Norton - A Configurable Tripod For the Study of Near-Bottom Ocean Processes

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A cost effective and highly configurable scientific platform, dubbed *Norton*, has been developed for the scientific study of near-bottom ocean processes. The platform is a collapsible lightweight aluminum tripod that can be transported in the back of a pick-up truck, and is easily accommodated on most vessels. The desired sensors are attached to the tripod legs and cross bracing.

Introduction

While its origins are obscure, there seemed to be a trend in naming bottom tripod/frames after characters from the old Honeymooners TV series. The New Zealand National Institute of Water & Atmospheric Research called theirs *Alice* (the lead female character), and the Geological Survey of Canada on the east coast named theirs *Ralph* [1] (the lead male). The *Ralph* platform is quite big and burly, much like the actor Jackie Gleason who played that role.

ASL's version, built for a Geological Survey of Canada study of the Fraser River delta, is more lightweight and portable, and we named it *Norton* after *Ralph's* scrawny and somewhat idiosyncratic sidekick. Characteristically, *Norton's* aluminum legs buckled slightly during the latest recovery, after encountering a much larger mass (the recovery vessel).

Norton

The *Norton* platform is an aluminum tripod with a base dimension of about 3 m and an overall height of 2.2 m. Aluminum was chosen for its light weight and resistance to corrosion. Large ship anodes are added to the foot pads for stability as well as corrosion protection. A mid-section brace adds strength as well as a means of attaching instruments. The legs are hinged at the apex and with the mid-section removed they collapse, making the platform easily transportable.

Sensor Suite

Norton is easily configurable with whatever sensors are required. At present the instruments are stand-alone with each having its own power supply and data logger. Time synchronization is used to later merge the data streams. This approach allows a highly configurable suite of various sensors that can be optimized for a particular application, and it also ensures simple field assembly and operation.

Instruments that have been used on *Norton* to date include:

- Coastal Leasing MiniSpec current/wave gauge. This instrument is equipped with a Marsh McBirney flow sensor for measuring near-bottom currents, and a Paroscientific pressure sensor. In burst mode directional wave measurements are obtained using the PUV method.
- Imagenex 881A Scanning Sonar. The multi-frequency (175-1000 kHz) scanning sonar head was integrated to a custom-built data logger/power supply. A large alkaline battery pack and up to 1 GB of data storage, allow the instrument to be deployed for 8-10 months using an hourly scan rate.
- OBS Sensors. Norton is usually outfitted with two D&A Optical Back Scatter (OBS) sensors, at different heights above bottom. Sediment samples are usually collected from the site to allow post-survey conversion of the OBS sensors output to suspended sediment concentration units.
- Acoustic Doppler Profiler. Doppler current profilers can be added to provide current profile data, as well as (directional) wave data.

Deployment / Recovery

Norton has been deployed twice off the Fraser River delta, once in 10 m water depth, and most recently on Roberts Bank, that dries at low tide. On both occasions, the Canadian Coast Guard Hovercraft *Siyay* was used for deployment and recovery (Fig. 1). At the 10 m depth site, the tripod was deployed with a ground-line and an acoustic release-activated pop-up buoy at the end of the ground-line. Often during such deployments there is some doubt as to whether the bottom frame is upright. ASL has developed a tilt-pinger that increases the ping rate from 1 to 2 Hertz if the tilt exceeds about 25°, providing assurance that the tripod was deployed upright.

Roberts Bank Sediment Dynamics

The Fraser River enters the ocean at Vancouver. Dredging and other river management projects have deprived some areas of the delta front of much of the sediment formerly received during the peak spring discharge. Previous multibeam surveys show outcropping beds aligned roughly north-south in the 5-15 m depth range, indicative of net erosion [2].

The currents are tidally dominated with flood tides (northerly) stronger than ebb, up to 1 m s^{-1} versus 0.4 m

Article published in Sea Technology Magazine, September 2004, Vol.45, No.9

s^{-1} respectively. The peak tidal flows re-suspended bottom sediment on both the flood and ebb. Wave orbital velocities, particularly during northwesterly storm winds, also re-suspend bottom sediment.

Winter 2002 Deployment

Norton was deployed in 10 m water depth off the edge of Roberts Bank.

