**RV SONNE**
**SO294 – CLOCKS**

*Northern Cascadia: Extent of locked zone, prism deformation, slip-to-toe, and the edge of subduction*

13. September – 27. October 2022
Vancouver (Canada) – Port Hueneme (USA)

**6th Weekly Report**
(17. - 23.10.2022)

We had started the recovery of our OBMT and OBS stations on the last weekend and continued with the operations until Monday morning, October 17.

Up until then in our cruise, all of our recovery operations were 100% successful. Bad luck struck at one location of an ocean bottom Magnetotelluric (OBMT) station in shallow water of ~130 m. We encountered problems at station OBMT #13 as the instrument did not surface, despite numerous signals sent acoustically for releasing it from its anchor. One of the confusions was that we received the usual signal back from the transponder, that the instrument has released, yet it never came to the surface. What was going on? We suspected that it was possibly entangled in its own recovery rope or hung up on something else unknown. After 3 hours spent on site, we decided to continue recovery of the remaining instruments and return to this position at daylight again. In the meantime, we submitted a request to the Canadian authorities to use the ship´s own ocean-floor observation system (OFOS, Figure 1), equipped with a camera.

After we received the permit on Tuesday morning from Global Affairs Canada, Department of National Defense, and Fisheries and Oceans Canada, we steamed back to the site of the OBMT and initiated the recovery operation. The OFOS was prepared with some hooks on chains and rope to either drag the instrument or pull it off its stuck position on the seafloor.

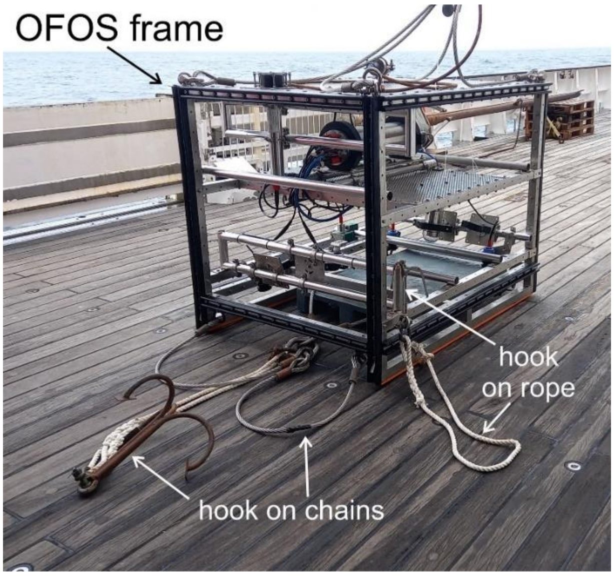



*Figure 1: OFOS ready to go for the recovery mission (Photo: M. Riedel).*

At first, we confirmed the position of the OBMT using acoustic triangulation. Prior to leaving the site of the OBMT #13 two nights ago, we had measured the distance to the instrument from three locations ~ 600 m away and by simple triangulation estimated a position for the tool on the seafloor (Figure 2). This best estimate was the site where we deployed the OFOS to start a grid of lines across the suspected position.

