

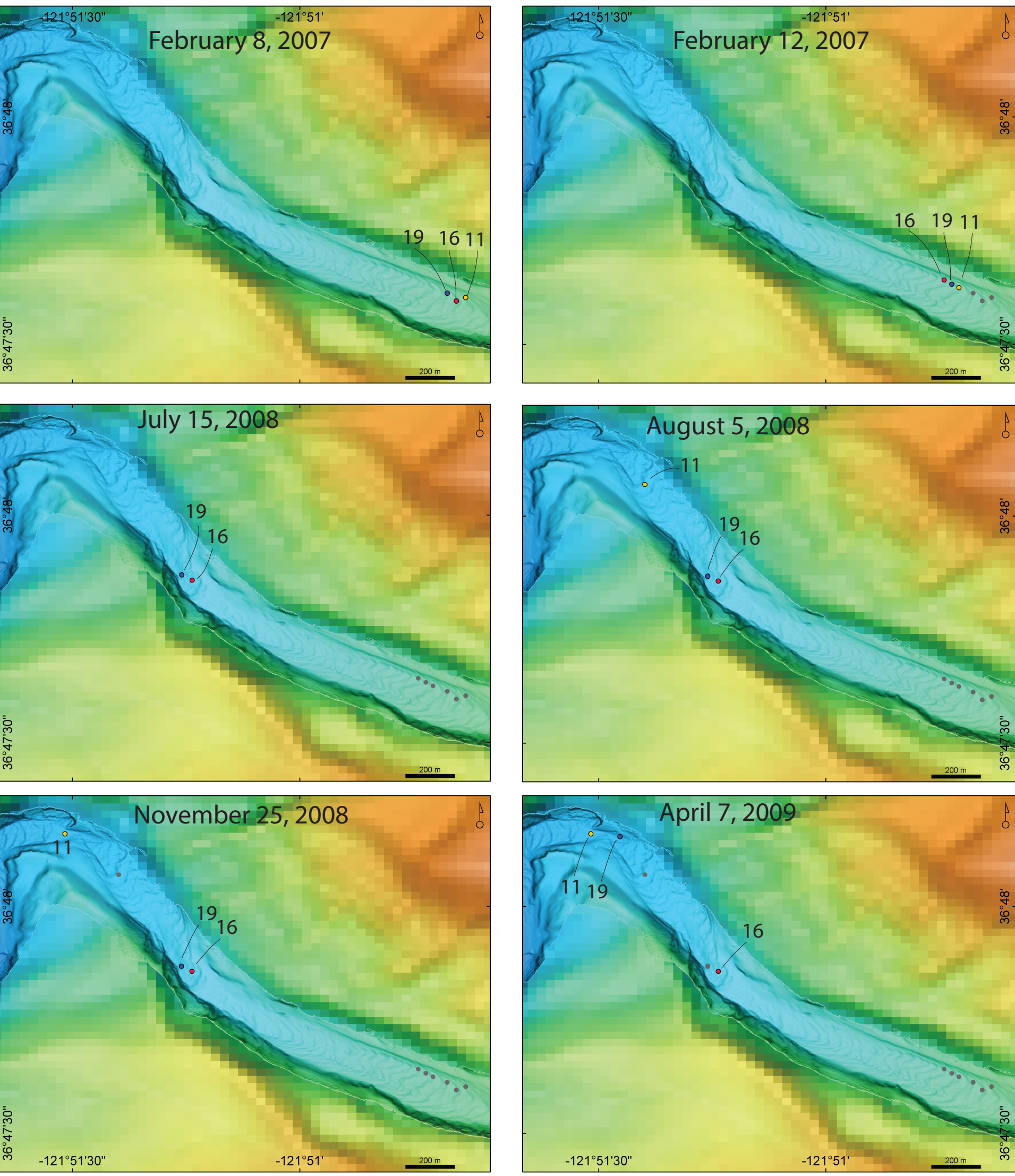


Benthic Event Detectors: a Novel Instrument for Characterizing Sediment Transport Events