Several storm events were recorded with significant wave heights up to 1 m, and 5 second peak periods. The scanning sonar (set to 30 m range and default 27 dB gain and 675 kHz frequency settings) showed high suspended sediment concentrations just trailing the storms and the emergence of long wavelength (c. 10 m), low-relief, irregular patches [2].

Winter 2003 Deployment

The 2003 deployment of *Norton* was at a location on Roberts Bank where bedforms were expected to consist of small ripple features about 2 cm high with a 5-10 cm wavelength. The Imagenex scanning sonar frequency and gain settings were optimized for this deployment using tank tests (Fig. 2). The final settings chosen were: 1 MHz frequency, 5 m range, and 18 dB gain.

A 1200 kHz RD Instruments WH ADCP™ with Waves firmware was also deployed in 9 m water depth just offshore of the edge of the Bank. The ADCP was to measure the 'offshore' waves so that we could determine the wave attenuation over the Bank. During the deployment, winds were blowing from the northwest and waves about 1 m high could clearly be seen breaking on the edge of the bank, reducing in height as they moved onto the Bank.

At the time of deployment the bedforms consisted of sand ripples about 1-2 cm high, and about 5-10 cm wavelength, similar to the ones fabricated in the test tank. However, the ripples were not continuous, nor linear, and far more complicated than the ones created for the tank test.

The first images from the scanning sonar show ripple-like features, particularly in the northwest quadrant with wavelengths of the same magnitude as seen visually. The ripple features were oriented northeast-southwest, as visually observed during deployment.

Ripple-like features were occasionally evident on sonar images at other times, but their characteristics (wavelength, orientation, etc) did not vary significantly from those observed initially. Several 'storms' occurred during the deployment, but significant wave heights in the deepwater increased to only about 1 m, and the sonar images following the storms were not noticeably different than before.

High suspended sediment concentrations occurred at diurnal time scales, centred on the lower low tides. 'Dropouts' in the middle of the peaks occurred when the sensor was in air at low tide. Waves from the west added to the high OBS readings on the 21^{st}.

These OBS diurnal peaks occurred only during the lowest low tides, the lower low tides that occurred when the diurnal inequality was most pronounced. Lower low tides are accompanied by strong ebb and flood currents, up to 50 cm s^{-1} ebb and 125 cm s^{-1} flood, as recorded by the ADCP.

Data from the *Norton* sensors help explain the processes causing these high suspended sediment values (Fig. 3). Starting at high tide, suspended sediment values are low and currents weak (near slack). As the tide ebbs and the water level drops, the current speed increases to 40-50 cm s^{-1}, and suspended sediment levels increase. As low tide nears, the water level falls below the level of the sensors which are then exposed to the air for up to 7 hours. During this period of low tide, we expect that suspended sediment levels are low, due to the 'slack' current. As the tide turns, the flood waters submerge the sensors. The flood tide is already running fairly quickly, and OBS levels are high. As slack high tide is approached, the current weakens and OBS levels fall.

Sediment re-suspension occurred when the current speed (as measured by the sensor 80 cm above bottom) reached about 30-40 cm s^{-1}. This is consistent with a 25 cm s^{-1} threshold current for re-suspension of fine sand (0.125 mm), based on the Hjulstrom Curves.

Summary

Norton has proven to be a versatile and effective tool for the study of sediment transport and other near-bottom processes. It is easily configurable to match the specific needs of a particular study. The lightweight and collapsible tripod allows it to be transported in a pickup truck and easily deployed from most vessels.

Future work planned for the Fraser River delta area includes a coastal observatory: VENUS. It too will have the ability to mix and match sensors to the needs and desires of the investigators. Individual nodes will be able to accept input from most oceanographic instruments. Included will be ASL's water column profiler. VENUS data, however, will be available in real-time.

Acknowledgements

- Dr. Phil Hill of the Geological Survey of Canada was the scientific authority for the Fraser River delta work and co-authored the Oceans 2003 paper (R. Birch, P. Hill, M. Clarke, D. Lemon & D. Fissel, 2003. A configurable multi-sensor tripod for the study of near-bottom ocean processes. Oceans 2003 Conference. San Diego September 2003. Geological Survey of Canada Publication No. 2003086).
- Within ASL: David Lemon who co-authored the Oceans 2003 paper; Dave English – fabrication, field work; Matt Tradewell – instrument set-up and field work; Vincent Lee – data processing.
- Gwyn Lintern (U. Victoria Post Doctoral Fellow) - assistance during deployment and recovery.