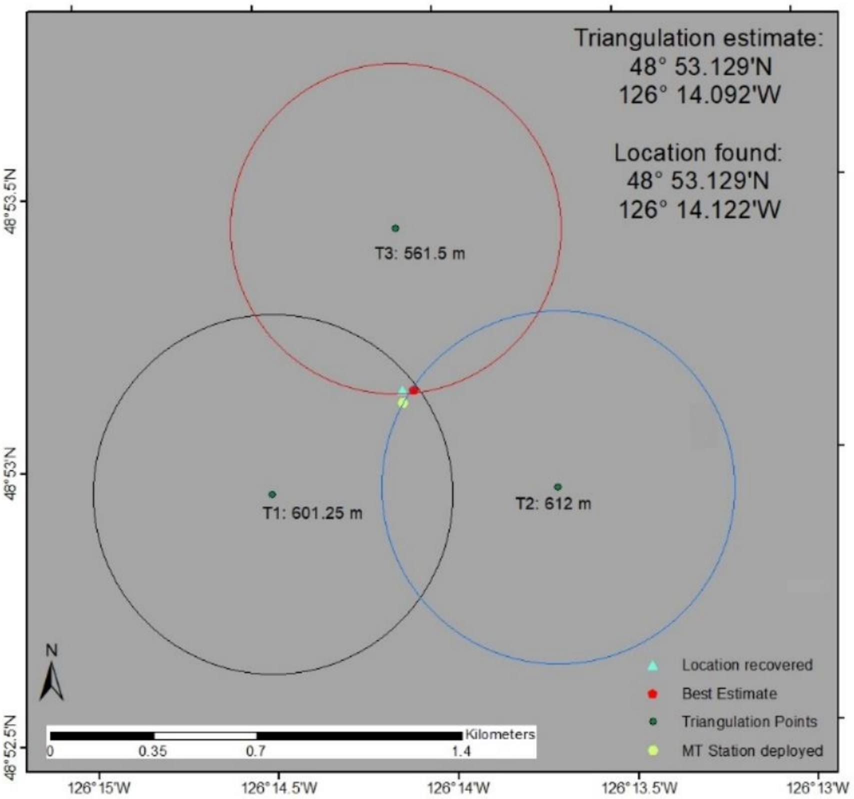
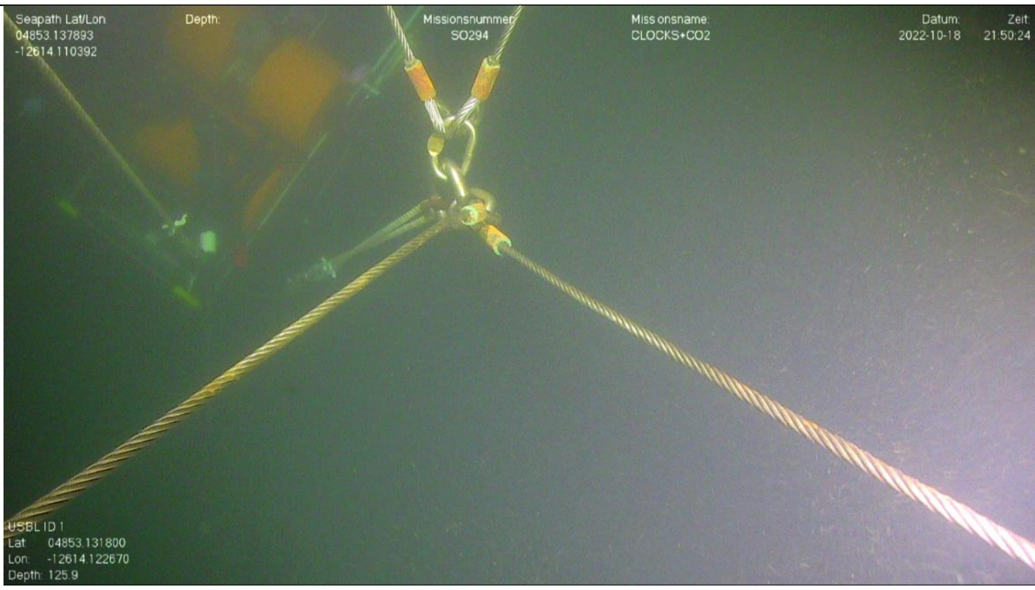



**Figure 2.** Triangulation to estimate the best positions and comparison to the actual found location: a difference of only 38 meters (Image: M. Riedel).

