

# AAPG EXPLORER

June 2021



**Land of Opportunity**

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Aerial view of the Eneva's Parnaíba complex, with the gas treatment unit in the foreground and gas-fired thermal power plants in the background. The complex has the capacity to generate 1.8 GW using the 8.4 MMm<sup>3</sup>/d of gas of the 5 current producing fields.

# Riding Brazil's Onshore Wave

*Geologic potential and government incentives make Brazilian onshore fields ripe for investment*

Throughout the past decade, Brazil's pre-salt basins and giant deepwater oil discoveries have brought significant attention to the country and to the offshore South Atlantic.

Though operating in the Brazilian pre-salt play promises billions of barrels of oil, it also requires billions of dollars in investment and technology, something just a handful of companies can bring to the table.

While Petrobras and international companies focus their attention on the Brazilian offshore, a handful of Brazilian companies and foreign investors have focused inland, where they are quietly starting Brazil's onshore revolution.

## Brazil's Best Kept Secret

For Marcio Felix, former energy secretary for the Brazilian government and current CEO of Energy Platform – better known as “EnP,” Brazil's onshore provides enormous opportunity companies inside and outside of the country.

“Brazilian onshore sedimentary basins are rich and diverse, with many oil and gas in situ waiting to be produced. There is a lot of space for foreign investments to increase the exploration activities in the new frontier basins and even in the matured ones,” he said.

He noted that the combination of

geologic potential and government incentives has created a friendly business environment in Brazil in recent years.

“The Brazilian regulatory aspects have been refined to promote a competitive natural gas market, attracting new investors, bringing more competitiveness to the sector, and reducing production costs and the final price to the consumer,” he said.

## Beyond the Pre-Salt

For Eliane Petersohn, upstream adviser to the Board of Directors of Brazil's Natural Oil, Gas and Biofuels Institute (ANP), having a healthy energy industry in Brazil requires offering a variety of options to investors.

“The Brazilian pre-salt is the only one of its kind that we know of in the world today. World-class giant and supergiant discoveries with highly productive wells make pre-salt a unique oil province with huge potential to explore and produce” she said. “Nevertheless, the pre-salt alone will not create the industry we need to develop in Brazil. To do this, both traditional offshore and onshore must be made attractive to companies that are specialized in these niche markets.”

Petersohn has spent the past 15 years working on the ANP's large-scale strategic projects, conducting geological evaluation for bidding rounds and developing a

multiyear geological and geophysical plan for the agency. She noted that the Brazilian onshore sector provides opportunities both in frontier and mature basins.

“Onshore new frontier basins are largely unexplored and have the potential for an extremely high yield,” she said. “The Parnaíba basin is an excellent example of an extraordinarily successful project, accounting for more than 6 percent of Brazilian gas production.”

## Success in the Parnaíba Basin

Discoveries in Northern Brazil have been fundamental to the success of Eneva, a Brazilian company who pioneered the reservoir to wire, or “R2W” model, combining onshore natural gas exploration and production and the generation of electrical energy.

For Frederico Miranda, AAPG Member and head of exploration at Eneva, working in the Parnaíba's Paleozoic setting provides an exciting opportunity to take on both geological and technological challenges.

“During our 10-year history we have aimed our exploration targets in Paleozoic basins that were previously not so promising, due to complex geology and/or logistics. This scenario always allowed us to work in a challenging environment, which is very exciting for an explorationist,” he said.

Eneva currently holds concessions for 16 exploratory blocks and company operates 10 gas fields that feed thermal power plants in the Maranhão state in the Northeast Region of Brazil.

In addition to ongoing activity in the Parnaíba Basin, Eneva is working to expand its oil and gas portfolio in other areas, Miranda noted.

The company recently added three exploratory blocks near their Azulão gas field in the Amazonas Basin; four exploratory blocks in the Paraná Basin, in partnership with Enauta; and a more than 1 trillion cubic foot Juruá Gas Field in the Solimões Basin.

“So far we've discovered more than 1.5 Tcf of gas at the Parnaíba basin which was considered two decades ago as a non-prolific basin ‘without the potential for commercial discoveries,’” Miranda said.

“We're aiming to break this paradigm in other Brazilian onshore basins as well.”

## Onshore Basin Overview

Petersohn expects companies like Eneva to continue making onshore discoveries.

“Brazil is a continental-sized country, and its potential for oil exploration has

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not yet been completely unveiled," she said. "The giant sedimentary area covers more than 7 million square kilometers and includes 29 basins, many of which have highly significant hydrocarbon potential."