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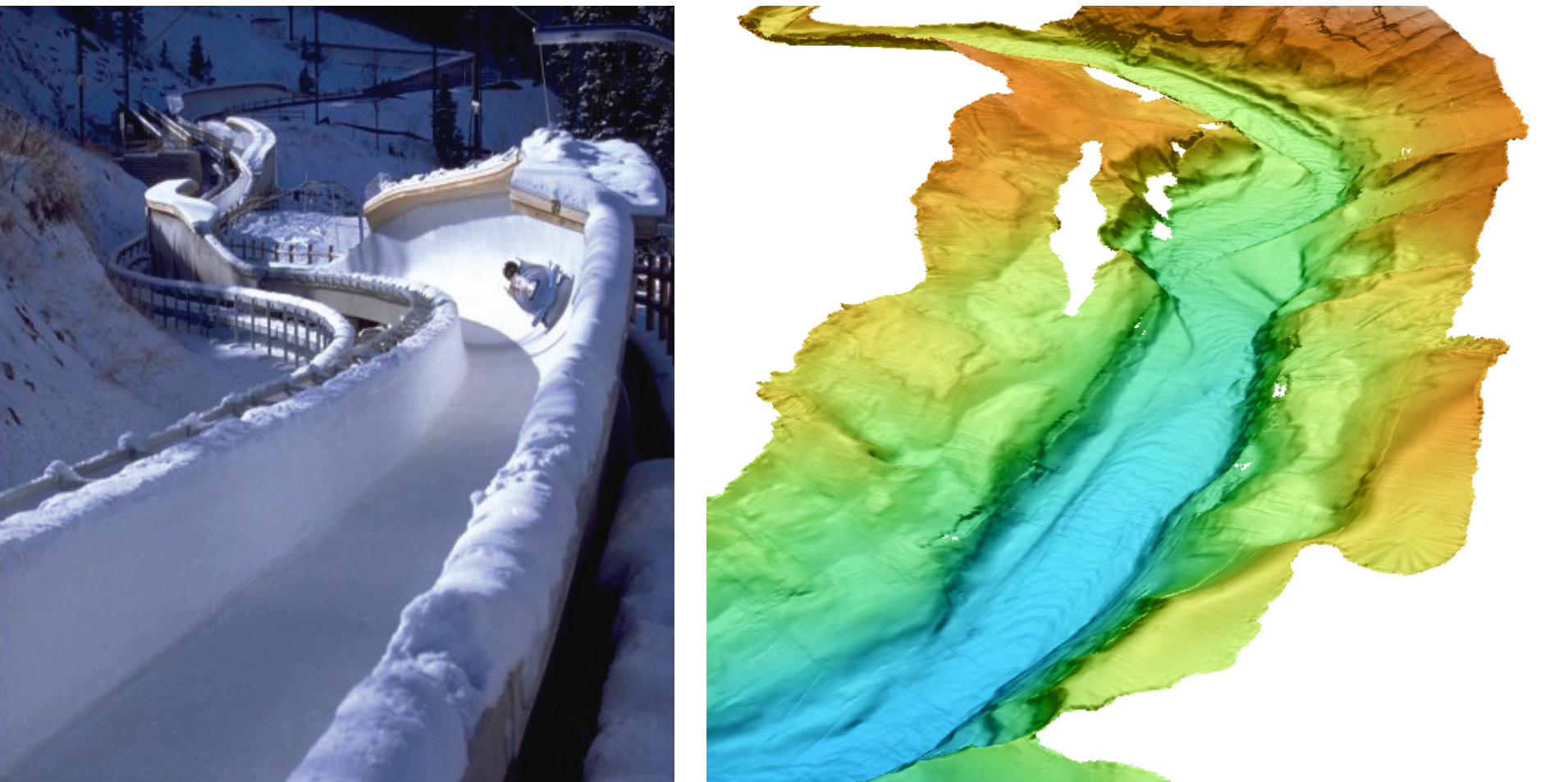
Introduction

The Benthic Event Detector (BED) project is focused on developing instrumentation to help understand the processes by which sediment moves on the floor of submarine canyons. Submarine canyons, such as Monterey Canyon, are conduits through which sediment, eroded from the continents, moves from shallow waters into the deep-sea. These canyons carry a substantial proportion of all the sediment transported onto the ocean floor.



