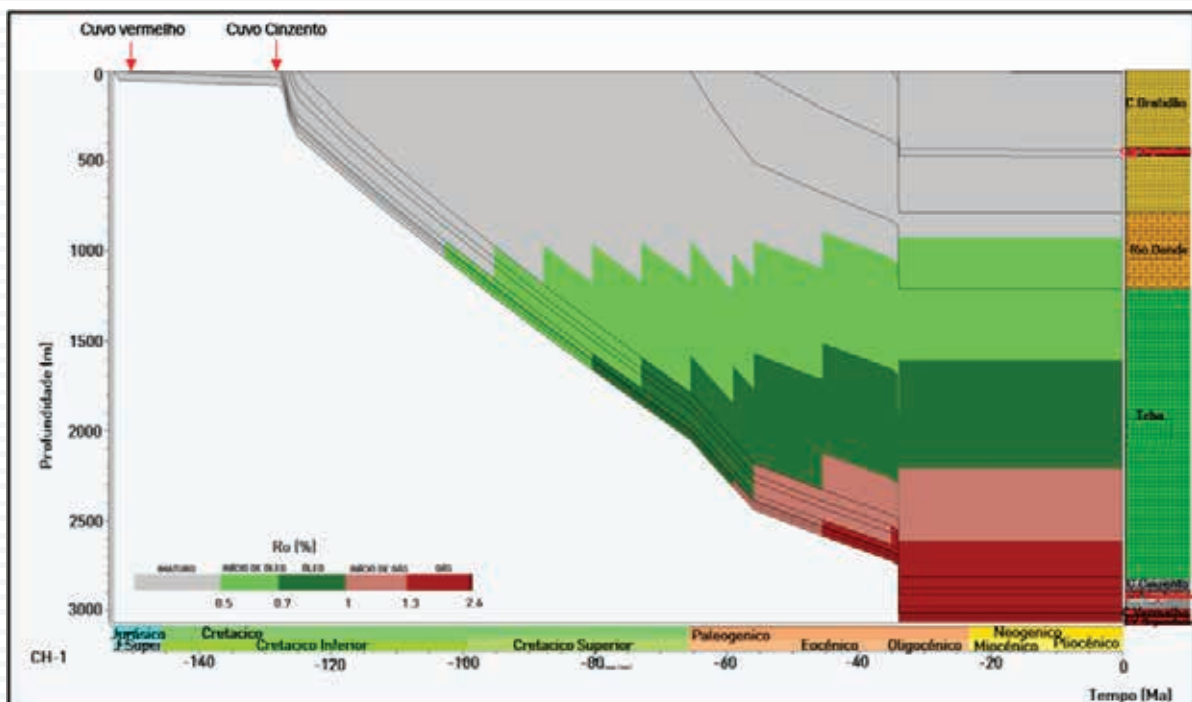
**Figure 12:** Occurrence map of Cunha-Gratidão Fm. Source rock

KON	WELL	SAMPLE	FORMATION	Depth (m)	Ro (%)	TOC (%)	S1	S2	TMax (°C)	IP	HI (mg HC /g COT)	OBS
13	Chio 1	Core	Cuvo Cinzento	2829,1	1,11	1,83	0,25	1,16	465	0,17	63,38	Mature Source Rock
		Core	Cuvo Cinzento	2829,9	n/r	1,06	0,16	0,73	458	0,17	68,86	Mature Source Rock
		Core	Cuvo Vermelho	2869.90	0,57	1,35	0,64	2,77	441	0,18	205,18	Source Rock at the beggining of maturation

**Table 1:** Geochemical Analysis of Cuvo Vermelho & Cinzento Formations

## 1D Model

The Chio-1 well shows that the Cuvo Vermelho Formation was deposited in the Lower Cretaceous. The thermal evolution of the generating facies at depths of 900 to 2300 m reached the oil window from Low Cretaceous to the Paleocene and the gas window at depths of 2 300 to 3 000 m from Paleocene to the present. On the other hand, the Cuvo Cinzento Formation was deposited in the Lower Cretaceous, having reached oil window depths of 1000 to 2 200 m in the Upper Cretaceous to Paleocene and gas window depths of 2 200 to 3 000 m from the Oligocene to present day.



**Figure 13:** Maturation profile of Chio - 1 well



## 6. EXPLORATION Opportunities

### 6.1 Identified Leads

The geological and geophysical data acquired allowed the pre- and post-salt identification leads described below.

#### 6.1.1 Pre-salt Lead 1

Located southwest of the Block, is characterized by reflectors with strong parallel amplitudes truncating over the base of the salt at the level of the Cuvo Formation (equivalent to the Chela in the Lower Congo). The low amplitudes characterized in the structural low identified in the Block may be a good indicator of the presence of source rock. In contrast, chaotic reflectors typical of the massive salt at the top of Lead-1 demonstrate the possible presence of the evaporites of the massive salt Formation, which serve as cap rock.

