



ONSHORE
LOWER
CONGO BASIN

2023
LICENSING ROUND
REPUBLIC OF ANGOLA

ONSHORE
KWANZA BASIN

ONSHORE KWANZA BASIN

Portfolio
OPPORTUNITIES

Block
KON15

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1. Introduction

The portfolio opportunities describe the general characteristics of Block KON 15, 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 for the seismic interpretation and the elaboration of the geological model by the ANPG/DEX team.

Block KON15 is in the southwest part of the Onshore Kwanza Basin. The first exploration activities in the block were conducted by the companies Purfina and Petrangol between 1955-1965 with the drilling of 13 (thirteen) exploration wells (Longa-1, Bamvo-1, Bamvo-2, São Brás-1, Kula-1, Sala- 1, Oco-101, Oco-102, Oco-103, Tanda-1, Tanda-1D, Cassau-101, and Cassau-102). The drilling campaign was motivated by discovering reservoirs in the Binga, Tuenza, Catumbela, and Teba Formations. The Tuenza and Binga reservoirs showed evidence of hydrocarbons in some of the wells. During 2009-2012, 2D seismic surveys were carried out by the Geokinectics Company.

Sonangol conducted recent geological mapping and well geochemistry data survey studies in partnership with Obrangol and Previsão Oil companies from 2010-2015 and 2012-2016, 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 hydrocarbon accumulation were identified at pre-salt and post-salt levels. The leads identified from geological and geophysical data integration present estimated resources from 750 to 1 300 MMB0.

2. GEOGRAPHIC Location

Block KON15 is in the Southwest part of the Kwanza Basin. It is bordered by KON 11 to the north, KON 16 and KON 19 to the east, Offshore block 8 to the south, offshore block blocks 7 and 8 to the west, and defined by the parallels $9^{\circ} 32' 50''$ S and $10^{\circ} 26' 11.97''$ S and meridians $13^{\circ} 18' 7.1''$ E and $13^{\circ} 34' 47''$ it has an area of approximately 1 007. 82 Km².

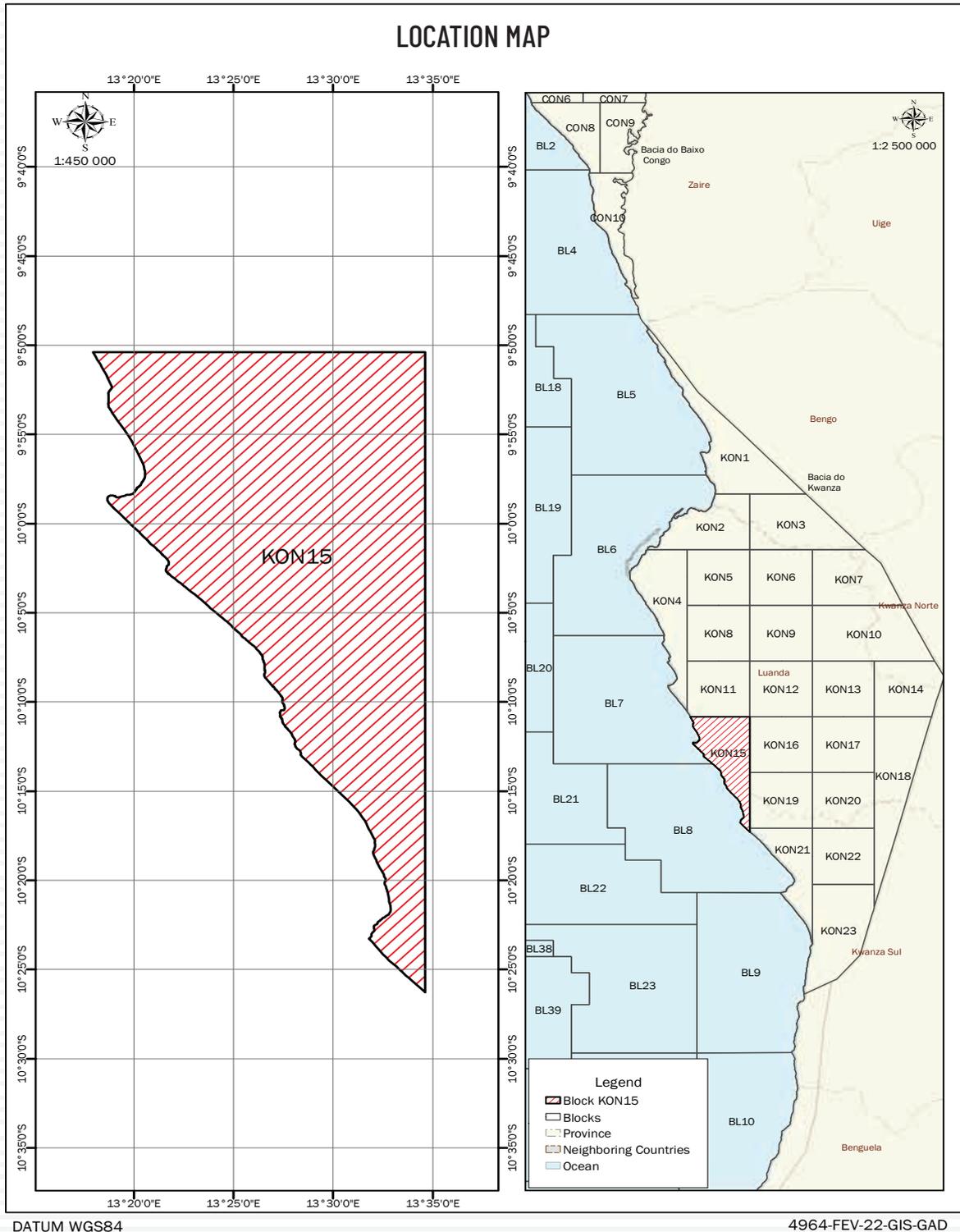


Figure 1: Location map of Block KON15, ANPG 2022

3. GEOLOGICAL Setting

The outcrops of Block KON 15 are represented by sediments of Precambrian to recent age, according to the geological chart of the Onshore Kwanza Basin (Figure 2). Its 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.