According to Petersohn, proven natural gas reserves in the Parnaíba, Amazonas, Solimões and Tucano Sul new frontier basins surpass 68 billion cubic meters.

The Paleozoic Parnaíba and Paraná basins are gas prone, as are the Paleozoic/Cenozoic Acre and Amazonas basins. The Acre Basin is unproven so far but is located close to significant gas discoveries in Peru.

The Proterozoic Parecis and São Francisco basins are also gas prone basins and appear to have potential for unconventional resources. The real potential remains uncertain due to technical data scarcity, but an ANP well test in Parecis indicated continuous gas shows for more than 200 meters.

The Mesozoic Tucano basin is gas prone and produces about 50,000 cubic meters per day but remains largely underexplored. Tucano basin is close to Recôncavo, the oldest producing basin in Brazil, which has infrastructure for the production and transportation of petroleum.

The Paleozoic Solimões Basin has both oil and gas, and is the third productive basin in Brazil, following Santos and Campos basins, producing more than 105,000 barrels of oil equivalent per day.

In addition to the frontier basins, Brazil also has several mature basins with recent discoveries and important remaining

potential to be explored.

Onshore mature fields in the Recôncavo, Potiguar, Sergipe-Alagoas and Espírito Santo basins are at the advanced exploration stage but have oil and gas infrastructure available and remaining potential.

While the Alagoas onshore sub-basin is gas prone, the Sergipe onshore sub-basin is oil prone. Recôncavo, Potiguar and Espírito Santo onshore basins are oil prone.

ANP estimates show proven oil reserves in mature fields at approximately 400 million barrels.

"As demonstrated, Brazil's onshore basins have highly promising petroleum prospectivity and wide diversity of plays, which could be attractive for different companies' profiles," Petersohn said.

**Government Strategies**

Developing the onshore oil and gas market is a priority for the Brazilian government, which has taken a variety of steps to attract investment through energy policy changes and regulatory changes.

Significant actions taken the last five years include the Petrobras divestment plan, the REATE program, ANP regulatory changes and Open Acreage.

The first game-changer in the Brazilian energy market happened in 2015, when national oil company Petrobras announced plans to focus activity on strategic deepwater assets and sell onshore and shallow water assets to other operators.

The Petrobras divestment plan has attracted the attention of national and independent companies who have jumped at the chance to enter a market previously limited to companies who worked directly with Petrobras.

Petersohn noted that Petrobras's divestment portfolio contains more than 50 assets at different stages of the sale process.

"The divestment plan that may make room for new companies not only through partnerships, but also through asset acquisitions," she said.

International operators received an additional boost in December 2018, when Brazil's Ministry of Mines and Energy launched the Program for the Revitalization

of Onshore Oil and Gas Exploration and Production Activities designed to increase onshore activities throughout Brazil.

"REATE's objective aims at ensuring incentives for the onshore activities in Brazil and competitiveness gains for the sector and for the economy," Petersohn said.

**Regulatory Incentives**

Petersohn described how the ANP is working to complement governmental strategies to make Brazil even more attractive for investors.

"The ANP has taken several actions in order to create a healthy environment for doing business in Brazil and boosting competitiveness," she said.

In May 2021, ANP approved free access to onshore public technical data in order to increase geological knowledge and encourage investment in onshore basins.

Additionally, the agency has accelerated the process for M&A approvals, royal reductions contract extensions, and currently is undergoing public consultation for an additional royalty reduction policy aimed at small and midsize companies.

**Open Acreage**

Another incentive designed to bring investors to onshore Brazil is the Open Acreage, a continual offering of blocks not auctioned at previous bid rounds. Petersohn noted how the open acreage policy allows companies to submit applications any time, as opposed to during specific periods.

"This process gives more flexibility to the industry and it will promote exploration activity in onshore areas where there are more small and medium-size companies," she said.

The ANP has run two auctions under the Open Acreage process, one in 2019 and another in December 2020.

Both attracted a diverse range of oil companies to operate in onshore areas, and 66 companies, from startups to super majors, have registered for the offering.

Currently, the ANP has 691 exploration blocks up for offer. Blocks are available in onshore basins of Espírito Santo, Potiguar,

Recôncavo, Sergipe-Alagoas, Amazonas, Paraná, Parnaíba and Tucano, as well as in the offshore basins of Campos, Santos, Sergipe-Alagoas, Ceará and Potiguar.

