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THE DISCOVERY OF A MAJOR HYDROCARBON OCCURRENCE IN THE GUIANA BASIN, OFFSHORE SURINAME: A BLESSING OR A CURSE?

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Abstract - For many years the petroleum prospectivity of the offshore part of the Guiana Basin was considered to be rather low, but innovative research and improved exploration and exploitation techniques opened new frontiers. Based on the similar configuration of the oil-bearing deposits in the offshore realm of Ghana and Ivory Coast, exploration moved to the unexplored offshore areas of northern Brazil, French Guiana, Guyana and Suriname. The recent oil discoveries in the deep-water area of the Guiana Basin in French Guiana and especially in Guyana have sparked an increase in exploration campaigns in this basin. Ultimately this led to the first major oil discovery offshore Suriname as announced on January 7th, 2020 by Apache Corporation and Total S.A. The future management of significant oil and gas resources and revenues will be a challenge for Suriname. Effective institutions, policies and procedures are needed to prevent the resource curse. The set-up of a sovereign wealth fund to protect for high volatility of hydrocarbon prices and carbon risk is to be considered. As large-scale oil and gas projects last for decades, scenario analyses with climate-resilient growth and with implementing Suriname's nationally determined contributions (NDCs) under the Paris Agreement in mind is recommended.

Keywords: Petroleum geology, Guiana Basin, Governance, Carbon Risk

1. Geological setting

The Guiana Basin is situated on the northeastern part of South America and includes parts of the offshore areas and coastal plains of French Guiana, Suriname, Guyana and eastern Venezuela (Fig. 1). The basin is characterized by its passive-margin setting, dating back from the Cretaceous and is similar to most other Atlantic margin basins (Fig. 2). To the south it is bordered by the crystalline Guiana Shield, a craton of Proterozoic age. Weathering of this shield resulted in the supply of vast amounts of clastic sediments in the basin. The sediments in the basin are mainly clastic, but reef carbonates developed at the palaeo-shelf edges. The deeper parts of the basin contain turbidites and low-stand fans originating from massive shelf-edge canyons (Kelly & Doust, 2016).

The development of the Guiana Basin is related to major plate tectonic movements and global sea-level movements. The development of the Suriname–Guyana Basin is linked to that of the Atlantic (Pindell & Kennan, 2001) and comprises three major phases:

1) rifting and drifting, which started during the Late Jurassic (150Ma);
2) inversion during the Late Cretaceous (130Ma);
3) drifting, which started during the Late Cretaceous (80Ma).

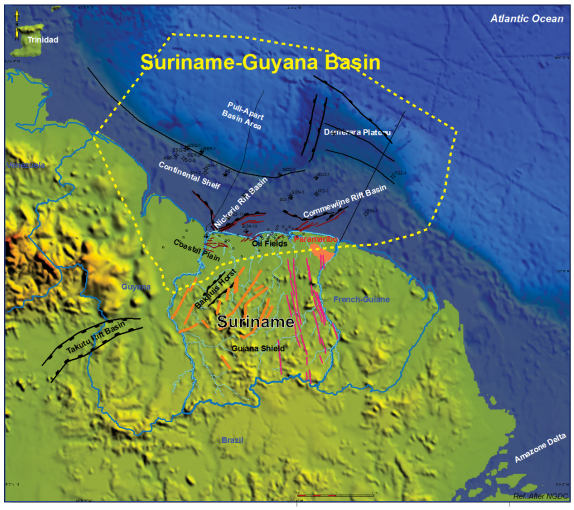

Fig. 1. Outline of the Guiana Basin, also referred to as Suriname-Guyana. asin. Yellow dashed line is the border of this basin (From Poeketi, 2019).

Remnants of early rifting are present in the form of Jurassic grabens, of which at least two have been identified on the Surinamese shelf: the Nickerie and the Commewijne grabens (Fig. 1). Their onshore equivalent is the Takutu Graben (Fig 1) on the border between Guyana and Brazil (Crawford et al., 1985). During the subsequent drifting episode, from ~200 to 150 million years ago, the newly formed Guiana Rift basin was transformed into a passive margin.

