



ONSHORE  
LOWER  
CONGO BASIN



**2023**  
**LICENSING ROUND**  
REPUBLIC OF ANGOLA

ONSHORE  
KWANZA BASIN

ONSHORE KWANZA BASIN

Portfolio  
**OPPORTUNITIES**

Block  
**KON19**

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# 1. Introduction

The portfolio opportunities describe the general characteristics of Block KON 19, presenting the main geological and geophysical aspects from the exploration history, petroleum system, and a series of opportunities identified in the block. This characterization is the result of the survey and framing of existing data, which allowed the seismic interpretation and the elaboration of the geological model by the ANPG/DEX team.

Block KON 19 is in the southwestern part of the Onshore Kwanza Basin. The first exploration activities in the Block were conducted by the company Petrangol between 1970 and 1973 with the drilling of 5 exploration wells, Morro Liso-1, Morro Liso-2, and Morro Liso-3. Morro Liso-4 and Lumbondo-1. In 2009-2012, 2D seismic surveys were carried out by the Geokinectics Company.

Recent geological mapping and surface geochemistry studies conducted by Sonangol in 2010-2015 and 2012-2016 in partnership with Obrangol and Previsão Oil.

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 were identified at Pre-salt and Post-salt levels. The leads identified from the geological and geophysical data integration present estimated resources estimated from 620 to 1 030 MMBO.



## 2. GEOGRAPHIC Location

The **KON 19 Block** is in the Southwest part of the Kwanza Basin. It is limited to the north by Block KON 16, to the south by Block KON 21, to the east by Block KON 20, and to the west by Block KON 15, between parallels  $13^{\circ} 52' 11''$  S and  $13^{\circ} 34' 47''$  S and meridians  $8^{\circ} 07' 45''$  E and  $8^{\circ} 25' 07''$  E, it has an area of approximately 1016.53 km<sup>2</sup>.

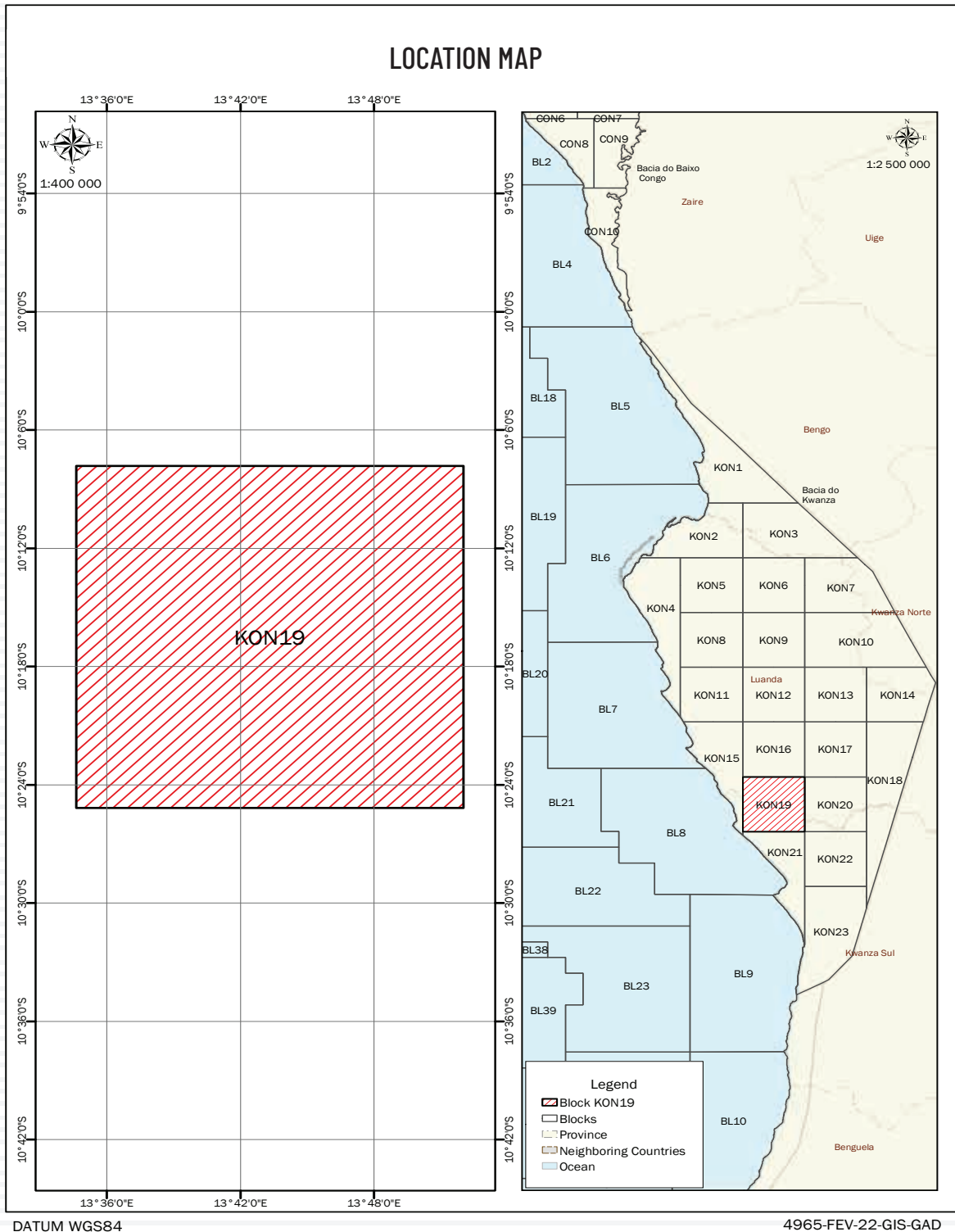


Figure 1: Location map of Block KON19, ANPG 2022

### 3. GEOLOGICAL Setting

The outcrops of Block KON 19 are represented by sediments of Precambrian to recent age, according to the geological chart of the Onshore Kwanza Basin (Figure 2). Block KON 19 is part of the Inner Kwanza Basin. Its sedimentary history is characterized by palaeoenvironmental variations between continental, transitional, and marine environments, in which two (2) lithostratigraphic units are evident: Pre-salt and Post-salt play.