ANP has approved adding 277 to the portfolio in the first semester of 2021. The board approved including the blocks and updating the tender protocol, which will be submitted for consultation and a public hearing in early June.

Once approved, ANP will have 1068 exploration blocks available for offer.

**Opportunities for Every Budget**

Petersohn said that ANP is working to make a variety of investment options available both for companies and suppliers.

"Brazil has more risky opportunities in new frontier basins, which can bring great rewards," she said. "Onshore mature basins are a choice for companies seeking new oil discoveries and those specializing in revitalizing mature fields, increasing their lifespan and maximizing oil recovery."

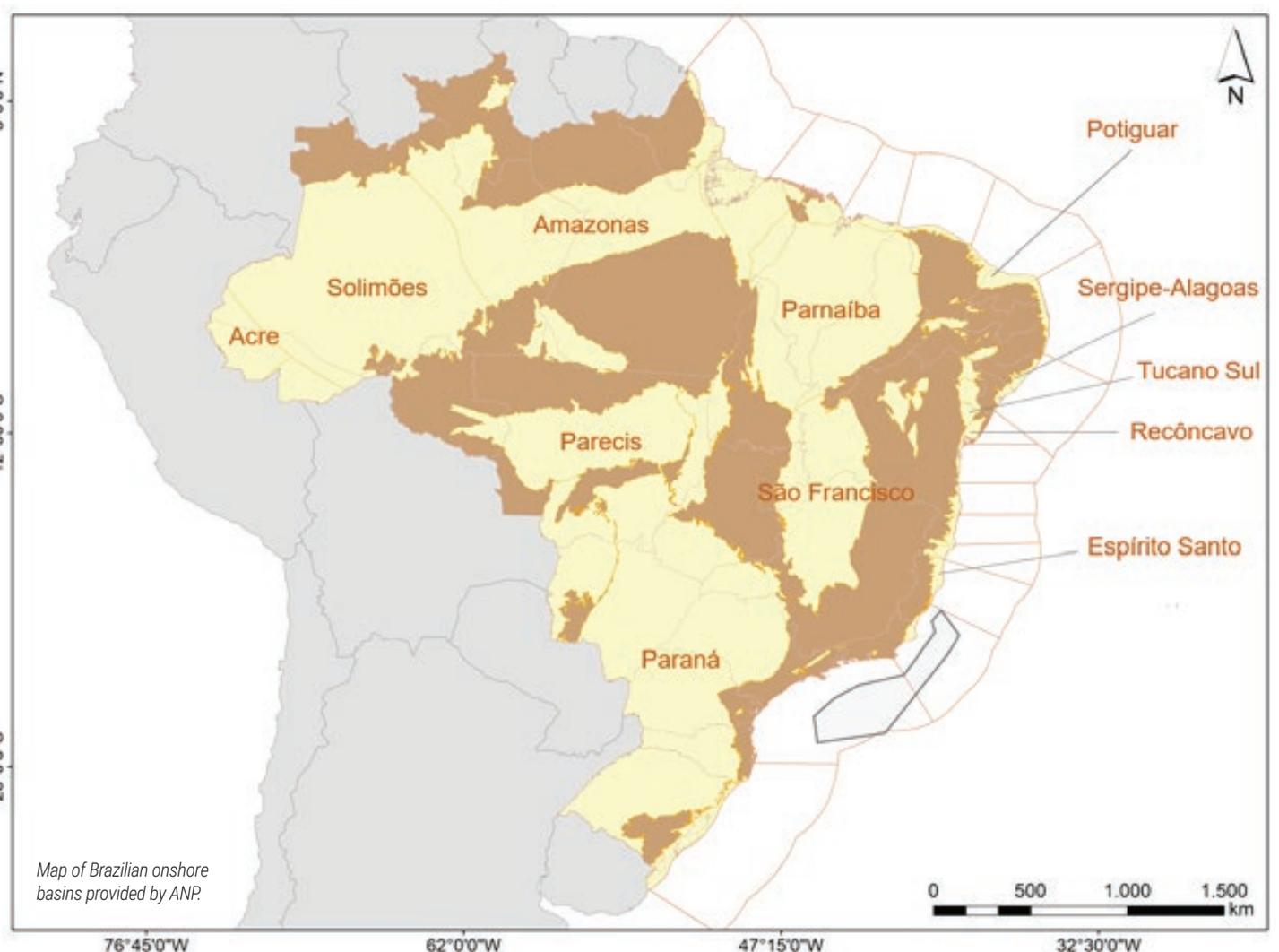
Petersohn said that onshore basins tend to be a good option for Brazilian operators unable to invest in deepwater pre-salt plays, at least for now.

