R/V Falkor (too) FKt240902

Cruise Report

RV Falkor(too) offshore the town of Chaitén, Southern Chile, 13/09/2024 (Alex Ingle)

Fire and Ice: Volcanic and Glacial Interactions

CODEX project

2nd September 2024 (Puerto Montt) to 23rd September 2024 (Talcahuano)

March 2025

Summary

The FKt240902 research cruise took place on the R/V Falkor (too) from 2nd to 23rd September 2024, from Puerto Montt to Talcahuano, Chile. The project aimed to generate a comprehensive understanding of the marine environmental processes that follow a large-magnitude explosive eruption of a coastal volcano, combining sedimentological, volcanological, geomorphological and biological approaches. The sedimentary archive adjacent to active volcanoes has the potential to hold a rich eruption record, which can be used to analyse the tempo of volcanism and how this reflects environmental and climatic factors. Unravelling such archives requires a holistic understanding of sedimentary processes following large eruptions, spanning terrestrial to marine settings. Building towards this long-term goal, we used the Chaitén 2008 eruption to exemplify the complex chain of processes initiated by an explosive eruption on a continental margin, producing the most complete reconstruction available of how such events impact, and are recorded within, the adjacent marine environment.

To address this problem, the project investigated sediment pathways and sources through the Chiloe sea. Although the particular focus was on the submarine basins and channels adjacent to Chaitén, particularly those associated with the Rayas and Blanco river deltas, the cruise also targeted the Reloncaví Fjord, as a region affected by the Calbuco 2015 eruption, and more distal regions south of Chaitén, through to the continental margin at the Simpson canyon. Most of the area had no available high-resolution bathymetry or sub-bottom data, and an important part of the project was exploratory mapping and oceanographic observations, to characterise seafloor morphologies, patterns of sedimentation and erosion, and ocean currents throughout the survey area. To identify sediment routes following recent volcanic eruptions, especially Chaitén 2008, to assess the potential of the region for longer term volcanic eruption reconstructions, and to investigate the biological and environmental impacts and recovery from volcanic eruptions, a major target of the cruise was the recovery of seafloor sediment cores. A vibracorer mounted on the ROV SuBastian was used for the first time during this expedition, and successfully recovered 44 vibracores from 24 sampling stations. These samples were supplemented by push cores, sediment sampled from scoop bags, and from separate van-Veen grab and gravity core sampling deployed from the ship.

Hydroacoustic data from throughout the region showed a complex seafloor morphology reflecting the influence of glaciation and postglacial sedimentation. Strong currents throughout much of the area exert a strong control on present-day sediment routes, with evidence from erosional and depositional relationships that these have varied through the postglacial period. Several cores preserved visible volcanic deposits, likely both from airfall and submarine gravity flow processes, further modified by ocean currents. Offshore the Blanco river system, sediment is transported southwards to the mouth of Chaitén bay, with several cores preserving multiple volcaniclastic units. Further north in the bay, evidence of volcaniclastic input is much more limited. Sedimentation patterns offshore the Rayas delta are very different, with strong currents producing a dune system dominated by mixed coarse sediment. Dune bedforms extend along coastal areas and NE along channels into the Ancud Gulf. Evidence of volcanic deposits likely to be from Chaitén was found at least 40 km away, although the age and origin of this remains to be verified by post-cruise geochemical and sedimentological analyses. This, alongside chronological data, will be key to understanding the volcanic event history of the region and the interplay of volcanic processes with environmental change.

The cruise involved an international and cross disciplinary team, including expertise in geophysics, marine and glacial geology, volcanology, physical geography, marine geomorphology, micropalaeontology, marine biology and physical oceanography. Over half

the science team were from Chile, alongside scientists based in the UK, USA, Italy, New Zealand and Malta, and with ten student participants. The team included two participants from SERNAGEOMIN, the Chilean geological survey, with expertise in regional volcanism. The team also included a schoolteacher from Isla Chuit, in the Chaitén region. This helped facilitate the outreach, education and community engagement programme, which formed a major part of the project. Over 21 ship-to-shores sessions took place during the cruise, 8 of which were to schools in the Chaitén area (each involving multiple schools). On 12th September, over 100 schoolchildren from 16 regional schools visited the ship, supported by the Chilean Navy and followed by visits from local authorities and government representatives. Continued community engagement will be an important element of post-cruise work.

Resumen

El crucero de investigación FKt240902 se realizó a bordo del R/V Falkor (too) del 2 al 23 de septiembre de 2024, desde Puerto Montt hasta Talcahuano, Chile. El proyecto tuvo como objetivo generar una comprensión integral de los procesos ambientales marinos posteriores a una erupción explosiva de gran magnitud de un volcán costero, combinando enfoques sedimentológicos, vulcanológicos, geomorfológicos y biológicos. El archivo sedimentario adyacente a los volcanes activos tiene el potencial de albergar un rico registro eruptivo, que puede utilizarse para analizar el ritmo del vulcanismo y cómo este refleja factores ambientales y climáticos. Desentrañar estos archivos requiere una comprensión holística de los procesos sedimentarios posteriores a grandes erupciones, abarcando entornos terrestres y marinos. Con miras a este objetivo a largo plazo, utilizamos la erupción de Chaitén de 2008 para ejemplificar la compleja cadena de procesos iniciada por una erupción explosiva en un margen continental, generando la reconstrucción más completa disponible de cómo estos eventos impactan y se registran en el entorno marino adyacente.

Para abordar este problema, el proyecto investigó las vías y fuentes de sedimentos a través del mar de Chiloé. Si bien el enfoque se centró en las cuencas y canales submarinos adyacentes a Chaitén, en particular los asociados con los deltas de los ríos Rayas y Blanco, el crucero también se centró en el fiordo de Reloncaví, región afectada por la erupción de Calbuco de 2015, y en las regiones más distales al sur de Chaitén, hasta el margen continental en el cañón Simpson. La mayor parte del área carecía de datos batimétricos de alta resolución ni del subsuelo, y una parte importante del proyecto consistió en la cartografía exploratoria y las observaciones oceanográficas para caracterizar las morfologías del fondo marino, los patrones de sedimentación y erosión, y las corrientes oceánicas en toda el área de estudio. Para identificar las rutas de sedimentos tras erupciones volcánicas recientes, especialmente la de Chaitén de 2008, evaluar el potencial de la región para reconstrucciones de erupciones volcánicas a largo plazo e investigar los impactos biológicos y ambientales, así como la recuperación de las erupciones volcánicas, un objetivo principal del crucero fue la recuperación de núcleos de sedimentos del fondo marino. Durante esta expedición, se utilizó por primera vez un vibracorer montado en el ROV SuBastian, que recuperó con éxito 44 vibracores de 24 estaciones de muestreo. Estas muestras se complementaron con núcleos de empuje, sedimentos obtenidos con bolsas de pala y muestras separadas de núcleos de gravedad y de cuchara Van-Veen desplegados desde el barco.

Los datos hidroacústicos de toda la región mostraron una morfología compleja del fondo marino, que refleja la influencia de la glaciación y la sedimentación postglacial. Las fuertes corrientes en gran parte del área ejercen un fuerte control sobre las rutas sedimentarias actuales, con evidencia de relaciones erosivas y deposicionales que indican que estas han variado a lo largo del período postglacial. Varios núcleos preservaron depósitos volcánicos visibles, probablemente provenientes de procesos de caída de aire y flujo gravitacional submarino, modificados posteriormente por las corrientes oceánicas. Mar adentro del sistema del río Blanco, los sedimentos son transportados hacia el sur hasta la desembocadura de la bahía de Chaitén, con varios núcleos que preservan múltiples unidades volcanoclásticas. Más al norte en la bahía, la evidencia de aporte volcanoclástico es mucho más limitada. Los patrones de sedimentación mar adentro del delta de Rayas son muy diferentes, con fuertes corrientes que producen un sistema dunar dominado por sedimentos gruesos mixtos. Las formas del lecho dunar se extienden a lo largo de las zonas costeras y al noreste a lo largo de los canales hacia el Golfo de Ancud. Se encontró evidencia de depósitos volcánicos, probablemente provenientes de Chaitén, a al menos 40 km de distancia, aunque su edad y origen aún deben verificarse mediante análisis geoquímicos y sedimentológicos posteriores al crucero. Esto, junto con los datos cronológicos, será clave para comprender la historia de los eventos volcánicos en la región y la interacción de estos con el cambio ambiental.

El crucero contó con la participación de un equipo internacional e interdisciplinario, con expertos en geofísica, geología marina y glacial, vulcanología, geografía física, geomorfología marina, micropaleontología, biología marina y oceanografía física. Más de la mitad del equipo científico era de Chile, junto con científicos del Reino Unido, Estados Unidos, Italia, Nueva Zelanda y Malta, y con diez estudiantes participantes. El equipo incluyó a dos participantes de SERNAGEOMIN, el servicio geológico chileno, con experiencia en vulcanismo regional. El equipo también contó con la participación de un profesor de la Isla Chuit, en la región de Chaitén. Esto facilitó el programa de divulgación, educación y participación comunitaria, que constituyó una parte fundamental del proyecto. Durante el crucero se realizaron más de 21 sesiones de intercambio de información, 8 de las cuales se realizaron en escuelas de la zona de Chaitén (cada una con la participación de varias escuelas). El 12 de septiembre, más de 100 escolares de 16 escuelas regionales visitaron el barco, con el apoyo de la Armada de Chile, y posteriormente recibieron visitas de autoridades locales y representantes gubernamentales. La participación comunitaria continua será un elemento importante del trabajo posterior al crucero.