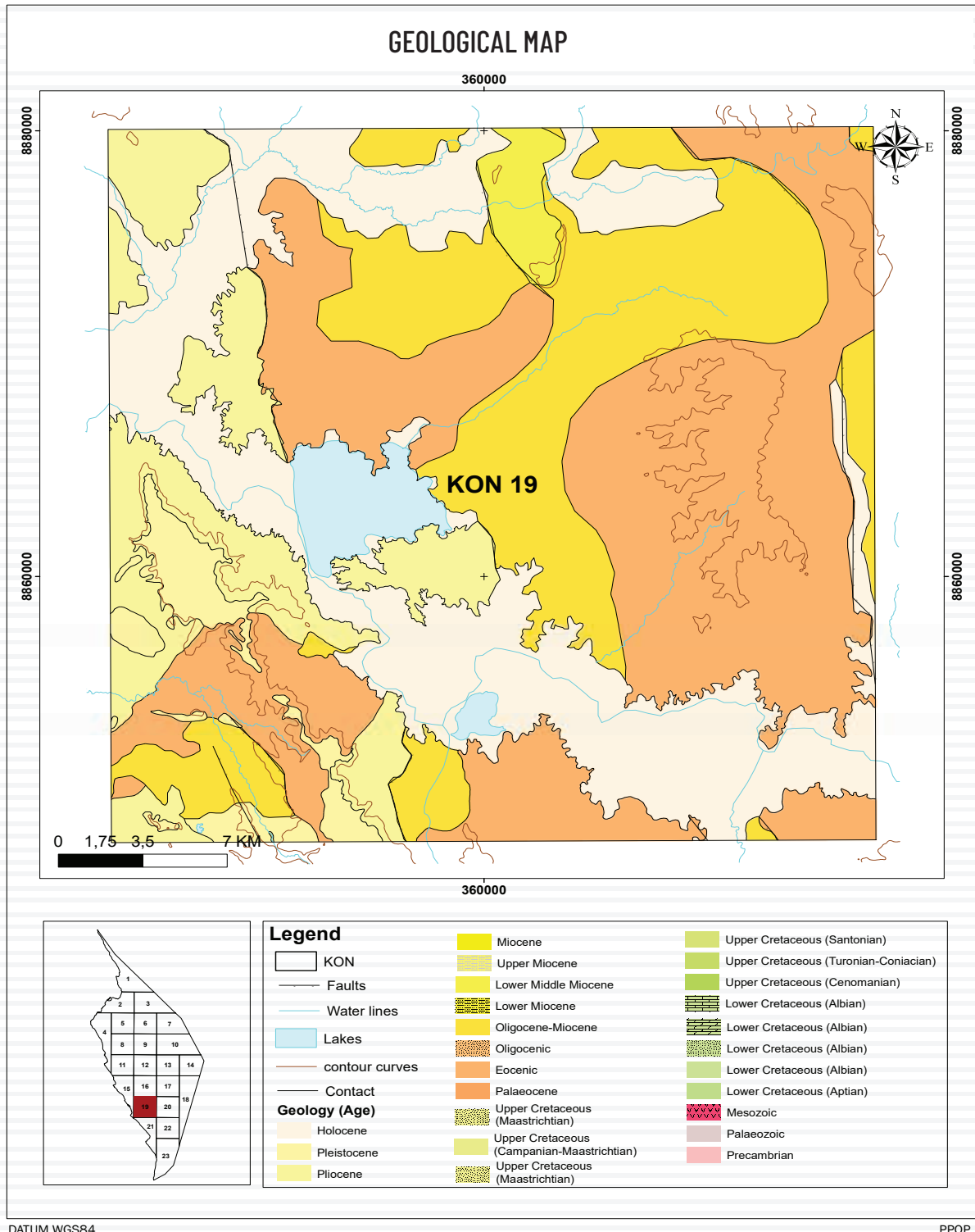


Figure 2: Geological map of Block KON 19, ANPG 2022

## Pre-salt Unit

The Pre-salt unit is dominated by horsts structures such as (Lumbondo), grabens (Maculungo), and faults eradicated in the basement along its entire length. In the deepest zones, the “Maculungo graben” have a more outstanding sedimentary contribution and potential for organic material accumulation, which generates hydrocarbons when submitted to high temperatures and pressures. The faults serve as migration paths of hydrocarbons to the high points, “horsts of Lumbondo.” The Sag sandstone sediments at the base of the upper Cuvo Formation present themselves as good reservoirs, as do the pinch-out sands deposited on the flanks of the horsts.

At the beginning of the Aptian, with the influences of the first marine incursions and high temperatures, a lagoonal depositional system developed in which the salt layer that constitutes the main seal at the level of this unit was deposited.

## Post-salt Unit

This Albian level unit is characterized by a tectonic style of growth faults with listric over thrusting, induced by sedimentary overburden and salt tectonics (Rafts tectonics), in response to reactivation of the punch faults and the first regional westward basin tilting in the Cretaceous (upper Albian, Cenomanian-Turonian), a period characterized by the high thermal regime. Large-scale salt sliding led to the formation of salt walls and rafts that represent the Coastal fold belts. In the Tertiary, sedimentation was conditioned by the Morro liso and Muxate Trough, which are mostly well distributed in the central part of Block KON 19 in the NE-SO alignment.

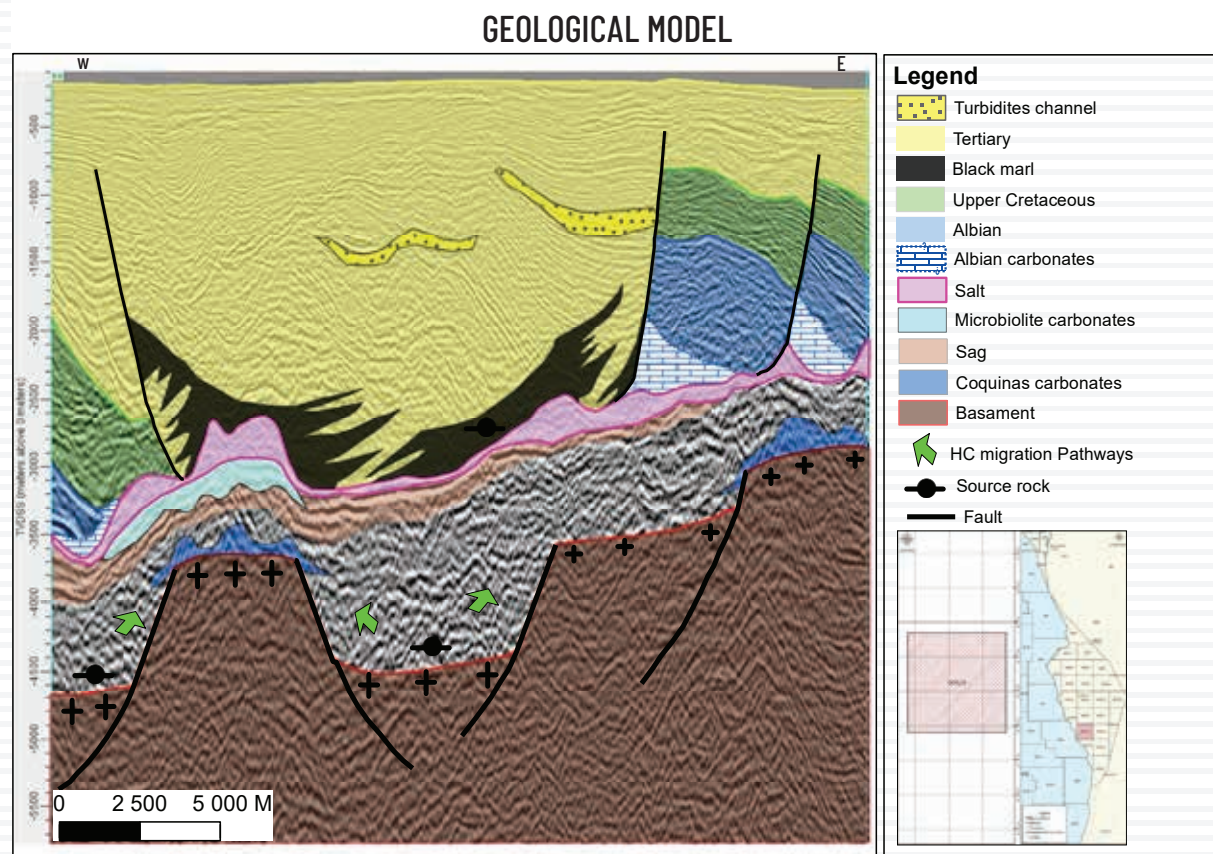


Figure 3: Geological Model of the Block KON 19, SKB 313s, ANPG 2022

## 4. EXPLORATION History

The first exploration works in the Block were carried out by the company Petrangol between 1960 and 1971 with the drilling of 5 exploration wells, Morro Liso-1, Morro Liso-2, and Morro Liso-3. Morro Liso-4 and Lumbondo-1.

Between 1970 and 1973, Petrangol carried out a 2D seismic survey that identified three structures: Lumbondo Horst, Morro Liso Trough, and Maculungo Graben, located to the Northeast and Southeast of the block. In 1998 ENI carried out an aero gravimetric and magnetometric survey. The Geokinectics Company carried out the period 2009-2012 a 2D seismic acquisition campaign of 121.062 Km.

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 2, 4, and 5).

Well	TD (mMD)	Spud Date	Reservoiir (Objectives)	Result
Morro Liso 1	2 385	22/11/1960	Cabo Ledo Fm. Limestone marls	Oil and gas shows
			Fractured dolomites of Cuvo Cinzento Fm.	Oil and gas shows
Morro Liso 2	2 383.1	24/05/1961	Cabo ledo Fm.	Oil shows
Morro Liso 3	2 765.5	23/11/1970	Cabo ledo Fm. sandstones	Oil shows
			Cuvo Cinzento Fm. conglomerates	oxidized oil shows
Morro Liso 4	2 911	20/01/1971	Itombe Fm.	Oil shows gas traces in fractured and fissured zones, with 33 <sup>º</sup> API oil.
			Sands and limestones of Cuvo Fm.	Oil shows
Lumbondo 1	2 730	10/1971	Cunga-gratidão, Rio Dande, Teba, N'golombe and Itombe Fm.	Gas shows

