As seen in the October 2007 issue of E&P

Indonesia object of massive study

A unique dataset places Indonesia's frontier potential under a microscope.

AUTHORS

***I.R.R. Pryono**, MIGAS, Indonesian Ministry of Energy and Mineral Resources, and **Paul Gilleran**, TGS-NOPEC Geophysical Co.*

Barely 6 months into an 18-month-long exploratory program that eventually will cover more than 193,000 sq miles (500,000 sq km) of unmapped acreage in Indonesia's vast offshore frontier, MIGAS and TGS-NOPEC Geophysical Co. (TGS) are generating a unique set of geophysical, thermal, oil-seep and geochemical data that are beginning to challenge many previously held concepts about the hydrocarbon prospectivity of the Indonesian Archipelago.

Indonesia is recognized as one of the world's largest hydrocarbon-producing countries, currently producing more than 950,000 boe/d of crude oil and natural gas. Production flows from eight basins containing an estimated 1 billion boe of recoverable reserves. But output has been dropping year on year at an average annual rate of 5%, creating a powerful incentive for the Indonesian Ministry of Energy and Mineral Resources to explore for and aggressively develop new petroleum resources.

Indonesia possesses more than 30 frontier sedimentary basins that remain unexplored because a lack of modern geophysical data in the region has made it difficult to assess their hydrocarbon potential. Oil and gas exploration companies have been unable to justify large exploratory investments in Indonesia's frontier basins because of the lack of useful data about the area's geology.

Groundbreaking geological study

MIGAS and TGS are rectifying this data shortfall with the Indonesian Frontier Basins (IFB) exploration program, a groundbreaking geological study that is integrating high-quality 2-D seismic data, gravity data, magnetic data and thermal data with recently developed multibeam sonar technology that can detect oil seeps and other active geological processes on the ocean floor. MIGAS and TGS also are collecting core samples next to oil seeps and analyzing their chemical characteristics to identify the most oil- and gas-prone areas within the IFB study area. MIGAS and TGS are interpreting the unique IFB data set in order to differentiate the various types of exploration opportunities.

By combining modern geophysical data with ocean-floor geochemistry near carefully mapped oil seeps, MIGAS and TGS intend to effect a paradigm change in the speed and efficiency with which exploration companies find hydrocarbons in frontier basins and assess their commercial potential.

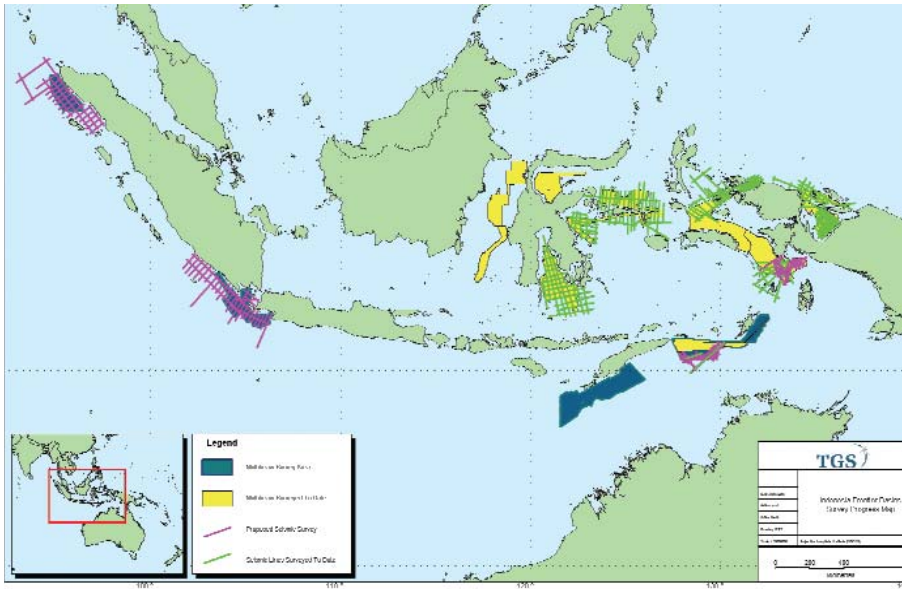

Figure 1. The Indonesian Archipelago is more than 3,000 miles (5,000 km) long, and areas of interest are scattered across its entire length. (Images courtesy of TGS NOPEC)

The scale of the IFB project is massive (Figure 1). The Indonesian Archipelago is more than 3,000 miles (5,000 km) in length, and areas of interest are scattered across its entire length. New data being acquired includes 21,315 line miles (35,000 line km) of high-resolution, long-offset 2-D seismic data, 60,000 miles (100,000 km) of gravity and magnetic data, heat flow probes, and the collection and analysis of more than 1,200 core samples. Ultimately, these data will provide detailed and comprehensive profiles of all the most prospective areas within the IFB project.