"Oil exploration is a capital-intensive business and most Brazilian companies are not capitalized enough to compete against large and medium-sized international companies. Consequently, the best opportunities available were the ones on the onshore," she said. "I expect that given proper time some local companies will naturally grow to be competitive with international independents on the offshore."

Just as Brazilian companies are starting to eye the offshore, international companies are starting to look onshore, she said.

"It is important to spotlight that the most successful bidders of the latest open acreage bidding rounds for the onshore were either international companies or national companies backed up by international investors, which proves the point of the attractiveness of the Brazilian onshore market," she said.

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### An Exciting Scenario

Miranda said that Eneva hopes to continue to expand its portfolio in the coming years, and the company is eyeing divestment opportunities in Brazil.

"The constant advance in Brazilian O&G regulations, promoted by the ANP in the recent years and aided by the REATE Federal program and Petrobras divestments is enabling a healthy and exciting scenario for the Brazilian onshore industry that hopefully will prosper for years to come," he said.

The business environment inspired 40-year industry veteran Marcio Felix start his own business, EnP, a company he describes as "a platform of projects integrated into an energy ecosystem."

Felix said he that working in the Brazilian Ministry of Energy inspired him to start a company focused on multiple energy sectors.

"The opportunity to face several challenges simultaneously, meeting many different stakeholders, made me dream of an energy-integrated platform: gas, oil, biofuels, upstream, midstream and downstream; power generation, blue and green hydrogen, renewables," he said.

EnP's current portfolio includes projects in the upstream, midstream and downstream oil and gas sectors, as well as new energy projects, including a blue hydrogen plant.

### COVID-19 – Finding Opportunity in Crisis

Felix launched his company in March 2020, at the outset of the COVID-19 pandemic.

"The beginning of a company always has numerous challenges, but the pandemic was undoubtedly the major one," he said. "However, what could be a challenge, became an opportunity. The practicality of video calls has put us in contact with a lot of opportunities and partnerships. In a short period, we have matured our business strategy and acquired excellent assets."

EnP is not the only company in Brazil to thrive throughout the pandemic, a fact noted by Petersohn.

"Brazilian oil production hasn't been severely affected by the COVID-19 pandemic, but CAPEX and OPEX investments have been reduced worldwide, so we've noticed that some exploration activities have been postponed to the future years," she said.

"Since the beginning of the pandemic, ANP has been diligent by issuing flexibility measures aiming at the maintenance of oil and natural gas exploration and production activities," she added.

### Eyeing the Energy Transition

Onshore discoveries, particularly those related to natural gas, are helping companies like Eneva fuel the energy transition in Brazil. The company has developed initiatives like the Azulão-Jaguatirica II integrated project, which replaces diesel fuel with natural gas in Brazil's Amazonas and Roraima states.

"Our position as the leading player in reservoir-to-wire business has allowed us to prove that it's possible to monetize hydrocarbon in remote onshore areas in Brazil at the same time reducing CO<sub>2</sub> emissions," said Miranda. "Also, our gas fired power plant at the Maranhão state is key to the national energy system, backing up the hydro power plants during our six-month drought cycles. We are showing the

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have been awarded to indigenous and local businesses, and there are \$1 billion in employment and contract opportunities.

"It's been a long evolution where it was once viewed that indigenous people were a barrier to pipelines, and now they are a necessity in building them," John said. "If indigenous people widely rejected them, then why does every major pipeline project in Alberta have an indigenous equity component associated with it?"

### Building an Energy Road Map

Fossil fuels will supply up to 70 percent of the world's primary energy by 2040, wrote renowned Czech-Canadian scientist, policy analyst and author Vaclav Smil –

basing his estimate on recent forecasts published by governments, institutions and companies.

In his paper, "Examining Energy Transitions: A Dozen Insights based on Performance," Smil said that in 1960, fossil fuels supplied 97 percent of the world's primary commercial energy; in 1990 their share was 90 percent, and in 2015, it was 85 percent – suggesting that if a complete transition to renewable energy occurs, it will be well into the future.

Furthermore, between 1990 and 2015, the world added 25 times as much energy supply from fossil fuels as it did in modern renewables. And, because wind and solar power depend on unreliable sources, "countries also need to maintain large fossil-fueled reserve capacities, virtually doubling their total installed power," Smil explained.

