



AUV Magnetometers a leap forward in seabed surveying

An Autonomous Underwater Vehicle-towed magnetometer proves itself in rough weather. The technique could reduce costs and time to complete seabed surveys, with improved accuracies.

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Use of Autonomous Underwater Vehicle-towed magnetometers could reduce costs and time to complete seabed surveys, with improved accuracies.

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-Doug Hrvoic

When Doug Hrvoic and his team were out on Lake Ontario to test a new AUV-magnetometer combination last September, they got a surprise bonus. An unexpected storm came up, allowing the unit to prove its utility for survey when the weather turns rough.

Hrvoic is president and owner of [Marine Magnetics Corp](#) in Markham, Ontario, a company which specializes in researching, developing and manufacturing marine magnetometers. He's working in partnership with Massachusetts-based AUV manufacturer [OceanServer Technology Inc](#) in an innovative approach to seabed surveys. The idea was to tow a small efficient magnetometer closely behind an AUV—the thinking was it should reduce the need for weather-dependent traditional boat-towed magnetometer arrays. Other devices, for example naval applications and emergency recovery floats, had been successfully deployed behind AUVs but it was first thought that electromagnetic interference would preclude their use as magnetometer tow vehicles.

But it was worth experimenting. “It’s not a thing you’d normally do—you usually would get a lot of magnetic interference,” says Hrvoic. As well, Marine Magnetics’s [Explorer](#) magnetometer had been designed for towing behind a boat, so some adjustments first had to be made such as modifying the housing. “We customized the magnetometer to make it neutrally buoyant and other things that you don’t do for a normal marine survey,” he says. “Normally it’s designed to be heavy so it sinks. Also we added some balancing weights so we could adjust trim to make it an easy load behind the AUV.” OceanServer’s [Iver2 AUV](#) model was chosen for its design. “The Iver2 was designed to enable the integration of various sensors by a third party, and without direct involvement of the Iver developers,” says Bob Anderson, president of OceanServer Technology. “From a hardware standpoint, one approach has been to tow a sensor in the water column behind the AUV, and to connect a tow cable/electrical interface cable to a rugged, waterproof connector on the back of the Iver antenna mast.” That connector provides power and a serial communications port to the vehicle CPU he says. “Once the standard Explorer magnetometer was connected, it was a minor effort to provide the limited control interface and to log the data from the magnetometer.”

With the hydrodynamics and connectivity challenges taken care of, the crucial question of electromagnetic interference came next: the towing distance was just five metres aft of the AUV. So the next step would be to collect data under real conditions. “I had a really good data set that we could use to truth and check the quality of the data from behind the AUV,” says Hrvoic. “And also the magnitude of the error that the AUV might be creating, if any.” Hrvoic’s data set was from the bed of Lake Ontario, which was an ideal testing ground because of its extensive non-magnetic sediment cover, making for magnetic gradients on a smooth geological background. Man-made objects show very clearly against it. Thus any error in the magnetometer data should show up precisely.

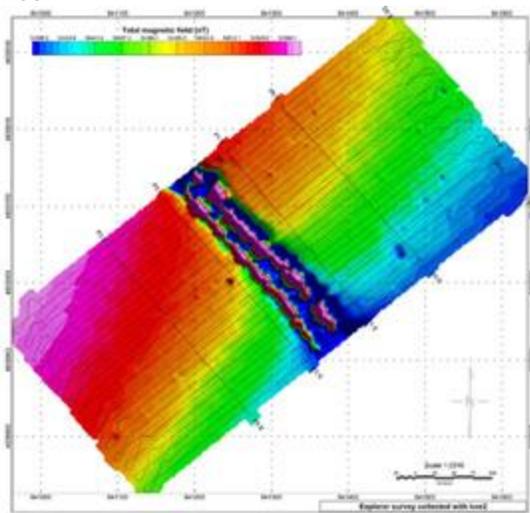
The schedule for serious testing had been arranged in advance but the late summer storm was unexpected. “I had [the AUV] shipped here for the weekend and we all had to converge at one spot,” recalls Hrvoic. “Friday afternoon I was watching the weather and could see it could turn bad.” So they decided to get a head start on the testing. It was 7 o’clock in the evening and winds were picking up but still only around 20 km/ph. The rain had started but conditions didn’t appear too bad so they went out to their survey block near the Scarborough Bluffs marina. Soon it turned rougher. Waves were coming off the shore in all directions but they persevered and launched the AUV. Communicating with it from the bridge of their 28-foot survey vessel, they sent it off on its first mission in darkness. Its survey pattern was pre-programmed so the team returned to the dock while the AUV combination did its work three metres below the surface, including data sensing from its Klein side scan sonar which would be used to supplement the mag data.