The second major phase is characterized by an inversion of the Jurassic-Cretaceous basins during the Late Cretaceous. The inversion is attributed to the differential rifting of Gondwanaland into a South American continent (westward) and an African continent (eastward). The rift initiated in the south and gradually opens the South Atlantic Ocean from the south to north; the rotational rifting caused compres-

sional stress and strains in the Central Atlantic which caused intense compressions, uplift and erosions in the Jurassic-Cretaceous Basins. The imprints of these compressional events are recognized in the many part of the Guiana Basin.

The third and final phase of the basin is related to the complete rifting of Gondwanaland resulting in a widespread opening of the Equatorial Atlantic Rift Margins. This drift phase is characterized in the Guiana Basin as a passive margin sedimentary setting with a transform fault systems that can still be traced on the present day seafloor. Figure 2 shows seafloor transform fault lineaments connecting the Guiana Basin/Demerara Plateau to Equatorial Guinea Bissau Plateau in West Africa.

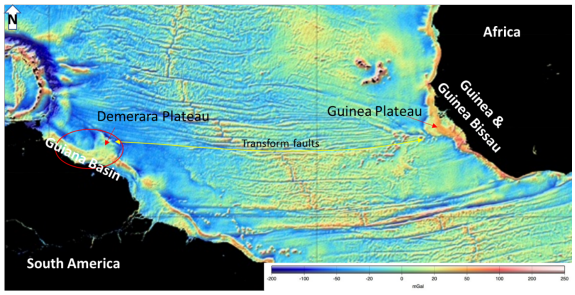

Fig. 2. Satellite gravity Present-day imprint of the seafloor spreading (modified by Poeketi, 2019, after Sandwell et al, 2014).

2. Petroleum Geology

The first oil finds in Suriname in the onshore area near Tambaredjo, Calcutta and Weg naar Zee in the 1960's, led to the later discoveries of the Tambaredjo, Tambaredjo North West and Calcutta oilfields by Staatsolie Maatschappij Suriname N.V. (Staatsolie), the National Oil Company (NOC) of Suriname. The first discoveries in the coastal plain proved the existence of a working petroleum system in the Guiana Basin and therefore the offshore area of Suriname understandably received great interest. As a result, the continental shelf has been the scene of activity of various oil companies since 1964. The first wells were drilled relatively close to the shore in shallow water but in the course of time, drilling took place farther away in deeper water. Although in many of these wells, some indications of oil had been recorded, no major discoveries had been made which resulted in a high exploration risk annotation for this part of the Guiana Basin. As a consequence, the oil companies were not eager to explore in this area. It was only when the United States Geological Survey (USGS) in 2002 reported that the basin could contain a mean risked reserves oil volume of about 15.3 billion barrels (bbls), comparable with both area, size and volumes of the proven Campos Basin offshore of Brazil (Schenk, 2002), that the activities in the basin increased. This was also supported by the fact that exploration results elsewhere in the South Atlantic had demonstrated that the post-rift passive margins of West Africa and Brazil were characterised by comparable petroleum systems (Beglinger et al., 2012a,b) which justified the assumption that similar relationships may hold true in the equatorial area. If this was the case, the same hydrocarbon plays and prospects that had been identified in offshore Ghana and Ivory Coast might exist in northern Brazil, French Guiana, Guyana and Suriname. Initial research on the geological evolution of both margins demonstrated that there were indeed strong similarities in their stratigraphic and structural framework. Therefore there was enough reason to believe that the same key elements for exploration success existed on the South American side of the Equatorial Atlantic (Kelly & Doust, 2016). A great deal of this success can also be attributed to the rapid evolution of 3D seismic acquisition, drilling techniques and rig capabilities in the last years of the 20th century. These drilling capacity contributed greatly to successful drilling in deep water areas.

The recent oil discoveries in the deep water area of the Guiana Basin (Zaedyus in French Guiana, Liza, Payara, Snoek, Turbot, Ranger, Pacora, Haimara, Joe and Jethro in Guyana: Fig. 3) have sparked an increase in exploration campaigns in the Guiana Basin.