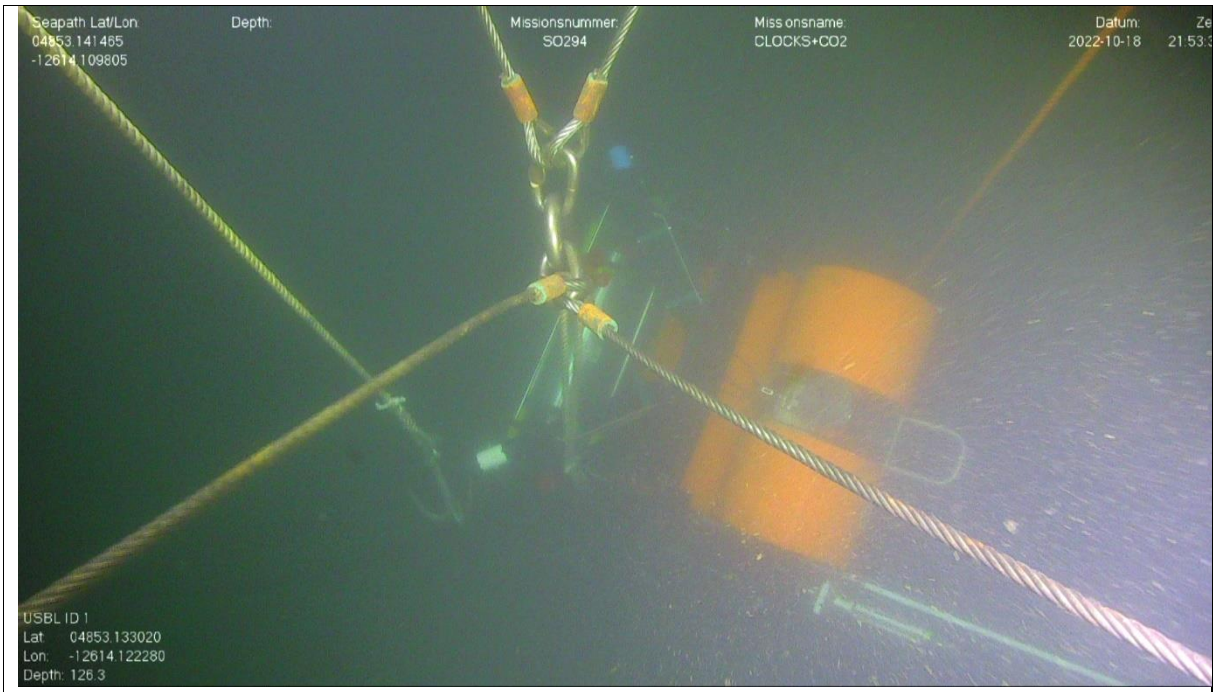
With OFOS held just above seafloor, RV SONNE traversed slowly at 0.3 knots across the suspected site and after ~50 minutes, we saw the bright orange flag of the MT instruments in the video – just long enough to get a position from the OFOS (Figure 3a). The ship stopped and retracted to the location where we found the tool hanging in the water column, rotated by 90° from resting position while taking measurements (Figure 3b). Thus, our acoustic signals received from the transponder were correct, yet the tool could not float to the surface on its own. The winchman connected the two hooks to the OBMT frame and one of the electrode arms and pulled OFOS quickly up (Figure 3c). This way, the MT instrument came free from the seafloor and floated back to surface faster than we could retrieve OFOS. Ultimately, the OBMT surfaced (Figure 3d) and was recovered back on deck.