The expedition was conducted under the following research permits:

SHOA permit: Resol J.E.M.G.A. Ord. Nº 13270/760/1

SUBPESCA: R. EX. No E-2024-500

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Danny Leviñanco	Escuela Chuit
Adrienne Copeland	NOAA
Jill Pelto	Artist

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1. Outline

The FKt240902 project investigated the linked marine environmental processes that follow a large-magnitude explosive eruption of a coastal volcano, combining sedimentological, volcanological, geomorphological and biological approaches, principally using the 2008 eruption of Chaitén volcano to trace the impacts of this event and its recording within marine stratigraphies. The research approach focused on collecting samples and datasets that could constrain sediment pathways following the eruption and the effects of volcanic sediment deposition on the environment. As an additional dataset, samples and data were also collected from the Reloncaví Fjord, impacted by the Calbuco 2015 eruption; and to trace distant sediment pathways through the Gulf of Corcovado and beyond, observations were made towards the continental margin at the Simpson canyon.

The survey area had little prior high-resolution bathymetry or sub-bottom data, and a comprehensive set of hydroacoustic and oceanographic observations were made throughout the survey. A major target of the project was to collect samples that could directly be used to trace the impacts of the Chaitén 2008 eruption, principally via deployment of the ROV *SuBastian*, using a vibracorer attachment. This sampling was supplemented by push cores, sediment sampled from scoop bags, and from separate van-Veen grab and gravity core sampling deployed from the ship.

1.1 Objectives

The overall goal of the project was to determine a complete picture of the impacts and imprint of the Chaitén eruption in the marine environment, via a combination of direct observation, high-resolution seafloor and sub-seafloor mapping, and sediment sampling. In doing so, we aimed to identify (i) how this eruption is recorded in the marine sedimentary record; (ii) how its products were dispersed; (iii) the impacts this had on marine biota and biogeochemical processes; and (iv) the recovery of systems from that perturbation. This would provide a uniquely comprehensive understanding of volcanic eruption impacts and recovery in the marine realm, applicable at other coastal and island sites globally. The samples and datasets that have been obtained during the cruise will allow us to address these objectives.

To complement this approach, we collected a secondary dataset from the Reloncaví fjord, which was affected by the Calbuco 2015 eruption and is likely to have received previous input from Calbuco volcanic eruptions. This will extend and test our insights from Chaitén. Finally, the bathymetric, sub-bottom and coring datasets collected during this expedition will characterise sediment transport pathways and the long-term fate of volcaniclastic sediment in the region, thus providing the baseline for follow-on research that will test how the tempo of volcanism and associated sedimentary and environmental processes in the region are coupled with climatic (glacial) processes.

Our observations seek to address six distinct research questions:

1. How does initial volcanic deposition and drainage basin capacity control the nature of the marine sedimentary response, flux and dispersal?
2. How are the types and sequence of primary volcanic processes recorded in the offshore sedimentary sequence, and what are the timescales of this?
3. What is the timescale of perturbation, anomalous sediment flux, and recovery to background conditions?
4. What is the spatial, volumetric and temporal distribution of volcaniclastic sediment routing towards the continental slope, and the transportation mechanisms and pathways involved?
5. What is the impact of major secondary volcaniclastic sedimentation on marine biota, and how do these systems respond and recover?

6. What is total organic carbon burial, and its spatial distribution, associated with a major volcanic perturbation of the terrestrial-marine system; and what does this imply about the significance of such events in biogeochemical cycling?

1.2 Highlights

FKt240902 has produced an extensive dataset of high-resolution mapping and sub-bottom profile data across a large part of the Chiloe Sea, from Reloncaví fjord through to the Boca del Guafo and Simpson canyon. The vast majority of this has been mapped in detail for the first time, revealing the interplay of glacial, marine and volcanic processes that have shaped the region. Strong ocean currents shape the region and exert a strong control on sediment accumulation and the potential of sites to preserve long-term volcanic event records. Several cores have recovered sequences of volcanic deposits, suggesting that many regions hold strong potential for longer-timescale reconstructions. The cores that have been recovered during the cruise will directly extend the histories of regional volcanoes and have identified deposits from poorly known and potentially unknown explosive eruptions.

Offshore Chaitén town, which was inundated by volcanic sediment flows following the 2008 volcanic eruption, submarine eruption deposits have now been identified for the first time. These extend for at least 12 km from the shoreline, along submarine channels and interconnected basins. Evidence of older Chaitén eruptions has been found further offshore, over 40 km from the volcano, providing new insights into past eruptive activity.

The mapping of unexplored regions west of Chaitén has revealed a glacially sculpted seafloor, created by ice advance and retreat over 17,000 years ago. Areas of this seafloor have been kept free from younger sediment deposits by strong ocean currents. The seabed here is still marked by ice-related lineations and deposits, formed prior to Holocene sea-level rise. Strong local variations in seabed characteristics, linked to sediment depositional patterns, result in distinctive benthic biological environments.

Offshore the Rayas delta, and extending along the shorelines to the north and south, a major submarine dune system is active, dominated by coarse sands to gravels, forming bedforms that extend to the NE for over 12 km. The fate of finer sediment exiting the Rayas river system remains unclear but may be resolved by further analysis of core samples.

The new vibracoring capability of the ROV SuBastian has enabled exploration of the seabed and sampling of underlying sediment, uncovering a history of volcanic events that have impacted the region. The system was deployed successfully across a wide range of environments, water depths and sediment types. Being able to combine this sampling with visual imagery and push cores was particularly valuable, providing important context for core interpretation at each site that isn't possible with other coring techniques.

A particular highlight of the project was the schools visit on 12th September, when the ship hosted over 100 children from sixteen local school groups. All the science team were involved with this activity, providing an important opportunity to share our work with regional communities.

2. Participants and Schedule

The science team comprised participants from several Chilean institutions (Universidad de Chile, SERNAGEOMIN, Universidad de Valparaiso, Universidad de Playa Ancha), the UK (University of Birmingham, University of Edinburgh), USA (University of Alabama, University of Virginia), Italy (OGS Trieste, Sapienza University of Rome), Malta (University of Malta) and New Zealand (Massey University, University of Auckland). Ten of the participants from this group were undergraduate, Master's or PhD students. Also part of the team was a schoolteacher from Escuela Chuit, an island school in the Islas Desertores, Sea of Chiloe. The SOI Artist-at-Sea, Jill Pelto, also worked closely with the science team throughout the project. Adrienne Copeland, on board as a NOAA observer, also supported the science team work alongside her NOAA role, particularly in oceanographic observations. Carmina Gonzalez was on board as SHOA observer.

Table 1: FKt24092 participants

Name	**Affiliation**	**Role**
Sebastian Watt	University of Birmingham, UK	Chief scientist
Rodrigo Fernandez Vazquez	Universidad de Chile, Chile	Co-lead/PI (geology)
Rebecca Totten	University of Alabama, USA	Co-lead/PI (micro paleontology)
Giulia Matilde Ferrante	OGS Trieste, Italy	Co-lead/PI (geophysics)
Javier Canete	University of Auckland, New Zealand	Marine geophysics
Monica Giona Bucci	University of Malta, Malta	Marine geophysics
Senay Horozal	University of Malta, Malta	Marine geophysics
Paola Peña	SERNAGEOMIN, Chile	Marine geophysics
Kerys Meredew	University of Birmingham, UK	Marine geophysics, geology (volcanology)
Claudia Morales	Universidad de Valparaíso, Chile	Oceanography
Natalia Varela	University of Virginia, USA	Geology, biology
Marianne Heberlein	University of Alabama, USA	Geology, biology
Jacob Helgeson	University of Alabama	Geology, biology
Gianluca Fedele	Universidad de Valparaiso, Chile	Biology
Diego Droguett	Universidad de Valparaiso, Chile	Biology
Anke Zernack	Massey University, New Zealand	Geology (volcanology)
Alastair Hodgetts	University of Edinburgh, UK	Geology (volcanology)
Constanza Perales	SERNAGEOMIN, Chile	Geology (volcanology)
Ivan Sunye Puchol	Sapienza - University of Rome, Italy	Geology (volcanology)
Sion Moraga	Universidad de Chile, Chile	Geology
Amalia Valdivieso	Universidad de Chile, Chile	Geology
Macarena Perez	Universidad de Playa Ancha	Geology
Colombina Valdés	Marine biologist/science communicator	Outreach, biology
Danny Leviñanco	Escuela Chuit	Outreach/education
Adrienne Copeland	NOAA	NOAA Ocean Exploration representative (scientist/observer)
Jill Pelto	Artist	Artist at Sea Programme
Carmina Gonzalez	SHOA	SHOA marine observer, Chile

The party was divided into three main teams, with the geophysics team overseeing hydroacoustics acquisition and processing (EM124 and EM712 bathymetry; SBP29 sub-bottom profiling) and route planning and mapping in the team's GIS project. The geology team was responsible for sampling, including grab sampling and gravity coring, for core splitting, imaging and description, including subsampling and description of volcanic units. The biology team included all sampling and sub-sampling for environmental indicators and chronology (e.g. micropalaeontology, microbial ecology, sampling for stable and radiogenic isotope analyses), including all work in the wet lab (water sampling from the ROV and the CTD rosette), as well as the marine biological work in the hydro lab. Physical oceanographic measurements were led by Claudia Morales, with support from Adrienne Copeland. Several participants worked across different teams during the project, where needed for specific tasks or to provide student training opportunities. The geophysics team broadly operated on a 12-hour shift from midnight to midday, but with more of the team present in the day. The other teams operated on staggered shifts from 6 am to 6 pm and midday to midnight, which were moved closer together later in the cruise as more samples came in for processing. Lab workflows and sample recording procedures were planned early in the cruise. All sampling procedures were recorded on paper log sheets alongside electronic records.

ROV dives were overseen by the team of four PI's, with at least two loggers (one for biology, one for geology and sampling) recording events and observations throughout each dive, using the SeaLog system and paper logs for sample collection. The science team rotated for the livestream commentary throughout the project.