**Table 1:** Drilled wells on Block KON 19

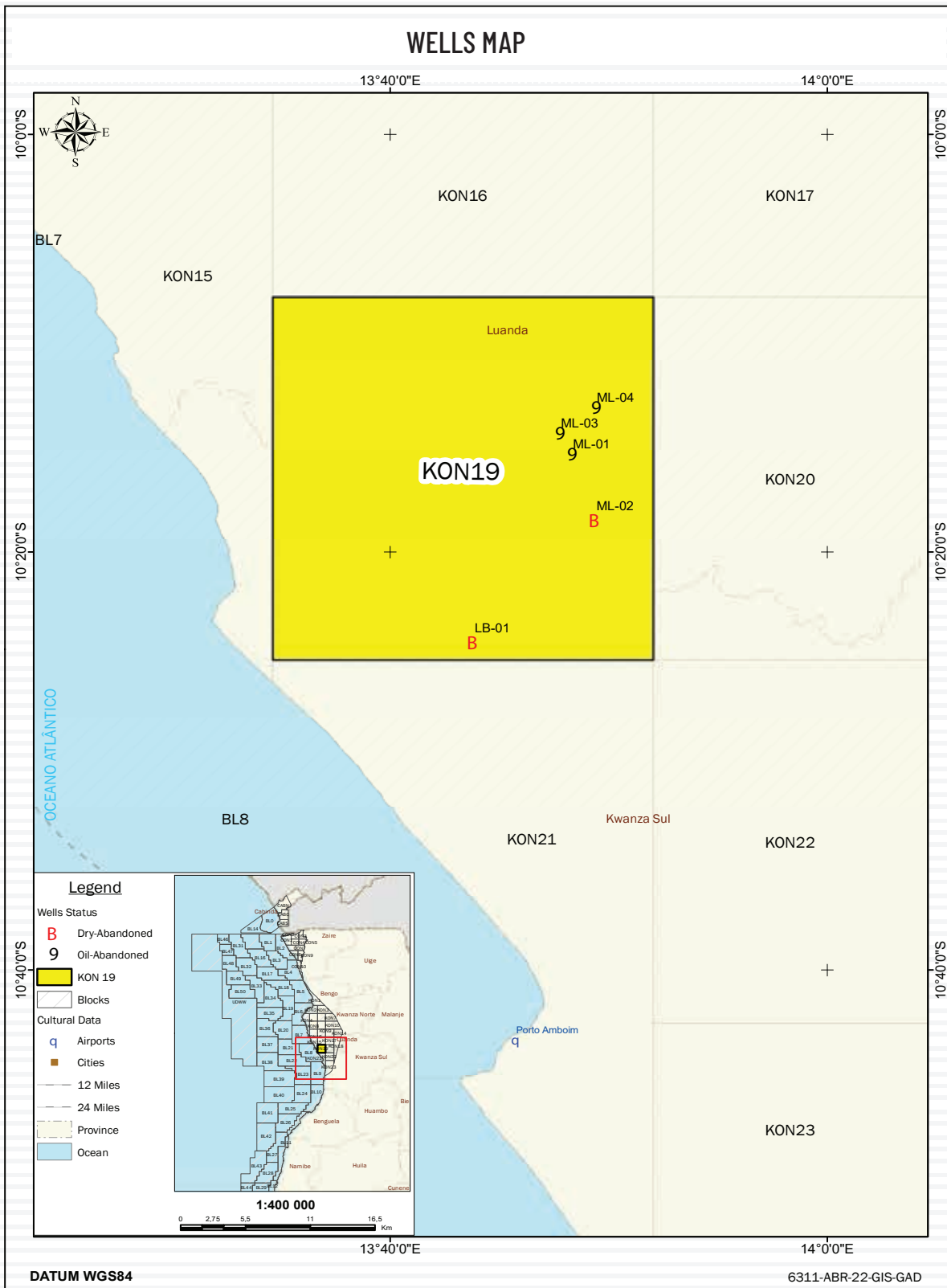


Figure 4: Well map of KON 19 ANPG 2022



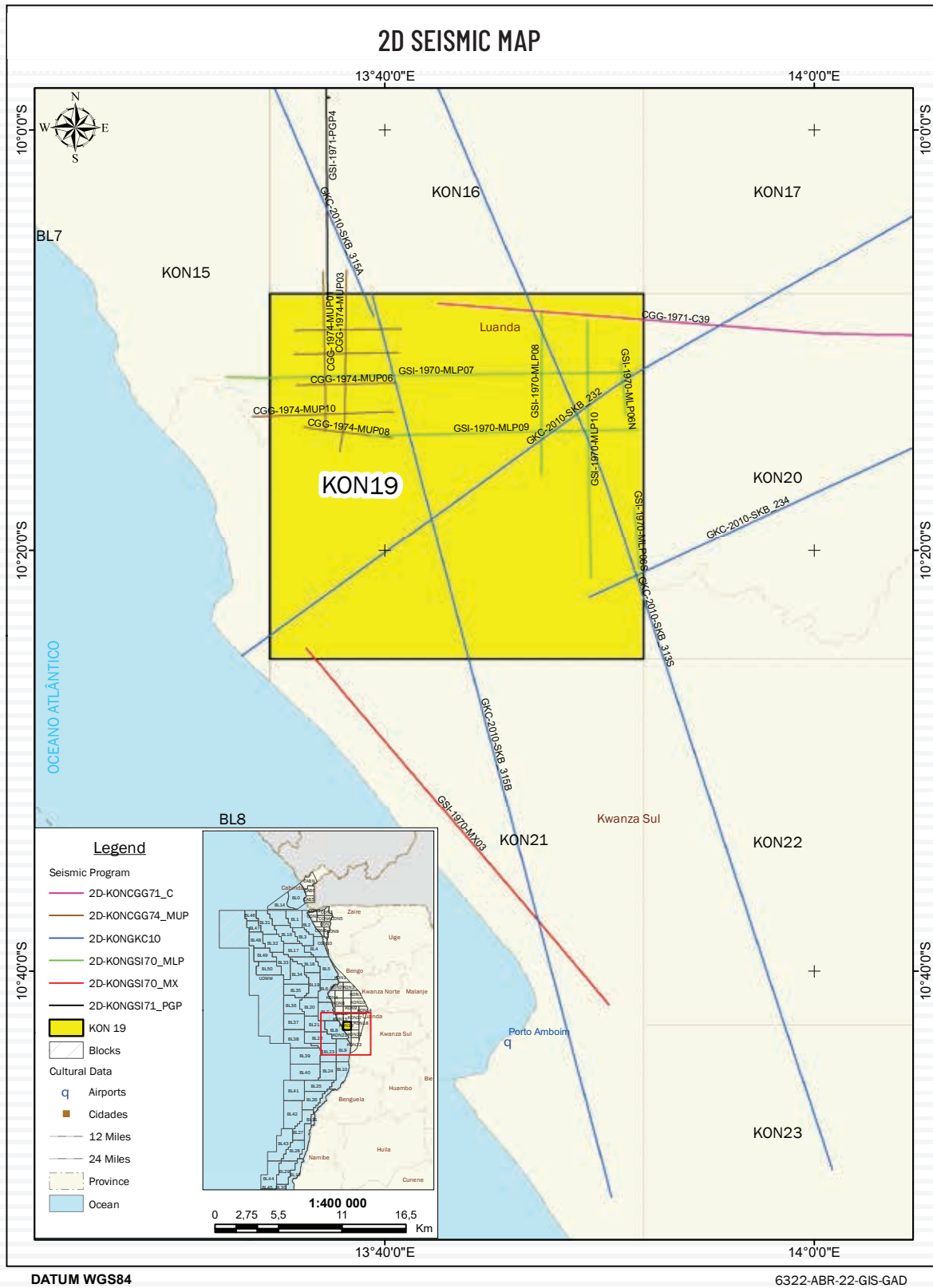


Figure 5: 2D Seismic Data Acquired on Block KON 19, ANPG 2022

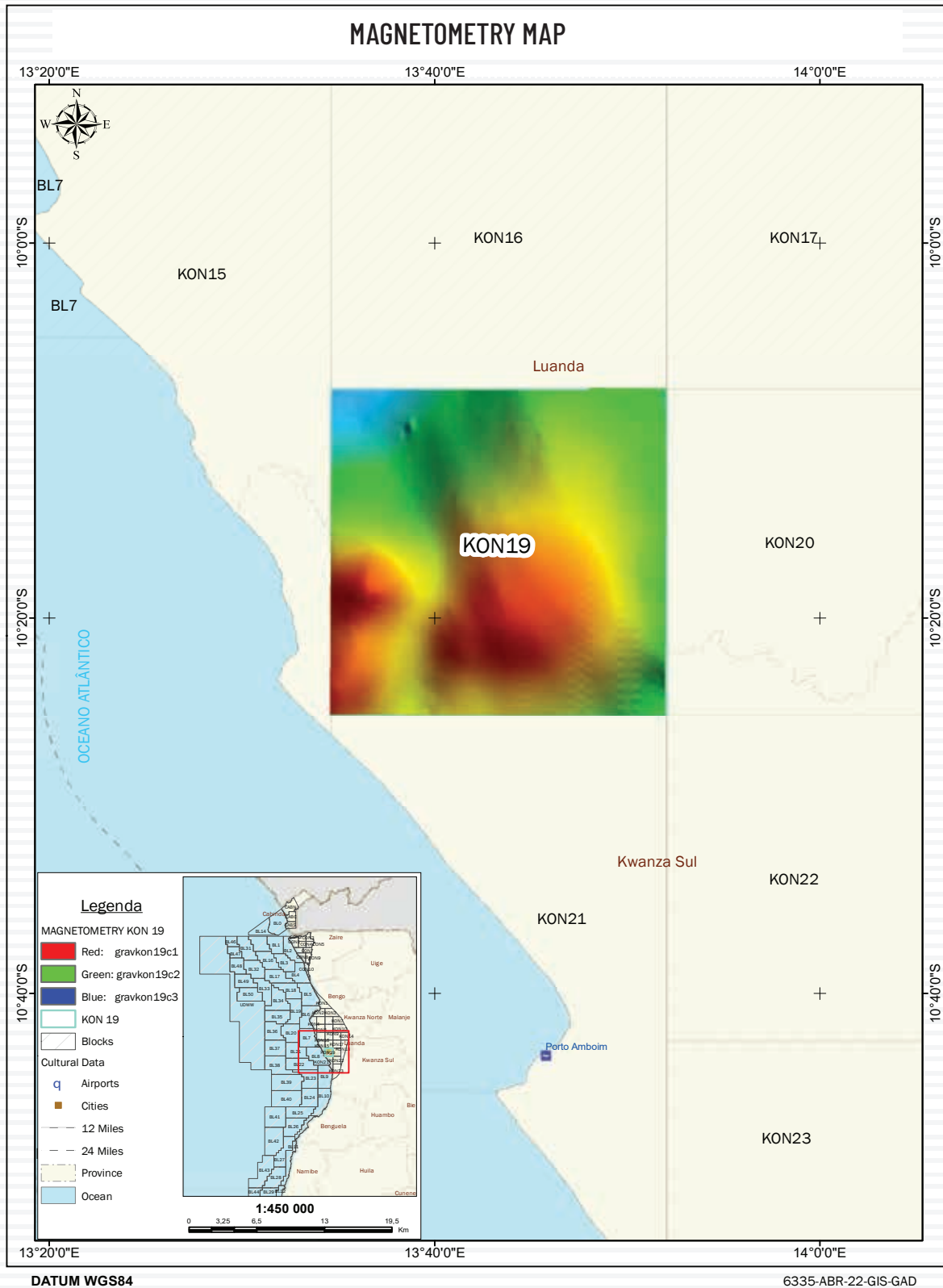


Figure 6: Magnetometry map of the KON 19, ANPG 2022

## 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).

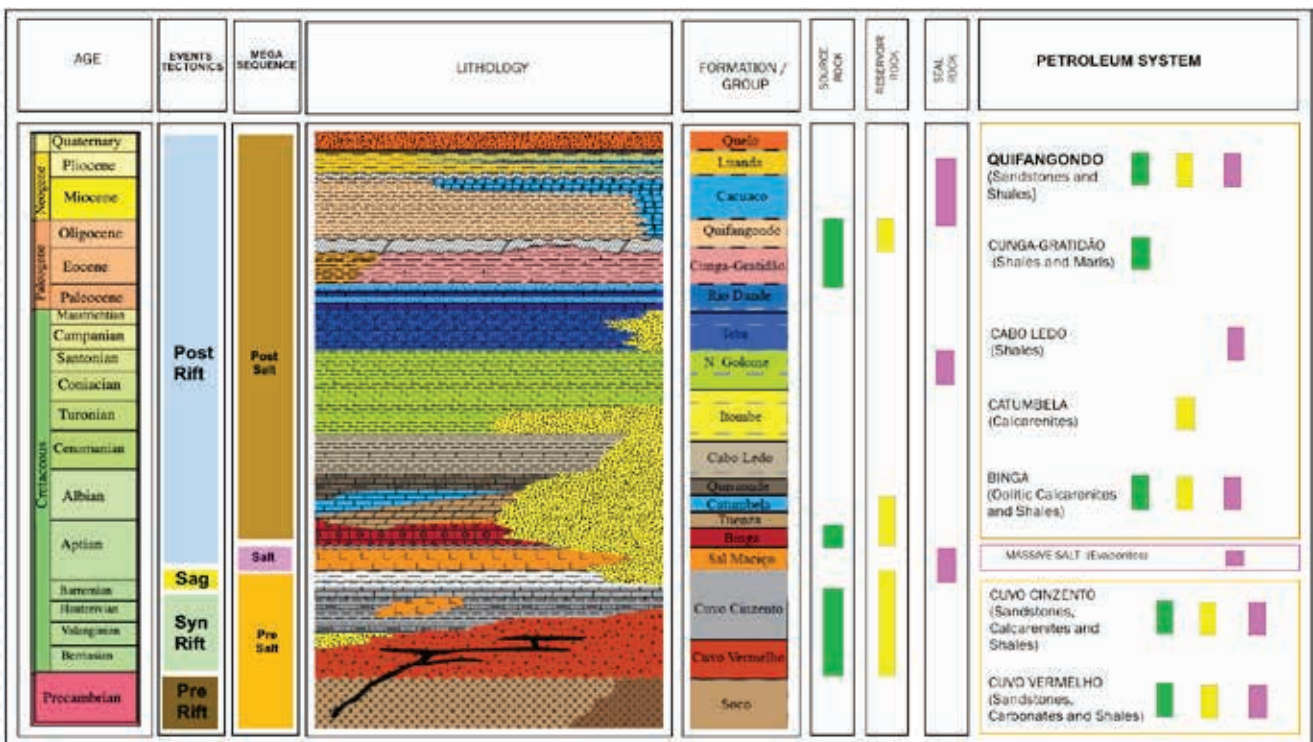


Figure 7: Lithostratigraphic Column of the Onshore Kwanza Basin, ANPG 2022



## 5.1 Generation and Migration

The source rock consists of Shale of the Cuvo Formation in the Pre-salt, carbonates of the Binga Formation in the Albian, and black marls of the Cunga-Gratidão Formation in the Tertiary. Migration pathways occur from faults and facies contact.

## 5.2 Reservoir Rock

At the Pre-salt level, the Cuvo Formation consisting of sands on the flanks of the horts, coquina carbonates on top of the horst, and the sands on top of the Barremian, constitute the primary reservoirs. The reservoirs identified in the Post-salt correspond to the oolitic dolomitic limestones of the Binga Formation and the sandstones of the Itombe Formation of the middle Cretaceous age, as well as turbiditic channels of the Tertiary period.