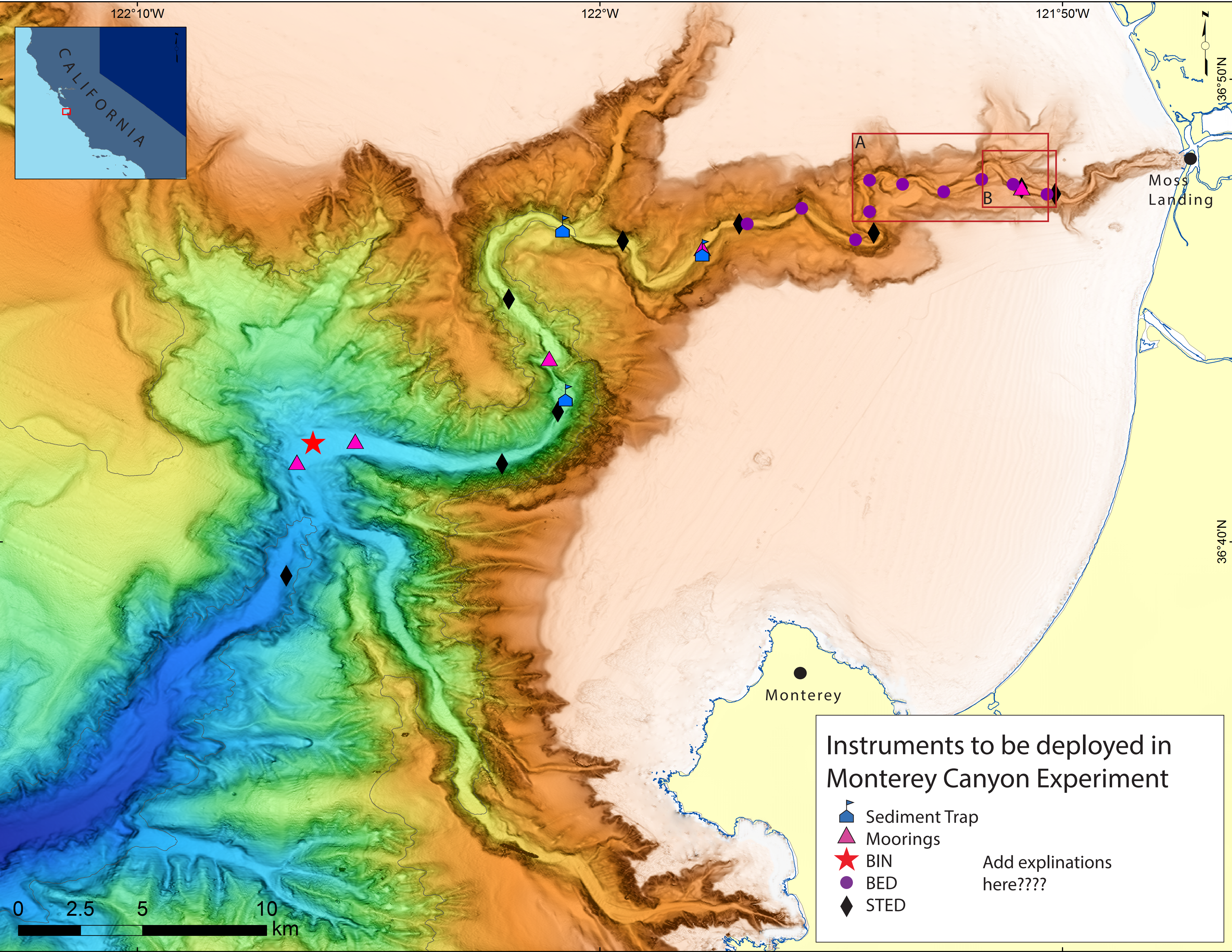
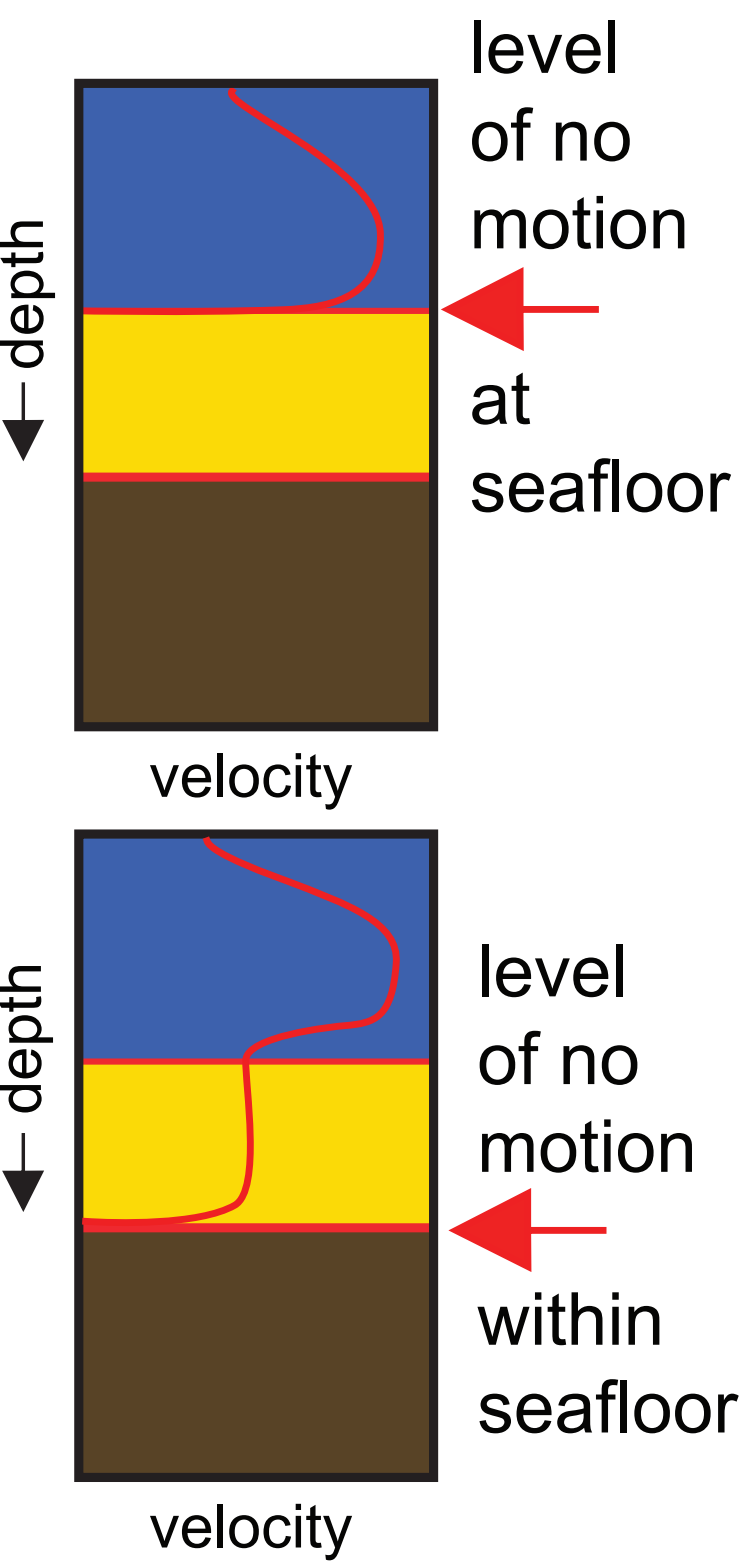
Past studies show episodic events