Several of the science party were involved in outreach activities, including the ship-to-shore programme and plans for the outreach visit offshore Chaitén town, with all the team involved during the visit on 12th September. These activities built on extensive pre-cruise work with the education authorities and local government in Chaitén, as well as with the Chaitén museum, and we plan to continue with these activities and relationships after the cruise.

The science team had regular update meetings throughout the project, including presentations and discussion of results. Several of the team also gave seminars that were also open to the crew.

3. Background and Aims

Southern Chile is a landscape shaped by the interplay of glaciation and volcanism, forming a natural laboratory in which the impacts of these processes on the natural environment can be investigated. On timescales spanning tens of thousands of years, eruption records suggest that glacial loading and unloading suppressed and then facilitated volcanism (Watt et al., 2013; Rawson et al., 2016), potentially contributing to climatic feedbacks during the Pleistocene-Holocene transition (cf. Huybers and Langmuir, 2009). On much more recent timescales, major volcanic eruptions including those at Hudson (1991) and Chaitén (2008; e.g., Pierson et al., 2013) resulted in dramatic landscape change and provide exemplars for understanding environmental response and recovery after volcanic eruptions. The impacts of large volcanic eruptions on the adjacent marine environment are poorly constrained, and yet they can cause major perturbations to both sedimentary (Major et al., 2000, 2009) and biological (Wall-Palmer et al., 2011; Carrillo and Diaz-Villanueva, 2021) systems. At island and coastal volcanoes, the majority of the products from explosive eruptions may ultimately be transported offshore (Le Friant et al., 2009), and the sedimentary sequences in these areas hold a rich, if complex, archive of past volcanic activity and ecological responses. If such processes can be unravelled, these sedimentary archives provide a route into understanding the long-term dynamics of volcanism, including how the style, magnitude and composition of volcanic events has varied through time, and how these may have been influenced by external factors such as glaciation.

Our workplan focused principally on the Chaitén 2008 eruption, the post-eruptive processes that were initiated by this event, their impact on the marine environment, and how they are recorded in the sedimentary record. Through this, we aimed to:

1) gain a uniquely detailed view of the cascading marine environmental processes following a large-magnitude terrestrial explosive eruption, which are important for our understanding of the response and recovery from major volcanic perturbations in marine settings globally.

2) build foundational knowledge that will underpin interpretations of the deeper sedimentary record offshore southern Chile, providing the basis for investigating fundamental questions about the long-term behaviour of volcanoes and a route into a much higher resolution reconstruction of past volcanic events than is available from distal tephrastratigraphic records (e.g., Kutterolf et al., 2019).

3.1 Description of the Study Area

The 2008 eruption of Chaitén had major impacts in southern Chile (Lara, 2010). The event occurred without recognised warning and began with a powerful explosive phase that caused extensive tephra fallout to the east, reaching the Atlantic coast of Argentina (Watt et al., 2009). The thick tephra deposits in the drainage basins around Chaitén volcano were remobilised in the days following the eruption by heavy rainfall, producing secondary lahars that carried large volumes of volcanic sediment downstream. These were particularly acute in the Blanco (Chaitén) river system, inundating the town of Chaitén to the south and rapidly constructing a delta from the redeposited volcanic sediment, which grew and evolved in the months following the eruption (Major et al., 2016). Full evacuation of the town had taken place ahead of this inundation, but the destructive impacts led to long-term consequences for infrastructure, resettlement plans, and the wider economy of the region due to the importance of the town as a regional port and transport link (Lara, 2010). Lahars also caused intense erosion, sediment transport and the flushing of organic carbon along the Rayas river system to the northwest (Ulloa et al., 2015, 2016). Large volumes of volcanic sediment were transported over days to years following the eruption into the marine sedimentary system offshore Chaitén, although the dispersal and volumes of this sediment, and its impact in the marine environment, is not constrained.

To further develop the insights offshore Chaitén volcano, we also plan to collect a secondary dataset targeting the marine environment impacted by the Calbuco 2015 eruption (Castruccio et al., 2016). This eruption produced pyroclastic currents and lahars entering the Petrohue river system, but not directly reaching the sea. The Petrohue river ultimately feeds into the Reloncaví fjord (to the north of Chaitén) (Vergara-Jara et al., 2021). This will enable exploration of the marine records of a smaller but still significant volcanic eruption in a similar environment, and potentially of the impacts of older Calbuco eruptions in the fjord.

Alongside surveying the Reloncaví fjord and the marine basins immediately offshore Chaitén (the Blanco and Rayas deltas, and nearby basins in the southern Ancud Gulf and northern Corcovado Gulf), we collected new mapping data through the southern Corcovado Gulf and out to the continental slope. It was unknown whether an imprint of recent volcanic eruptions would be found at these distances, but these sites are informative for understanding longer-term sedimentation rates and pathways through the continental shelf, and how and where terrigenous sediment input is distributed, and the impact of glaciation on these sediment pathways. The most distal site targeted is the Simpson Canyon, which has been previously mapped (Rodrigo et al., 2022) and therefore presents a good location for understanding sediment routes into the deep water of the Pacific Ocean.

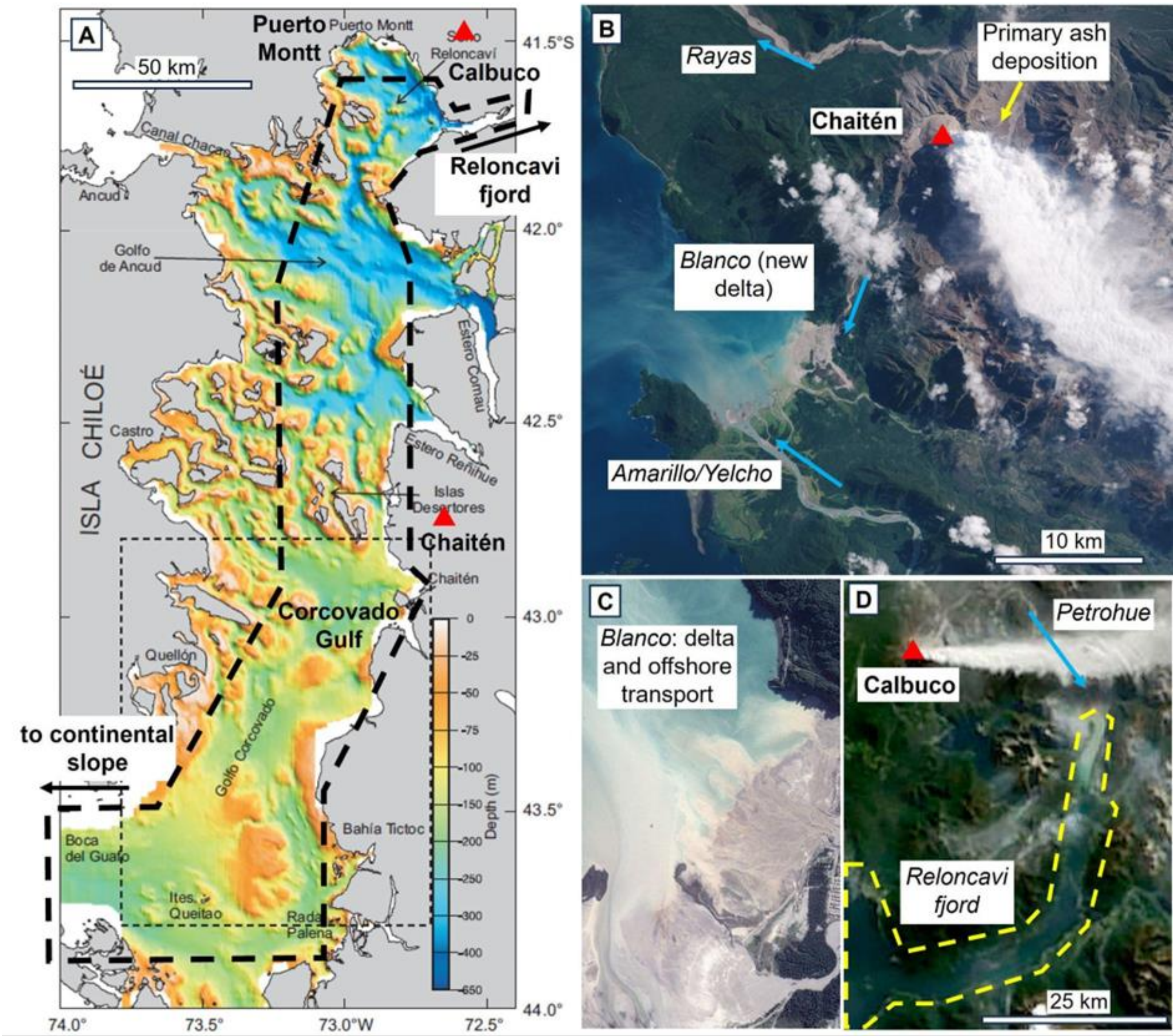


Fig. 1: The limits of the main planned survey area. A: bathymetric map showing study area delineated in black, with extensions to continental slope and Reloncaví fjord (from Rodrigo, 2008). B: Satellite image of Chaitén region following 2008 eruption showing areas affected by primary tephra fallout and tephra redeposition (river valleys; blue arrows). C: Inset showing detail of landforms and sediment transport offshore Chaitén town following the eruption. D: Detail of Reloncaví fjord study area following 2015 Calbuco eruption. Satellite base images from https://earthobservatory.nasa.gov

3.2 Research Targets

Our research posits that marine depocentres offshore Chaitén and other volcanoes will preserve the long-term record of eruptive events that provided mobile sediment to the drainage basins in which they are located. This could include products derived from lahars, pyroclastic density currents and tephra fall deposits. In cases such as the Chaitén 2008 eruption, which transported tephra principally to the west, these offshore deposits may form in westward, coastal and marine environments, despite those areas not receiving primary volcanic input from the eruption. This type of volcano-sedimentary process, which produces an event-record that is entirely secondary in origin, have been explored in lacustrine settings (e.g., Bertrand et al., 2014), but are not well explored in the marine environment.