## 5.3 Seal Rock

The seal rock, at the Pre-salt level, corresponds to the massive Salt Formation (Halite) and the intraformational Shale of the Cuvo Formation. In the Post-salt, anhydrite of the Tuenza Formation, marls of the N'Golome Formation and the intraformational Shale of the Cabo Ledo and Quifangondo Formations.

## 5.4 Trap

In the Pre-salt, structural traps of anticlinal type were identified. The traps in the Albian, Cretaceous, and Tertiary are combined in the Post-salt unit.

## 5.5 Source Rock Occurrence

The primary source rocks identified in the Kwanza Basin are the Shale of the Cuvo Vermelho and Cinzento Formations in the Pre-salt and, for the Post-salt, the carbonates and black marls of the Binga and Cunga Gratidão Formations. The geochemical data from wells Morro Liso-1, Morro Liso-2, and Morro Liso-3 allowed us to assess the potential of the source rocks. Total Organic Carbon (TOC), Rock-Eval Pyrolysis, and Vitrinite Reflectance analyses were performed in the Pre-salt and Post-salt units. In the Pre-salt unit, the geochemical data revealed organic content values ranging from medium to highly matured. At the Post-salt level, the characterization of the source rock suggests excellent organic content in a mature stage

## Cuvo Vermelho Source

The Shale of the Cuvo Vermelho Formation at the Pre-salt level, at 2750 m depth, present average values of Total Organic Content (TOC) of 0.93%. The HI values indicate type III kerogen. The parameters indicative of maturity Tmax 447 °C and Ro 0.5% show that the rock is mature.