“The survey block would take five or six hours, broken up into one-hour sections,” says Hrvoic. “We didn’t want it to go too far without checking on it so we came back after an hour and it was where it was supposed to be.” By then the weather service had issued a strong wind warning, waves were hitting two metres in heavy rain, and thunderstorms had moved in, “so it was getting to the point

where I didn't feel comfortable being out any more." They retrieved the AUV and magnetometer at a pre-programmed pickup point, which they found easy despite the storm. "I thought it would be hard to get close and we would be banging around," recalls Hrvoic. "But literally to get this thing out of the water the engineer just reached down with one hand and hauled it out—completely painlessly. That was a worry working in rough weather."

Pre-programming was a definite plus, and Hrvoic says an added advantage of the Iver2 is its Iridium satellite system option, which they didn't have for the test. "The satellite system allows you to send and receive messages from the AUV," he says. "If we had that we could get feedback in from onshore letting us know everything is fine and then we could send a message to it to proceed."

After processing the magnetometer data with [Oasis montaj](#), the team was impressed. "The images are pretty phenomenal," says Hrvoic. "Extremely sharp." A number of targets they located were truthed with the OceanServer [Mosaic](#) side scan data as well as their existing set. He says because the survey area was close to a marina, there was a lot of junk around—some of it natural and some man-made—but "the mag picture clearly identified things that were man-made and those that were not."



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Iver2-collected Explorer magnetometer dataset, showing two large steel water intake pipes over a smooth regional gradient background. The survey track is shown as a solid black line. The uniformity of the regional gradient illustrates the high accuracy of the data, showing no signs of heading shifts or motion induced error. Several small magnetic targets are clearly visible and can be correlated with the simultaneously collected side scan sonar data. For example, the anomaly at around 641475E 4839125N is visible in the side scan record as a small partially buried anchor.

Hrvoic likes the accuracy and maneuverability of the Iver2 platform. "We collected 10-metre survey lines," he says. "It travelled at 2.5 knots, and spent so little time in turnaround. It is more efficient than a boat that is going maybe twice its speed. The survey lines it collected and the altitude it maintained were perfect. When you tow survey lines with a boat you are going left and right and kind

of snaking along. This thing collected perfect survey lines under pretty bad conditions—where I would never survey with a boat.”

And the convenience is unsurpassed when compared with boat tow. “All we did was check every hour and then push the button to send it on its next mission,” he says. “And downloaded the data every hour.” That can be relaxed too: the Iver2’s endurance is eight hours and it can store a whole eight hours of data. “You could set it up in the morning and retrieve it in the evening. Or the opposite. Come back when you wake up in the morning.”

A major selling point he figures is that the AUV data set is far better quality than they had recorded in the area with the earlier boat tow. “It blew away my expectations,” he says. “I thought there would be a bit more error with the AUV but it was just the opposite.”

Hrvoic sees no reason why AUV-towed couldn’t eventually dominate over traditional boat towed systems. “In the end it’s cheaper and you don’t have to worry about weather, a major consideration with a boat towed survey,” he says. “And the quality of the data is really a leap forward over any kind of boat towed method. There’s no human being that can drive a boat the way an AUV can drive itself.” Which, although the resolution is the same, vastly reduces errors caused by erratic positioning and noise levels. And that in turn reduces data processing times. “Because there was so little error it didn’t take that much to do the processing,” he says. “We had to do the regular steps like lag correction and diurnal as with any mag survey. It’s the method-caused error that’s being reduced.”

Anderson agrees survey accuracy is a major factor in using the AUV, along with reduced costs. “An AUV system, which includes a mission planning GUI such as the OceanServer [VectorMap](#) software program, can predictably follow a defined sub-sea course that covers the area of interest at the optimum track spacing, height from bottom and speed over the bottom,” he says. “Once launched, the operator is free to review previously collected data or to plan future missions. Towing a device with a boat requires more on-site equipment, two skilled operators, and constant attention to safely maintaining the proper positioning of the towfish.”

The combination will be especially useful in marine UXO detection, figures Hrvoic. “It is all boat towed surveys right now and you need very high resolution, which is more difficult with boat survey because you need tighter survey lines and to be more precise when driving.” In UXO surveys for the extensive wind farms in the North Sea for example, operations are continually curtailed due to rough and windy conditions—as these areas are typically chosen for their high wind exposure. He also sees AUVs as useful for anyone doing surveys in shallow waters, i.e. 100 metres or less; often archaeological surveys are in this range.

Hrvoic says R & D on the system is now complete. “This is a product now,” he says. Together with OceanServer Technology, “we are promoting it as a leap forward in surveying.”