We identified the Chaitén eruption as a key event through which we can not only explore the complex and significant geological, environmental and biogeochemical impacts of the extreme marine sedimentary flux that can accompany a volcanic eruption, but which also provides the ground-truthing through which marine sedimentary records can be used to reconstruct past volcanic events over decadal to millennial timescales. Sedimentary products of the Chaitén eruption were the main focus of this project, as a source-to-sink study of the eruption that combines investigation of its geological and geomorphological record, the sedimentary processes involved in the event and preserved within its deposits, and the marine ecological response to this major perturbation. Our target was to collect an integrated dataset through which to understand sedimentation and impacts of the Chaitén eruption. This involved first collecting new hydroacoustic data, including sub-bottom profiles, which were critical in this region due to an absence of high-resolution prior mapping data. This mapping data was then used to select dive targets, with a principal focus on sediment sampling. The opportunity to collect intact seafloor samples, using coring methods, was a key part of this project. The sub-bottom profiles and bathymetry have provided broader contextual understanding of sediment pathways, but the cores are essential to ground-truth those observations and to obtain materials that can be used to understand sedimentation rates, to identify sources of material, to identify volcanic-event beds, and to investigate evidence of environmental change in the sediments spanning these event layers. The ROV-mounted vibracorer had particular advantages in this context. First, it enabled visual examination of the seafloor that was being cored, and to use this to refine core locations. Second, the vibracoring method can successfully recover a variety of sediment types, including sandy deposits. Finally, the method allowed us to recover duplicate cores in the same location, providing more material for subsequent analysis and allowing one core to be opened on board, which enabled initial interpretations and was used to guide later sampling decisions. Vibracores were collected in combination with push cores, which were key to recovering intact sediment-water interface samples at the seabed, and to preserve the youngest stratigraphy.

To address the broader questions of the project and to interpret sediment pathways, oceanographic data also constitute an important part of our dataset. Our results show that currents are spatially variable, with strong tidal influences in areas. Parts of the seafloor preserve surface glacial features that indicate no sediment accumulation through the Holocene. Biological sampling of benthic fauna was also undertaken on several ROV dives, with the intention of providing a broad geographic range of present day seafloor environments across a broad depth range and variety of sedimentary environments.

In addition to the main geographical target of the basins adjacent to Chaitén volcano, we targeted channels within the Ancud and Corcovado gulfs, in order to constrain sediment pathways and accumulation rates at more distal sites, and to test the extent and nature of volcaniclastic sedimentary input to these more distal regions. Given the size of the study area, exploratory mapping lines were planned on the basis of existing low resolution (GEBCO) bathymetry. Routes through the Corcovado gulf and out to the continental margin at Simpson canyon were chosen to access longer-timescale records and more distal sediment pathways, with the aim of producing a dataset suitable for a full source to sink analysis. Finally, the Reloncaví fjord study area was chosen as a target at the start of the cruise, both to provide a complementary dataset to those samples collected offshore Chaitén (targeting the 2015 Calbuco eruption), and as a spatially confined and sheltered region, with some existing bathymetry, in which to first deploy and test the vibracorer in what were expected to be relatively fine-grained sediments.

3.3 Outreach Programme

An important aspect of activities throughout and following the expedition were our outreach activities, involving local schools and remotely delivered national and international talks. The local outreach programme in particular involved close work with the local education authority and delivered both remote sessions with multiple schools throughout the area, as well as a ship visit mid-way through the expedition, offshore the town of Chaitén, during which several school groups came on board. Through this programme, our aim was to engage effectively with local communities and to reach as broad an audience as possible. This was facilitated by the participation of a regional school teacher, Danny Leviñanco, who led this work.

Members of the team also worked with the museum in Chaitén and through activities at the Chaitén science fair, to share the work being done within the project. Beyond the local region, several outreach talks were conducted during the project, advertised beforehand to school and university groups, museums and other scientific interest groups, via investigators' networks. Talks were organised through the SOI ship-to-shore programme, typically comprising an introduction to the project, a tour through the ship, laboratory facilities and ROV, and an opportunity to ask questions. Throughout the project, ROV dives were also live-streamed, with commentaries given by many of the science team, in both Spanish and English. These reached online audiences, who could ask questions about the project and science aims during each dive.

An artist, Jill Pelto, also participated on the cruise via the artist-at-sea programme, working closely with the science team, as part of the outreach programme, and producing a series of paintings that captured the background, methods, aims and sampling being done through the project.

4. Narrative Expedition Summary

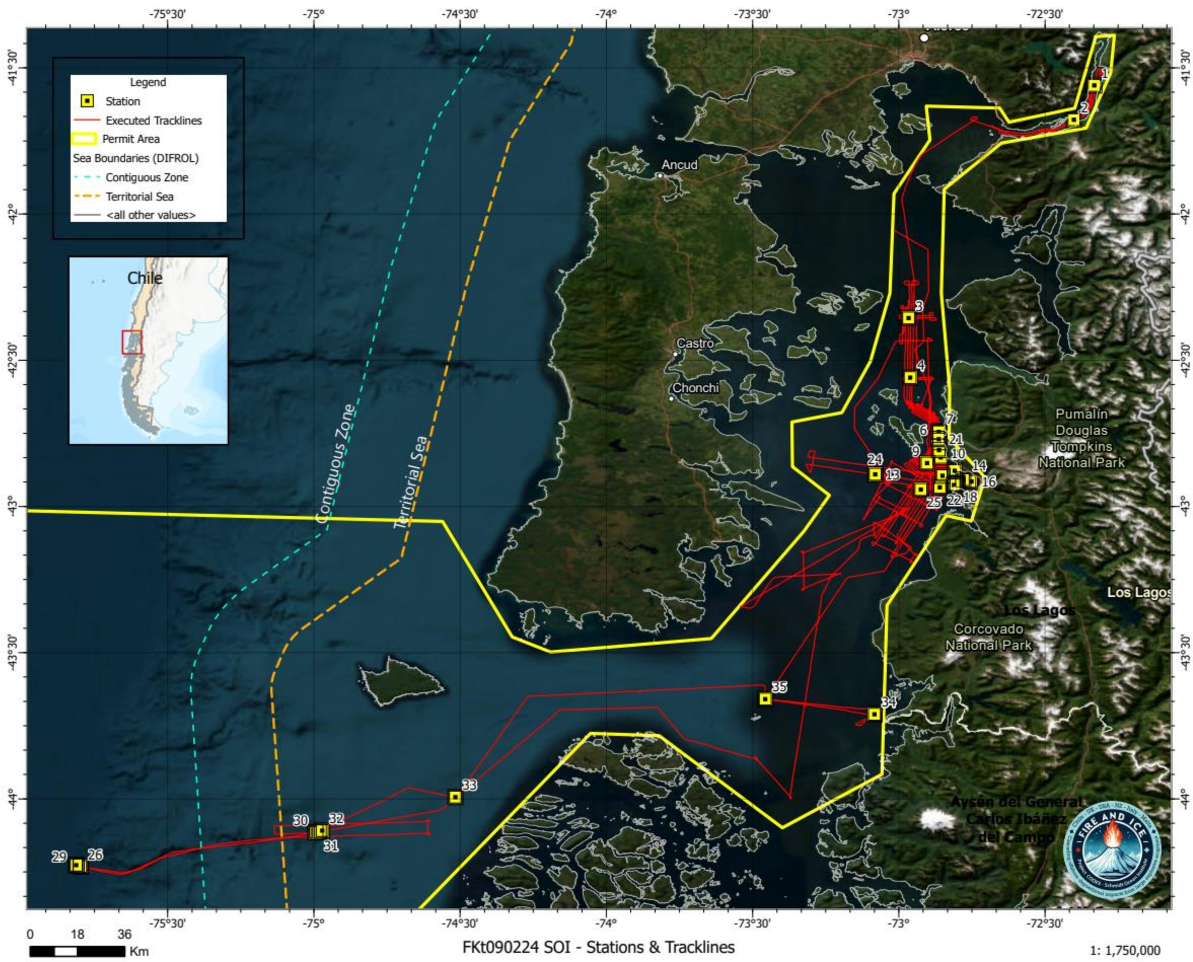


Figure 2: Map of surveyed area (the permit area is delimited in yellow), showing the ship track and acquired bathymetry (red lines), with sample stations and CTD sites (numbered).

Table 2: Summary of FKt240902 daily activities

Day	Date	Location	Activity Summary	Sampling stations
0	01/09/24	Puerto Montt (port)	Orientation activities, lab set-up	
1	02/09/24	To outer Reloncaví Fjord	Mapping, SBP and CTD	
2	03/09/24	Reloncaví Fjord	Two ROV dives; mapping, SBP and CTD	001,002
3	04/09/24	Southern Golfo de Ancud	Mapping, SBP; CTD	
4	05/09/24	Southern Golfo de Ancud	Two ROV dives; mapping, SBP and CTD	003,004
5	06/09/24	Offshore Rayas delta	One ROV dive; mapping, SBP and CTD	005
6	07/09/24	Offshore Rayas delta	Two ROV dives; mapping, SBP and CTD; Van-Veen Grab	006-008
7	08/09/24	Outer Chaitén bay and Rayas delta	Mapping, SBP; CTD	
8	09/09/24	Chaitén bay	One ROV dive; mapping, SBP and CTD; Van-Veen Grab	009,010
9	10/09/24	Chaitén bay and west	Two ROV dives; mapping, SBP and CTD	011,012
10	11/09/24	Chaitén bay	Two ROV dives; mapping, SBP and CTD; Van-Veen Grab	013-015
11	12/09/24	Offshore Chaitén town	Outreach day (schools visits); One ROV dive; mapping, SBP	016
12	13/09/24	Chaitén bay to Rayas delta	Two ROV dives; mapping, SBP and CTD; Van-Veen Grab	017-021
13	14/09/24	Channel and basins SW of Chaitén bay	Two ROV dives; mapping, SBP and CTD	022,023
14	15/09/24	N Corcovado Gulf	One ROV dive; mapping, SBP and CTD; Gravity core	024,025
15	16/09/24	Corcovado Gulf to Simpson Canyon	Mapping, SBP; CTD	
16	17/09/24	Simpson Canyon	One ROV dive; mapping, SBP; CTD	026-029
17	18/09/24	Simpson Canyon to S Corcovado Gulf	One ROV dive; mapping, SBP; Van-Veen grab; CTD	030-033
18	19/09/24	Corcovado Gulf	One ROV dive; mapping, SBP; Gravity core	034,035
19	20/09/24	N of Rayas delta and Ancud Gulf	Mapping, SBP	
20	21/09/24	Transit to Talcahuano	Final sample processing; packing	
21	22/09/24	Transit to Talcahuano	Final sample processing; packing	
22	23/09/24	Arrival in Talcahuano	Packing and clearing lab spaces	
23	24/09/24	Disembarkation		