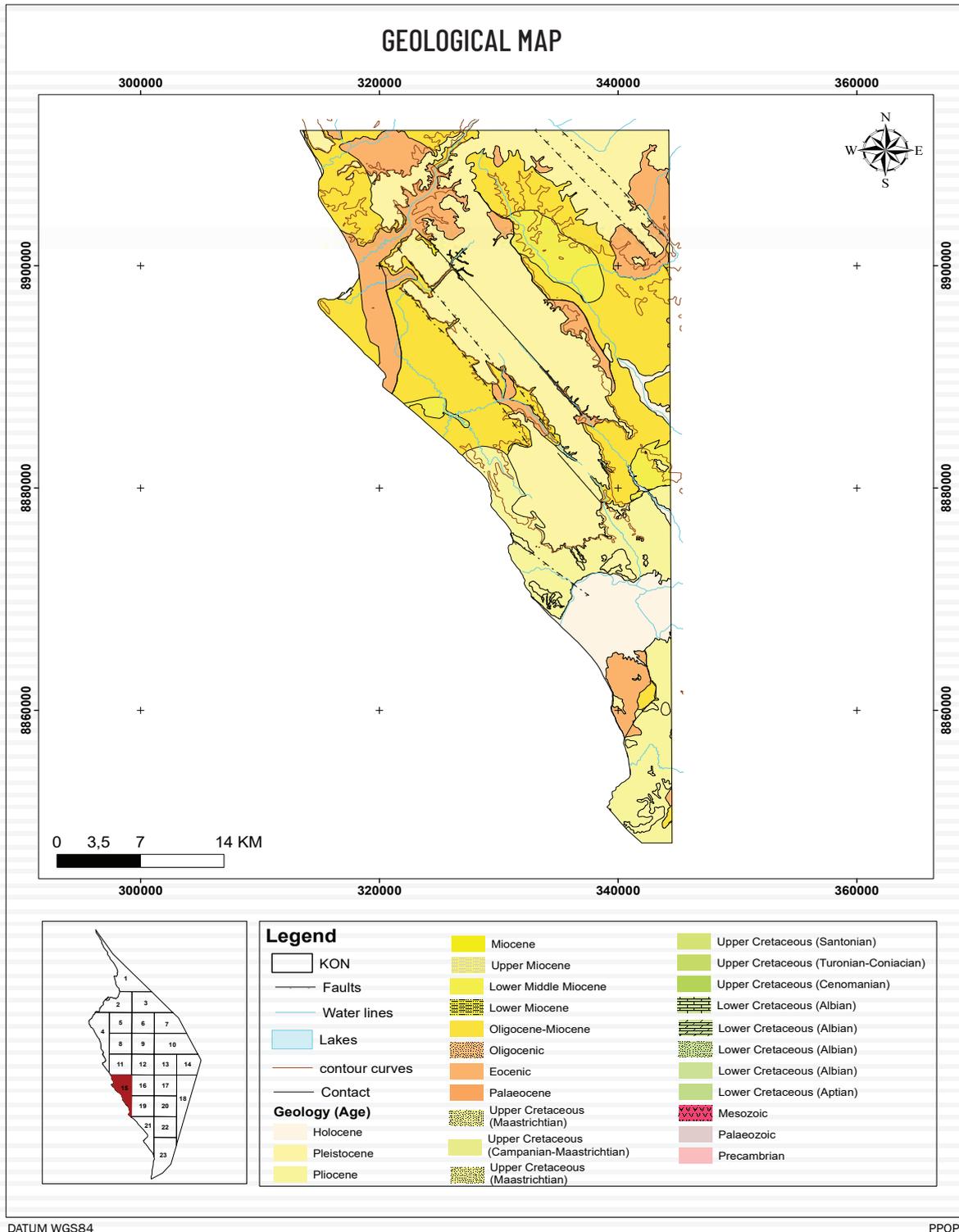


Figure 2: Geological map of Block KON 15, ANPG 2022

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 greater sedimentary contribution and potential for organic material accumulation, which generates hydrocarbons when submitted to high temperatures and pressures. The faults serve as migration paths for the 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 primary seal rock at the level of this unit was deposited.

Post-Salt Unit

It comprises formations with ages ranging from the Albian to the recent Quaternary. It is characterized by the strong influence of salt tectonics, Syn- depositional growth faults with listric relicts, and the existence of a Tertiary Trough filled with argillaceous sediments rich in organic matter, interspersed with sandy channels, with reservoir characteristics.