The key is to convey such facts to younger generations, who voice a growing

distaste for fossil fuels but might not fully understand their critical role in the world, Hayes said. These future leaders will ultimately make the decisions that will affect all North Americans and the world.

"The challenge to the industry is to understand how to engage in effective communication tactics that are respectful of our code of ethics and desire to be truthful while making impacts on people," Hayes said. "There has to be better communication. My greatest fear is that we will fail at that communication and the world will be driven to some kind of crisis. We will get rid of what sustains us and what we put in its place won't sustain us."

Having seen tremendous ripple effects from positive interaction between industry and citizens, John offered the following: "We need to show how we are all connected to each other and the land. That is how people need to see the industry so it can move forward into the future." 

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# SCHEDULED TOPICS

Visit <https://library.seg.org/page/inteio/Interpretation-special-sections> for more details about these sections.

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Special-section editors: Saleh Al-Dossary, Qiang Fu, Sadaqat Ali Syed, Jinsong Wang, Ferhan Ahmed, Azer Mustaqeem, Valentina Baranova, and AbdoulShakour Nour

### MAY 2022

#### Recent Advances in Lacustrine Moderate-Low Maturity Shale Oil Exploration and Development

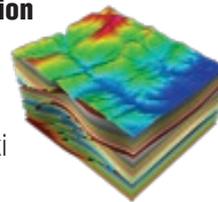
**Submission deadline: 1 July 2021**

Special-section editors: Min Wang, Shu Jiang, Tongwei Zhang, Zhejun Pan, Tim Carr, Zhuoheng Chen, Guochang Wang, and Chungqing Jiang

#### Automated approaches to interpretation

**Submission deadline: 1 August 2021**

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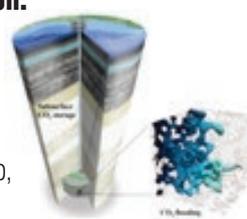


#### CO<sub>2</sub> geologic storage and utilization: Recent advances and future perspectives

**Submission deadline:**

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Special-section editors: Dallas B. Dunlap, Sahar Bakhshian, Rajesh J. Pawar, Joshua A. White, Reza Soltanian, and Hassan Dashtian



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**Submission deadline: 1 August 2021**

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### FEBRUARY 2022

#### Arabian Peninsula in the spotlight

**Submission deadline: 1 June 2021**

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**Submission deadline: 1 June 2021**

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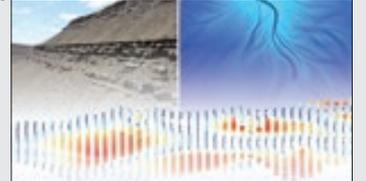
#### FEBRUARY 2021

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**1 May 2021**

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world that strong and reliable partners like Eneva can help renewables become a reality in Brazil.”

### Sharing Opportunities

Petersohn and Miranda will join Rodolfo Saboia, ANP general director, Petrobras executives and 10 local and international operators in discussing Brazil's onshore and offshore potential,

June 22-23, at the “Optimizing Exploration and Development Opportunities in Brazil's New Regulatory Scenario,” a Virtual Technical Symposium organized by AAPG's Latin America and Caribbean Region and the Brazilian Association of Petroleum Geologists.

The symposium features technical presentations and Q&A themes organized into half-day sessions dedicated to four topics: onshore basins and mature fields; post-salt and equatorial margin basins; pre-salt basins and technological advances and applications.

To see the program and register, visit [aapg.to/brazil2021](http://aapg.to/brazil2021). 

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After clustering, each cluster is trained and tested with different ML algorithms (such as random forest, convolutional neural network, and long short-term memory, among others). Then the results are aggregated to derive the final prediction results of shear wave velocity. Long-short term memory is a deep learning algorithm that uses log responses from previous depth or time to predict the response in subsequent depth. We can run both unidirectional and bidirectional LSTM.

### Discussion of Results

Based on the optimal model-based clustering, at least five clusters are found in the Wolfcamp formation in the study area (figures 2 and 3). These clusters are repetitive at a local scale but distinct when the full Wolfcamp formation is considered. This indicates the combined impact of mineralogy (which is repetitive to an extent)

and increasing stress gradients along the depth. The ML-based results showed an accuracy of 0.96 in predicting shear wave slowness for a test well (figure 4). Preliminary results showed consistency across several wells in the study area. This indicates that we can predict shear wave velocity with high accuracy in wells where no such log data are available, due to either vintage or cost. The combined application of time-series clustering and ensemble ML modeling makes it possible to predict rock properties successfully. It is still an area of early research. It is an understatement that we need more research on time-series clustering and ensemble class-based ML modeling approaches as it suits geology and data.

