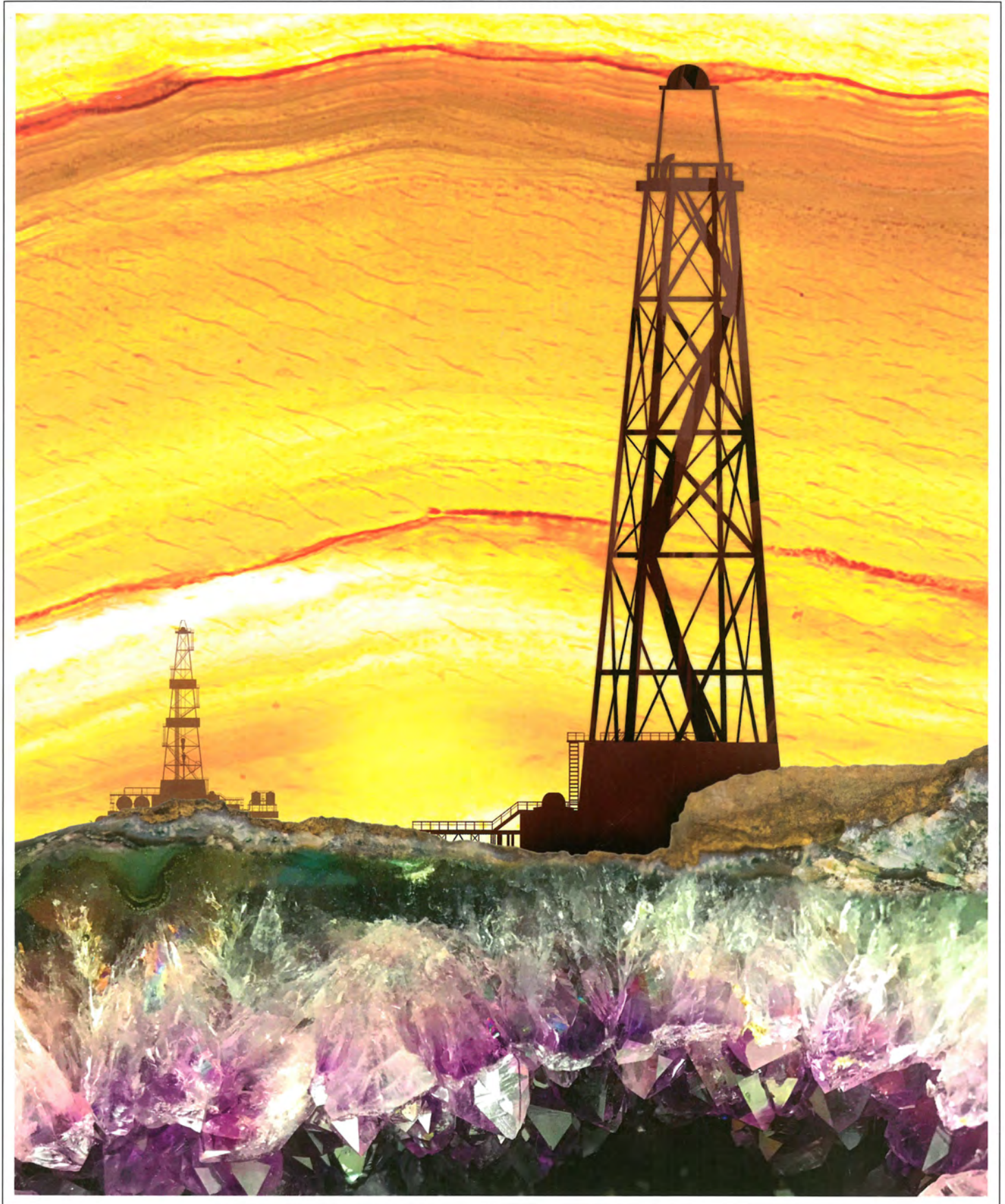


Oil and Gas Investor

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Mineral interests capture the fancy of operators and investors alike.

REDISCOVERING MICHIGAN

Core Energy has found the way to more oil in the northern state via EOR and exploration in the Niagaran reefs.

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In the early 1970s, Michigan's hydrocarbon production advanced thanks to the discovery of the Niagaran Reef trend. A vast amount of oil and gas were trapped in the reefs, which were formed along the edges of a sea that once covered the state of Michigan during the Silurian period.

Though you don't hear much about the state's oil and gas exploration and production today, one company has taken the lead in rediscovering the Niagaran Reef trend in northern Michigan through 3-D seismic technology and CO₂ EOR.