Pinpointing underwater oil seeps

No naturally occurring oil field has a perfect seal; leaks and seeps of hydrocarbons, either to the surface or to other subsurface strata, are inevitable. In fact, finding seeps is precisely how most of the world's onshore oil was discovered. Now new multibeam sonar technology allows MIGAS and TGS to

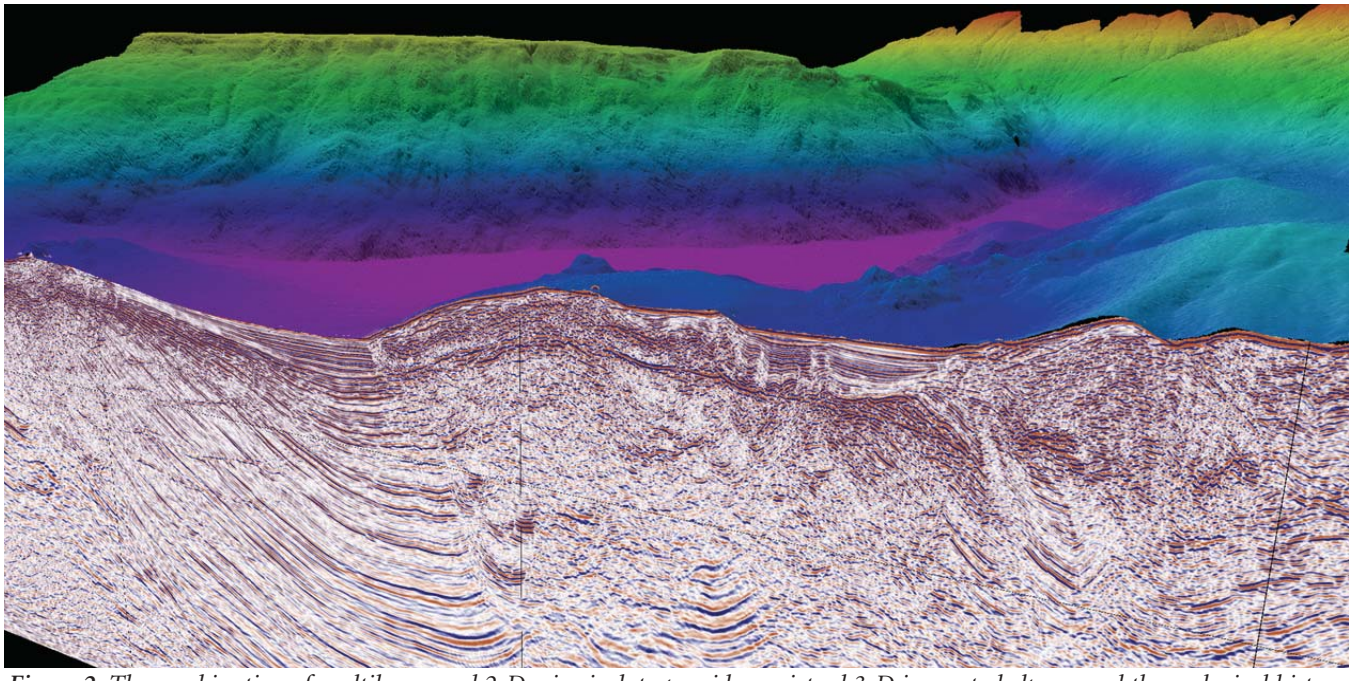

Figure 2. The combination of multibeam and 2-D seismic data provides a virtual 3-D image to help unravel the geological history of these very complicated areas.

use this same method of locating oil on the ocean floor. Once seepage has been located by multibeam sonar, a core sample can be accurately taken right next to the seepage point. Geochemical analysis of that core sample can reveal whether naturally occurring hydrocarbons are present at a seepage site.

The technology and expertise TGS has gathered to acquire this unique dataset is extensive. An operating division of the UK's leading hydrographic survey contractor, which specializes in seabed mapping services, has been entrusted with acquiring the multibeam sonar data. It is the responsibility of a world leader in offshore surface geochemical exploration and heat flow programs to undertake the coring program. A geophysical company with industry-leading expertise in using high-resolution multibeam sonar and backscatter data to define possible cold-water hydrocarbon seep sites is providing quality control services for both the multibeam sonar and coring programs.

The largest and most powerful sonar arrays in the world have been fitted to two vessels in order to enable deepwater collection of high-resolution multibeam and backscatter data. These new technologies enable MIGAS and TGS to gather far superior data than was otherwise possible. The sonar vessels have detected seepage points on the ocean floor at depths of 1.5 miles (2.5 km) while traveling at a speed of nine knots. They have located mud volcanoes, pinnacles and blowouts on the ocean floor in very deep water — all of these geological features are signs of potential hydrocarbon seepage. The sonar arrays can even identify seeps by identifying invertebrate life like deep-sea mussels, which live off the bacteria present in hydrocarbon seeps and geothermic vents. These results were unthinkable nine years ago.

Analyzing core geochemistry

The coring program that this new technology enables started in April. Using USBL navigational techniques, the service contractor is able to navigate the piston core probe (the device used to take soil samples) to within 1% accuracy (as a percentage of the water depth). The piston core's location is constantly monitored throughout the process.

Recent developments in the analysis of core sampling technology mean that it is possible to detect seeps in the recent geological history of the core area and not just seeps that are currently active. Approximately three geochemical analyses will be conducted on each of the 1,200 core samples taken. The coring data this geochemical analysis provides gives TGS vital information on hydrocarbon charge and likely migration fairways

The data create a beautifully clear image of the sea floor and help determine active geological processes. These tools are proving particularly powerful where tectonic processes are currently active, such as eastern Indonesia. The combination of multibeam and 2-D seismic data provides a virtual 3-D image to help unravel the geological history of these very complicated areas, allowing a frontier basin to be fast-tracked from an area of limited activity to a hydrocarbon exploration hot spot (Figure 2).

As expected, the IFB program is generating a huge amount of new data and fresh ideas about Indonesia's geology. Early indications are that the complete dataset will challenge previously held concepts of the hydrocarbon potential of Indonesia's frontier basins, which will prove valuable to explorers and the people of Indonesia for years to come.

Further information on the Indonesian Frontier Basins project can be found at *www.tgsnopec.com/newsroom.* E&P