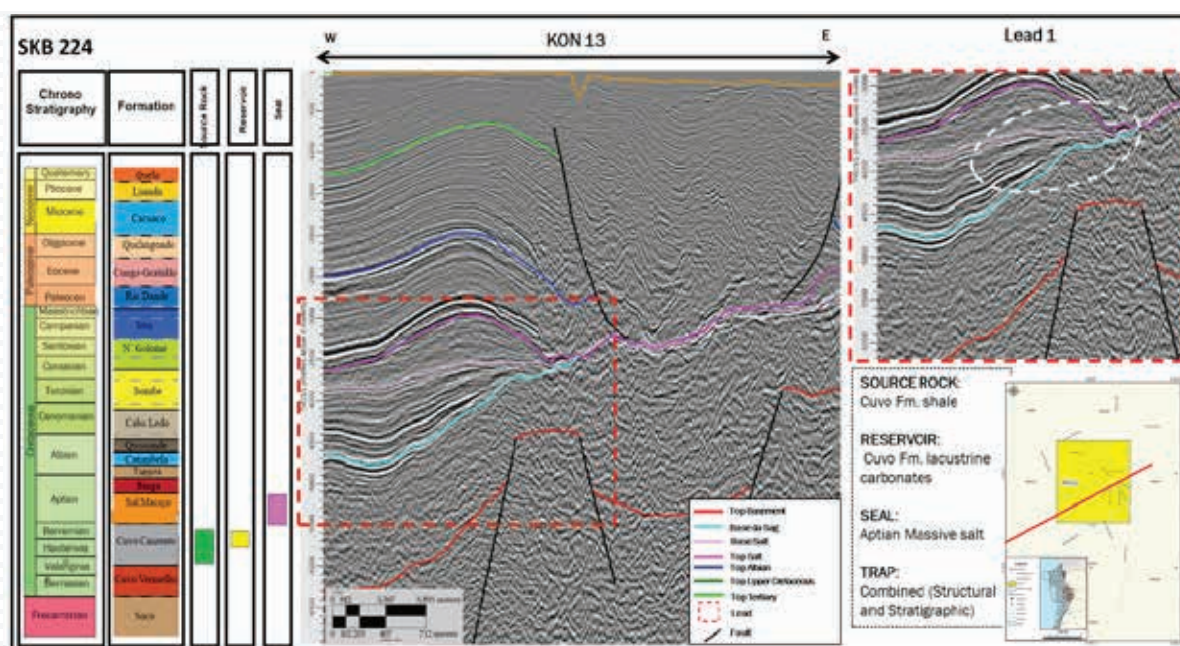


Figure 14: Pre-salt lead 1, ANPG 2022

#### 6.1.2 Post-salt Lead 2

Located in the southwestern part of the Block, it is an anticlinal structure with closure in all four directions; it consists of oolitic limestones of the Binga Formation of the Albian age. Salt from the Tuenza Formation and shales from the Cabo Ledo Formation provide good seals for this reservoir.