Traverse City, Mich.-based Core Energy LLC has been flooding depleted fields in the northern Niagaran trend, a play once exploited by majors Shell and Amoco and independents, with CO₂ through its EOR operations.

"These reefs are maybe a mile deep," said Bob Mannes, president and CEO of Core Energy. "They're going to be anywhere from 60 to 300 acres in size and they're encased in salt—totally encapsulated—which makes

for good CO₂ EOR because we don't have to manage the CO₂ going off the lease into the neighboring leases like some of the challenges other EOR operations can face in other parts of the world. These fields are small by comparison to other EOR projects; we will have anywhere from two to six wellbores per field, so they're very efficient from a capital and operational standpoint."

The reservoir's properties and mechanics work similar to other miscible CO₂ EOR operations, he explained.

Mannes formed Core Energy in 2003 to jump-start the CO₂ EOR program in Otsego County, Mich., where most of its operations are located today. At the start of operation, the company purchased two existing fields that had been piloted years earlier by Diamond Petroleum, which also built out some of the infrastructure. Core Energy has since then added eight additional fields that are in various stages of development and recently commenced its 10th CO₂ EOR project.

"Some of them [Niagaran fields] were still producing a smattering of oil—20, 30 barrels a day on primary. The field that we just started had been completely plugged, abandoned for 25 years. It varies; we're out trying to acquire fields where we can and where it makes sense. There are over 700 reefs in the northern trend, and we've got them all screened and we know which ones we want to go after. You're doing what you've got to do to secure those fields," Mannes said.

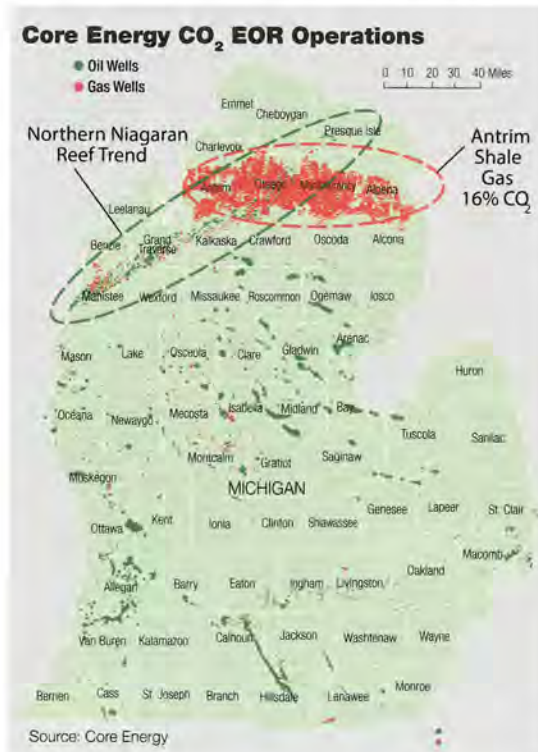
The operations have already produced more than 2 million barrels of incremental oil that would not have otherwise been produced in Michigan, all while sequestering more than 1.5 million tons of CO₂ in the process, according to the company.

Core Energy's commercial CO₂ EOR operation is the only one of its kind in the eastern U.S., according to Mannes.

The CO₂

Core Energy sources its CO₂ from a gas processing plant operated by Denver-based DCP Midstream LP. The latter is removing CO₂ from the Antrim Shale, a play developed in the early '90s that spans through the northern part of Michigan.

Core Energy uses 3-D seismic technology and its CO₂ EOR operations to recover oil from the northern Niagaran Reef in northern Michigan.



With about 11,000 Antrim wells already drilled there, a considerable amount of CO₂ is coming off the Antrim gas. Currently, about 26 million cubic feet per day (MMcf/d) of CO₂ is being produced out of the plant, located in Otsego County, based on the current status of the Antrim Shale trend and current production levels.

“When the Antrim wells first come online, they’ve got about 6% CO₂. Over the course of life, the CO₂ composition of the gas goes up and some fields are now as high as 25% CO₂. And for that gas to meet pipeline specifications it has to be less than 2%,” Mannes said.

The industry went the way of centralized CO₂ removal facilities for all of the producers for those 11,000 wells. With Core’s operations set up next to the largest gas processing plant, it has exclusive rights to capture that CO₂ for the life of the plant. Of the 26 MMcf/d, Core is capturing about 18.5 MMcf/d.

The CO₂ is delivered to the company’s various fields that it’s flooding via compression and pipeline infrastructure that is owned and operated by Core Midstream.

