

CarbonSAFE Project Uses Core Technology to Identify CO₂ Storage Potential

Increasing global concern about climate change and its impact on the environment and society has led to a variety of strategies to reduce carbon dioxide emissions and to remove CO₂ from the atmosphere and find places to store it.

Many companies are hard at work to perfect methods of carbon capture, use, and storage. Franek Hasiuk, associate scientist at Kansas Geological Survey, said CCUS is the best technology available to reduce emissions produced by the global economy.

"CO₂ storage is a fundamental part of the current energy transition," he said. "Every petroleum company is looking at building it into their business plans because policymakers, regulators and the general public are becoming increasingly interested in the ways to reduce CO₂ emissions to the atmosphere."

Hasiuk is part of a team of scientists working on the Integrated Midcontinent Stacked Carbon Storage Hub, a project to investigate subsurface geology in southwest Kansas and southwest Nebraska and demonstrate the viability of injecting CO₂ into underground rock layers.

KGS is one of several public and private partners involved in the effort, which forms part of the U.S. Department of Energy's Carbon Storage Assurance Facility Enterprise, or "CarbonSAFE" program.

CarbonSAFE aims to identify and develop geologic storage sites, each capable of storing at least 50 million metric tons of CO₂ captured from industrial sources. Program contributors are working to prepare more than 50 sites for injection by 2026.

CarbonSAFE projects have two phases: pre-feasibility and feasibility. The IMSCS-HUB project has passed the feasibility phase and now is in phase 2.

"Our main goals during this phase are to provide all necessary background work such as geological and engineering characterization of the storage site, capture-facility design, infrastructure design and injection permitting," said Eugene Holubnyak, petroleum engineer and the project's co-lead investigator at KGS.

In addition to his work with the CarbonSAFE project, Holubnyak leads the Kansas CCUS Task Force, and represents KGS at the Regional Carbon Capture Deployment Initiative.

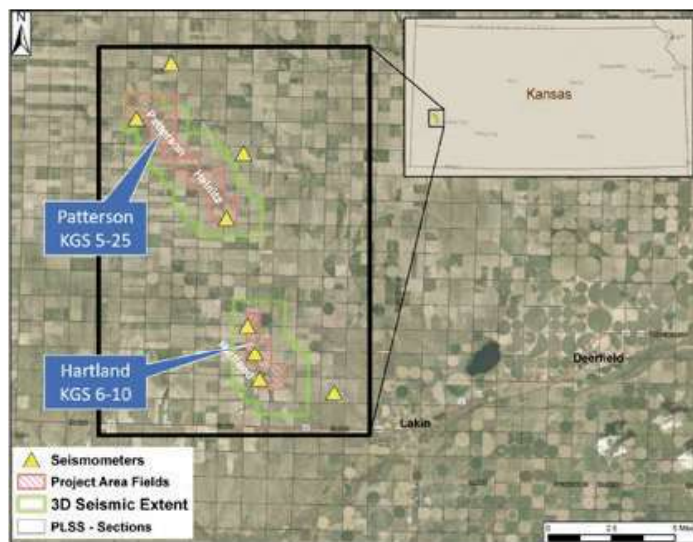
In the past 10 years, the KGS Energy Research Section has led or played a key role in five large-scale CCUS projects funded by the U.S. Department of Energy and has been tasked with developing a plan to address challenges and opportunities for commercial-scale CCUS in Kansas.

The IMSCS-HUB Project

IMSCS-HUB tasks include drilling wells – two in Kearny County, Kan., and one in Red Willow County, Neb. – conducting a seismic survey and analyzing acquired data. Cores, drilling records and 3-D seismic data obtained in the process will be made available to the public once the project is complete.

Holubnyak noted that the results will be useful not only for CCUS projects but also for conventional oil and gas exploration, geologic research and other activities.