Daily Narrative

Pre-departure: The full science team boarded Falkor(too) in Puerto Montt at 9am on 31st August 2024. Following introductory and orientation activities, equipment was unpacked and labs set up. Coring and sampling materials had been delivered and unloaded the previous day with the support of Sernageomin and Universidad de Chile. This included a gravity/piston corer and core liners and a van-Veen grab. The gravity corer and grab were stored on deck, with vibrocoring and core sampling materials set up in the hangar, including a table for core cutting. The adjacent sink space was kept for initial biology sample processing and sediment sample processing (e.g. push cores and scoop bags). The cold lab was chilled to 4 °C for core sample storage, the hydro lab set up for biological sample processing and description, and the wet lab set up for water sample and micropalaeontological sample processing, sieving, and with microscopes for observation and picking. The main lab was set aside for core processing and description. Here, benches were set up for core photography, description and sub-sampling, and for smear slide preparation. Space at the far end of the lab was set aside for further volcanic sample processing and description, including microscopes and hand-held XRF, and with an oven for sample drying. At the other end, the fume hood was used for acid-cleaning of water sample bottles. The geophysics team was based in the computer/electronics lab. The wet lab was also used to set up magnetic susceptibility measurements, although the instrument was found not to work with the aluminium vibracore liners and this wasn't subsequently used. Shift plans, sample logging sheets and recording procedures, and laboratory processing sequences were discussed across the teams, with some adjustments in the first few days of the cruise. An emergency drill took place on the day before departure. The port captain in Puerto Montt was visited by S. Watt and C. Gonzalez (SHOA observer) as required by the SHOA permit.

02/09/2024: The ship left Puerto Montt in the morning and had a short transit through Seno Reloncaví to the edge of the permit area, entering the study region just before 1 pm (local time), with subsequent testing of the EM712, EM124 and SBP29 systems. The CTD was deployed just outside the entrance to Reloncaví fjord, with two further operations in the fjord during the night. Water samples targeted the seafloor and chlorophyll maximum. The shallow water sample outside the fjord entrance had very high planktonic content. Transects were mapped into the inner basin of the fjord.

03/09/2024: The first ROV dives of the expedition were undertaken in the Reloncaví fjord, targeting first the inner basin, at a site north of the Palena river outflow (and therefore expected to have a stronger Calbuco/Petrohue sediment influence), and then in the intermediate basin, south of the Palena outflow. MBES and SBP systems provided good data in transects along the fjord, revealing a range of sediment transport and mass transport features. Both ROV dives successfully recovered vibracores, the first collected on a science expedition by SOI. The dives followed a standard sampling procedure of seafloor water samples, followed by push cores (targeting the seabed interface), scoop bags (for bulk sampling of sediment for biological purposes) and vibracores (for deeper sediment recovery), replicated across ROV dives throughout the cruise. Vibracores used 1.5 m tubes. Penetration met little resistance, consistent with the recovered mud-rich sediments, with moderate vibration applied. Cores penetrated to approximately 1.3 m, but recovery was just under 1 m for the longest core, suggesting some sediment compaction. Duplicate vibracores were collected at each dive site, as was the plan throughout the cruise, with the shorter core being opened on board for imaging. At both dive sites, the most prominent unit in the vibracores is a thin dark volcaniclastic sand, slightly coarser and with internal structure at the southern dive site. The origin of this unit remains to be determined. All other samples were processed following the standard procedures that will be used throughout the cruise: ideally collecting 3 push cores per site for geological purposes (chronology, stable isotope analyses, grain-size and surface water sampling), 2 push cores used to supplement the scoop-bag biological samples, for bulk geochemical analyses, the scoop bags sieved for biological analyses of infauna, and water samples taken from the Niskin bottles, collected at 5 m above the seafloor and on the seafloor. Vibracores were cut to size and the archived core stored vertically in the cold lab, with the opened core photographed, logged for visual stratigraphic description, and then subsampled. The first two ship-to-shores took place on this day, to regional Chilean schools and to a robotics team in Brazil.

04/09/24: Mapping was undertaken overnight through the entrance to the Reloncaví fjord (with further CTD sites) and then south through the Ancud Gulf, towards the main survey regions offshore Chaitén. Given the distance, the day was spent on mapping and SBP transects, with N-S parallel lines along a series of basins. Sub-bottom profiles showed highly variable seafloor facies, with stratified and parallel bedded infill in some basins, and erosional surfaces in others. The new mapping revealed topographic complexity across the area, likely linked to glacial erosion, and the interplay of currents with this topography as a control on sedimentation patterns. Large-scale bedforms, visible in the EM124 bathymetry, demonstrate N-S orientated transport through the basins. One ship-to-shore, to regional schools in Chile, took place this day.

05/09/24: Following the previous day's mapping, two sites were selected on a N-S transect, to characterise sedimentation to the north of the main study region, and potential northward transport of volcanic sediment exiting the Chaitén delta systems. The first site was selected in a well-stratified and relatively isolated basin sequence to the north of the channel system. The split core contained very fine sand to silt with dark mm-scale laminations. No visually distinctive volcaniclastic layers were evident. The second ROV site (station 004) was further south beneath a scarp in a channelised region north of Chulin island. The split core contained a fine sand to silt sequence with several distinctive horizons, several of which are potentially fine volcaniclastic layers. The most distinctive of these is a 4.5 cm thick very fine pale grey ash; the origin of this and how it correlates to other exposures and core sites is important to resolve. Chronology on this core will be important for wider correlation and interpretation. At both core sites, push cores, water and biological samples were collected and processed as described above. Two further CTDs were taken on this day, with a similar pattern over subsequent days, providing good coverage of physical oceanographic data and water sampling through this area. Three ship-to-shores, to local schools, UK schools and the Universidad de Chile took place this day.

06/09/24: Mapping took place overnight towards the Rayas delta system, the northward of the two deltas impacted by the Chaitén 2008 eruption. An afternoon ROV site was selected on the basis of this, in a flat region directly west of the Rayas delta, showing a layered and partially eroded sequence of transparent units in sub-bottom profiles, and initially interpreted as an outer part of the delta sequence. The dive showed a seafloor with angular pebbles to cobbles of mixed lithologies. This was partially covered with rippled dark grey sand, forming a seafloor with sandy and pebbly patches. One vibrocore was attempted but could not penetrate, recovering only a core catcher sample of clay. No push cores were taken. Sand and pebbles were sampled using the scoop bags. The current throughout the water column in this area was very strong, limiting ROV operations to short dives around high or low tide. The hard seafloor and lack of muddy surface sediment was in clear contrast to prior sites, and suggests an eroded older surface is exposed at the seafloor, kept clear of younger sediment by the currents. Mapping revealed a dune system on the east side of the channel, west of the Rayas delta, with large dunes orientated broadly E-W and indicating transport parallel to the shoreline. Two further ship-to-shores, one in Chile and one in the USA, took place this day.

07/09/24: Mapping continued overnight in the region south of the Rayas delta and in the western end of Chaitén bay. Two short ROV dives were scheduled around suitable tide times, in the channel west of the Rayas delta, as well as two CTDs. The first ROV dive (station 006) was in a flat region close to the base of the dune system west of the Rayas delta. The seafloor was pebbly with discontinuous thin patches of rippled dark grey sand, overlying eroded patches of cohesive pale grey clay (a small sample was taken with the manipulator arm). A short transect to the east was taken, onto the crest of a dune margin, comprising gravelly sand with a mix of dark and white lithologies, recovering pumice and mixed volcaniclastic material. A vibrocore into this material had good penetration but very poor recovery. A second ROV dive (station 007) further north on the dune system (N of Rayas delta) showed pumice-rich gravel, mixed with dark volcanic lithologies. Three vibracores were attempted, two with recovered material but far shorter than the penetration depth. Despite the 2 m core tubes attempted at these sites, the longest core was 57 cm. The split core showed a sequence of bedded coarse sands to fine gravels, with alternating pumice rich and dark lithic rich horizons. Scoop bags were used to sample additional material, also recovering black woody debris. The observations suggest an active dune system dominated by coarse material, with an absence of clasts below coarse sand grade and with very little biology. At the same location, the van-Veen grab was deployed for the first time and successfully recovered a full grab of sand and gravel, with woody debris.

08/09/24: The day was focused on mapping and sub-bottom profiles through the Chaitén Bay region, including around the coastline offshore Chaitén and adjacent to the Blanco delta, the second river system affected by the Chaitén eruption, which carried the lahars that inundated Chaitén town. The first seminar of the cruise was given by Constanza Perales and Paola Pena from Sernageomin. Further CTDs were deployed alongside the mapping.