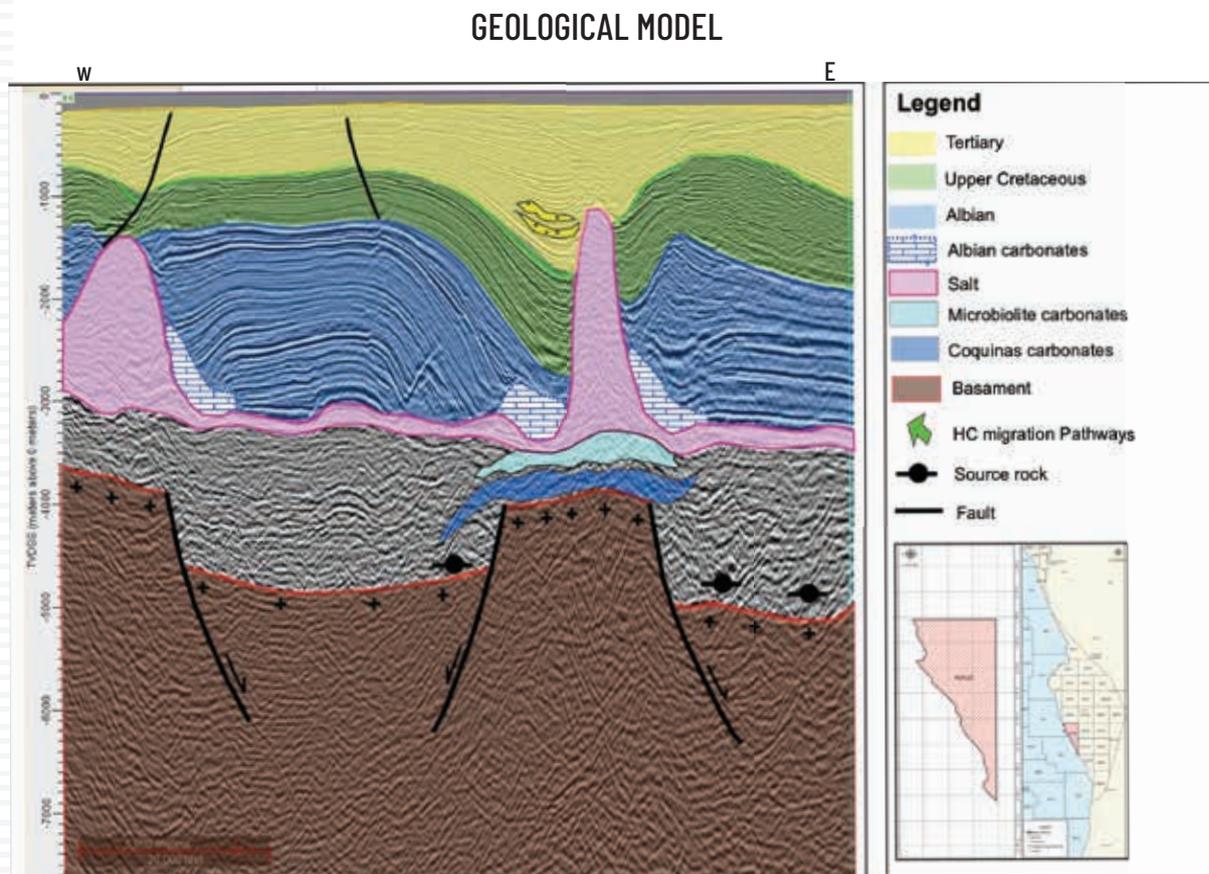


Figure 3: Geological Model of the Block KON 15, SKB 224 ANPG 2022

4. EXPLORATION History

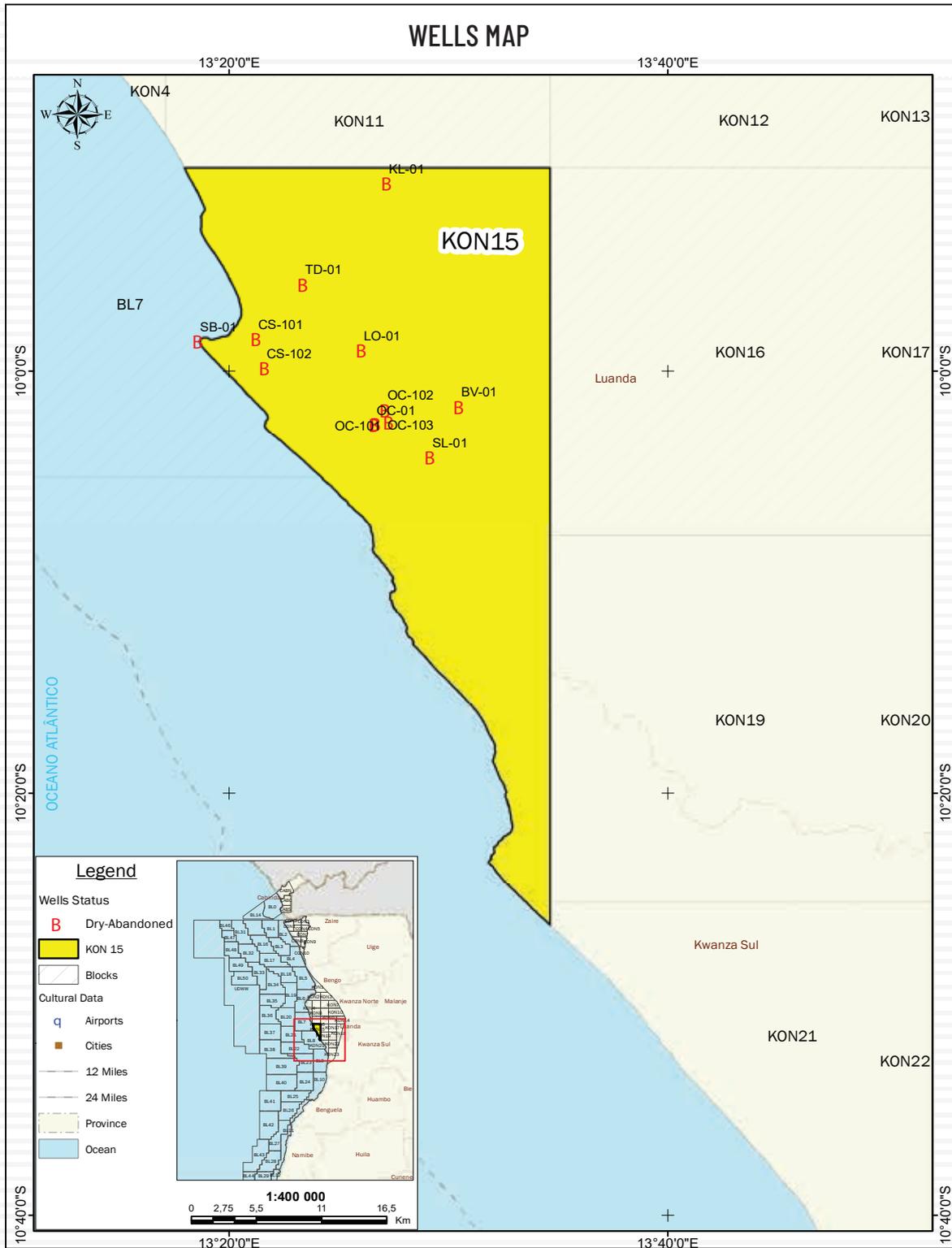
From 1955 to 1965, the first exploration works in Block KON 15 were conducted by the Purfina and Petrangol companies. The Longa, Oco, Cassau, Kula, São Bráz, and Tanda anticlines located to the North were drilled with a total of 13 exploration wells (Longa-1, Bamvo-1, Bamvo-2, São Brás-1, Kula-1, Sala-1, Oco-101, Oco-102, Oco-103, Tanda-1, Tanda-1D, Cassau-101, and Cassau-102).

Petrangol conducted seismic acquisition studies in the period between 1970 and 1973. ENI conducted aero gravimetry/magnetometry surveys in 1998, and the company Geokinectics conducted in the period 2009 to 2012 a 2D seismic acquisition campaign with a coverage of 97.8 km.

Recent geological mapping and surface geochemical studies were carried out by Sonangol in partnership with the companies Obrangol 2010-2015 and Previsão Oil 2012-2016.

Wells	Objective of the Survey	Operator	Year	Depth (m)	Reservoir	Result
Cassau-101	Research	Petrangol	1963			Indication of HC
Cassau-102	Research	Petrangol	1965	1 062.5		Dry
Bamvo-1	Research	Petrangol	1965		Tuenza e Binga (carbonates)	Indication of HC
Bamvo-2	Research	Petrangol	1965			
Kula-1	Research	Petrangol	1962	3 162.5		Dry
Longa-1	Research	Purfina	1958	3 070	Tuenza Dolomítico e Binga (carbonates)	Indication of HC
Oco-101	Research	Petrangol	1964	1 600	Tuenza Dolomítico	Indication of HC
Oco-102	Research	-	-			Dry
Oco-103	Research	-	-			Dry
Sala-1	Research	-	1964	1 809		Dry
São Brás-1	Research	Petrangol	1962	2 973	Catumbela, Tuenza e Binga (carbonates)	Indication of HC
Tanda-1D	Research	Petrangol	1965	2 407	Tuenza e Binga (carbonates)	Indication of HC