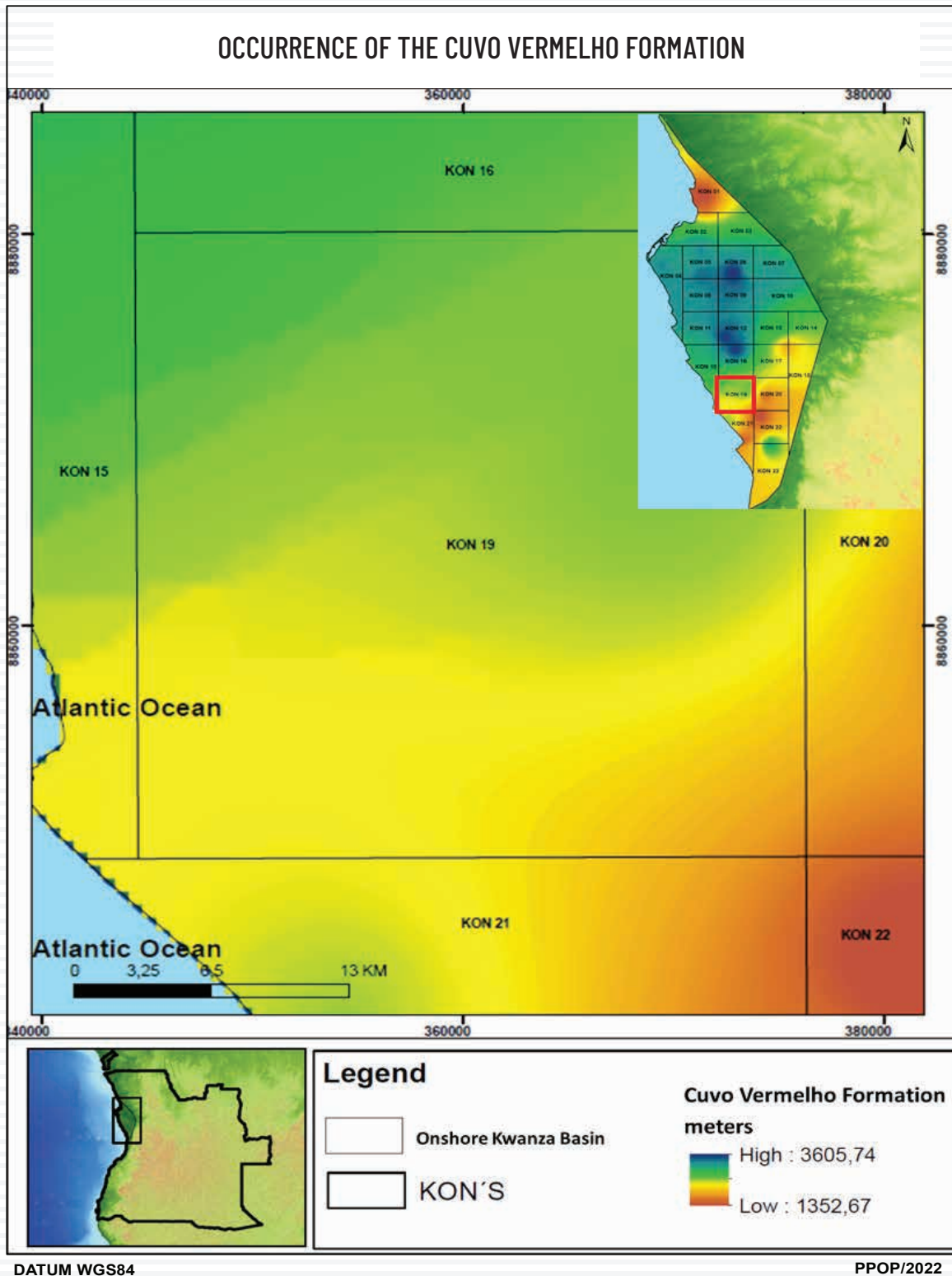


Figure 8: Occurrence map of Cuvo Vermelho Fm. Source rock

## Cuvo Cinzento Source

The Shale of the Cuvo Cinzento Formation in the Pre-salt unit, at a depth of 2369.4 m, show an excellent Total Organic Content (TOC) value of 2.13%, while at 2623 m average values of 0.7% TOC. The S1 and S2 parameters suggest medium petroleum potential. HI values indicate type III kerogen. Maturation parameters Tmax 438 at 442 °C and Ro 0.9% suggest that the rock is in the early to peak maturation stage.

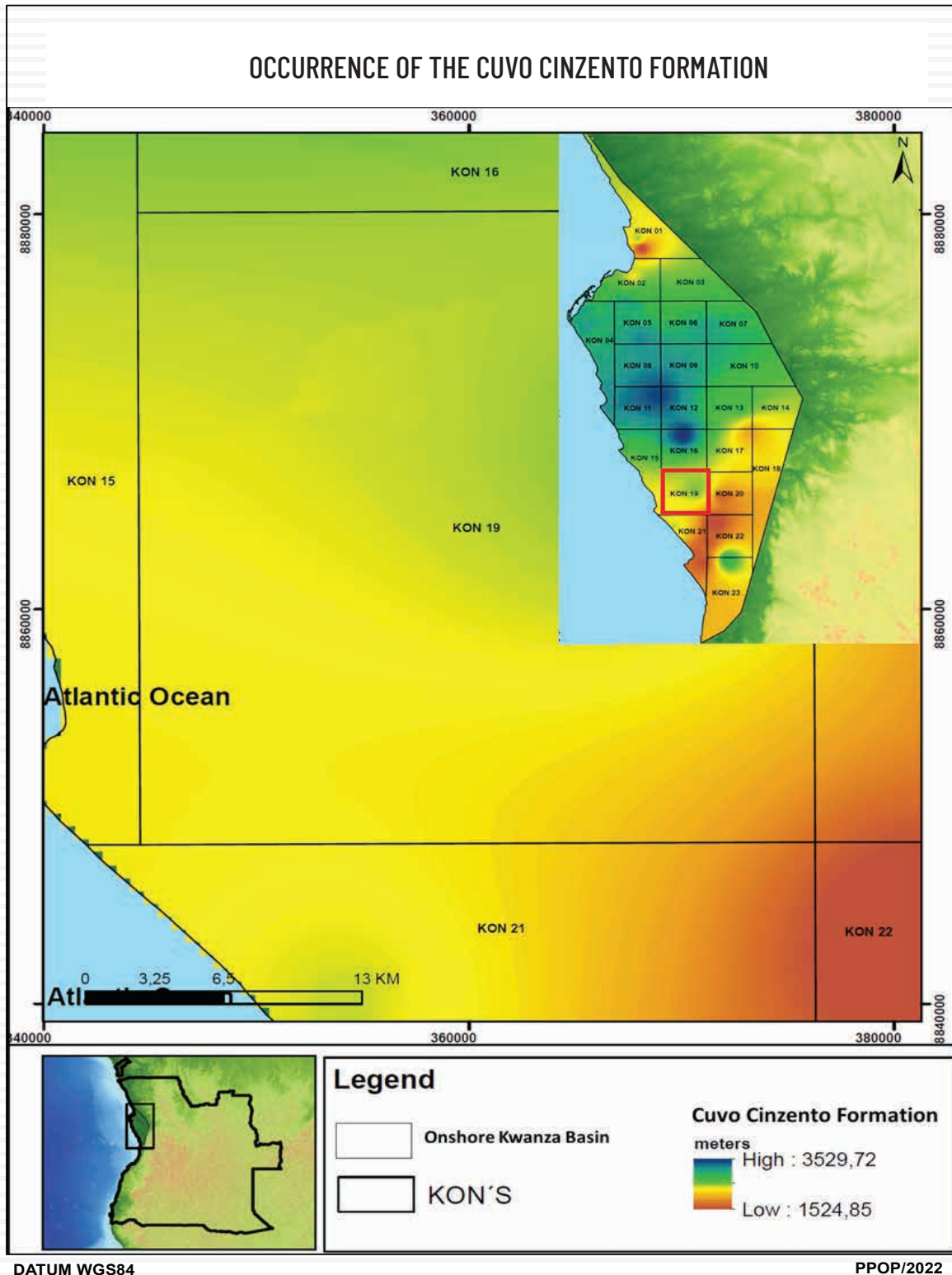


Figure 9: Occurrence map of Cuvo Cinzento Fm. Source rock

## Binga Source

The carbonates of the Binga Formation, a proven Albian source rock, are partially distributed in the block. Geochemical studies carried out in neighboring blocks prove its generation potential.