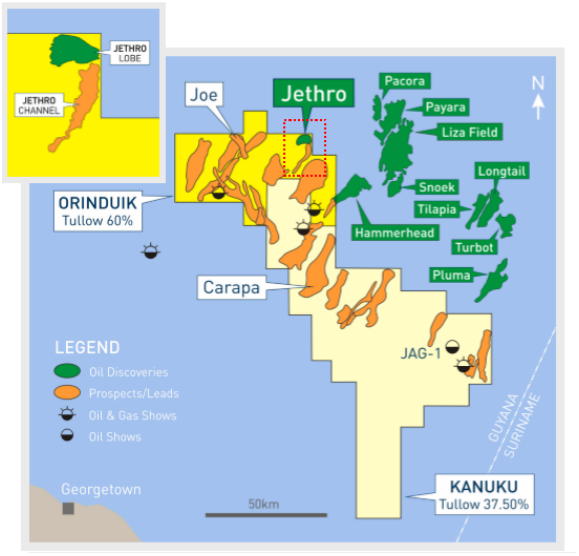

Fig. 3. Various oil discoveries, prospects, oil and gas shows in the Guiana Basin offshore Guyana. The prospects clearly show an elongated trend, re-presenting turbiditic bodies deposited in SW-NE running sub marine channels perpendicular to the coastline (after Tullow Oil, 2019).

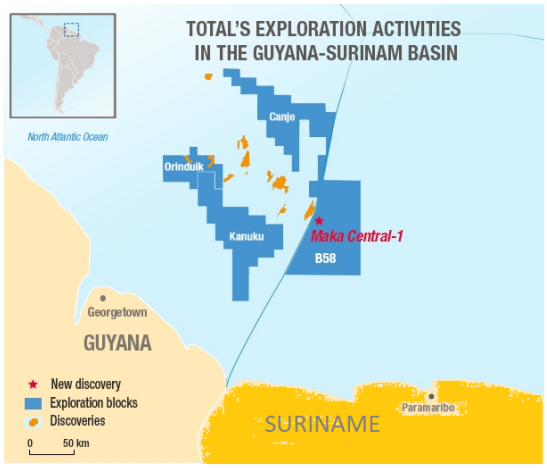

Fig.4. Discovery well Maka Central-1 in Block 58 by Apache and Total, January 2020 (Modified after Total, 2020).

Ultimately this lead to the first major oil discovery off-shore Suriname as announced on January 7th, 2020 by Apache Corporation and Total S.A (Fig.4). They reported: "a significant oil discovery at the Maka Central-1 well drilled offshore Suriname on Block 58". Maka Central-1 was successfully tested for the presence of hydrocarbons in multiple stacked targets in the upper Cretaceous-aged Campanian and Santonian intervals and encountered both oil and gas condensate. The announcement included some specific details on the oil occurrences: "The shallower Campanian interval contains 50 meters (164 feet) of net hydrocarbon-bearing reservoir. Preliminary fluid samples and test results indicate light oil and gas condensate with API gravities between 40 and 60 degrees. The deeper Santonian interval contains 73 meters (240 feet) of net oil-bearing reservoir. Preliminary fluid samples and tests results indicate API oil gravities between 35 and 45 degrees. The Maka Central-1 also targeted a third interval, the Turonian, a geologic analogue to oil discoveries offshore West Africa. Prior to reaching this interval, the well encountered significantly over-pressured, oil-bearing reservoirs in the lower Santonian, and the decision was made to conclude drilling at approximately 6,300 meters (20,670 feet). The pressures encountered in the lower Santonian are a positive sign for the Turonian and future drilling will test this interval". To establish the exact reserves of this prospect Apache and Total will continue with a follow-up drilling program. However, first estimates of experts reported that the discovery could contain hundreds of millions of barrels of oil and condensate, and over a trillion cubic feet of gas (https://oilnow.gy/featured/suriname-discovery-contains-300-million-barrels-of-oil-over-1-trillion-cubic-feet-of-gas-woodmac/).