Table 1: Drilled wells on Block KON 15



DATUM WGS84

6310-ABR-22-GIS-GAD

Figure 4: Well map of KON 15 ANPG 2022

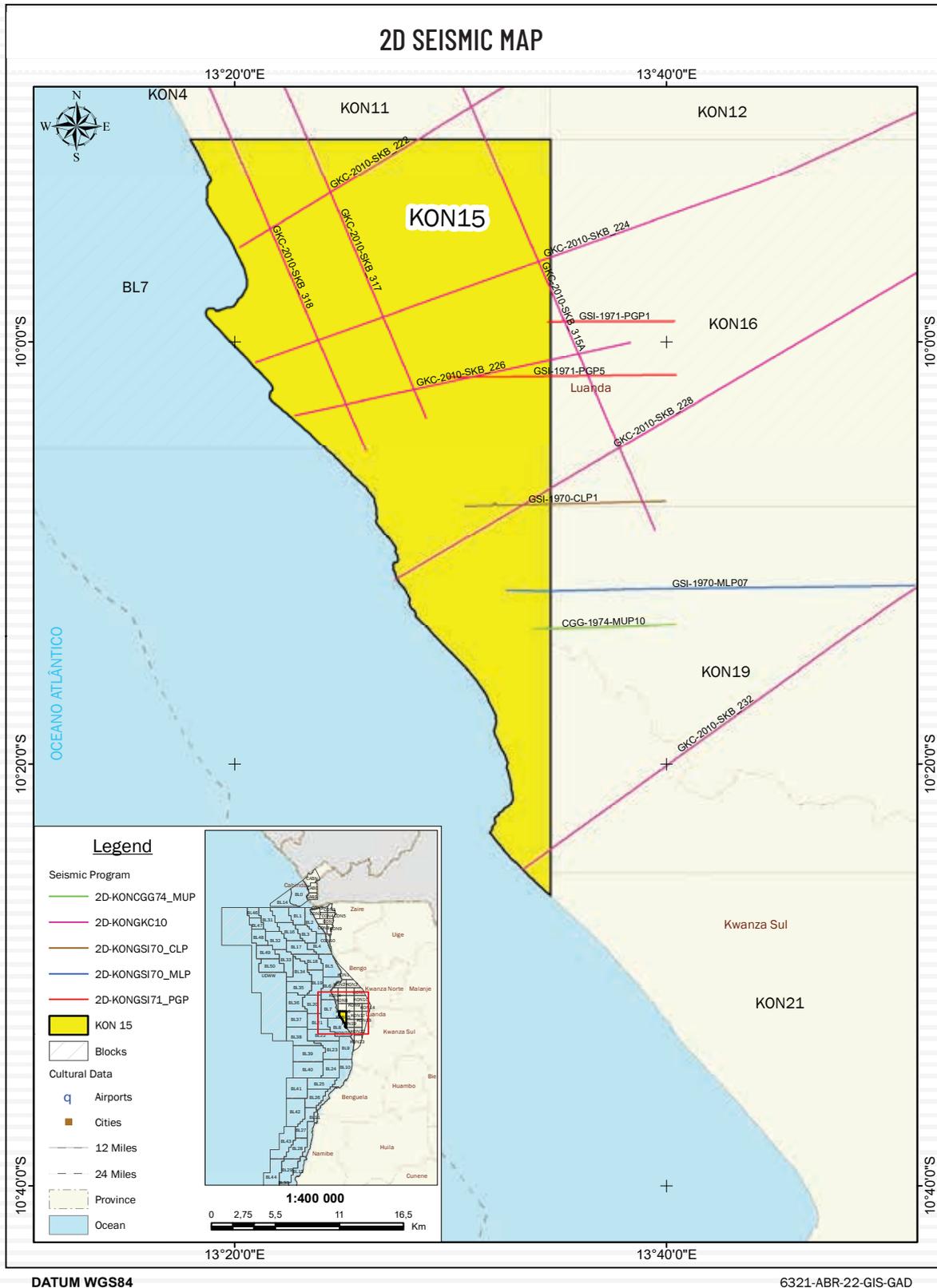


Figure 5: 2D Seismic Data Acquired on Block KON 15, ANPG 2022

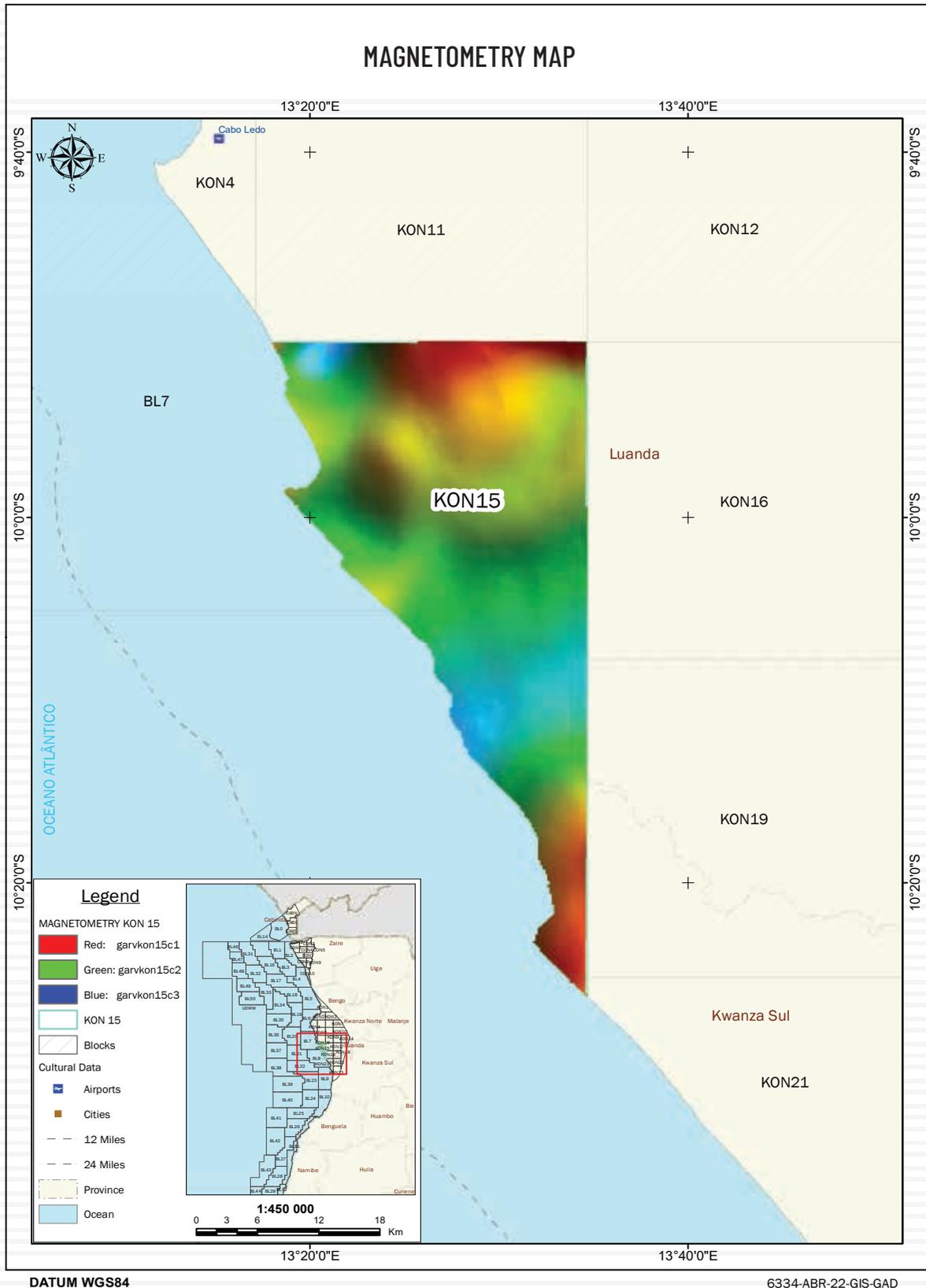


Figure 6: Magnetometry map of the KON 15, ANPG 2022

5.1 Generation and Migration

The primary source rocks identified in the Kwanza Basin are the shale of the Cuvo Vermelho and Cinzento Formations in the pre-salt and the carbonates of the Binga Formations in the post-salt. Migration pathways occur from faults and facies contact.

5.2 Reservoir Rock

In the pre-salt, the Cuvo Formation consisting of sands on the flanks of the horsts, coquina carbonates on top of the horsts, and the sands on top of the Barremian constitute the primary reservoirs. Carbonate rocks of the Binga and Catumbela Formations characterize the Post-salt.

5.3 Seal Rock

Thick layers of the Loeme Formation evaporite and the Cuvo Formation's intraformational shale represent the pre-salt seal rock. In the post-salt unit, the seal rock is the Tuenza Formation and intraformational shale of the Cabo Ledo and Quifangondo Formations.

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. Salt movement generally controls post-salt traps, resulting 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 Inner Kwanza Basin are the shale of the Cuvo Vermelho and Cinzento Formations in the pre-salt; for the post-salt, the carbonates and black marls of the Binga and Cunga Gratidão Formations, respectively.

Cuvo Vermelho Source

The Cuvo Vermelho Formation, a proven source in the pre-salt, is distributed along the entire length of the block and presents good geochemical characteristics at the basin level. Furthermore, geochemical studies carried out in surroundings blocks prove its generation potential.