Over the last 14 years efforts by MBARI and other groups working in Monterey Canyon have shown that sediment transport in the canyon is primarily associated with relatively brief events. A previous study captured the episodic movement of boulder-sized monuments, which resulted in approximately 1 km of down-canyon displacement over a two year time span (see above and for context in main map, inset B). This experiment only illuminated monument position at the time of survey and provide no information about the timing, rate, nature and frequency of that movement.



Capturing the nature of sediment movement

The existing paradigm is that high-energy underwater avalanches of sediment, called turbidity currents, transport boulders over the bottom either in suspension, or as bedload. However, previous measurements of large objects deployed on the floor of Monterey Canyon suggest that large objects may be carried downslope 'within the seafloor' as sections of the seafloor slump downslope. The key question is whether large objects are transported as bedload over the seafloor, or whether they ride down-canyon on fluidized seafloor sediments. These two models imply two different motions: in the former the object will rotate and bounce along the seafloor, whereas in the latter the object will slide down-canyon. To differentiate between these mechanisms a BED will record the motions of an object as it moves down canyon during a flow event. An individual BED will provide detailed data on when an event occurred, how far and fast it moved and the nature of its motion. An array of BEDs deployed simultaneously within the canyon will be used to understand how much of the canyon is effected during an individual flow event.