The author thanks the sponsors of the TORA consortium at BEG, UT Austin. 

*(Editors Note: The Geophysical Corner is a regular column in the EXPLORER, edited by Satinder Chopra, Founder and President of SamiGeo, Calgary, Canada, and a past AAPG-SEG Joint Distinguished Lecturer.)*

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We look forward to many  
more years to come.

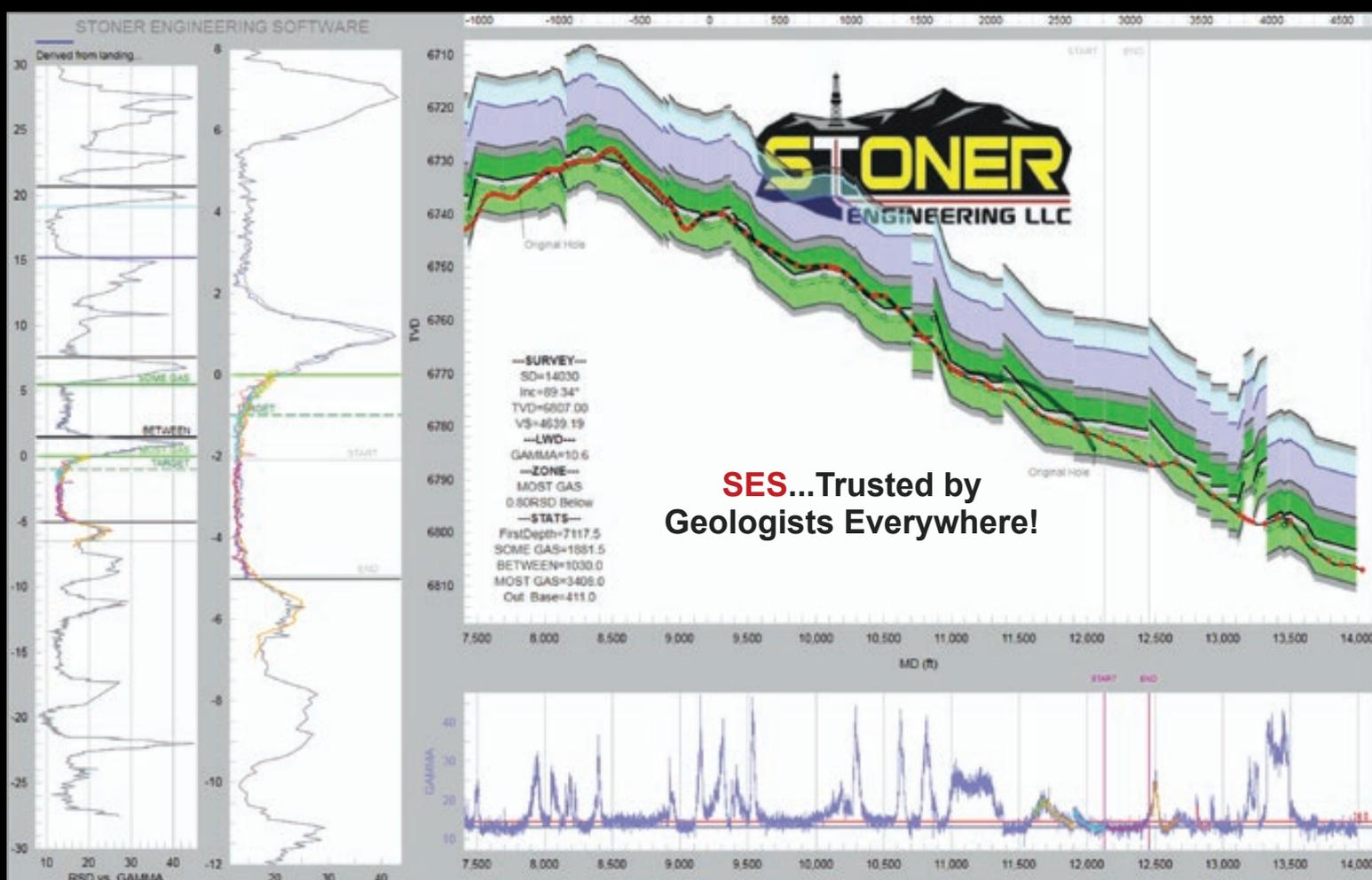


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# SES LEADS TO SUPERIOR GEOSTEERING

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