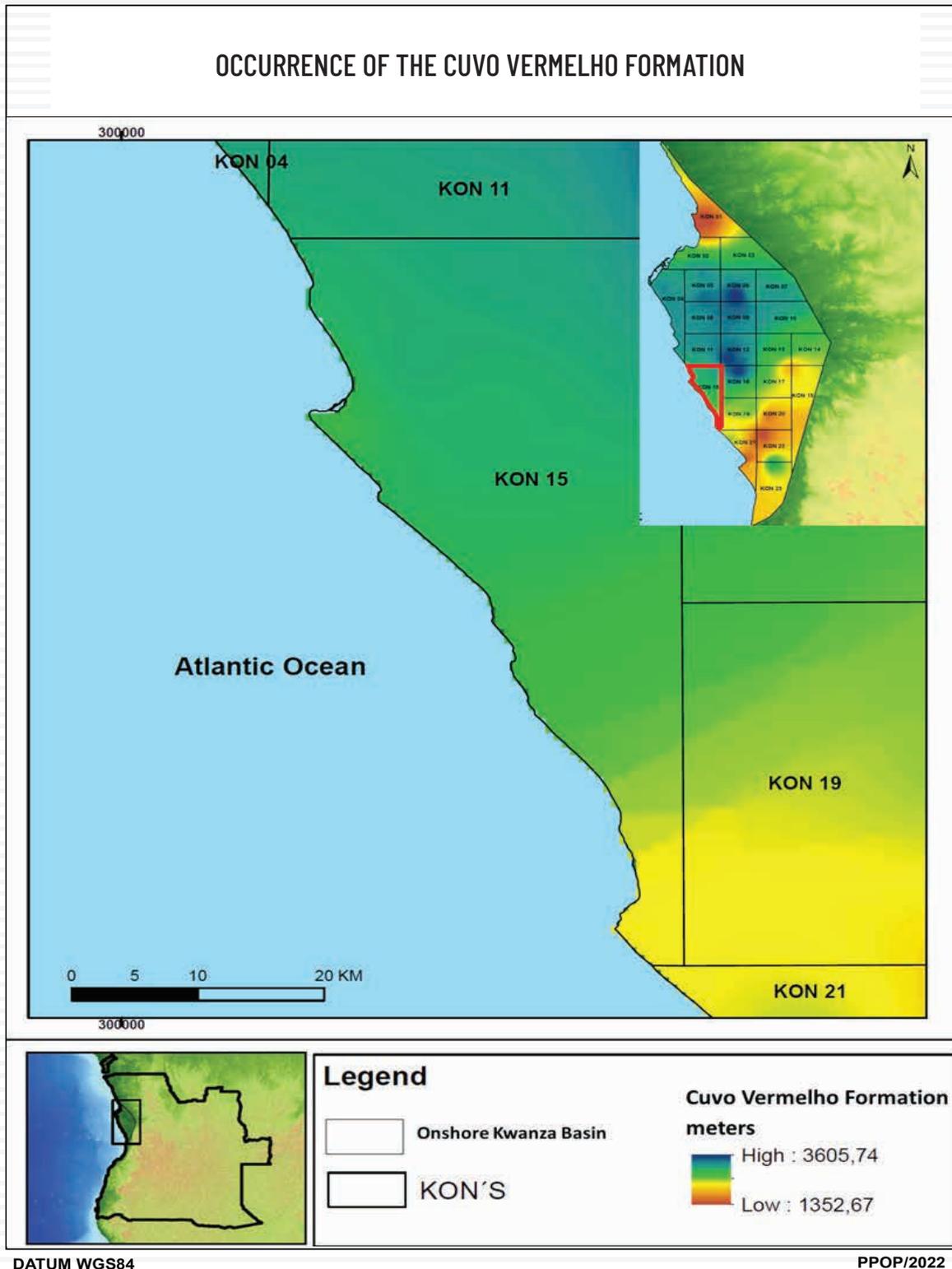


Figure 8: Occurrence map of Cuvo Vermelho Fm. Source rock

Cuvo Cinzento Source

The Cuvo Cinzento Formation, a proven source at the pre-salt level, is distributed along the entire length of the block. Geochemical studies carried out in neighboring blocks demonstrate its generation potential.

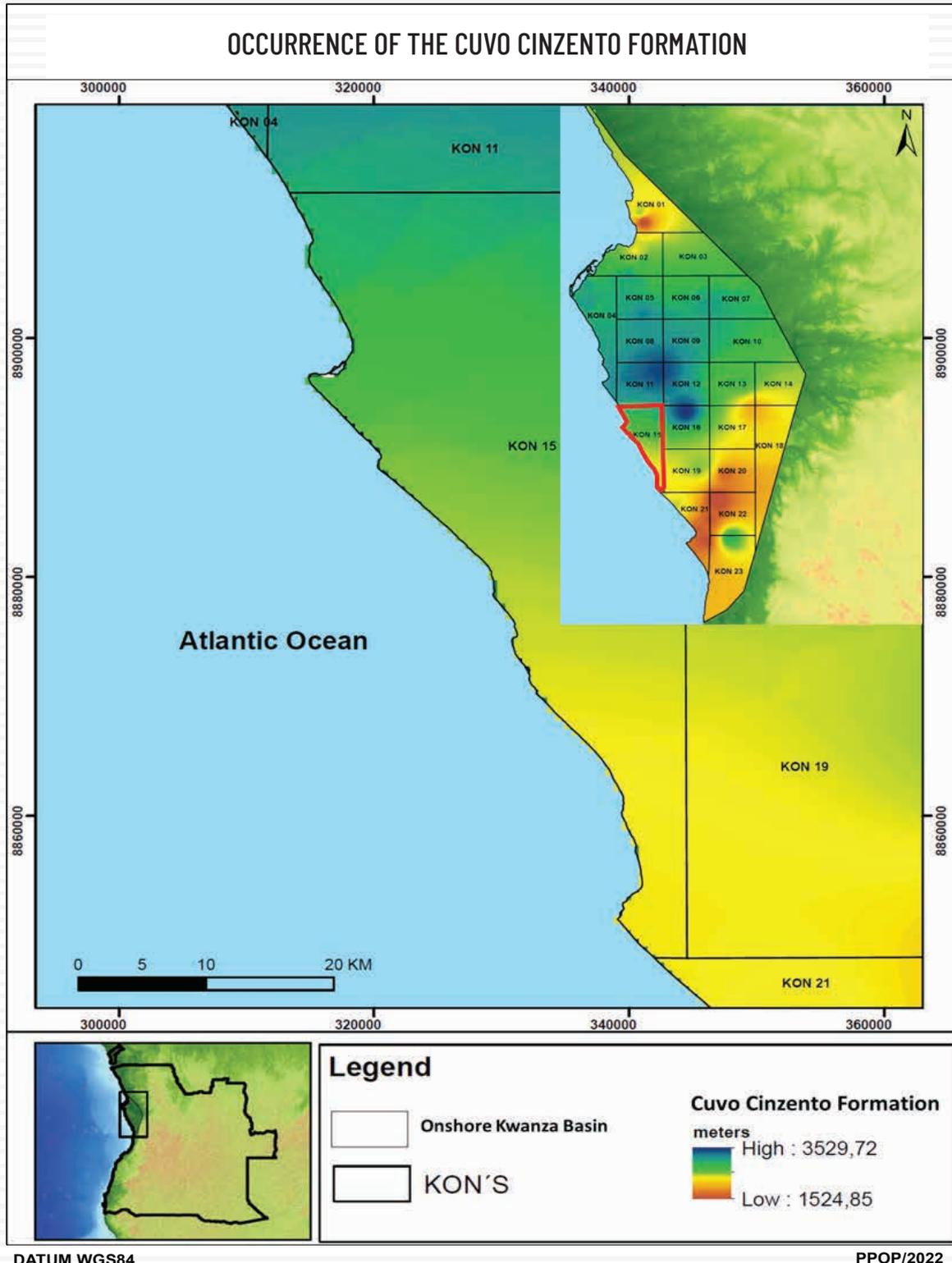


Figure 9: Occurrence map of Cuvo Cinzento Fm. Source rock

Binga Source

The carbonates of the Binga Formation, a proven Albian source rock, are distributed north of the block except in the Muxate Trough area. Studies carried out in Block KON 11 confirm its geochemical generation potential.