"Extensive 3-D seismic datasets, such as the one acquired at the Kearny County site, are expensive and not often available to the public," he said. "This dataset will provide insight on the architecture of structures in the subsurface throughout the region, where there are many similar structures. We hope that by analyzing this data we will better



Hartland-Patterson site with science wells locations, with newly acquired 3-D seismic outline and locations of seismometers. Images provided by the Kansas Geological Survey. Map printed 10/22/2019. Sources: Kansas Geological Survey, DASC, Kansas Corporation Commission, USGS, IRIS

understand the Ordovician-age Arbuckle and Precambrian basement interface and other geologic formations in Kansas."

Western Kansas is home to the Viola, Osage and Arbuckle rock units, porous rock formations containing highly saline water separated from shallower, freshwater aquifers by thousands of feet of impermeable rock. The Arbuckle sits just above the Precambrian basement, composed of igneous and metamorphic rock.

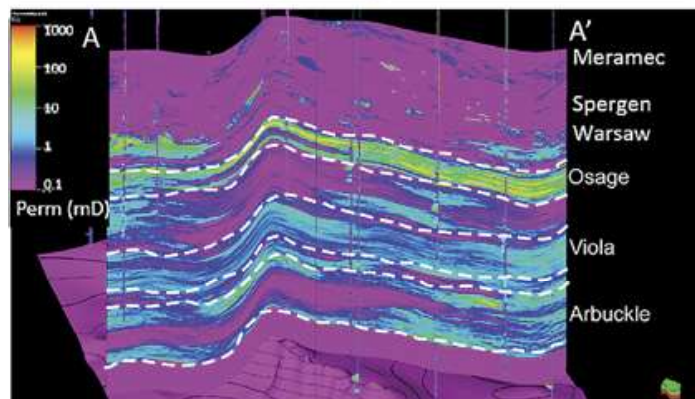
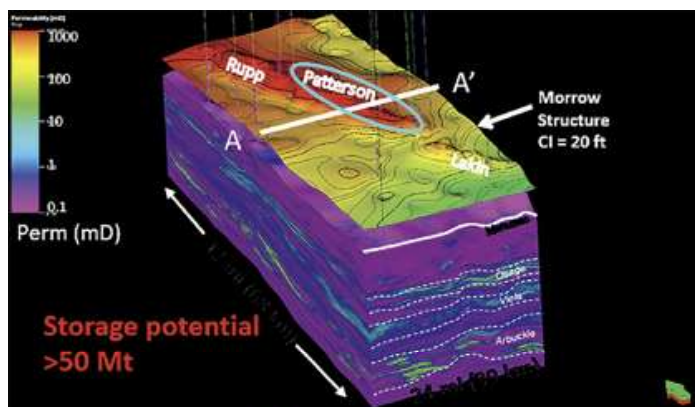
Holubnyak noted that the Viola, Osage and

Arbuckle are the key targets for CO₂ storage, and data gathered during the IMSCS-HUB investigation will help determine whether it can store CO₂ safely in the long term.

"Data on the Precambrian/Arbuckle interface is sparse, but it is essential for both fundamental science and applications such as CCUS," he said.

Analyzing Cores

To better understand the data, KGS



The 3-D model (top) shows storage potential of rock layers from the top of the Meramec formation – more than 4,000 feet deep in Kearny County – to the top of the basement. The map above is the top of the Morrow formation overlying the Meramec. The cross section (bottom) shows formations underlying line A-A' on the 3-D model.



Berexco's rig at the first IMSCS-HUB well site in Kearny County, Kansas

contracted geoscientists from Houston-based Premier Oilfield Group to assist in analyzing cores obtained from the Patterson 5-25 well drilled in Kearny County in early 2020.

Since 2016, Premier Oilfield Group has been a global leader in the aggregation, generation and application of rock and fluid data for unconventional and conventional plays throughout the United States, Europe, the Middle East and Asia.

Tim Prather, senior geologist and project manager at Premier, oversaw the core analysis program and coordinated processing, analysis and reporting of data to KGS scientists and engineers.