*Figure 3: Screenshots taken form the OFOS video of the OBMT recovery mission:*

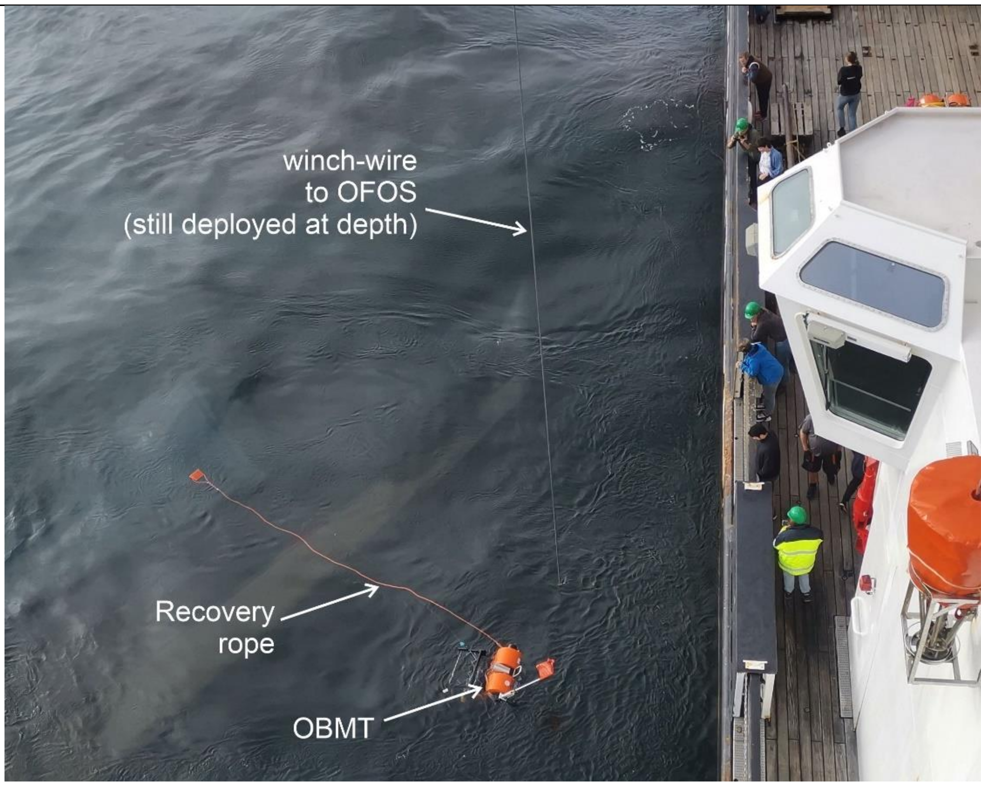

*(a) We saw the orange-colored flag for just a few seconds while the ship traversed across the station, enough to get a quick screenshot and position of the OFOS. The ship needed to then stop and return to that location. We hoped to find the tool again quickly.*




*(b) Only four minutes later, the MT instrument came into sight again and the winchman successfully connected the hooks to the instrument's own frame and one of the electrode-arms. He then immediately heaved OFOS and thus pulled the MT station from the bottom.*




*(c) The OBMT came free of the seafloor and anchor and floated quicker to the sea surface. We were then able to retrieve OFOS.*




*(d) View from the bridge down to the surfaced OBMT. All were happy to see the tool and the instrument was swiftly recovered and secured back on deck (Photo: T. Birnbaum).*

At this point, we would like to express our sincere gratitude to Mr. El- Haddad from Global Affairs Canada and all others involved from additional agencies for the strong support and fast response to our request to use OFOS. Without this support, we would have had no chance to recover the tool.

During the night from Monday to Tuesday, while eagerly awaiting the permission to use OFOS, we also squeezed in a short program of heat-probe measurements at the northern end of the fragmented deformation front. Seven stations were successfully visited (Figure 4) and data look excellent. The data will be fully processed back in our office at GEOMAR in Kiel. After completion of the heat-probe measurements and steaming to the site of the lost OBMT #13, we closed (as previously hoped) some gaps in the multibeam bathymetry dataset and also acquired one more crossing of the interesting strike-slip fault (Figure 5).