On April 2, 2020, Apache Corporation and Total S.A. announced a second significant oil discovery by the Sapakara West-1 well drilled approximately 15 km SE of the Maka-1 Central-1 discovery on Block 58. Preliminary fluid samples and test results indicate at least 79 meters of net oil and gas condensate pay in two intervals. The shallower Campanian interval contains 13 meters of net gas condensate and 30 meters of net oil pay, with API oil gravities between 35 and 40 degrees. The deeper Santonian interval contains 36 meters of net oil-bearing reservoir with API oil gravities between 40 and 45 degrees.

The presence of oil in the coastal plain of Suriname already proved the existence of at least one significant petroleum system. The basin contains a proven world-class source rock of Cenomanian–Turonian age, which is equivalent to the Naparima Hill Formation in Trinidad and Tobago and the La Luna Formation in Venezuela (Crawford et al., 1985). Numerous studies suggested that these rich, organic shales to which the oil discoveries and seeps in West Africa are strongly linked, were also developed along the Atlantic margin of South America (Fig. 5). According to Kelly & Doust (2016) the Guiana and Ghana–Ivorian basins display clear geological parallels which are of interest from a petroleum exploration perspective. Besides the common source rock, Kelly and Doust mentioned as other similarities: a well-developed system of Late Cretaceous erosional canyons allowing coarse-grained shallow-water clastics to enter the deep marine basin to form attractive turbidite exploration targets; a broad shelf with strong longshore currents which sort and transport coarse clastics into the canyon heads; a series of extensional fault-networks along the shelf margin that extend upwards from the Rift Sequence into the overlying Drift Sequence and which, along with the canyon geometries, enable migrating oil and gas to accumulate in combination structural and stratigraphic traps.

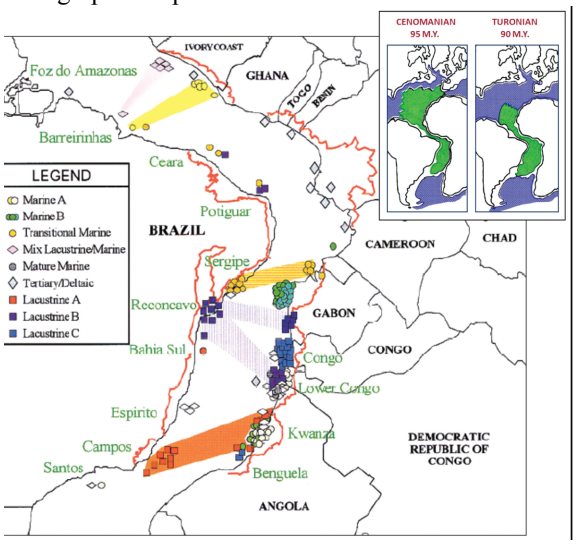

Fig. 5. Oil families and their correlation across the Atlantic (from Schiefelbein et al., 2000).

In 2007, the potential of the Tano Basin offshore Ghana was finally realised with the Mahogany discovery. Today, the same geoscience technologies and expertise are being applied towards the same goal in Suriname. They led to early success with the discovery of 72m of net pay in Late Cretaceous turbidite

fans in the Zaedyus well in French Guiana. Since then, ExxonMobil has had success in a similar Late Cretaceous turbidite fan play with well Liza-1 in Guyana (90m oil sand), so clearly the concept of analogous petroleum systems works. This consortium has discovered more than 8 billion barrels of recoverable oil and gas resources offshore Guyana. The company started oil production in December 2019 at the Liza Phase 1 Development project, followed by a series of other projects, which by 2025, could see production climbing to more than 750,000 barrels per day. (ByOilNOW, November12, 2019). Moreover, it appeared that also during the Tertiary turbidite fans developed. They are also oil-bearing as proven by the drilling results of Tullow Oil in well Jethro-1 (Fig. 6) in which 55m of net pay has been reported. In this context, also the Tertiary play has been upgraded.