Prather, whose interest in CCUS started during his master's studies at the University of Texas, said he appreciated the opportunity to work on a project that enabled him to use his geology skills to benefit the environment.

"I only attended a few talks facilitated by the Gulf Coast Carbon Center housed at the Texas Bureau of Economic Geology, but they had a profound impact on informing me about the relationship between carbon emissions and climate change," he said.

"The combination of these academic presentations and the time I've spent working in subsurface reservoir characterization has inspired me to consider climate change as a problem that can be solved by the same technologies and experts in the oil and gas industry which partially contribute to the CO₂ emissions we are working to offset," he added.

Bryan Guzman, AAPG Member, Houston Geological Society vice president and senior account manager at Premier, also worked on the core analysis project. He agreed that CO₂ storage is a great fit for geoscientists who are both skilled in unconventional techniques and interested in reducing emissions.

"I believe that CO₂ storage is imperative as we explore ways to reduce our carbon footprint globally," he said. "It is one of many techniques that will bring us one step closer to combating rising CO₂ levels and is an excellent technique that can leverage the vast experience of scientists working subsurface in the unconventional space."



Left: Ingenuity Flight 4- April 30, 2021 (Sol 69). Ingenuity is left of center with a spectacular delta outcrop in the distance. Right: Mars Perseverance Rover front right HazCam image Sol 79/May 11, 2021. Visible in the image is the rover's right front wheel, and the turret at the end of the instrument arm carries scientific cameras, mineral and chemical analyzers for studying Mars geology. Instruments on the turret are SHERLOC, WATSON, PIXL, and the geology sample drill. Image courtesy of NASA/JPL-Caltech.

Perseverance Rover and Ingenuity Flight Tests in Jezero Crater

At the time of this writing, it is May 15, 2021 that is Sol 83 for the Perseverance "Percy" Rover on Mars. Last month, we witnessed the deployment and first flight of the Mars Ingenuity helicopter. With the world watching the first powered aerial flight on another planet, Ingenuity has accomplished successively more difficult flight tests this month while Percy observes and relays flight data and images to Earth. The location where Percy has been observing Ingenuity's powered controlled flight is called "Van Zyl Overlook," after Jakob van Zyl, a leader at NASA's Jet Propulsion Laboratory.

First Flights

Ingenuity completed its first flight on April 19, flying to a height of 10 feet, hovering, rotating 90 degrees and then softly landing. Its second flight, on April 22, flew to a height of 16 feet and tested horizontal flight. Its third flight, on April 22, flew to a height of 17 feet, taking a roundtrip ranging up to 164 feet north of its takeoff site. Its fourth flight, on April 30, flew to a height of 16 feet, taking a roundtrip up to 436 feet south of the takeoff site at up to 3.5 meters per second.

Ingenuity took black and white images along the way and color images while hovering at the farthest point before returning to the takeoff site. The images were stitched together to create a 3-D map. Ingenuity completed its fifth flight on May 7 (Sol 75) with a one-way journey 423 feet to the south.

"The fifth flight of the Mars Helicopter is another great achievement for the agency," said Bob Pearce, associate administrator for NASA's Aeronautics Research Mission Directorate. "The continuing success of Ingenuity proves the value of bringing together the strengths of diverse skill sets from across the agency to create the future, like flying an aircraft on another planet!"

Future UAV helicopters will help guide geologic exploration on other worlds.

Ingenuity awaits new instructions from mission controllers. The next phase of testing will involve more challenging one-way flights and maneuvering.

MOXIE Producing Oxygen on Mars

Meanwhile, on April 20 (Sol 60), Perseverance made history on Mars by converting atmospheric carbon dioxide into oxygen. The demonstration was conducted in a toaster-sized instrument in the rover's undercarriage called the Mars Oxygen In-Situ

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Left: On May 4, the Ingenuity helicopter sent this text message to NASA JPL. Right: The toaster sized MOXIE package is mounted in the rover's undercarriage.