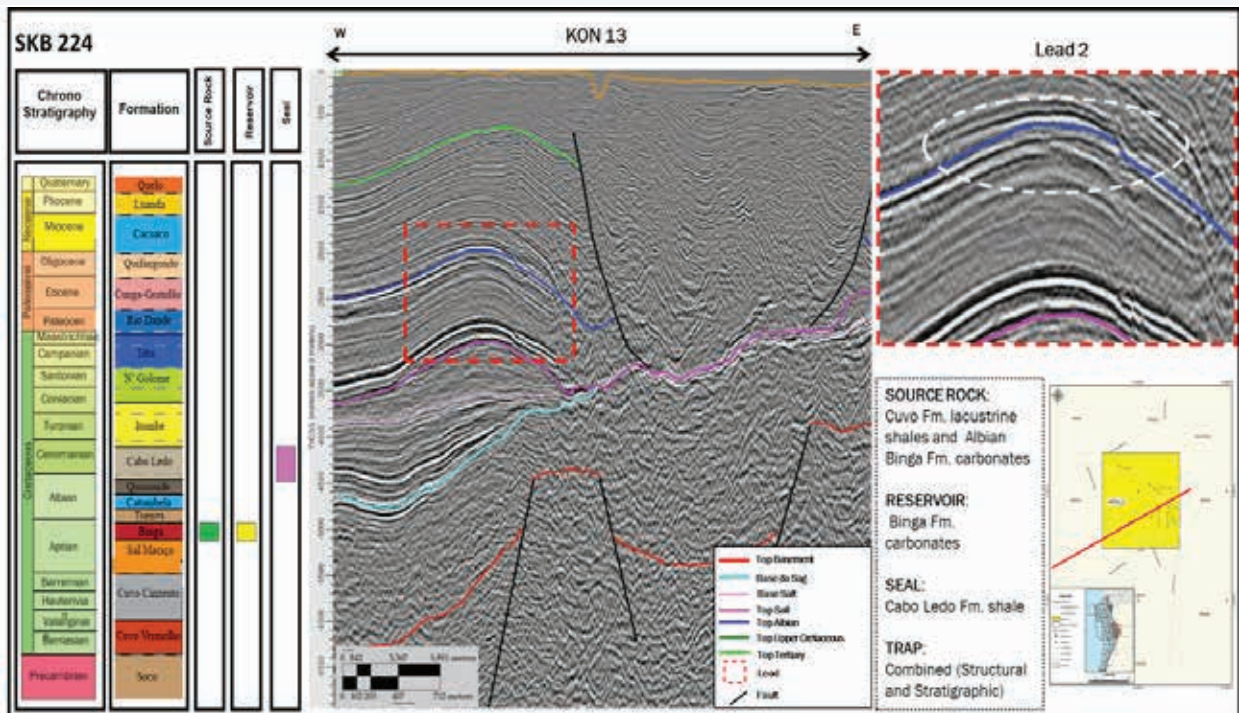


Figure 15: Albian Lead 2, ANPG 2022

### 6.1.3 Post-salt Lead 3

Located in the southwestern part of the Block are Tertiary-aged sandstone channels belonging to the Quifangondo Formation located in a trough zone, as source rock the black marls of the Cunga Gratitude Formation. The cover rock consists of the intraformational shales of the Quifangondo Formation and presents a mixed-type trap. The presence of salt windows in the block allows the migration of the oil generated in the Pre-salt to the Post-salt.

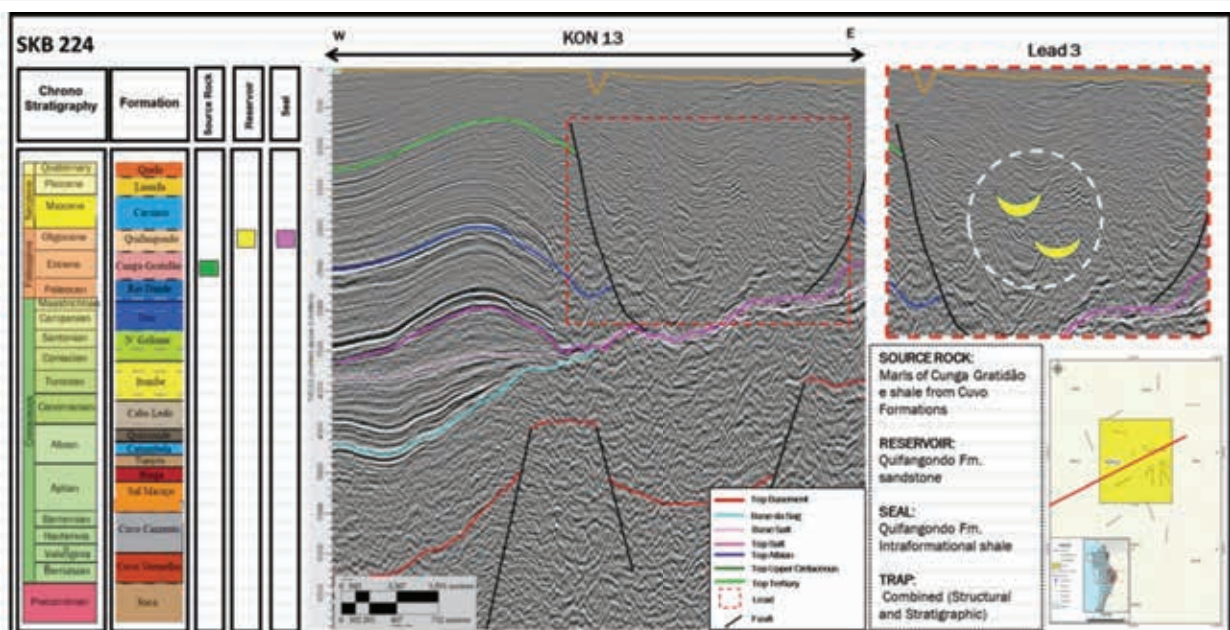


Figure 16: Albian Lead 2, ANPG 2022

## 7. FINAL Remarks

After reassessing Block KON 13, it became evident that the Onshore Kwanza Basin has a solid potential to be exploited in pre-salt and post-salt plays in a region widely known as having a proven, functional, and active petroleum system.

In the Pre-salt, the primary source rock is the Cuvo Formation, equivalent to the Bucomazi in the lower Congo Basin. The reservoirs are the sands and carbonates of the same formation equivalent to the Lucula, Toca, and Chela Formations in the lower Congo Basin.

In the post-salt, the Albian age carbonates of the Binga Formation are the primary source rock, and the carbonates of the same formation are the reservoir rock. In the Tertiary, the source rock is the black marl of the Cunga-Gratidão Formation, and the reservoir is the sandstone channels of the Quifangondo Formation.

The ANPG encourages the companies to invest in this block through additional studies to ensure the discovery of the real potential, which should allow for the boosting of exploration activity aiming to revert the production decline observed over the last decade.

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# ONSHORE KWANZA BASIN



## BLOCK KON 13



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