09/09/24: Overnight mapping of exploratory E-W transects across the Corcovado gulf extended the survey area to the far west of Chaitén bay. An ROV site (station 009) then targeted the seafloor immediately south of the Rayas channel, a region marked by high backscatter, a continuation of the hard and eroded surfaces noted at stations 005 and 006. This surface is marked by lower backscatter crossing lineations. One set are curved and sub-parallel, with broadly E-W orientations, with a second set of sub-parallel sinuous lineations in a broadly N-S orientation. These were interpreted as potential glacial features associated with ice advance and retreat, consistent with the prior interpretation of this high-backscatter region marking an old surface kept clear of sedimentation by the strong currents in the region. The dive site targeted the lineations. Two vibracores were attempted, the first with better penetration but meeting resistance (archived). The second only recovered around 30 cm of material, with the base formed of compacted clay beneath a horizon of broken shells and hard clay fragments (this core may be compromised in the upper part), with pebbles in the core catcher. Away from the lineations, large cobbles were observed protruding at the seafloor, although the seabed through the area had a cover of mud (which the vibrocores suggest is <30 cm), contrasting with the rippled sand and absence of any mud cover in the Rayas channel. Transects on the ROV dives were undertaken across the lineations to test the ROV-based mapping. A second ROV dive was prevented because of repairs, with a second grab site on the south end of the Rayas dune system recovering medium dark grey sand with wood fragments and a minor mud fraction. The remainder of the day was spent mapping. Two ship-to-shores were done with schools in the region and in the USA.

10/09/24: The day was focused in the Chaitén bay area, with two ROV dives. The first ROV site (station 011) targeted a low-backscatter region immediately west of the high-backscatter region with lineations. There is a sharp contrast between the two regions, interpreted to be linked to current-controlled patterns of sedimentation. SBP profiles in the low backscatter area show well stratified sediment accumulations. The ROV recovered three vibrocores, one compromised on recovery. The other two recovered long cores, one over 1.5 m. The relatively short length of vibrocores at previous sites led to various testing, with cores taken with and without the top valves, without any conclusive difference. At this site, a modified core-catcher, with sharper and slightly shorter cut blades, was used to provide less resistance and limit compression. This coincided with longer core recovery, and subsequent sites generally used this modified core-catcher design. The recovered samples in the split core contained dark silt to medium sand, generally structureless but with faint paler laminations in the upper part. There was no visible evidence of the expected pale Chaitén 2008-derived deposits, in contrast with recovery at subsequent ROV sites in Chaitén bay. A second ROV site (station 012) targeted the northern margin of Chaitén bay, east of the coastal dune facies. The split vibracore recovered fine to medium dark sands, with one prominent pale grey layer at 40 cm depth. The lower part of this unit is very fine grained, with the upper part coarser. In thickness, appearance and depth, this is similar to the pale grey deposit at station 004. Sub-bottom profiles show a transparent structureless unit at this core site. Ship-to-shores this day were done for local Chilean schools and Sernageomin.

11/09/24: Following long overnight exploratory transects into the northern Corcovado Gulf, the day started with an ROV dive in the previously mapped basin to the far west of Chaitén (station 013). The vibrocore here recovered a normally graded sequence with a fine dark sand at the base and monotonous silts in the upper part. No visibly distinct volcanic horizons were observed. Forams were abundant, suggesting good chronological potential. Later mapping moved back towards Chaitén town. A second planned ROV dive was cancelled, with two grab sites on the Chaitén delta undertaken. Despite thick transparent and irregular-surfaced units observed on SBP profiles and in bathymetry, both grabs retrieved only mud samples, suggesting a drape of tens of cm of mud on top of the imaged delta units. A second science seminar was given this day by Becky Totten. Further mapping overnight collected additional transects in the northern Corcovado gulf.

12/09/24: The principal activity of the day was the schools visits to the Falkor(too), involving groups from 16 regional schools from both the continental Chaitén region and the islands. The day was a great success, with over 100 visitors to the ship through the day. Several members of the science team had been extensively involved in planning activities in the weeks and months ahead of the cruise. The ship anchored offshore Chaitén, close to the ferry slipway, with transport support provided by the Chilean Navy and a local vessel. The port captain arrived at 8.45 to meet S. Watt and C. Gonzalez, as requested by the SHOA permit. The first school group arrived soon after 9.00 am, with two boat trips required to transport the group. Each group had a 1.5 hour visit, through a series of stations. This started on the bridge with Jill Pelto, the artist at sea on the expedition, and with a general introduction to the ship. Groups then split into two, visiting the geophysics lab, ROV SuBastian, Main lab (geology and core samples), wet lab and hydro lab (biology). The visiting school groups ranged in age from 10 to 18, divided into four visiting groups. At 4 pm, after departure of the final school group, a group of officials and local authorities visited the ship, including the mayor of Chaitén, regional government representatives, local councillors and education authorities, and Alvaro Amigo from Sernageomin. All the science team were involved in the visit, as guides, overseeing logistics, and at the various stations, and with additional support from Spanish-speaking crew members. During the day, two of the science team (Javier Canete and Anke Zernack) visited Chaitén to undertake drone surveying and observations and sampling of lahar deposits, providing useful reference materials for analysing and interpreting offshore samples.
At the end of day, a short ROV dive (station 016) was undertaken on the Chaitén delta, the most proximal sampling site of the survey, collecting two vibracores (one over 1.5 m) and water samples. The shorter vibracore recovered brown mud in its upper parts, with laminated organic-rich muds beneath, and with volcaniclastic grey sands and silts in its lower parts, ranging from pale grey silt beds to mid-grey and dark-grey sandy beds, varying on a cm-scale. The core penetrated deeper than the grab samples on the delta and can be inferred to have sampled the uppermost parts of the transparent wedge-shaped delta frontal unit imaged on delta-perpendicular sub-bottom profiles.

13/09/24: Mapping overnight continued to fill in transects to the west and south of Chaitén, in the northern Corcovado gulf, returning to the Chaitén delta front. A first ROV dive targeted the lower slopes of the delta front (station 017) collecting a full set of ROV dive samples. The split vibracore had a sandy upper part, before a mud interval mixed with sand, followed by a layered sequence including dark volcanic horizons and then a unit with multiple pale grey layers and dark organic rich laminations. CTDs and further mapping were undertaken through the day, with a second ROV dive to the south of Chaitén bay, on an elevated platform marked by large dune-like forms with higher backscatter than the adjacent region. The seafloor here was muddy, suggesting the dune features are inactive (in contrast with the dunes around the N side of the bay). Samples were taken at two stations (018 and 019) on a short transect from a dune crest to trough. Both sites recovered vibracores just under 1.5 m in length, with the shorter cores split on board. Core 018 preserved varied stratigraphy in its upper part, with a 1 cm fine grey ash bounded by clayey-sands, followed by a fine grey ash layer with fine laminations, and pods of grey ash in the mud below, although the majority of the core doesn't preserve visible volcaniclastic layers. Core 019 preserved several distinct volcaniclastic beds, starting with a felsic very fine grey ash mixed with mud in the uppermost part (potentially Chaitén 2008 derived deposits), with clayey sands below containing a discontinuous layer of light grey ash, and layers below of mid-grey ash and pale grey discontinuous layers. In the lower part of the core is a dark volcaniclastic sand, and a further dark ash in the core catcher. Two grab sites were visited in the evening along the dune system south and west of the Rayas delta, providing a connecting transect to previous grab sites. The first, south of the delta, recovered coarse grey sand with a pumiceous component and with some mud and a variety of biology; the second, immediately west of the delta, recovered several rounded pebbles with mixed lithologies, alongside pumiceous and dark volcanic sand and gravel. Two ship-to-shores took place this day, to Chilean schools and a school in the USA. Anke Zernack gave the next science seminar.

14/09/24: Following further overnight mapping, a first ROV dive (station 022) was done in the channel at the south side of Chaitén bay, south and deeper than the previous dive site. The base of the channel shows a series of large scale bedforms along the channel, with the dive targeting the lower (western) end of these. The vibrocores had good penetration, but on moving the first vibrocore onto the rack, sand was observed pouring from the base of the core, suggesting loss of material on extraction. To minimise this, the second core was retained in the clamp on recovery, with the gate closed. Recovered samples were far shorter than the penetration and had fine sand bases, suggesting a large volume of fine sand had been lost through the core catchers. The split core has a well stratified lower sequence of light- to dark-grey volcaniclastic sands, including units containing pumice, and with fine silt intervals, with a base in a coarse volcaniclastic sand, potentially a sequence associated with the Chaitén 2008 event. A second ROV dive targeted the first basin to the west of this channel (station 023), recovering a full set of ROV samples. The uppermost part of the core preserved 20 cm of stratified pale-grey volcaniclastic silts and fine sands, potentially derived from Chaitén 2008 and correlating with the coarser deposits at the previous dive site, suggesting a southern transport pathway through Chaitén bay.

15/09/24: Overnight mapping moved south to Laitec to exchange pilots at 08:00. Following this, a transect north returned to the site of station 013 to deploy the gravity corer and test if deeper recovery could be obtained. The corer was successfully deployed, although the recovered core was slightly shorter than the prior vibrocores at this site. An ROV dive (station 025) then took place in a basin further east, displaying complex contourite sedimentation but the next potential depocentre to the west from station 023. The core recovered normally graded coarse to medium dark sands in its lower part, with silt in the upper part, but no visible pale volcaniclastic unit correlatable with the dive sites to the east. The core catcher of the archived core recovered a coarse sand to fine gravel, with mixed volcaniclastic and igneous lithologies. Mapping overnight moved southwards through the Corcovado gulf, over the southern platform and towards the exit from the fjords to the south.

16/09/24: Following transects over the Corcovado gulf platform, and because of the weather outlook for later in the week, which looked likely to prevent any ROV sampling and to potentially delay the transit north, a decision was taken to head west to the Simpson canyon to target those sites, and to then return inland and head north at the end of the week through the survey area and gulfs of Corcovado and Ancud. The day was therefore spent mapping a long transect through the Boca del Guafo and towards the Simpson canyon. Two CTDs were taken on this route. A science seminar was given during the day by Jill Pelto, artist-at-sea on the project, and two ship to shores, to a school in the USA and the Lapworth lecture at the University of Birmingham, UK.