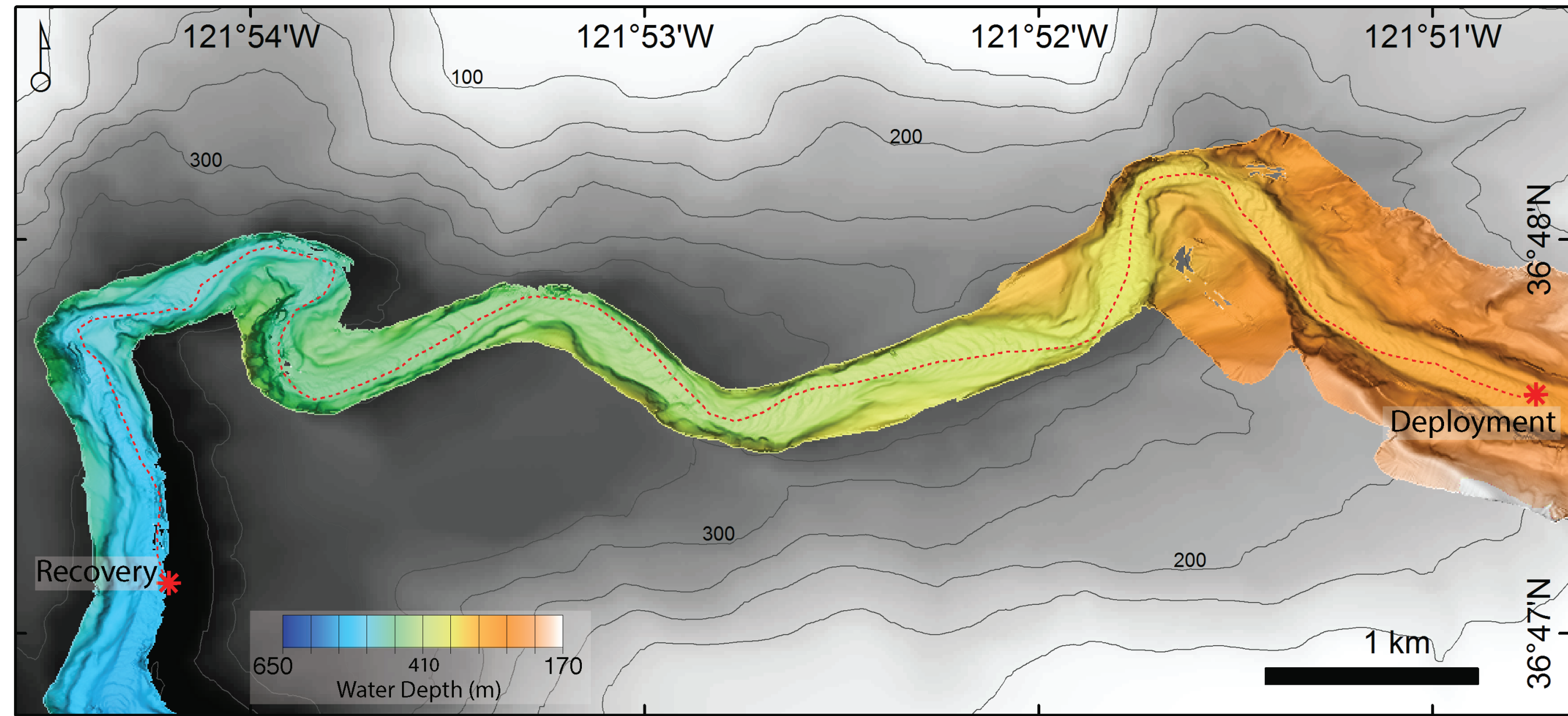


BEDs, part of a Monterey Canyon wide experiment

Monterey Canyon provides a uniquely located and dynamic setting to study canyon processes. ...more Monterey intro/background? BEDs are one component of an experiment being planned in 2014 and 2015 will be part of a large multi-institution project with the goal of directly documenting the passage of a sediment density flow down through the axis of Monterey Canyon. This will be the first time that the study of submarine sediment transport will be scaled from a lab setting to the field. In this experiment direct measurements will be made of the physical properties of the water and the sediment bed during episodic events to document the effects of their passage through the canyon system. The ability of the BEDs to