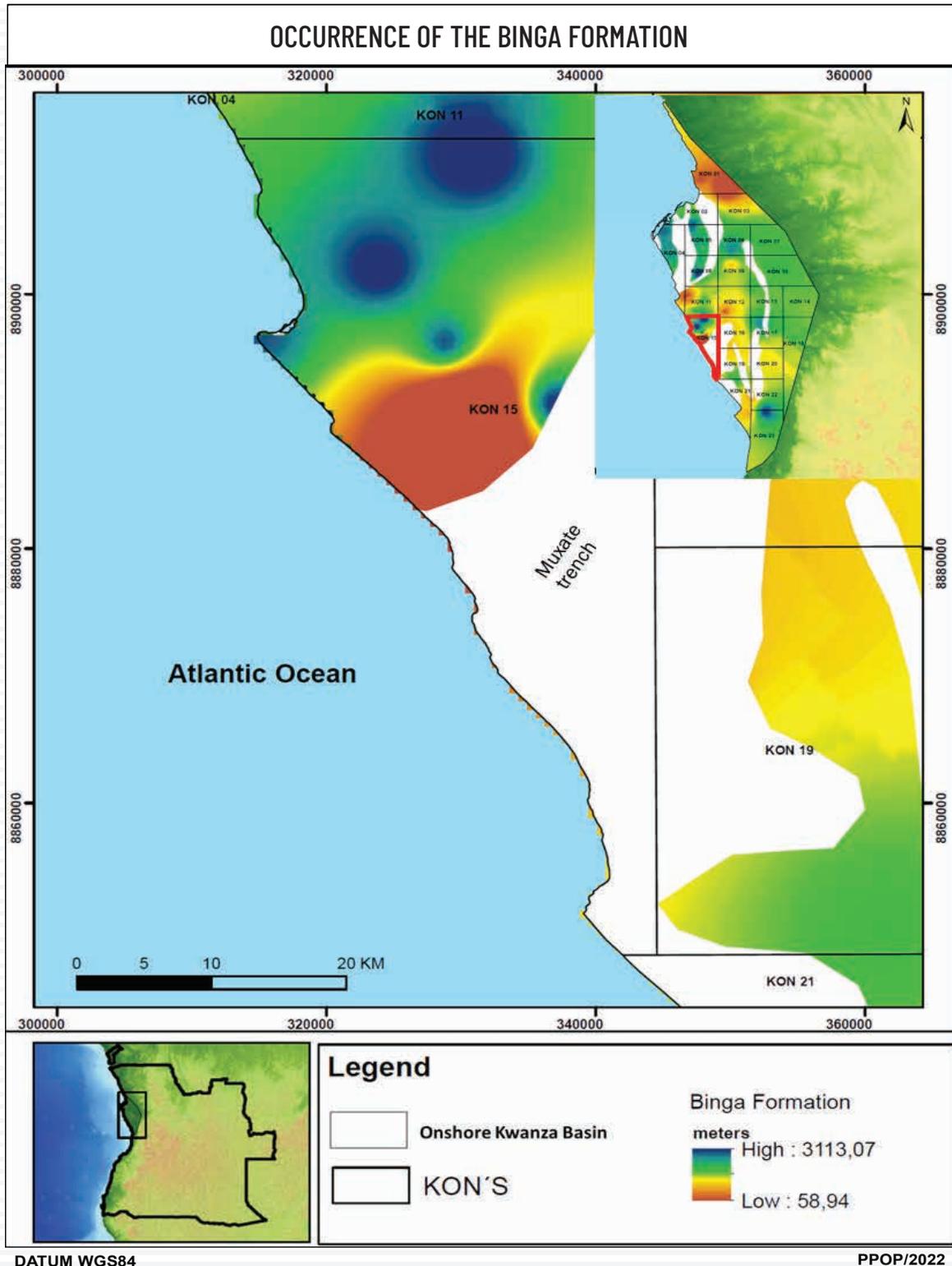


Figure 10: Occurrence map of Binga Fm. Source rock

Cunga-Gratidão Source

The black marl of the Cunga-Gratidão Formation, a proven source rock at the Tertiary level, is distributed throughout the block area, emphasizing the Muxate Trough. In addition, studies in Block KON 6 and 4 (Quenguela and Calomboloca Trough) confirm its geochemical potential in Trough zones.

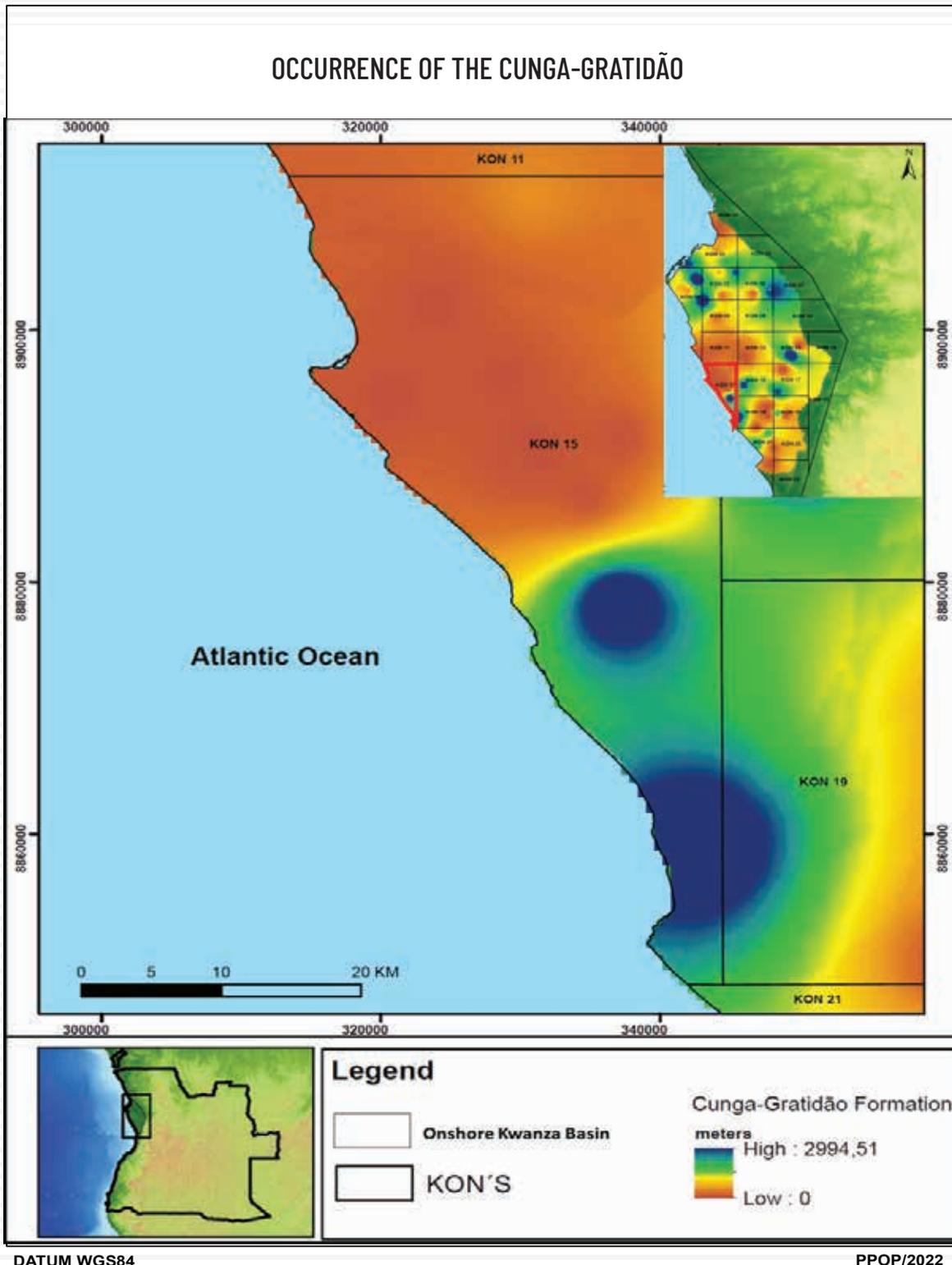


Figure 11: Occurrence map of Cunga-Gratidão Fm. source rock

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

Leads 1 & 2

Located north 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 shales facies of the same formation deposited on the bottom of the grabens and as cover rock the evaporites of the Massive Salt Formation, in a mixed type trap.