17/09/24: Poor weather conditions through the night affected the quality of the mapping data collected in a westward direction and slowed progress. Good SBP profiles could not be collected along the canyon, likely also due to the steep walls. Despite the conditions, an ROV launch was possible and a long dive was undertaken (11 hours; stations 026 to 029) perpendicular to large-scale bedforms on a fan at the base of the canyon. This was at over 3400 m, by far the deepest sample site during the cruise. Biological observations were made throughout the dive, across a largely muddy substrate. Push cores revealed underlying dark sandy layers interbedded with brown mud. Four vibracores were taken in a transect away from the canyon exit, with the second longest of these opened on board, revealing a set of dark well-sorted sands on mm- to cm-scale, interbedded with brown mud and interpreted as a series of turbidites. Biological specimens were collected, although there was poor recovery in the scoop bag samples. Overnight mapping was undertaken in a NE direction to minimise the effects of the waves on data quality, towards the upper feeder channels of the canyon. The final Chilean schools ship-to-shore took place this day, alongside a ship-to-shore to a New Zealand school. A science seminar was given by Javier Canete.

18/09/24: Following mapping transects around the upper channels of the Simpson Canyon, an ROV site (stations 030 to 032) was selected on a northern channel. A transect up the channel revealed varied biology, particularly on rocky substrates on the steeper parts of the channel, where boulder deposits suggested mass-wasting deposits. Samples were collected through the transect, including vibrocores on a platform at the end of the transect. Penetration, as with the previous dive, was limited due to the vibrocorer meeting resistance. The two collected cores were less than 1-m in length. The shorter one was split on board and contained a sequence of dark sands interbedded with muds, comparable to that sampled at the foot of the canyon. Following the dive, a grab sample was taken in a basin on the platform NE of the canyon, recovering fine sands. Celebrations for the 18th September Chilean independence day took place in the evening. There was also a ship-to-shore to a UK school during the day.

19/09/24: The weather conditions improved during overnight transects back to the east during the day, over the Corcovado gulf platform. Sampling sites were collected on the basis of data coming in during the morning, and an ROV dive site (station 034) was selected in a basin offshore Yanteles volcano and also close to Melimoyu, in channels that connect basins from the north and from the fjords to the south. Sub-bottom profiles showed variation in the sediment infill across these basins. Two vibracores were successfully collected, alongside push cores, water and scoop bag samples. The corer met very little resistance, with the core split on board recovering a black volcaniclastic silt rich in organic material near the top of the core, interbedded with mud, and a thin black ash bed above this. A second ROV dive was not possible due to time, but a gravity core was taken in the evening on a thick unit of parallel-bedded sediment on the western margin of the Corcovado gulf platform. Penetration was low, with the core nose recovering fine to medium sand, with sandy units potentially preventing better recovery. A science seminar was given during the day by Alastair Hodgetts.

20/09/24: Weather conditions were forecast to deteriorate through the next two days, with strong northerly winds this day. A transect overnight was taken back towards Chaitén and the Rayas delta. The primary target was the northern parts of the dune system north of the Rayas delta, both NW along the channel structures into the southern Ancud Gulf, and north along the coastline. The initial plan was for an ROV dive on one of these, but this was not possible due to the sea conditions. Grab sites were then selected, but this was also prevented by the weather conditions. Mapping was therefore undertaken to the north, marking the end of the survey and exiting the permit region in the evening. Time was spent finalising sample processing and description. The final ship-to-shore was on this day, to UK schools.

21-24/09/24: The ship exited the survey area around 8 pm local time on the evening of 20th September, with all data acquisition systems turned off at this point. Rough seas had limited activities that day, and these conditions persisted through the 21st September. The transit time was used to develop subsequent project plans, finalise sample processing, pack equipment and to work on cruise reports. A science seminar was given on 21st September by Monica Giona Bucci and Kerys Meredew. 22nd September was used for final packing, with the ship arriving at Talcahuano (Lirquen) on the morning of 23rd September. Equipment was unloaded that day, and samples unloaded on the following morning, with all of the science team disembarked by the morning of 24th September.

An operational summary of data and sampling is given below:
- 3235 km of bathymetry (EM214 and/or EM712) and sub-bottom profiles
- 28 CTD deployments
- 20 ROV dives, 7 van-Veen grabs, 2 gravity core sites
- 35 sampling stations
- 44 recovered vibracores, totalling 40.40 m in length
- 40 ROV water samples
- 58 push cores sampled for stratigraphy, totalling 10.47 m; 15 push cores sampled for biology
- 53 sediment scoop bag samples

A full station list is provided in Appendix A.

5. Data and Methods

5.1 Bathymetric mapping and ultra-high resolution seismic data

Bathymetric mapping was carried out using Multibeam Echosounders (MBES) EM 712 and EM 124 systems, both by Kongsberg, surveying with a cruise speed of ~ 6.5 kn (varying between 4 and 7 knots depending on sea conditions). Survey areas were designed according to the research needs, giving priority to the region of the Reloncaví Fjord, Blanco, and Chaitén deltas and optimising the transit in between those areas. Survey lines were planned with an overlapping rate of 50% in between adjacent MBES swaths. No major technical problems were encountered with the MBESs utilisation, however, the high variability of freshwater characterising some of the sectors investigated across our survey area made the calibration of the sound velocity profiles at times challenging. Data was recorded in .kmall format and stored in .qpd format after processing with QPS Qimera.

In parallel with MBES bathymetry, coincident sub-bottom profiles were acquired with a Kongsberg SBP29 system and used onboard for a first analysis of sedimentary processes and for selecting promising locations for collecting cores and samples. Technical problems occurred rarely and could be solved during the cruise. The overall data quality was good (except for Simpson canyon area, see below). All data was stored in RAW proprietary format and converted in SEGY. Data was then processed in Seismic Unix and python and loaded to the seismic interpretation software IHS Kingdom.

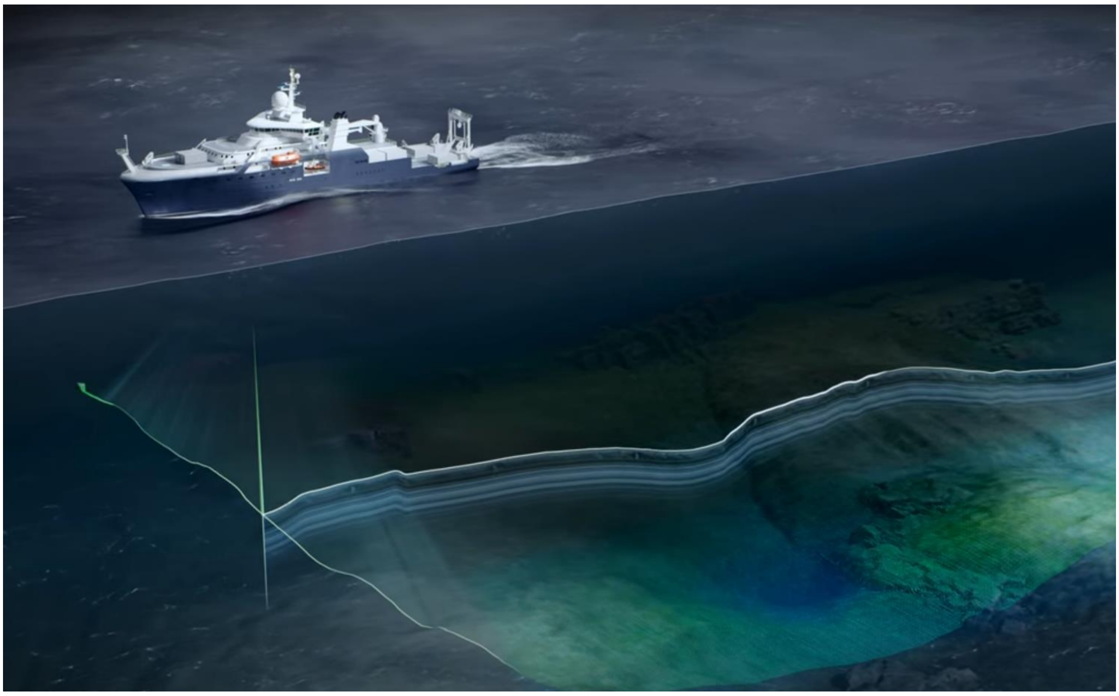


Fig. 3: Illustration of the principal mode of operation of MBES and SBP systems.

5.1.1 Systems, methods and processing

MBES bathymetric data

The R/V Falkor (too) is equipped with two MBES: the EM124 system which operates at 12 kHz and covers water depths from 20 metres below the transducers up to full ocean depth; the EM712 system which offers a frequency range of 40-100 kHz for water depths ranging from 3 m below transducers to roughly 1000 m. Two different transmit pulses can be selected: a CW (Continuous Wave) or FM (Frequency Modulated). The sounding mode can be either equidistant or equiangular or mixed, depending on operation preferences and requirements. Furthermore, both MBES systems can be operated in single-ping or dual-ping mode, where one beam is slightly tilted forward and the second ping slightly tilted towards the aft of the vessel. The whole beam can also be inclined towards the front of the back and the pitch of the vessel can be compensated dynamically. The EM124 system produces 1600 beams covering a swath angle of up to 150° while the EM712 system produces 1600 beams for a maximum swath angle of 140°. Both systems offer a high-density beam-processing mode with up to 800 soundings per swath. The swath angle, if required, can be reduced. The transducers of both MBES systems are mounted in the so-called Mills cross array, where the transmit array is mounted along the length of the ship and the receiver array is mounted across the ship. The EM124 system is of a 0.5° x 1° design, while the EM712 system is of a 0.25° x 0.25° design, but transducers are much smaller. The echo signals detected from the seafloor go through a Transmit and Receive Unit (TRU) into the data acquisition computer or operator station. In turn, the software that handles the whole data acquisition procedure is called Seafloor Information System (SIS v5.12.2). In order to precisely locate the source of the acoustic echo, information about the ship's position, movement and heading, as well as the sound velocity profile in the water column, are required. Positioning is implemented onboard with two redundant, dual antenna GPS/GLONASS GNSS systems, the Seapath380-5+ and the Applanix POSMV. Differential corrections (DGPS) are supplied by Fugro Marinestar G2 Corrections giving ~ 5 cm and ~ 7 cm of horizontal and vertical accuracy, respectively. These signals also go through the transceiver unit to the operator station. Ship's motion and heading are compensated for within the Seapath and SIS. Beamforming also requires sound speed data at the transducer head, which is available via a sound velocity probe. This signal goes directly into the SIS operator station. Finally, the sound velocity profiles for the entire water column were obtained from CTD (conductivity, temperature and density), ROV and XBT measurements.