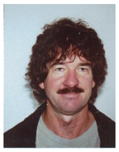
- Captain/crew of the Canadian Coast Guard Hovercraft *Siyay*.

REFERENCES

[1] D. Heffler, 1996. RALPH – A Dynamic Instrument for Sediment Dynamics. Proceedings Oceans'96, 5 p.

[2] P.R. Hill, S. Meule, L. Carle, S.H. Davidson and J.V. Barrie, 2002. Detailed morphology and sediment transport processes in the nearshore of the Fraser River Delta, British Columbia. Proceedings American Geophysical Union 2002 Fall Meeting, San Francisco, California, 6-10 December 2002.

Rick Birch is a physical oceanographer whose interests include coastal zone oceanography, aquaculture site considerations and environmental effects, and sea ice.



Murray Clarke has a degree in electrical engineering. He is responsible for instrument development and design, including ASL's product line of upward-looking sonars.

David Fissel is Vice-President of ASL, having joined as a founding member, and has over 25 years experience in physical oceanography.

Ed Norton, a.k.a. Art Carney, is Ralph's sidekick in the TV series the Honeymooners. His main interests include sewers and bowling.

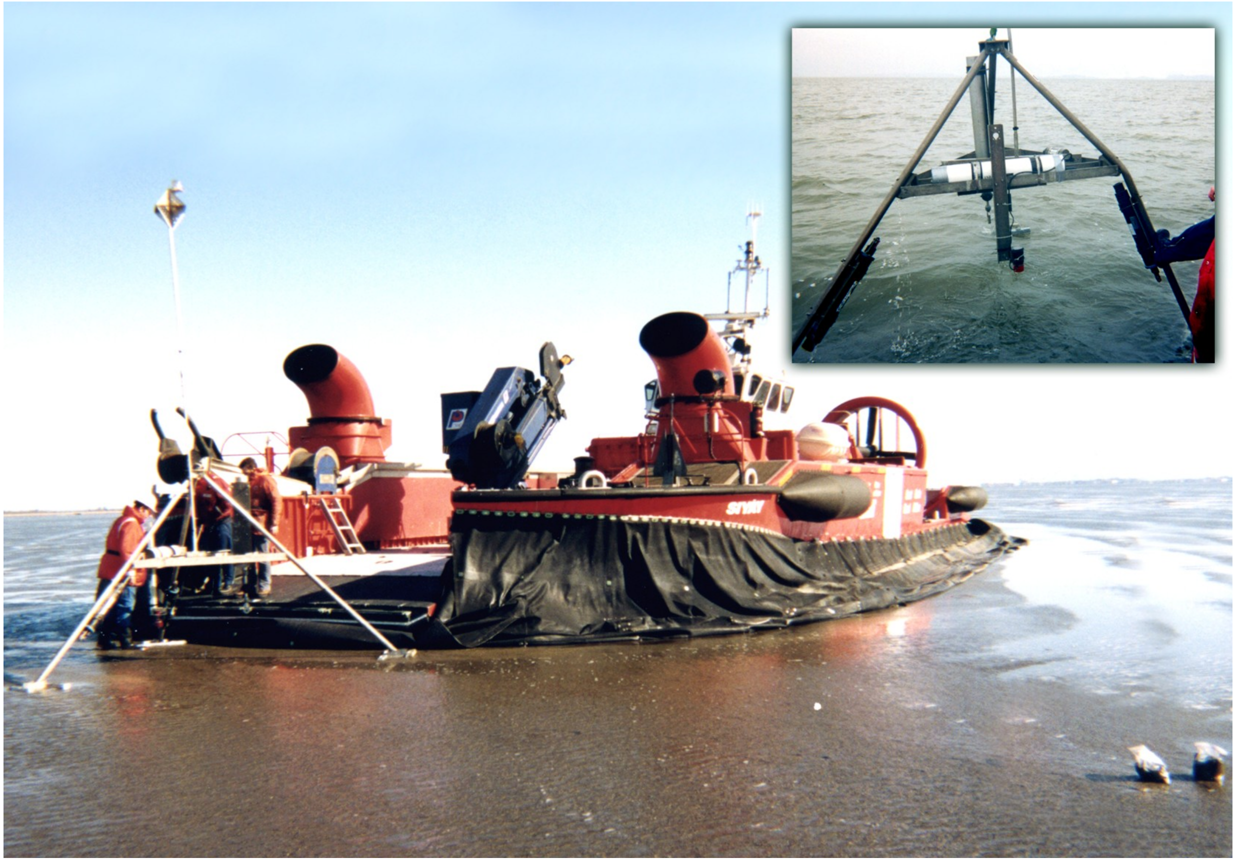


Fig. 1. *Norton* being deployed on Roberts Bank using the Canadian Coast Guard hovercraft *Siyay*. A relatively easy deployment, and we knew that it was deployed right-side-up. Insert shows the tripod being recovered. Two OBS sensors were attached to the legs, while the Imagenex scanning sonar (red head) and the Marsh McBirney flow sensor (black ball) were mounted in the centre of the tripod.

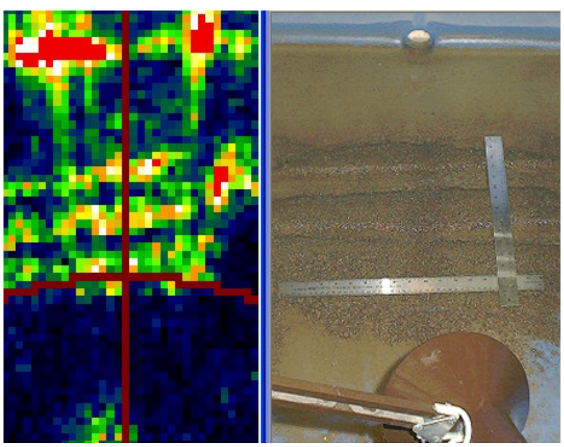


Fig. 2. Imagenex sonar image (left) of a set of three test sand ripples (about 1-2 cm height, and 10 cm length) in a tank.

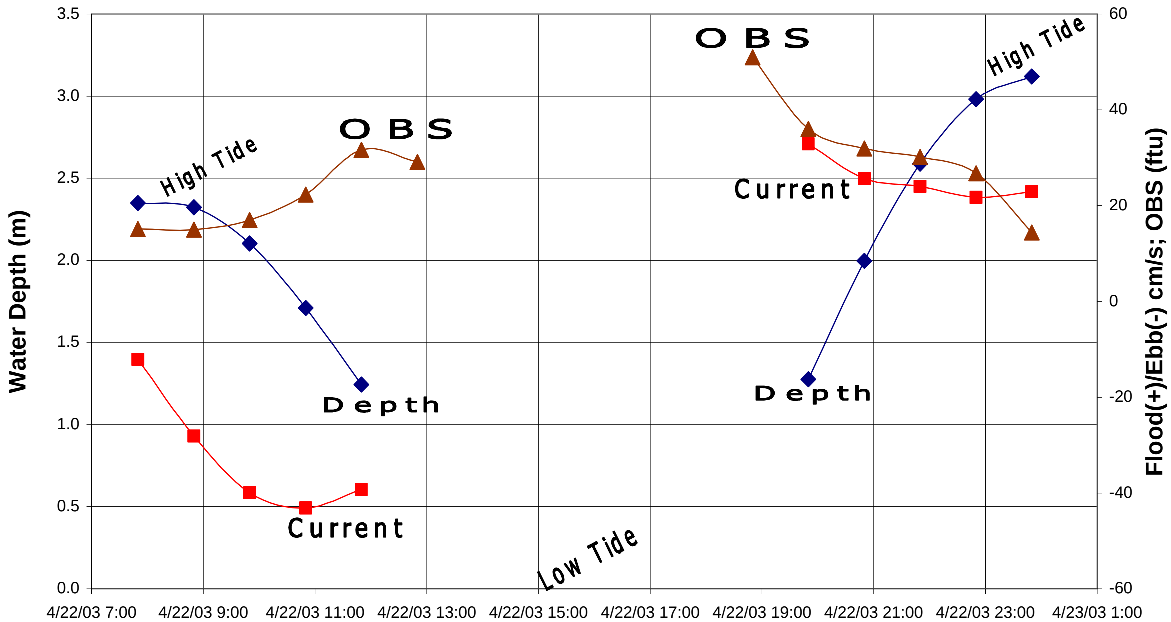


Fig. 3. *Norton* sensor data during the lower low tide of April 22, 2003. The gap is the in-air period when the water level was below the sensors.