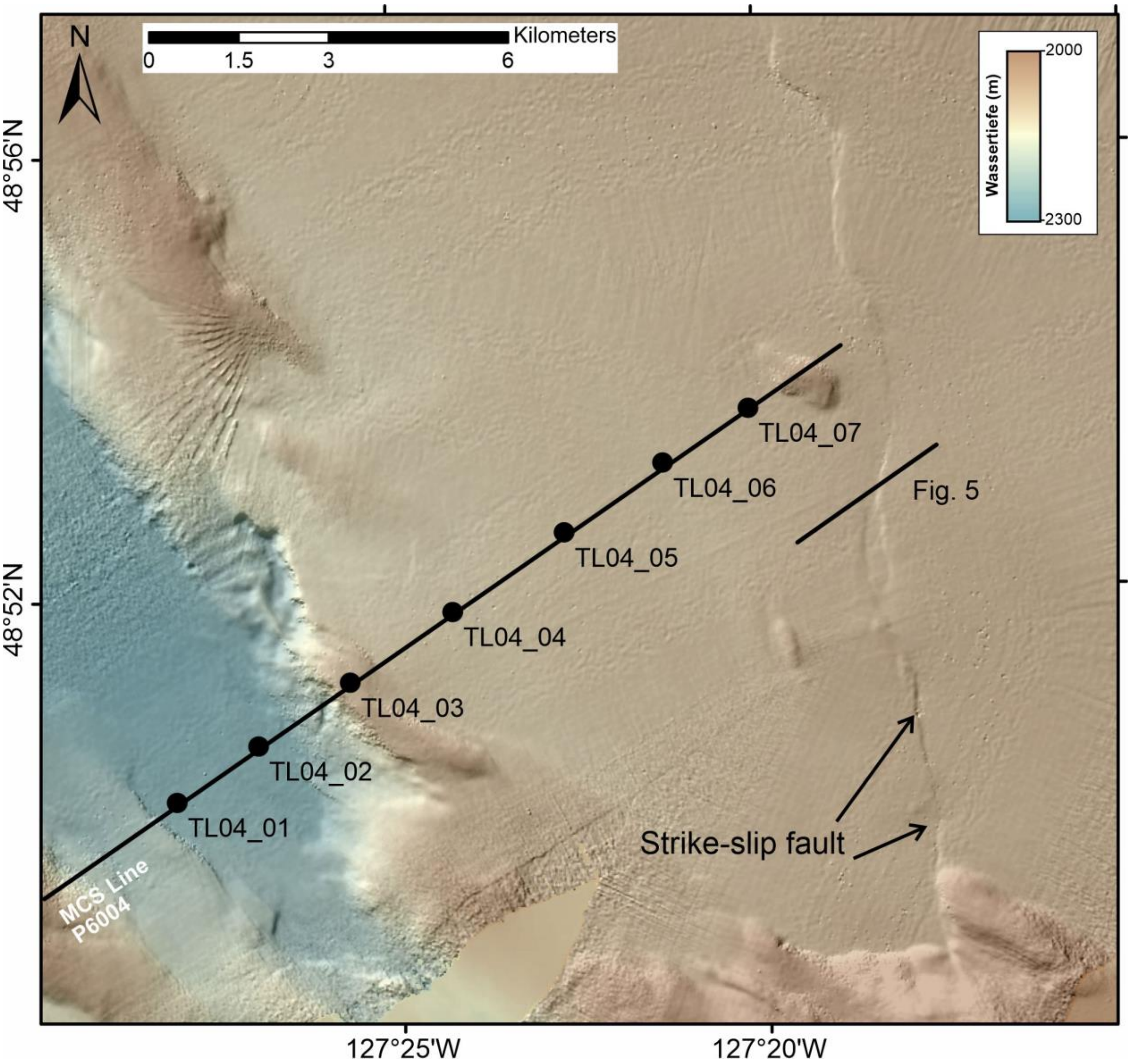



*Figure 4: Map showing location of the heat-probe stations and crossing of the strike-slip fault with PARASOUND (Fig. 5; image: M. Riedel, K. Douglas, J. Kehew, I. Klaucke).*