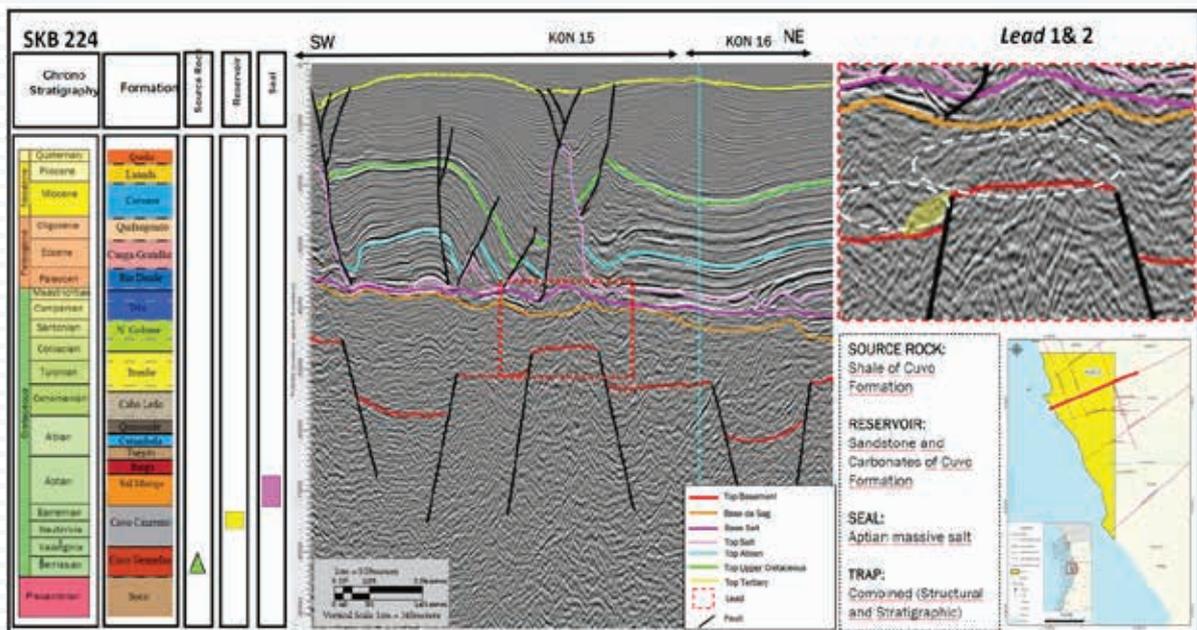


Figure 12: Lead 1 & 2 of Pre-Salt, ANPG 2022

Leads 3

Located north of the Block, is characterized by reflectors with strong amplitudes truncating over the base of the salt at the level of the Cuvo Formation (equivalent to the Chela in the Lower Congo). Therefore, the low amplitudes characterized in the structural low identified in the Block may be a good indicator of the presence of source rock. At the same time, chaotic reflectors typical of the Massive Salt at the top of Leads-1 demonstrate the possible presence of the evaporites of the Massive Salt Formation, which serve as cap rock.

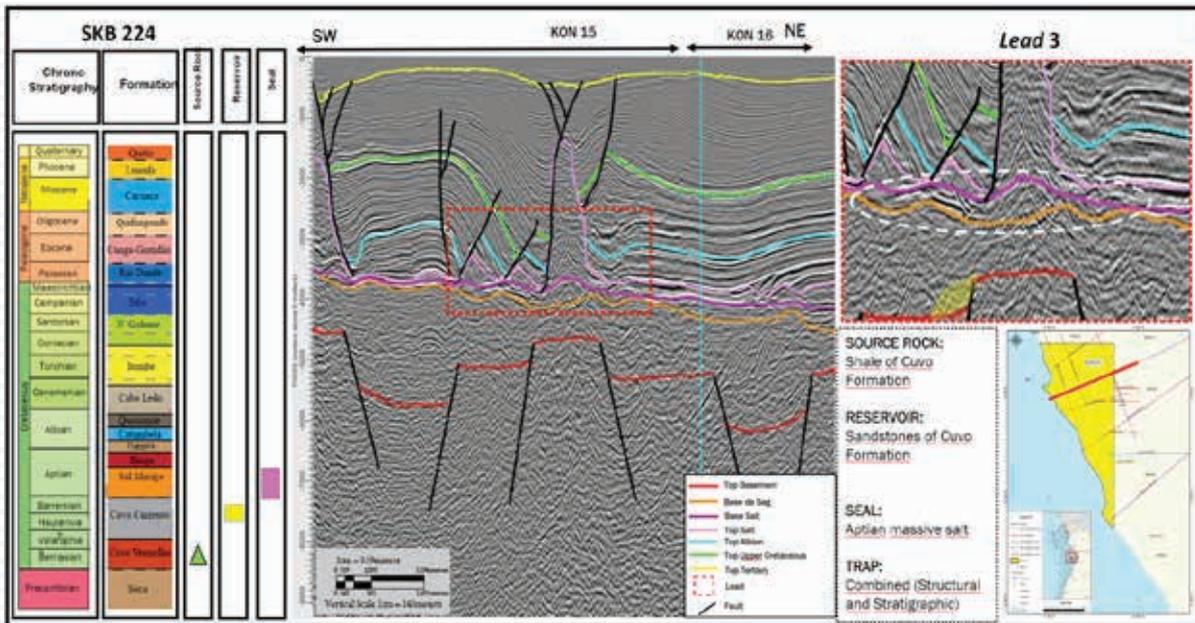


Figure 13: Lead 3 of Pre-Salt, ANPG 2022

6.1.2 Post-salt Leads

Lead 4

Located north of the Block, the reservoir corresponds to the carbonates of the Catumbela Formation; it is a structure flanked by two normal faults with listric relicts due to salt tectonics and sedimentary overburden. The organic-rich shale facies of the Binga Formation is the source rock, and as a cap rock, the intraformational shales of the Cabo Ledo Formation and mixed type trap.

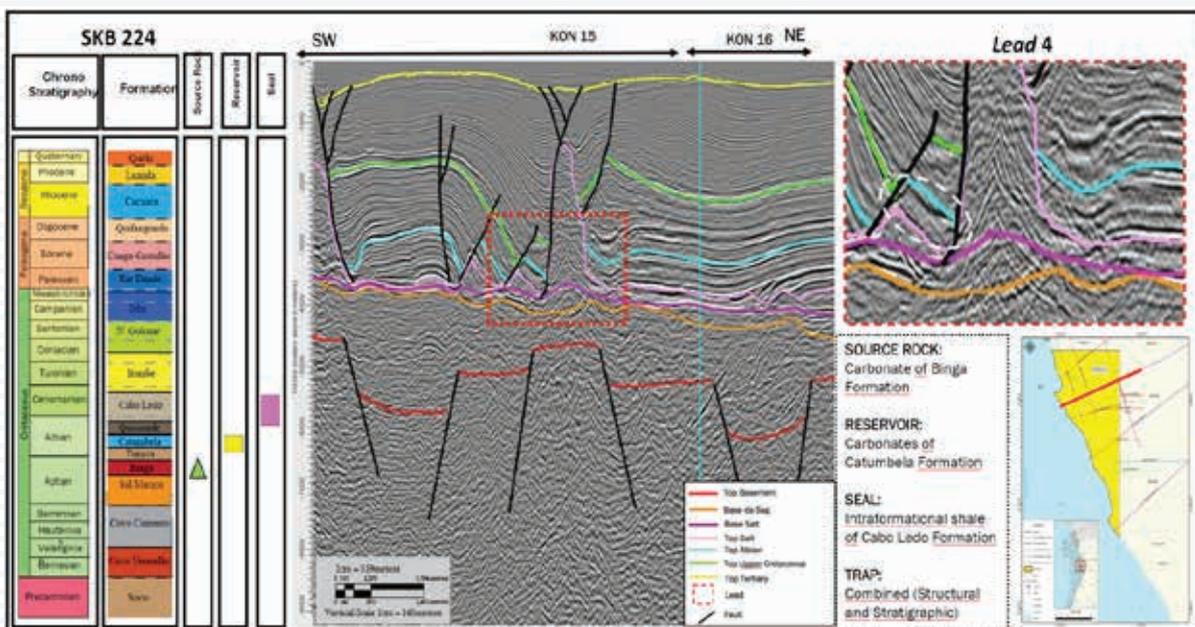


Figure 14: Lead 4 of Albian, ANPG 2022

Lead 5

Located north of the Block, the reservoir corresponds to the carbonates of the Catumbela Formation, is a structure flanked by two normal faults with listric relict due to salt tectonics and sedimentary overburden. The organic-rich shale facies of the Binga Formation is the source rock and, as a cap rock, the intraformational shales of the Cabo Ledo Formation and mixed-type trap.