Resource Utilization Experiment. MOXIE's first oxygen production was only 5 grams. That would be about 10 minutes of oxygen for an astronaut. MOXIE can produce up to 10 grams of oxygen per hour. Practical systems producing oxygen for humans or for rocket propulsion can be scaled up from here. However, energy requirements increase with the task. NASA has demonstrated a small, lightweight fission power system capable of producing 10 kilowatts of electrical power for future human explorers.

Perseverance Instrument Calibration

Perseverance has not moved far from its landing site, but it has given us some tantalizing images of the local geology. Mission planning interpretation from Mars Reconnaissance Orbiter data has the landing zone in mafic, basaltic terrane in Jezero Crater. The rock images in the immediate vicinity of the rover seem to be consistent with that. However, according to Rice University Perseverance geologist Kirsten Siebach, "We cannot report rock types at this time. The SuperCam LIBS has not been fully calibrated. Once it is, they can report all the chemistry from the previous observations, but it's not ready yet."

Why would such a precisely constructed suite of instruments need time-consuming calibration? Every scientific instrument needs calibration, especially the sensitive instruments on the rover that were violently jiggled during launch and landing. Accuracy is required to identify atomic lines with laser-induced breakdown spectroscopy and Raman spectroscopy. For example, the position of the absorption lines of some carbonates can require 1 nanometer accuracy.



Calibration targets for the Mastcam-Z cameras on NASA's Mars 2020 Perseverance rover will help get the colors of Mars exactly right, both in visible light as well as in the near-ultraviolet and near-infrared light that the cameras can detect.

The calibration targets for SHERLOC include aluminum gallium nitride on sapphire; a quartz diffuser; a slice of Martian meteorite; a maze for testing laser intensity; a separate aluminum gallium nitride on sapphire with different properties.

The SuperCam calibration target includes a grid of visual elements for adjusting the focus of the remote micro-imager, and various samples to calibrate SuperCam's four spectrometers. The RMI can observe dust grains as small as 100 microns. SuperCam spectrometers can identify the chemical and mineral


composition of geologic targets on Mars. The SuperCam Calibration Target assembly is mounted on the right, rear of the rover deck. It consists of micro-imager calibration targets and suite of 22 minerals of precisely known compositions.

Follow the Exploration

The images that Percy's Remote Micro Imager returned of the distant, 3.5 billion-year-old, deltaic clinoforms remnants are a tantalizing hint of amazing Earth-like geology we may find in the Jezero delta. One source hints that Ingenuity may make exploration hops to follow Percy as the rover explores the delta in search for evidence of possible past life in these ancient lake deposits. You can take the journey with Percy as we follow along in the AAPG EXPLORER. [\[E\]](#)



SuperCam Remote Micro Imager zoomed in on distant, interpreted deltaic clinoforms remnants. Scale is less than 10 meters. April 29, 2021 Sol 68.



'Infrastructure' Bill Includes Major Proposals for the Energy Sector

When introducing his American Jobs Plan, President Biden promised it would invest "in America in a way we have not invested since we built the interstate highways and won the Space Race."

To put that investment in perspective, the interstate highway system, encompassing 47,000 miles of roads, cost \$500 billion in today's dollars, adjusting for inflation; the Apollo Program, about \$194 billion.

The price of the American Jobs Plan: \$2.3 trillion.

The centerpiece of the plan, as it has been presented, is the improvement of America's overall infrastructure, which includes vast expenditures in building or repairing 20,000 miles of roads, repairing bridges and eliminating all lead pipes and service lines in drinking water systems; offering \$56 billion in grants and flexible loans to states, tribes and territories to upgrade drinking, wastewater, and stormwater systems.

There is also significant investment proposed to the energy sector, which includes expanding clean energy sector tax credits, offering block grants and increasing government purchasing power to aid the new renewable sector. It is of some note that the president mentioned the word "climate" only once in unveiling the plan, instead focusing on the impact he expects the plan will have on jobs and the economy.

