Imaging tool improves debris removal operations

Advances in subsea imaging expedite cleanup through enhanced visualization.

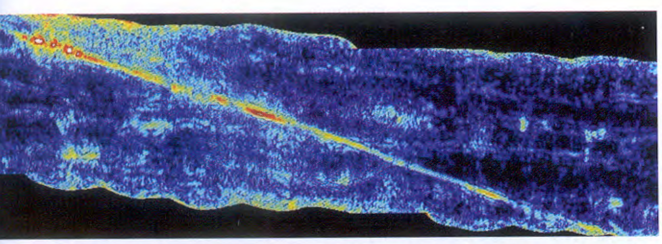
Andrew Safer, Contributing Editor

Decommissioning operations have to be carried out in accordance with strict guidelines. Because these projects can be costly, expediting the cleanup process is the operator's goal. The challenge is to perform the work rapidly without compromising safety or the quality of the work.

On a decommissioning project in the North Sea in May 2011, operator ConocoPhillips needed to remove old debris from a 250-m by 250-m (820-ft by 820-ft) area in preparation for the installation of a new platform. The site, which had been in use for 30 years, lies 322 km (200 miles) southwest of Stavanger near the border between the Norwegian and UK sectors of Ekofisk, the oldest field in the North Sea.

PanGeo Subsea was contracted to carry out a post-debris clearance survey with the Sub-Bottom Imager (SBI), an acoustic survey tool that uses an array of five hydrophones with 40 channels, to create a 5-m (16.4-ft) deep by 5-m wide 3-D volumetric image of the sub-seabed.

The tool measures the acoustic return of a buried target and can detect differences in acoustic impedance of varying sedimentary layers. When the impedance of an area is significantly different from its surroundings, the system detects a transition indicating the presence of an object or layer. Although the SBI does not differentiate between compact sands, a boulder, or an object, PanGeo staff apply additional geological, geometrical, and survey information to interpret the SBI data. "Since there are not many geotechnical linear features," explained Alex Fleming, PanGeo vice president Global Operations, "the linear features stand out quite well."



The SBI was able to clearly image a buried 30-in. concrete clad pipe. (Images courtesy of PanGeo)

On the North Sea project, the object was to ensure the sub-seabed was cleared of all manmade objects to a depth of 2 m (6.6 ft). This project marked the introduction of the SBI for pipeline decommissioning.

Operations

The debris removal operation included a 200-m (656-ft) section of 30-in. concrete clad pipe and a 200-m section of 4.5-in. bundled pipe (10 in. in total width).

Team members worked 12-hour shifts from a pipelay vessel to carry out the operation. Existing maps were used to locate the 30-in. pipe, but in assessing the area, it was discovered that the coordinates of the 4.5-in. bundled pipe were inaccurate. Assumedly this positional inaccuracy was due to the historical database not being updated as performance and repeatability of surface and subsurface positioning systems continually developed over the years since the pipe was laid.

PanGeo deployed the SBI, mounted on a workclass ROV, at a depth of 80 m (262 ft).

Initial attempts by the PanGeo team to locate the 4.5-in. bundled pipe following the as-given route failed. On reviewing the data, however, the team discovered that the SBI had imaged a section of the pipe that crossed the original survey line. Using a proprietary mosaic, the full survey gridlines had been set 4 m (13 ft) apart, which provided 100% coverage.

"We found the entire length of 4.5-in. bundled pipe in the next pass," said Jody Pynn, PanGeo senior systems engineer. He attributes this to the SBI's ability to image a 3-D volume of a given area. The pipe was found at distances up to 12 m (39 ft) from the as-given coordinates at burial depths as great as 4.5 m (~15 ft), a 3.5-m (~11.5-ft) discrepancy from the map, which indicated a burial depth of 1.5 m (~3.5 ft).

"We were getting immediate feedback from the excavation crew that they found what we said was going to be there," said Gary Dinn, PanGeo vice president of technology development. "That was proof of the success.

This was well beyond the ability to image pipelines using any other technology." A magnetometer, for example, would not have been able to locate the pipeline because the maximum depth at which it can detect an object typically is 2 m.