record the start and end times of each event will allow the data to be correlated with other instruments in the canyon and will help provide a complete picture of the processes occurring the length of the canyon.

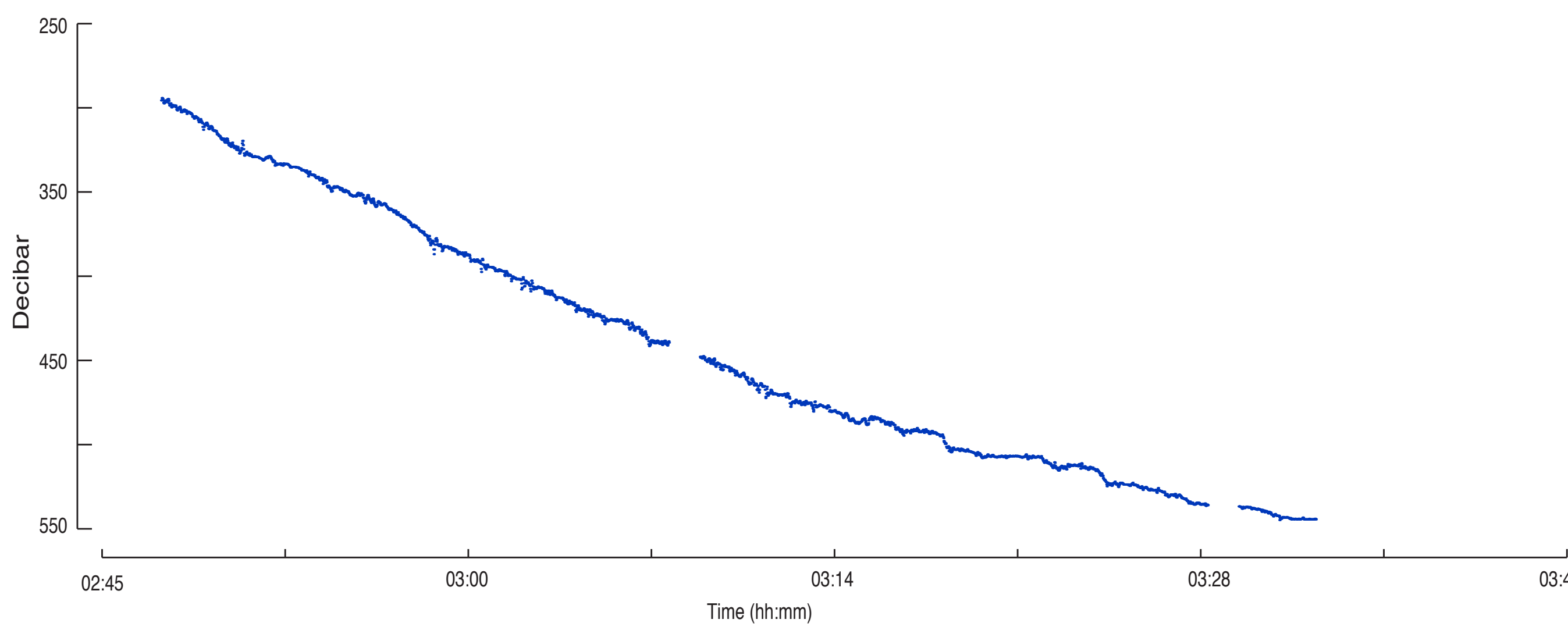
A test run

The first deployments of a BED occurred in the winter and spring of 2013 at 300 m water depth (see photos to the right). The initial tests validated event detection, acoustic communication between a ship and a BED, and also demonstrated that geolocation by acoustic ranging is feasible. The BED had traveled nearly 9 km down the canyon's axial channel (see below and for context in main map, inset A). Event data was downloaded using the modem and showed that the BED was swept down canyon on June 1st in a ~50 minute long sediment transport event.