For the energy sector specifically, the American Jobs Plan would provide resources for renewable natural gas, hydrogen and carbon capture, utilization and storage, as well as electrifying 20 percent of the nation's school buses. It also dedicates \$16 billion to plug old oil and gas installations and clean up

abandoned mines and orphaned wells. This part of the plan will be a key element of job creation for industries and states, like coal-producing ones. Additionally, on the legislative front, Democrats on the House Energy and Commerce Committee proposed a \$312 billion infrastructure bill that would devote nearly an additional \$70 billion to clean energy and energy efficiency and \$48.1 billion to electric vehicle deployment, clean ports and smart cities.

Defining 'Infrastructure'

Opponents of the bill took issue with the overall cost, which Sen. Roger Wicker, R-Miss. said is not an infrastructure package at all, but "a huge tax increase," and raised questions about whether the bill includes projects that have nothing to do with infrastructure.

The president's package, as well as the proposal by House Democrats, will need Republican support, which at this point looks unlikely in the bill's current form, as GOP lawmakers are expected to block the legislation from ever reaching the president's desk, citing both the cost and the scope of the bill, which included \$400 billion to expand Medicaid services and \$213 billion to build and retrofit more than 2 million homes and commercial buildings, including community colleges, aging schools, child care facilities, veterans' hospitals and federal buildings; it calls for one million affordable housing units to be produced or retrofitted, more than 500,000 homes for low- and middle-income homebuyers to be built or rehabilitated, and the elimination of exclusionary zoning.

Many of these goals, according to Republicans opposed to the plan, speak mostly to the president's social agenda

and feelings on the role of government. Passage of the bill, congressional watchers insist, would be greatly improved if the bill was limited to projects like roads and bridges.

The devil, though, as it usually is, is in the details, and one of these details is terminology – what is and isn't considered "infrastructure" and what does or doesn't belong in a national energy conversation.

Specifically, transportation gets \$621 billion in the new plan, including \$174 billion on electric cars; \$650 billion on what is being termed "quality of life," including expansion of homes, building, water infrastructure and Internet; and \$300 billion in manufacturing and domestic production of technologies.

Impact on the Energy Sector


The plan's effect on the energy sector, in light what the administration is calling "a carbon pollution-free power sector by 2035 and net zero emissions economy by no later than 2050," is a hot topic within the industry.

The president's proposal also attempts to deal how the different energy sectors in America will look in the decades to come. In West Virginia, the second-largest coal producer in the nation after Wyoming, the bill's effects on workers would be enormous. The money allocated to clean up those "orphaned" wells, as mentioned, will be targeted to those coal workers out of work (or soon to be) by the new effort at de-carbonization. In a study conducted by Columbia School of International and Public Affairs Center of Global Energy Policy, a program to plug these wells could create more than 100,000 jobs. Additionally, if the plan's efforts to aggressively capture carbon are successful, this, too, will save

coal jobs for the near future.

The entire fate of the bill (and what it will ultimately include), moreover, may very well be in the hands of the West Virginia's U.S. Sen. Joe Manchin, a Democrat, who said he is already concerned about its cost. To pay for the package, it raises the corporate tax rate from 28 percent (it is currently 21 percent), closes some loopholes and eliminates some corporate deductions. Manchin said the 28 percent is too high, but said he might agree to a 25 percent tax.

For its part, the American Petroleum Institute, the largest oil and natural gas association in the country released a statement from Frank Macchiarola, API's senior vice president for policy, economic and regulatory affairs. In it, API reiterates its opposition to tax cuts to pay for the plan and reminds the administration of the vital role of the oil and gas industry:

"We support the administration's goal of modernizing the nation's infrastructure – including roads, bridges, rail and ports. We also welcome the administration's efforts to address the risks of climate change by incentivizing innovation for hydrogen and CCUS as part of this infrastructure package. At the same time, this proposal misses an opportunity to take an across-the-board approach to addressing all our infrastructure needs – including on modern pipelines. Targeting specific industries with new taxes would only undermine the nation's economic recovery and jeopardize good-paying jobs, including union jobs. It's important to note that our industry receives no special tax treatment, and we will continue to advocate for a tax code that supports a level playing field for all economic sectors along with policies that sustain and grow the billions of dollars in government revenue that we help generate." 