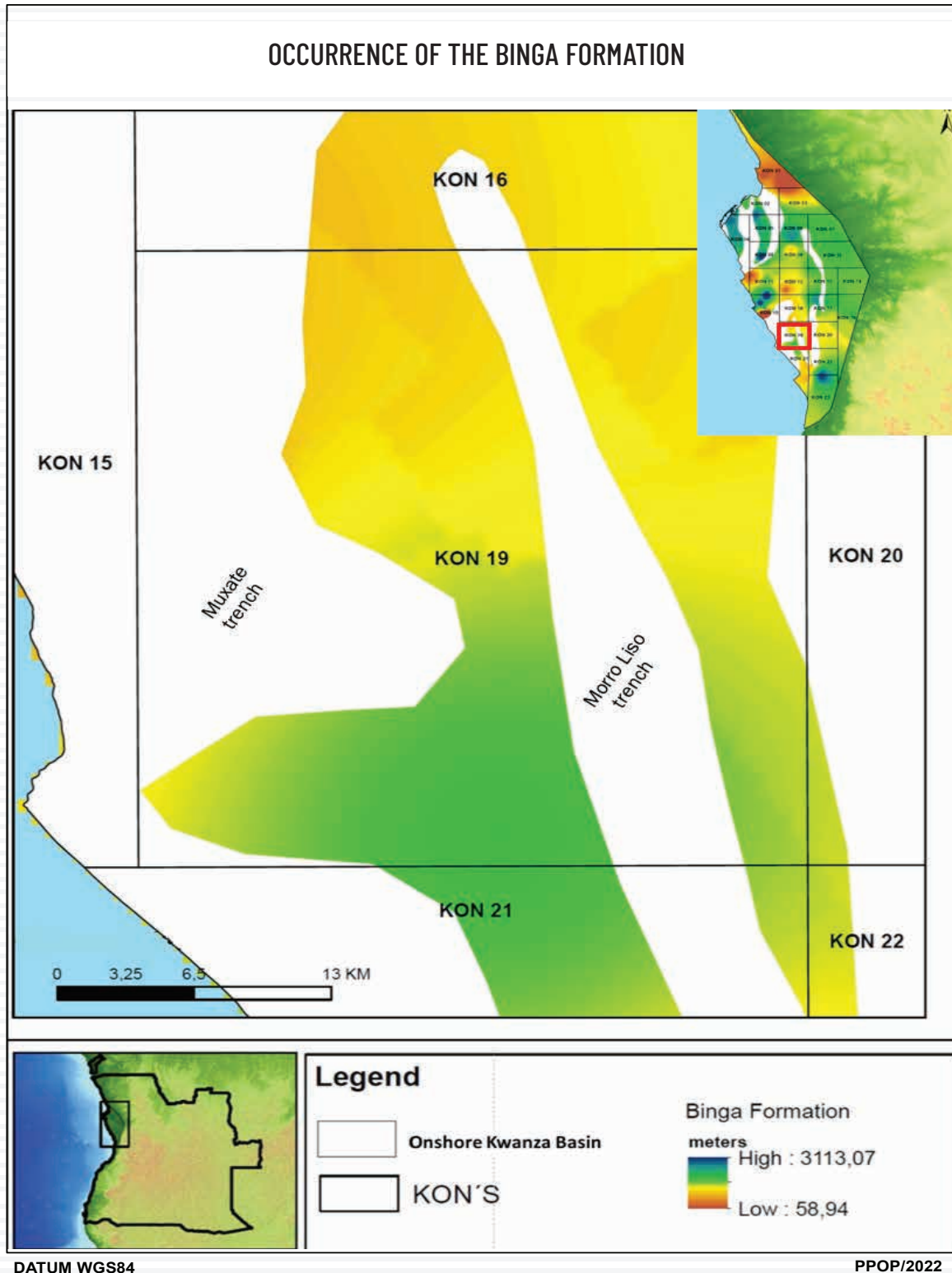


Figure 10: Occurrence map of Binga Fm. Source rock

## Teba Source

The Teba Formation, a source rock with Upper Cretaceous potential, is partially distributed in the block, absent in the Muxate and Morro-Liso Trough. Geochemical studies carried out in the block prove its generation potential.

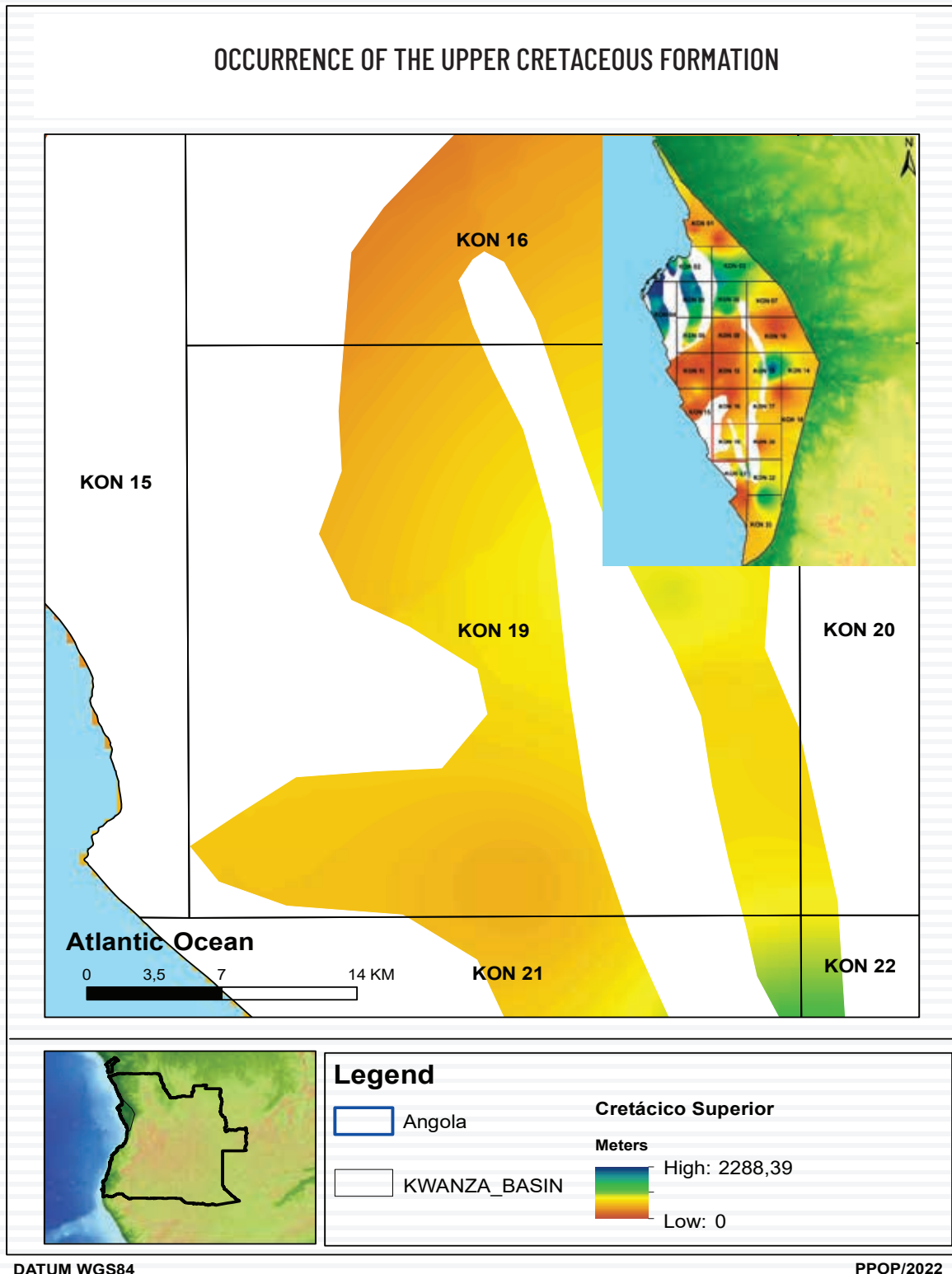


Figure 11: Occurrence map of Upper Cretaceous Fm. Source rock



## Cunga-Gratidão Source

The black marls of the Cunga-Gratidão Formation, proven generative rock at the Tertiary level, are distributed in the Muxate and Morro-Liso Trough, with good geochemical characteristics for the generation of hydrocarbons in the block.