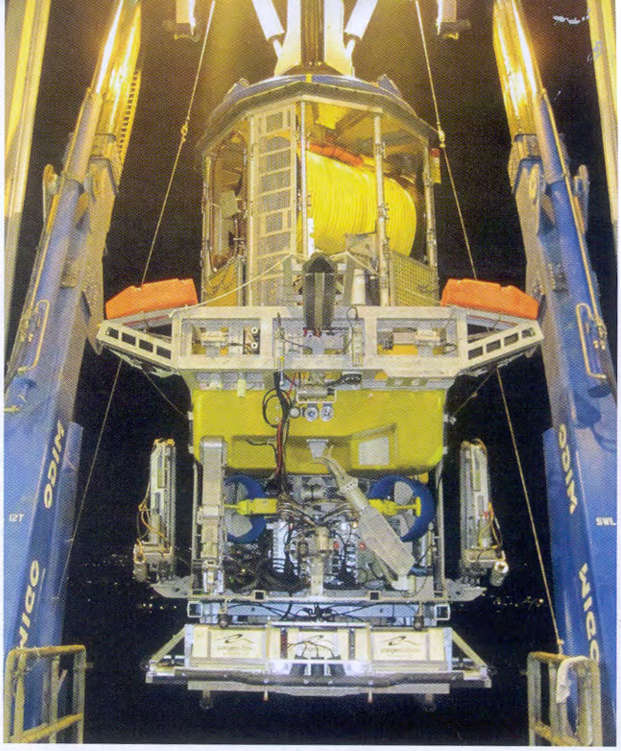
How it works

The SBI flies 3.5 m from the seabed, imaging an 8-m (26-ft) wide swath that is coarse-rendered to a 5-m by 5-m image made up of voxels sized at 15 by 15 by 10 cm that are constantly being updated with live data. Once a given section is surveyed, the data are rendered using smaller 5 by 5 by 5 cm voxels, a process that enables the detection of smaller objects. With the fine rendering, the SBI was able to locate an item that was not on any of the drawings: a 7.5-cm electrical cable with a smaller steel cable attached at a depth of 1.5 m.

In addition to removing the two lengths of buried pipelines, the operator had requested that an attempt be made to confirm the location of a life-of-field seismic array with 19- and 35-mm diameter cables linked together with hydrophones that they knew was buried beneath the seafloor.

"It was highly unlikely that we could see the cables (with the SBI)," Fleming said, "but the hydrophones were of sufficient size. We knew where it was laid, so when we flew over a small test section, we didn't see it in real time, but we saw the hydrophones in post-processing (when the image was rendered to 5 by 5 by 5 cm). The client was extremely happy with the operation."

PanGeo anticipates the SBI technology will prove its merit further in varied applications in the future, having shown its worth in its inaugural deployment in the North Sea. E&P



The SBI was launched from a pipelay vessel to carry out imaging of a buried pipeline in the North Sea.

Combining technologies delivers value

The Sub-Bottom Imager (SBI) combines three technologies – non-linear acoustics, near-field coherent array processing (multichannel arrays), and synthetic aperture sonar – to image the sub-seabed in 3-D. The tool traces its origins to the nonlinear acoustics component of the SBI that Dr. Jacques Guigné developed in Paradise, Newfoundland, in the early 1990s.

The dynamically responding ultrasonic matrix systems (DRUMS) technology Guigné developed was first put to use in an underwater probe that the Department of Fisheries and Oceans used to determine the effects of trawling on fish habitats on the seafloor of the Grand Banks offshore Newfoundland. A further application of the technology was to detect mines and unexploded ordnances in the seabed.

Guigné International Limited (GIL) merged with the offshore oil and gas consulting firm PanMaritime Energy in 2006. PanGeo Subsea was founded to exploit GIL's acoustics technology. This effort resulted in the development of the SBI. In the first demonstration project in 2009, the SBI imaged through a rock dump covering a pipeline in the North Sea. The images showed the point where two buried pipelines intersected, and the SBI also recorded exact distances. In 2010, the system imaged a 13-cm buried cable between Norway and The Netherlands in conjunction with a NorNed cable survey. After the repair work was completed, it verified the depth of burial at approximately 1 m (3 ft). "This was the first time anybody has imaged something like that in the seabed with that degree of resolution," said Gary Dinn, vice president, technology development, at PanGeo. "And it worked successfully both with the cable energized and not energized."

The SBI's ability to identify boulders and characterize soil types makes it well suited for pre-engineering route surveys for buried pipelines. Further applications include arctic applications where pipelines will have to be buried to avoid ice scouring. The system also can be used to determine how deep a pipeline has to be buried in ice-prone waters because it can image the disturbance of the soil underneath a visible ice scour.