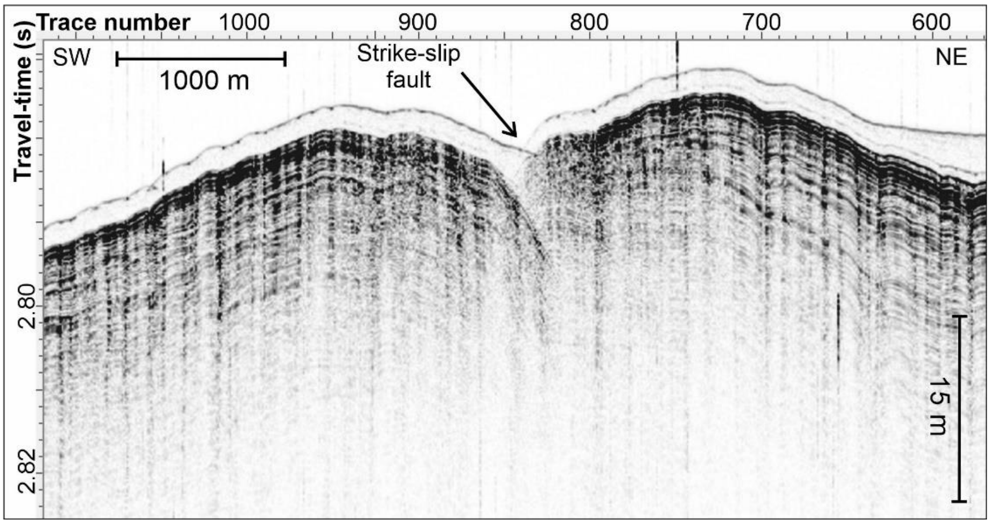



*Figure 5: PARASOUND image of the strike slip fault showing vertical offset of ~3 m.*

With the main program of CLOCKS completed we attempted to honour requests from our Canadian colleagues and agencies involved in the permitting process for SO294. In order to use the remaining time of our cruise in an optimal way, we completed multibeam mapping on a canyon and channel system, known as “Father Charles” canyon in water depths < 200 m. Two nights were used for EM710 and PARASOUND imaging revealing interesting structures possibly linked to erosion from either meltwater runoff or glacial erosion (Figure 6). Day-time operation was dedicated to a study of pockmark generation and evolution and their linkages to natural degassing and habitat. All of these efforts will feed into a collaborative project between scientists from GEOMAR, the Christian Albrecht’s University Kiel, Ocean Networks Canada, and Fisheries and Ocean Canada. We attempted acquisition of EM710 high resolution multibeam bathymetry but the occurrence of numerous humpback and Orca whales created a rather spotty data set. Nonetheless, we will be able to use the data after careful re-processing at home to accommodate for swell, acoustic sound velocity variations and tides.

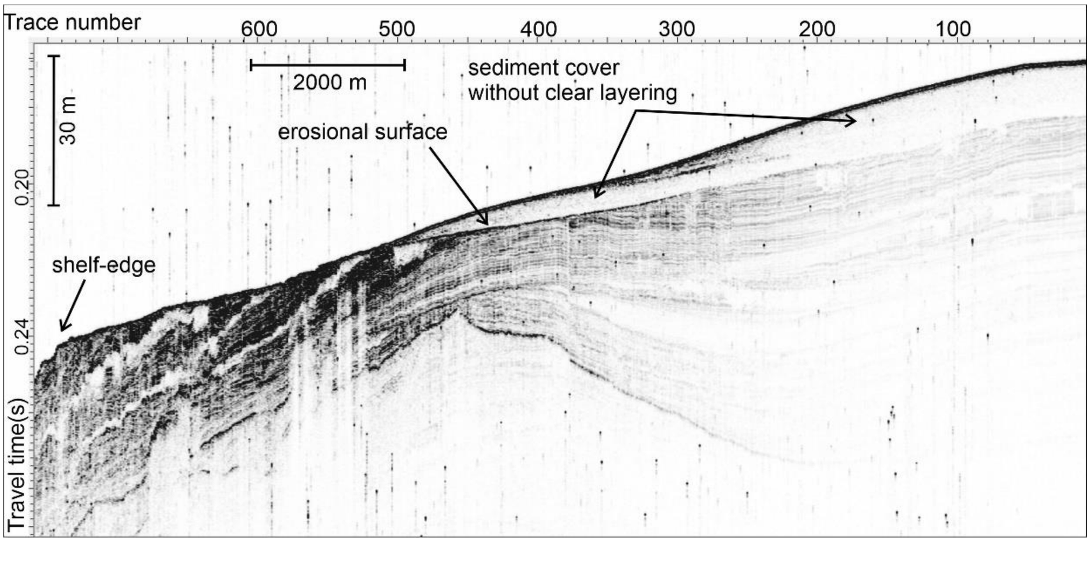



*Figure 6: PARASOUND image revealing intriguing features that could be linked to erosion from glacial activity or meltwater runoff with razor-sharp erosional surfaces and homogenous sediment cover of now internal layering.*