Core’s CO₂ EOR operations can recover an additional 15% to 20% of original oil in place, according to Mannes. “In Michigan, with these reefs, they typically have not been subjected to secondary recovery efforts. There have been maybe a couple dozen water floods tried through the years and very few of them have really been successful,” he said, adding that Core goes from the primary production phase straight to CO₂ EOR flooding.

Most of Core Energy’s operations are in Otsego County, of which 80% is focused on CO₂ EOR. “We don’t control a huge inventory of fields to go flood right now. Our challenge to grow has been field acquisition, but

there’s a significant opportunity coming up this year,” said Mannes.

3-D seismic activity

Core utilizes proprietary 3-D seismic to define existing reefs that it plans on flooding to know the shape, size and volumetrics. “If we need to drill new wellbores in these reefs, then we know what the reefs look like and can design our wellbores to best sweep the oil,” said Allen Modroo, exploration manager and partner at Core Energy.

Modroo said they also use 3-D seismic for the exploration side and have been successful in finding new reefs that have been left behind.

“As in any exploration program, the big reefs, the big fields have been found, and they did a pretty successful job at that, but we are finding there are smaller reefs left that are perhaps 20 acres in size. And believe it or not they do make a lot of oil,” Modroo said.

The company just drilled a small reef that’s about 38 acres in size and that will produce in excess of half a million barrels, he said. “The 3-D science is working in Michigan,” Modroo noted.

“The proof is in the pudding. Our success rate of finding reefs is at least 80% based on 30 to 40 wells,” Mannes said. However, not all reefs are good reefs, according to Modroo. When finding a reservoir, challenges can occur such as porosity development and salt plugging.

“You need to find the sweet spot in the reef, and we’ve been working toward that direction. We’re getting better at this,” Modroo said. He said Core Energy is working with



“We know that we will get oil back from using our CO₂; it’s low risk as far as exploration is concerned,” Allen Modroo, exploration manager and partner, Core Energy LLC.



PHOTO COURTESY CORE ENERGY

Most of Core Energy’s operations are in Otsego County, of which 80% is focused on CO₂ EOR. To the left is one of the company’s CO₂ EOR production facilities.



"We know where the oil is, it's where it was. We're going to go back into existing fields using existing wellbores and harvest oil that we know is left behind," said Bob Mannes, president and CEO, Core Energy LLC.

companies in Calgary and Houston to unravel the detection of porosity anomalies within the reefs.

"No one has figured out the magic sauce to know what's inside them, but we've made huge strides at least just finding them," said Mannes. Once the targets are identified, exploration wells have been commercial 50% to 60% of the time.

In 2015, the company shot 10 miles of 3-D seismic in Manistee County and drilled a 4,500-foot deep well targeting a Niagaran reef. That well today is still producing a full proration allowable of 300 barrels per day, Mannes noted.

"I don't think there's a 3-D seismic data collection in northern Michigan as extensive as ours," Mannes said, adding that the company has more than 275 square miles of 3-D data scattered throughout every county in the western and northern Niagaran Reef trend. "We're the only company that has been drilling Niagaran Reef wildcats in the last five years."

Opportunities arise

Merit Energy is one of the largest producers in Michigan and holds an extensive position in the northern Niagaran Reef trend. The company recently announced that it is exiting Michigan, leaving a significant target of oil behind, which "will lead to an increase of activity in CO₂

EOR" and opportunities for exploration, according to Mannes.

Mannes said that he is excited about Otsego County because of the EOR potential. "We know where the oil is, it's where it was. We're going to go back into existing fields using existing wellbores and harvest oil that we know is left behind," he said. Other counties of interest to the company are Manistee, Grand Traverse and Kalkaska.

Core Energy spends anywhere from \$5- to \$15 million in capital per year, which is internally generated or funded by outside investors. The company produces around 22,000 barrels of oil per month and hopes to drill three to four wells and begin another CO₂ project, all in Otsego County, this year.

"We know that we will get oil back from using our CO₂; it's low risk as far as exploration is concerned," Modroo said.

Currently, Core Energy is getting involved with other operators in the state looking at the Dundee Formation and other exploration targets using 3-D seismic. However, the company's main area of operations and prospect development right now is the northern Niagaran Reef trend.

"For the remainder of 2017 we intend to start another CO₂ project and also drill two, maybe three, wells in the exploration program. We're also very much looking forward to working with the next owner of the Merit assets ... that will consume a good part of our year," said Mannes. □

Core Energy's operations have already produced more than 2 million barrels of incremental oil that would not have otherwise been produced in Michigan. Here, a workover rig on the injector well, and a CO₂ pipeline being constructed for the injector.



PHOTO COURTESY CORE ENERGY