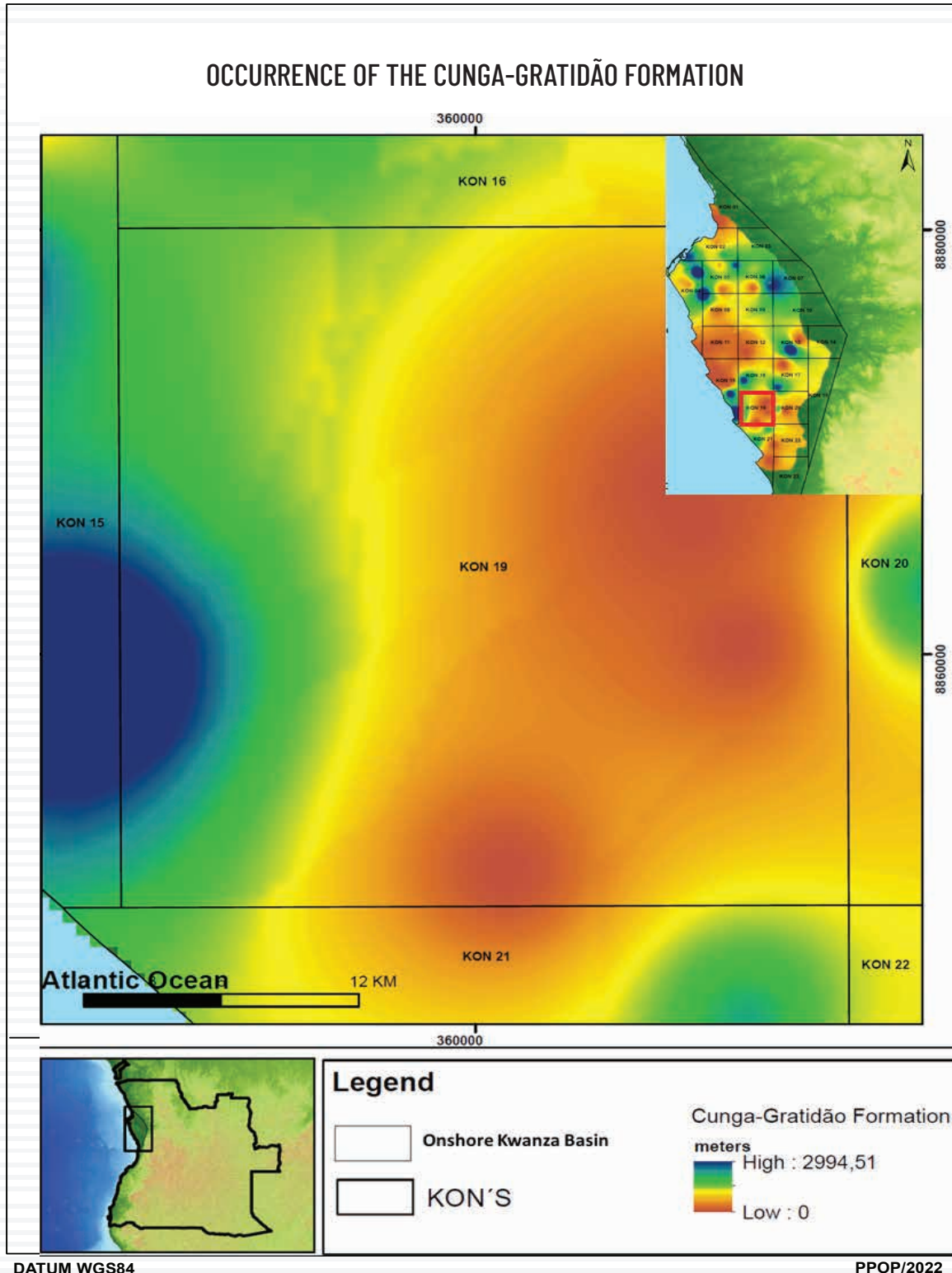


Figure 12: Occurrence map of Cunga-Gratidão Fm. source rock



## 1D Model

Chio-1 well shows that the Cuvo Vermelho Formation was deposited in the Lower Cretaceous. The thermal evolution of the generating facies at a depth of 1300 to 2400 m reached the oil window of the Upper Cretaceous to Paleocene and the gas window at a depth of 2400 to 3000 m from the Paleocene to the present day. At the same time, the Cuvo Cinzento Formation was deposited in the Lower Cretaceous, having reached the oil window at a depth of 1350 to 2380 m in the Upper Cretaceous to Eocene and the gas window from 2380 to 2700 m from the Eocene to the present day.

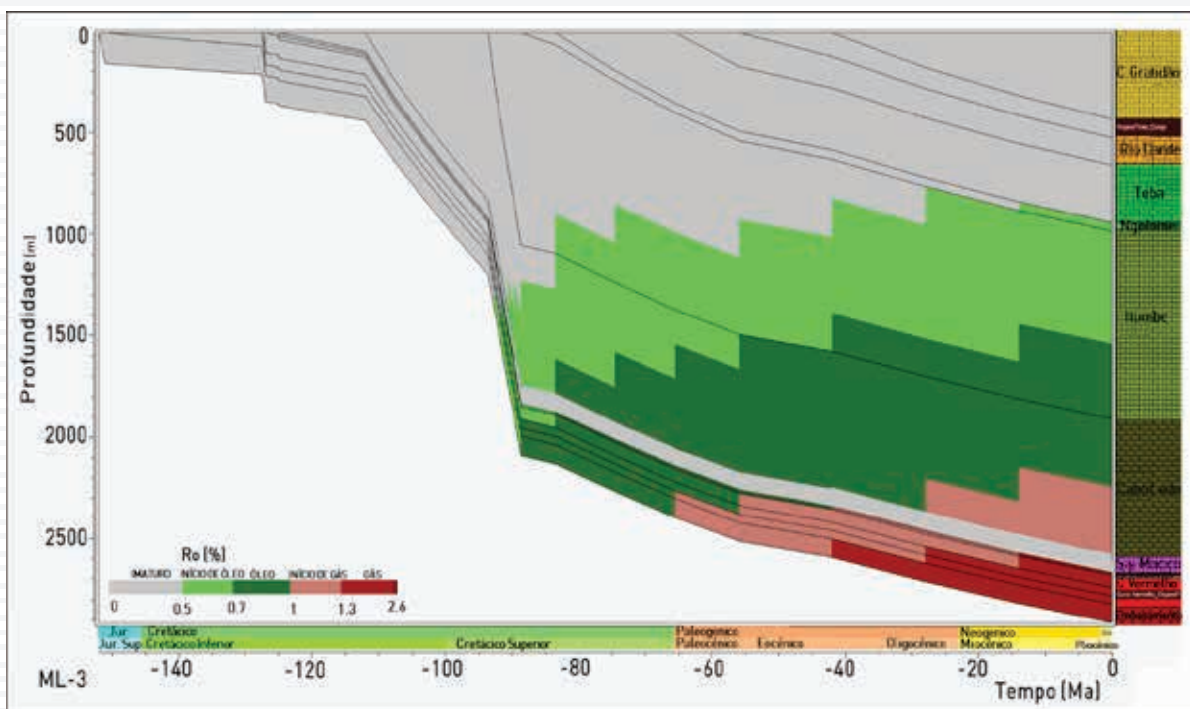


Figura 13: Maturation Profile of Morro Liso-3 Well



## 6. EXPLORATION Opportunities

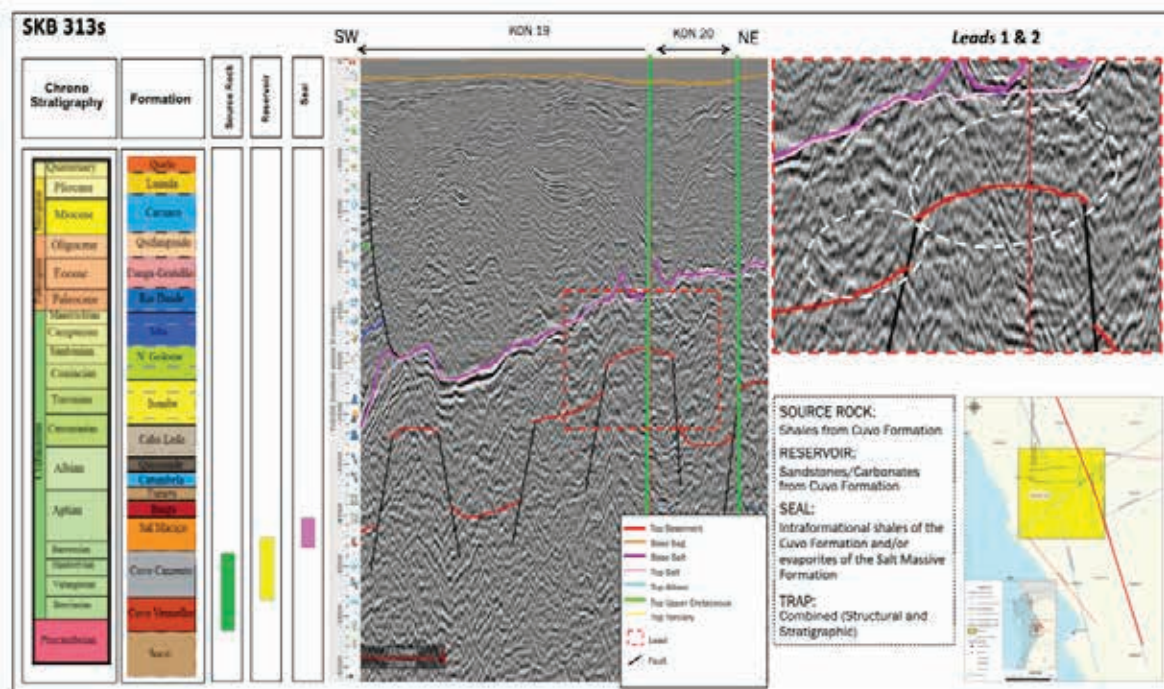
### 6.1 Identified Leads

As described below, the geological and geophysical data acquired allowed the identification of leads in both plays.

#### 6.1.1 Pre-salt Leads

##### Lead 1 & 2

Located east of the Block, is a double target, corresponding to the sands on the flank of the horsts and the carbonates on top of the horsts of the Cuvo Formation, having as source rock the organic-rich shale facies of the same formation deposited on the bottom of the grabens and as cap rock the evaporites of the Massive Salt Formation, in a mixed type trap.



##### Lead 3 & 4

Located west of the Block, is a double target, corresponding to the sands on the flank of the horsts and the carbonates on top of the horsts of the Cuvo Formation, having as source rock the organic-rich shale facies of the same formation deposited on the bottom of the grabens and as cap rock the evaporites of the Massive Salt Formation, in a mixed type trap.