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 MMm3/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 Jurua 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 is 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."

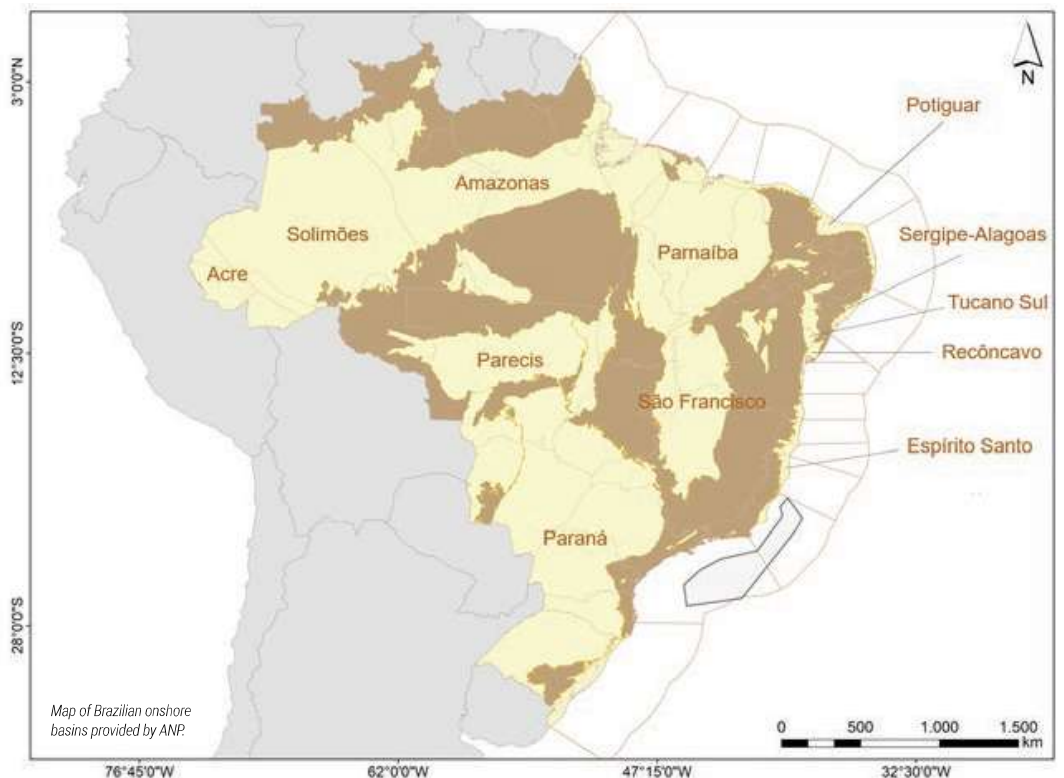
Petersohn said that onshore basins tend to be a good option for Brazilian operators unable to invest in deepwater pre-salt plays, at least for now.

"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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CarbonSAFE

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Project Findings

Guzman said Premier team members are working to summarize the core analysis data program to better understand the variability in reservoir characterization across the cored interval for the Patterson No. 5-25 well.

"Existing core analysis techniques are invaluable to understanding the best way to approach CO₂ injections when combined with other subsurface data," he said. "Looking at the rock can never be underestimated from a value perspective."

Next steps include wrapping up the reservoir characterization component for the Patterson No. 5-25 well and focusing on understanding the aging effects by testing rock/fluid interactions with the formations of interest over time.

Sharing Results

Guzman will deliver a presentation about the Patterson No. 5-25 core analysis at the Wednesday topical breakfast held during the Unconventional Resources Technology Conference in Houston on July 28.