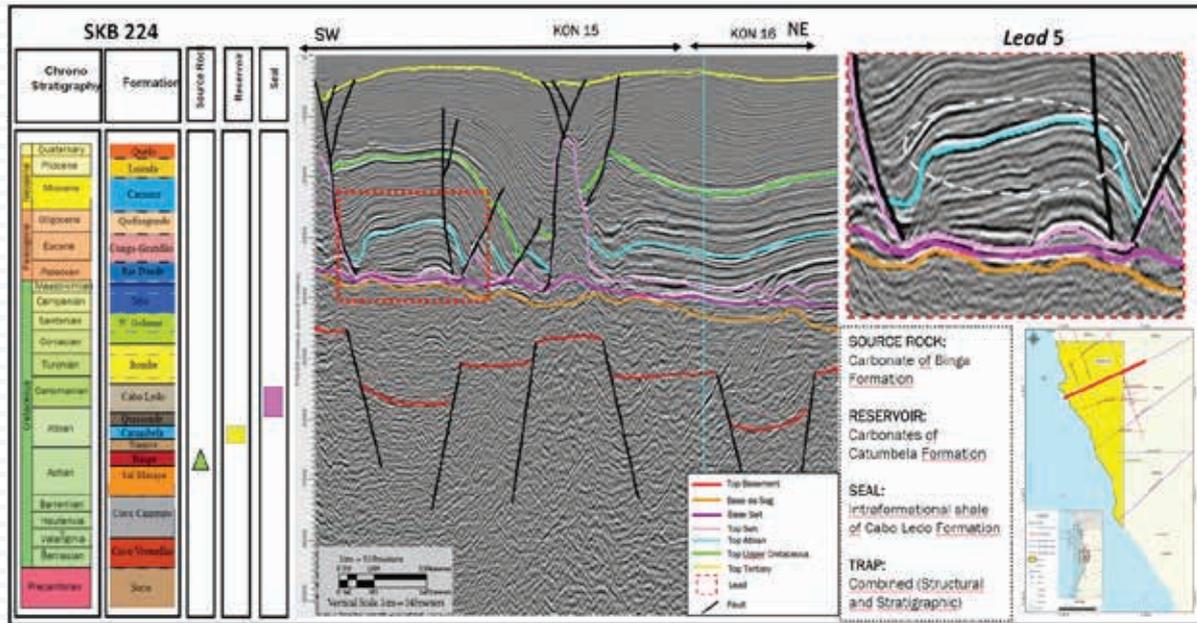


Figure 15: Lead 5 of Albian, ANPG 2022

Lead 6

Located north of the Block, the reservoir corresponds to the carbonates of the Catumbela Formation, an anticlinal structure due to salt tectonics and sedimentary overburden. The organic-rich shale facies of the Binga Formation is the source rock, and as a cap rock, the intraformational shales of the Cabo Ledo Formation and mixed-type trap.

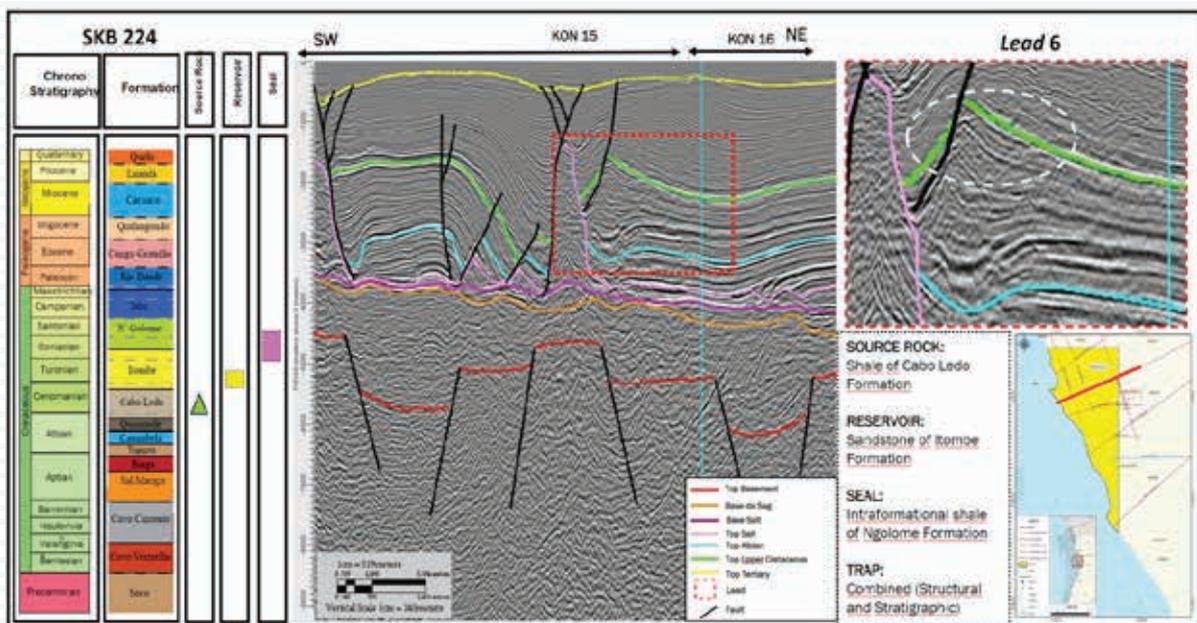


Figure 16: Lead 6 of Albian, ANPG 2022

7. FINAL Remarks

After reassessing Block KON 15, 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.

8. References

BROGNON, G. P. and VERRIER, G. R., 1966. Oil and Geology in Cuanza Basin of Angola. Bull. Amer. Assoc. Pet. Geol., 50 (1), pp. 118-158.

BURWOOD, R., 1999. Angola: source rock control for Lower Congo coastal and Kwanza basin petroleum systems, in Cameron, N. R., Bate R. H. and Clure, V. S. (eds). 'The Oil and Gas Habitats of the South Atlantic.' Geol. Assoc. Spec. Pub. 153, pp. 181-194.

EXPLORATION CONSULTANTS LIMITED, 2003. "The Prospectivity of the Onshore Part of the Kwanza Basin (Inner Kwanza Basin), Angola."

GETECH, 2011. "Magnetic and Gravity Interpretation of the Kwanza Basin," Report No. G1104.

HUDEC, M. R., and JACKSON, M. P. A., 2002. Structural sedimentation, inversion, and salt tectonics on a passive margin: Evolution of the Inner Kwanza Basin, Angola. Geol. Soc. Amer. Bull., 114 (10), pp. 1222-1244.

LUNDIN, E. R., 1992. Thin-skinned extensional tectonics on a salt detachment, northern Kwanza Basin, Angola. Marine and Pet. Geol., 9, pp. 405-411.

CRAMEZ, C. and JACKSON, M. P. A., 2000, Superposed deformation straddling the continent-oceanic transition in deep-water Angola. Marine and Pet. Geol., 17, pp. 1095-1109.

EXPLORATION CONSULTANTS LIMITED, 2003. "The Prospectivity of the Onshore Part of the Kwanza Basin (Inner Kwanza Basin), Angola."

SONANGOL /TOTAL, 1987. Carte Geologique du bassin du Kwanza, Angola.

ONSHORE KWANZA BASIN



BLOCK
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