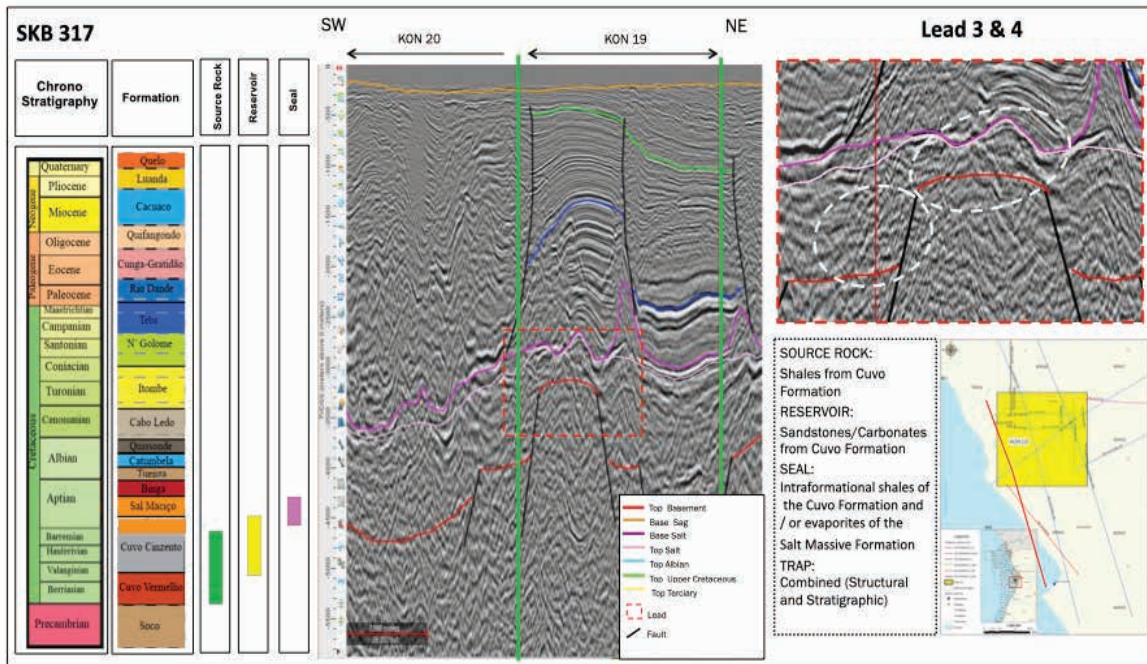


Figure 15: Lead 3 & 4 of Pre-salt, ANPG 2022

## Lead 5

Located east of the Block, is characterized by reflectors with strong parallel amplitudes truncating over the base of the salt at the level of the Cuvu 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 a cover rock.

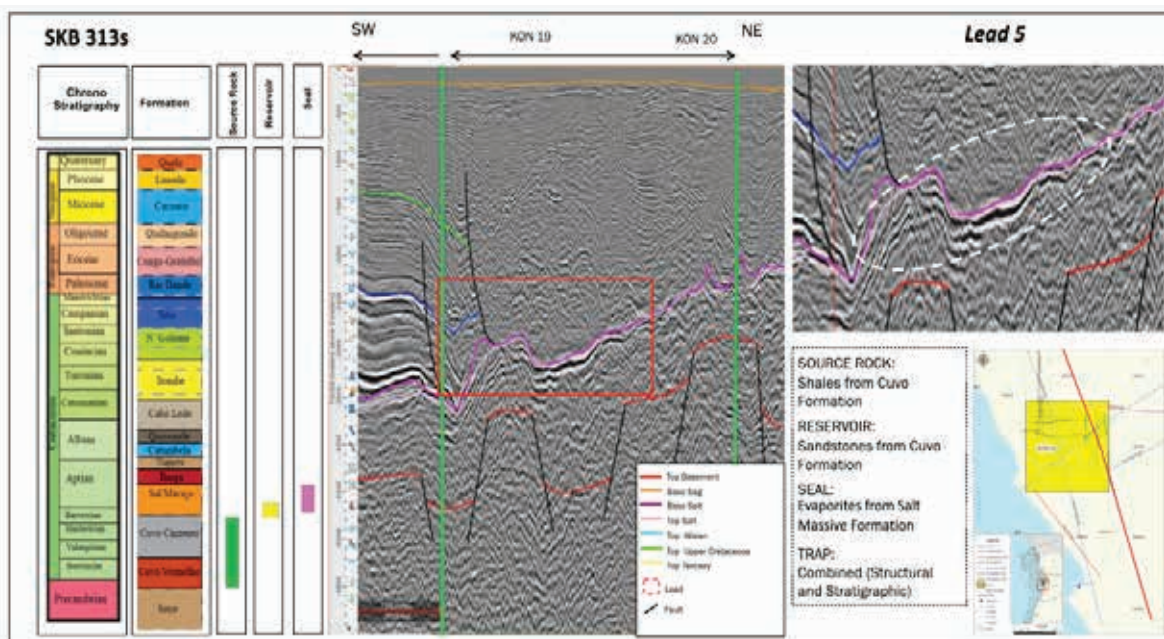


Figure 16: Pre-salt Lead 5, ANPG 2022



## Lead 6

Located west of the Block, is characterized by reflectors with strong parallel amplitudes truncating over the salt base at the Cuvo Formation level (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 a cover rock.

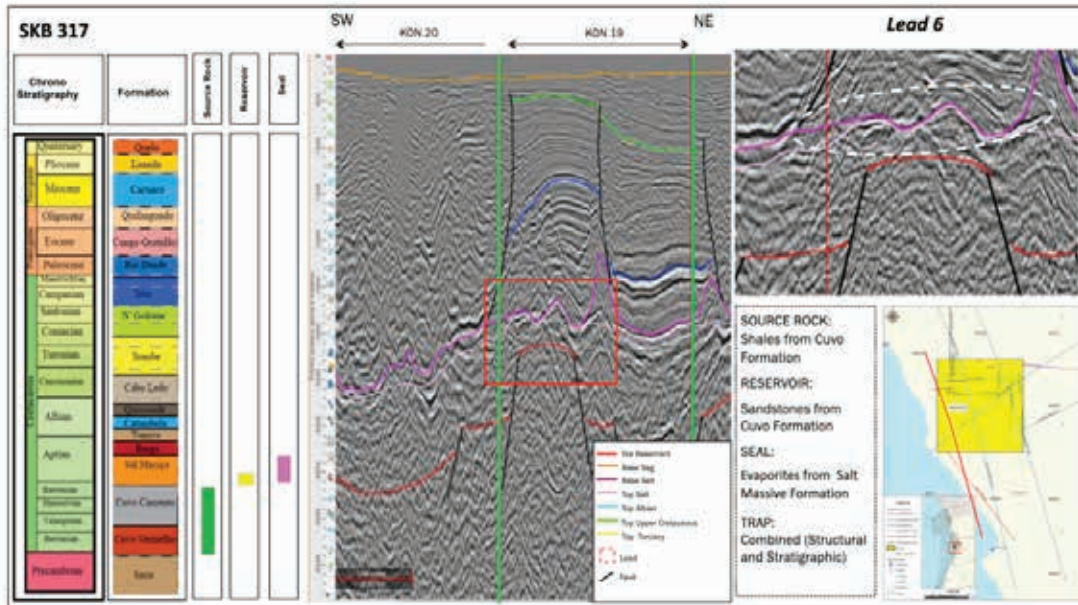


Figure 17: Pre-salt Lead 6, ANPG 2022

## 5.1.2 Lead of Post-salt

### Lead 7

Located west of the Block, the reservoirs consist of oolitic and dolomitic carbonates of the Binga Formation. The probable source rock is the argillaceous limestones of the same Formation with the Tuenza saliferous Formation as seal rock and mixed type trap.

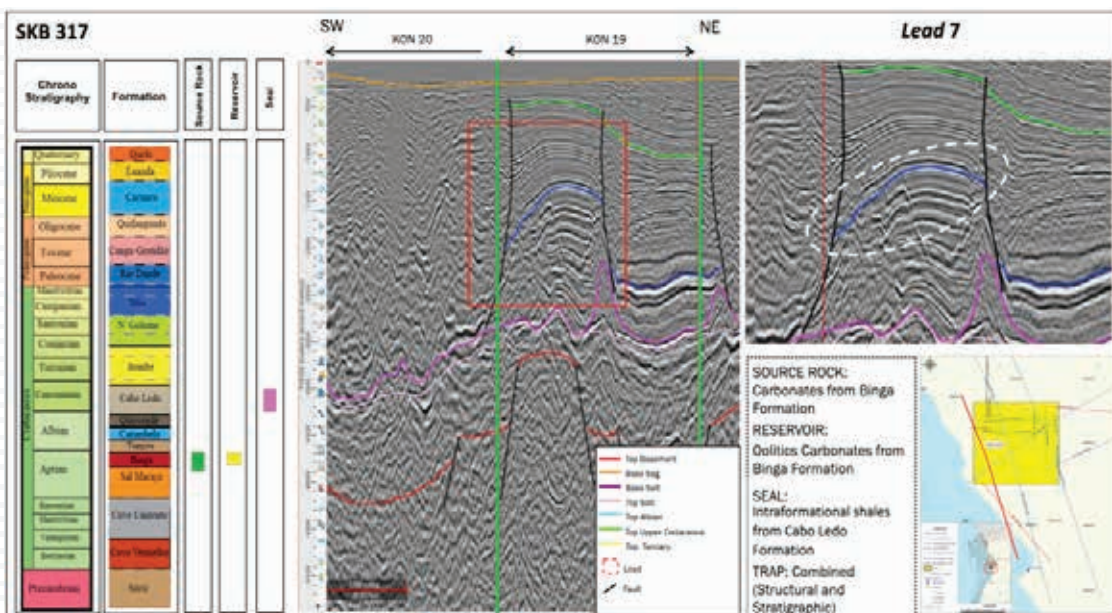


Figure 18: Post-salt Lead 7 ANPG 2022

## 7. FINAL Remarks

After reassessing **Block KON 19**, 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 19



# ANGOLA



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