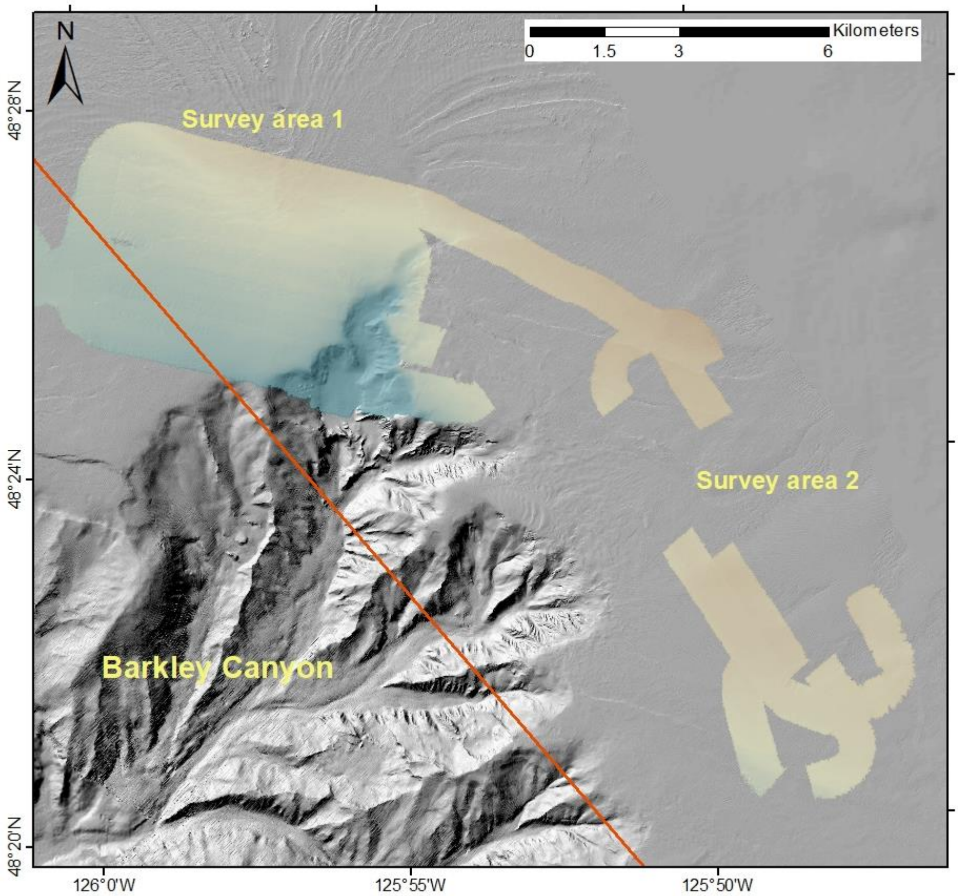



***Figure 7:*** *(a) EM710 multibeam coverage at the pockmark region used to study generation and evolution of these feature and their linkages to habitat. Orange line represents boundary of the Southern Resident Killer Whale critical habitat region (image: M. Riedel, K. Douglas, J. Kehew, I. Klaucke).*

With gradually deteriorating weather conditions, we decided to leave on the evening of October 20, a little earlier than anticipated. This allows us to go south ahead of the arriving high wind and sea state that would have prohibited any additional work in our CLOCKS study area anyhow. We are thus also able to complete the transit at slower speeds to save on fuel consumption. The remaining time of the week was spent by the science team onboard cleaning up the laboratories and packing our gear into boxes and containers, as well as finishing our reports and onboard data analyses.

All on board are well and send greetings home.

Michael Riedel (on behalf of all participants of Expedition CLOCKS)

(GEOMAR Helmholtz Center for Ocean Research Kiel)