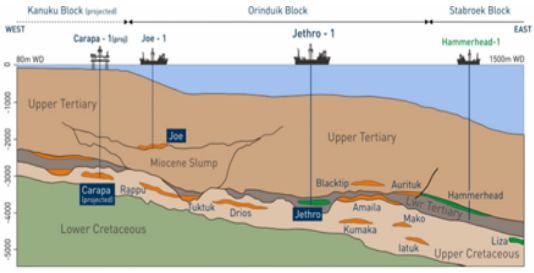

Fig 6. Cross section through the Guyanese concession area of Tullow Oil, showing the Tertiary and Upper Cretaceous prospects (Tullow oil, 2019).

The Liza-1 exploration well, drilled in 2015, was the first significant oil find in Guyana. The Liza oil field was appraised by three appraisal wells during 2016 and 2017, which confirmed recoverable oil resources in excess of one billion barrels of oil equivalent. The Liza phase one development involves 17 wells, comprising eight production wells, six water injection wells and three gas injection wells, to be drilled from four drill centres, and a floating production, storage and offloading (FPSO) vessel with the capacity to produce up to 120,000 barrels per day (Fig.7; from: https://corporate.exxonmobil.com/Locations/Guyana/Guyana-project-overview#discoveriesInTheStabroekBlock)

A comparable development scheme for the discoveries in block 58 can be foreseen.

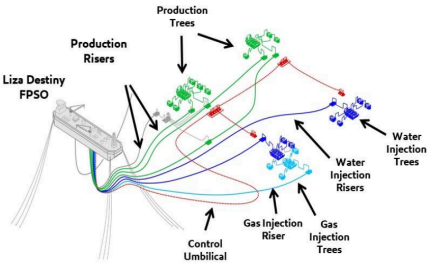

Fig. 7. Production facilities of Liza Phase 1 Project. From: https://corporate.exxonmobil.com/Locations/Guyana/Guyana-project-overview#discoveriesInTheStabroekBlock

3. Discussion of governance and international climate issues

Governance issues

Now that the key to successfully unlock the petroleum potential of the Surinamese part of the Guiana Basin has been found, it is to be expected that more significant discoveries will be made. This opens a new era for Suriname and this will have significant economic, political and social effects. It will take at least 5 years before the oil and gas revenues will start influence the countries financial situation in a positive way. Currently, Suriname suffers a considerable debt burden: in 2019, the country owes $2.4 billion to creditors on a GDP of $3.5 billion (2018, https://data.worldbank.org/country/suriname). China is the biggest creditor to Suriname with outstanding loans of approximately $500 million with another loan of $500 million agreed in November 2019. 'Above ground risks' are looming on the horizon unless properly managed.

Strong institutions are needed to prevent the resource curse and to ensure effective management of oil and gas resources and revenues. Now that a significant discovery is made, Staatsolie should allocate more resources to building capacity in auditing and monitoring operations. Ultimately it will be the governments' task to evaluate the NOC's performance in achieving that. If public funds are limited, technical advisory groups such as the Norwegian Oil for Development (OfD/Norad) programme or the Natural Resource Governance Institute (NRGI) can support capacity-building in the civil service (Stevens & Lahn, 2015).

The oil discoveries in Block 58, offshore Suriname, were made by Apache and Total each holding a 50% working interest. Block 58 is located approximately 200km northwest off the coast of Paramaribo in water depths of 55-2250m (Fig. 4). In 2015, Staatsolie and Apache signed a 30-year production sharing contract (PSC) for exploration, development and production of offshore Block 58. In December 2019, Total paid a multi-million dollar bonus as part of the farm-in deal with Apache to develop Block 58,

where Total will become the operator and bring its deep-water expertise.