Initial results

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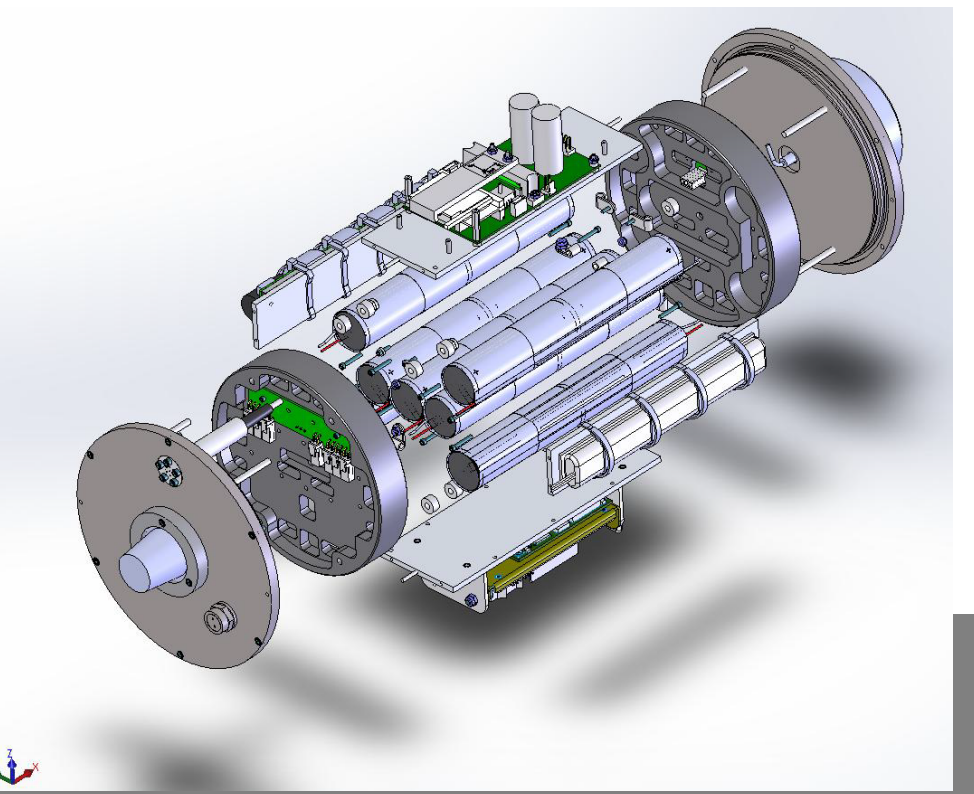


BEDs

BEDs are designed to do little until triggered by an initial acceleration, which inevitably marks the beginning of an event. Once triggered the instrument 'wakes-up' and starts to record any continuing accelerations, changes in orientation, and pressure (depth) at a high frequency until the accelerations stop. From this data the nature of movement of the instrument can be reconstructed.

Software

The BEDs software interfaces the acoustic modem, pressure sensor, a realtime clock, and an off the shelf IMU. It also provides an interface to offload event data over the acoustic link. Reliable data transfer over an often broken and low bandwidth link is essential as is reducing the amount of data transfer overhead since the acoustic modem uses a great deal of energy. Accurate timing is necessary to correlate event start/end times with other instruments or BEDs deployed in other areas of the canyon.