In his presentation, "Investigation of Multiple Formations in the Midcontinent for CO₂ Storage Potential Through the Acquisition and Analysis of over 700ft. of Whole Core," Guzman will share results from the 2020 project and share how new and traditional core analysis methods for CO₂ storage compare with protocols used in oil and gas exploration.

"I believe the topic is very relevant at this time and that scientists working on unconvencionals can contribute a lot with all the technologies that were developed for unconvencionals," said Guzman.

For Hasiuk, including CO₂ storage talks at society conferences makes sense not only for scientists, but also for the companies who are interested in entering the CCUS space.

"CO₂ storage is a frontier industry. There is still plenty of opportunities for growth. There are no majors or supermajors in terms of CO₂ storage yet," he said.

Incentives for CCUS

Corporate interest in CCUS increased in 2018 when the U.S. Internal Revenue Service implemented 45Q tax credits for companies that capture and store CO₂ that would otherwise be emitted into the atmosphere.

In addition to the federal credits, companies can take advantage of state-specific tax credits like the California Low Carbon Fuel Standard. With some of the programs, CO₂ used for enhanced oil recovery also counts as CO₂ storage.

Hasiuk noted that incorporating CCUS into the portfolio allows companies to make both a profit and an impact.

"If you want to make a difference in the world, there is no better way than contributing to the reduction of CO₂ in the atmosphere. CO₂ storage is the best technology for doing this," he said.

Industry's Role in the Energy Transition

Prather said he sees the oil and gas industry uniquely positioned to help solve the looming global climate-energy crisis.

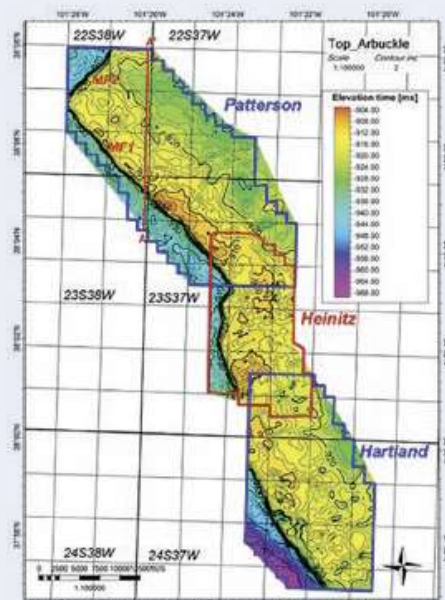
"No other entity understands the subsurface reservoirs of the world better than the geologists, engineers, and other scientists working for the petroleum industry," he said. "If the collective knowledge and the technologies supporting U.S. petroleum operations could be partially directed towards CCUS efforts, the net benefits would greatly outweigh the growing pains of an expanding new industry," he said.

Prather said that when oil and gas companies embrace CCUS they create new geoscience jobs, ensure the continued use of fossil fuels while reducing net emissions, and expand access to energy worldwide.

"Energy poverty will be a catastrophic force in the coming decades if average citizens around the globe lack consistent access to reliable energy sources to provide electricity and fuels to meet their growing demands," he said. "CCUS efforts should play a central role in enabling a more stable energy transition and in providing socially/economically accessible energy to the developing world in particular."

Advice to Future CCUS Professionals


Prather encouraged students and young professionals to consider CCUS when they choose a career path.



Seismic-generated model showing contours on the top of the Arbuckle formation in the vicinity of the Kearny County IMSCS-HUB well site

"Addressing the impact of CO₂ emissions on global climate change will require a workforce of scientists and engineers who are creative and intelligent," he said. "Don't be afraid to get your hands dirty working with the actual rocks we are trying to understand and characterize to achieve the goal of net neutral carbon emissions."

To see the URTeC program and register for the conference visit URTeC.org.

For information about the IMSCS-HUB project see www.kgs.ku.edu/PRS/IMSCSH. 

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