Staatsolie, Apache and Total have agreed to a minimum working program for the exploration period; all costs during the exploration phase will be covered by the Apache/Total joint venture and must only be redeemed by Staatsolie in case of a commercially recoverable find and commences production. The contract offers Staatsolie a maximum stake of 20% for participation in the development and production phase. Staatsolie has a long history of respecting agreements with International Oil Companies (IOCs) which is considered as a strong asset. An overview of the current 14 active PSCs is given on the Staatsolie website (https://www.staatsolie.com/en/petroleum-regulator/active-production-sharing-contracts/)

As for neighbouring Guyana, the government estimates the Exxon deal will bring in $300 million in 2020 and surge to $5 billion by 2025. How to manage and spend a sudden windfall of money? Guyana has set up a Sovereign Wealth Fund (SWF) like Norway's oil fund. This special purpose investment funds is state owned and should benefit the country's economy and citizens. In case of large-scale oil and gas developments in Suriname, a SWF can stabilise the government budget against oil price volatility and saves it for future generations. A robust political process and rules are needed to ensure the fund is properly managed. Both Guyana and Suriname are members of the New Producers Group, an initiative of UK think tank Chatham House, the NRGI and the Commonwealth, which brings together experts, politicians, government and civil society from a number of newly-established oil- and gas- producing countries. This project offers guidance for a strategic vision and effective decision-making on the structure and rules of the petroleum sector in an imperfect context (Marcel, 2016).

Also, it is of vital importance to properly educate the civil society and media, so they understand when the potential future wealth is coming, and how it is used. Bodies such as the Extractive Industries Transparency Initiative (EITI) report on oil revenues and their allocation. Staatsolie is a supporting company of the EITI. Staatsolie is committed to transparency along the value chain and for the fight against corruption. It has actively participated in the process led by the government of Suriname to become a candidate country as of 24 May 2017, and is a primary member of the Multi-Stakeholder Group responsible for implementing the EITI in Suriname (ref. https://eiti.org/supporter/staatsolie-maatschappij-suriname-nv).

Carbon risk

The 2015 Paris agreement to limit global warming to well below 2°C above pre-industrial levels means that fossil fuel use must fall considerably over the next 30 years. To significantly reduce worldwide greenhouse gas emissions (up to 95 percent of the 1990 level by 2050) means that *carbon risk* has become a serious subject and has re-shaped global investment behaviour, especially in the fossil fuel sectors. The World Bank Group has announced that it will stop financing upstream oil and gas after 2019 (https://www.worldbank.org/en/news/press-release/2017/12/12/world-bank-group-announcements-at-one-planet-summit).

Growing global and national climate action, the increasing range and falling cost of clean energy technologies and the relative decline in oil prices present a rapidly evolving landscape for emerging fossil fuel producers (Bradley et al., 2018).

Nationally determined contributions (NDCs) are at the heart of the Paris Agreement and the achievement of these long-term goals. Suriname committed to the 2015 'intended nationally determined contributions' (INDCs) and should demonstrate ambition to create a range of social goods through climate resilience and emissions management measures. The formulation of a national vision for green growth and sustainable development with the emphasis on energy policy, industrial planning, investment in efficient, resilient infrastructure and the development of skills such as the management of carbon is necessary.

The changing global context poses a new challenge for fossil fuel-led growth: significant volumes of coal, oil and gas will be left 'unburned'. It is therefore recommended that Suriname develops an interest in global climate policy and decarbonisation trends and that it starts realising what this means for their future markets e.g. through scenario analysis (Bradley et al., 2018).

4. Conclusions

The potential huge values and the capital importance of the recent oil and gas discoveries offshore Suriname are a major challenge for the country. In case of large-scale oil and gas developments in Suriname, a special fund can stabilize the government budget against oil price volatility and saves it for future generations. Robust political processes and rules are needed to ensure that the fund is properly managed. The growing implications concerning the Paris Agreement on Climate Changes, also supported by Suriname, should be taken into consideration and evaluated in respect to ethical and economic challenges. The discovered natural resources are anticipated to become a key growth factor for Suriname's economic future. However, pending the final investment decisions for the petroleum exploitation of the discoveries, the government need to be realistic in its public statements about the way these growth expectations will be developed and maintained through policy making and strong institutions.

5. Acknowledgment

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