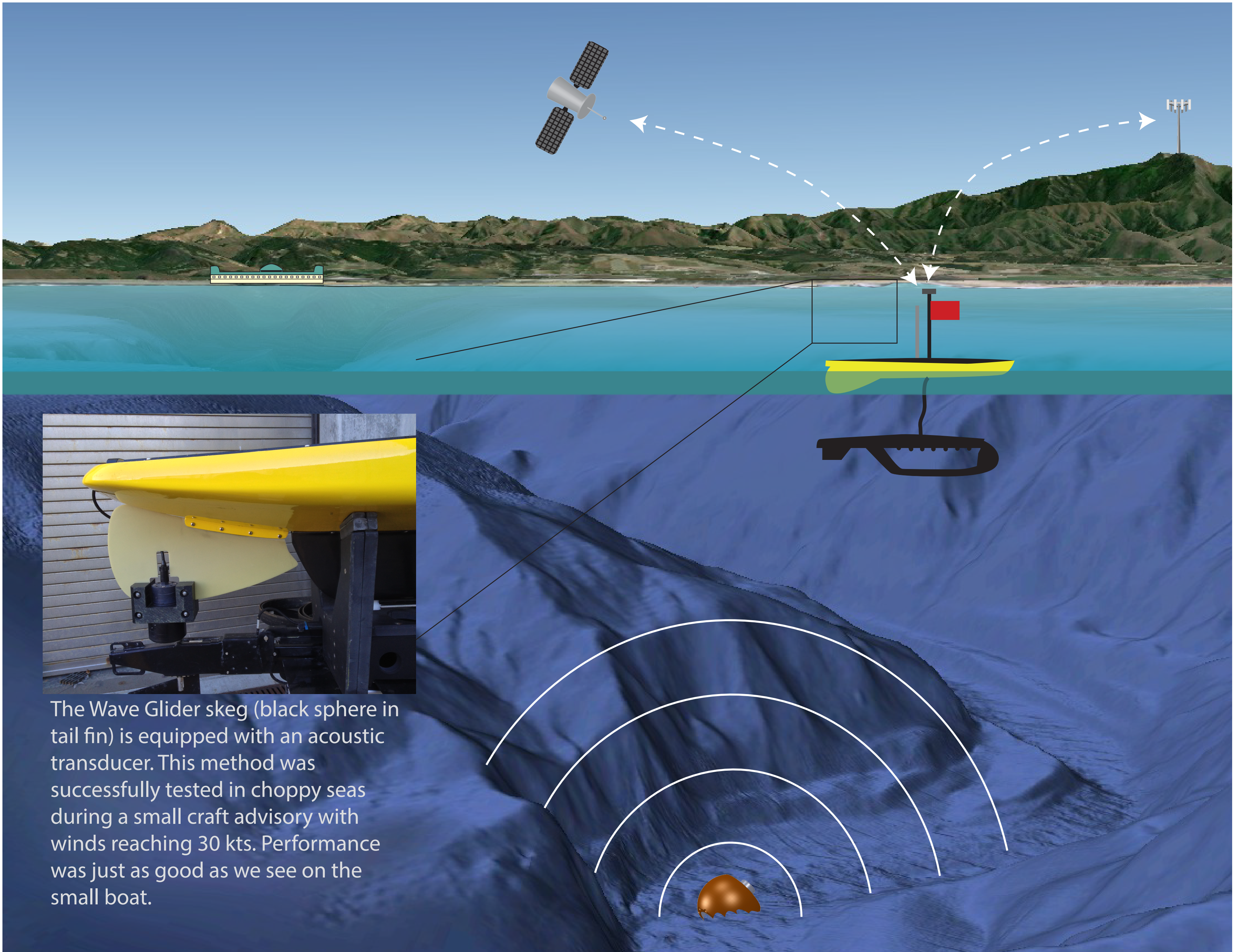
The BED housing is made of carbon fiber with titanium endcaps and is designed to be placed into various host containers such as the syntactic foam sphere seen above to allow scientists to alter the shape, density, and size of the overall instrument package.



Recovering the data

The BED design does not depend on physically recovering the BED instrument, but instead the data recorded by the BED can be transmitted via a modem to a mobile receiver. Currently, the mobile receivers can be deployed from a boat or carried on an ROV. Using a boat to communicate with an array of BEDs over a long period of deployment can be logistically challenging (see above), time consuming and costly. In the future the receivers will be carried by a Wave Glider that is positioned nearby and will be used to monitor BED movement and recover data from the instrument (see below).

The Wave Glider - an x, y z, approach to data recovery



The Wave Glider skog (black sphere in tail fin) is equipped with an acoustic transducer. This method was successfully tested in choppy seas during a small craft advisory with winds reaching 30 kts. Performance was just as good as we see on the small boat.

Future work