In addition to bathymetric information, both the EM124 and the EM712 system register the amplitude of each beam reflection as well as a side-scan signal for each beam (so-called snippets) (Beam Time Series). The amplitude signals correspond to the intensity of the echo received at each beam. It is registered as the logarithm of the ratio between the intensity of the received signal and the intensity of the output signal, which results in negative decibel values. For each ping, both the EM124 and the EM712 record a number of backscatter intensity values. Both systems also allow recording the entire water column. The water column data correspond to the intensity of the echoes recorded from the instant the output signal is produced. All echoes coming from the water column, the seabed and shallowest sub-seabed (down to ~ 50-100 cm) are recorded for each beam. When the water column data of one ping is divided into a starboard and portside subset (with 4 beam sectors per side, 8 in total), one can produce two traces, one for each subset. Each trace is built up as a time series in which for each time the highest amplitude is selected from all beams. Then the starboard and the port traces are joined together.

During the cruise, the following settings of the Kongsberg EM124 system were used. The pulse was FM, ping mode was set to High-Density equidistant, dual ping mode was set to dynamic, and depth mode was set to automatic. The beam angle was 150° during most of the survey. Survey speed varied between 4 and 10 knots. Data was acquired continuously, except when the ship was stationary during sampling/ROV operations. Acquisition parameters for the EM712 system were the same as those for the EM124, with a beam angle aperture of 140° for most of the time. Water column data were recorded by both systems.

Data processing was carried out onboard using QPS Qimera and FMGT software. After loading the raw data (.kmall files) and the correct sound velocity profile, a dynamic surface was created showing the ship's track and the raw data. Qimera allows an automatic elimination of major erratic data points using a spline filter. Furthermore, there are several tools for detailed elimination of erratic data points, for example a swatch editor, a 2D editor or a 3D editor, which enable the operator to process each single beam stepwise. All editors display not only the cleaned data but also, if desired, the rejected data points and offer a variety of visualisations of the data (according to files, depth, intensity etc.). After data cleaning, a static surface was generated from the dynamic surface creating a .sd file, which was loaded in the QPS Fledermaus software, allowing 3D visualisation of the cleaned data. Furthermore, the .GSF (.kmall data post processed and exported in GSF formatting) data can be imported in FMGT to generate backscatter grids. To deliver an immediate 3D impression of the bathymetry, uncleaned data were visualised with QPS Fledermaus and used for the quick selection of ROV sites. Both the EM124 and the EM712 multibeam echosounder produce a second type of raw data files with extension *.wcd, which stores water column data. The dynamic grids obtained from Qimera were imported into GIS.

Ultra-high resolution seismic data

The R/V Falkor (too) is equipped with a hull-mounted Kongsberg SBP29 Sub-Bottom Profiler, designed as an optional extension to the EM124. The operating principle of the SBP29 is the same as that of the EM124, with lower penetrating frequency (about one third of the frequency of the EM124). The acoustic transmissions are made using a dedicated transducer array, the return signals are observed using the same transducer as the EM124. The SBP29 uses information from 9 collected beams simultaneously (4 per side), selects the beam with the stronger signal, and forms a composite echogram. The purpose of the composite echogram is to provide an image with the slope tolerance of a wide beam with the data quality of a narrow beam. The beam widths should be adapted to the water depth to avoid strong near field effects. Considering our water depth range, the full array was used (except for the Simpson Canyon area, as highlighted below).

During the survey, all the SBP29 acquisition parameters were adapted depending on the water depth, observed seabed reflectivity, achieved penetration in the subsurface and on the weather conditions (see Table 3). The SBP ping synchronisation was done almost the whole time via EM trigger, with trace length and time delay calculated from the EM124 seabed depth. In specific areas and when possible, the whole water column was recorded in order to attempt a seismic oceanographic study. To acquire data along specific profiles where high lateral resolution was needed, the vessel speed was sometimes reduced or, if the SBP had the priority over the MBESs, the ping interval was fixed and reduced.

Table 3: Acquisition parameters of the SBP29

Acquisition parameters	
Pulse form	*Hyperbolic up* *Hyperbolic down*
Sweep low frequency	*2000 Hz*
Sweep high frequency	*8000 Hz*
Pulse length	*10 - 15 ms*
Ping interval	*600 - 3500 ms (~ 1500 ms for most of the profiles)*
Source power	*0 to -20 dB*
Beam width	*Full array (7 beams with 3°spacing)*
Pre-processing (Kongsberg TOPAS OS)	
Band-pass matched (cross-correlation) frequency filtering	*Corner frequencies selected depending on the start and stop f of the relevant chirp signature. The window has a cos2 roll-off.*
Gain correction for spherical loss	*2 dB/km*
Additional Gain correction (automatic)	*Gain coefficient calculated by the ping peak value of the previous ping*
Processing (Seismic Unix and python)	
1. Time shift correction	
2. Splitting in lines	*Cut on the basis of the curvature angle of the turn*
3. Bandpass filtering	*Corner frequencies: 2000,3000,8000,9000 Hz*
4. Automatic gain control	*Window of 10 ms*
5. Envelope calculation	

Data collected in the Simpson Canyon area have very poor quality for several reasons, primarily the rough weather conditions and the consequent air bubbles under the transducer blocking the acoustic signals. Furthermore, the complex seabed morphology and steep canyon's walls caused strong out-of-plane events and interference from the sides, especially considering that the orientation of the profiles was following, for most of the time, the canyon's axis. Therefore, different acquisition and pre-processing parameters were tried to increase signal-to-noise ratio. In order to avoid strong near field effects, the beam widths were adapted to the significantly greater water depth and only half of the array was used. Furthermore, all the algorithms that were automatically reading the seafloor depth from the EM124 (often unreliable in these conditions) were switched to manual or removed. A low-cut frequency filter was added at the end of the pre-processing flow to remove the strong low-frequency noise. Despite all the efforts, the quality of the data remained very poor in this area.

5.2 ROV SuBastian

The SOI ROV, SuBastian, was deployed throughout the cruise to collect seafloor samples and make direct camera observations. The location and target of each ROV dive is provided in Appendix B.

The ROV SuBastian was set up with a vibrocorer attachment, deployed on a science expedition for the first time during this cruise. Because of the time taken to fix and remove the vibrocorer on the ROV, the corer remained mounted on the ROV throughout the expedition. The corer rack places some limits on other observational and sampling instruments on the ROV, but could still be used in conjunction with several cameras, and with other sampling methods using the ROV manipulator arms. At several sites, the arms were used to collect surficial sediment samples using numbered canvas scoop bags, and intact short samples of seabed sediment were collected using push cores, retrieving up to 25 cm of surface sediment with limited disturbance. These samples were taken to meet the biological aims of the project, and to complement the longer cores collected with the vibracorer.

5.2.1 Dive overview and sampling

ROV dive sites were selected based on geological interpretations of sediment routing through the survey area, to obtain as wide a spatial coverage as possible, and on the basis of seabed morphological and sub-bottom interpretations from data collected during the expedition (see Appendix B). For the latter, we targeted sites that indicated well-layered sediment accumulations, likely to be penetrated by the vibrocorer. Because the principal target was sampling, dives were not generally used for extensive seabed transects and video observations. Each dive therefore comprised a descent, a short observation of the local seafloor to select a landing site, and then sampling of the seabed. Dive times were generally between one and three hours, depending on the number of samples being collected. At a few sites, there were exceptions to this approach. Offshore the Rayas delta, it was found that very strong currents limited the diving window to periods of high or low tide. Furthermore, the seabed in this area was found to be scoured by strong currents in this area, preventing core penetration and preserving hard, pebbly clay deposits that could not be sampled using our coring methods. Offshore the Chaitén delta, visibility at the shallowest sites was extremely poor due to suspended mud, and this also limited sampling in this area. Short mapping transects, using an echosounder on the ROV, were attempted at Station 009, over glacial scour structures south of the Rayas delta, but this did not recover usable data, likely compromised by the weight of the vibrocorer rack on the ROV. Finally, at the Simpson Canyon sites, the ROV dives were much longer because of the water depth, and to maximise the potential of these sites, transects were taken across short sections of seafloor to make observations and collect samples at multiple nearby locations.

A typical ROV dive sequence was as follows: Pause 5 m above seafloor to collect a near-seabed water sample (1-2 Niskin bottles). Descend to seafloor, wait for any disturbed suspended mud to clear, and take a second water sample (1-2 Niskins). If the site was suitable (e.g. clear of rocky material), geological sampling was then undertaken, starting with push cores. Each push core was inserted using the manipulator arm to remove a numbered core from the storage rack, insert this smoothly into the sediment, and then retrieve the core and return it to the rack. Visual observations could be used to identify and record disturbance (e.g. loss of sediment, disruption to layering) and to make basic observations through the transparent wall of the cores. Three push cores were generally taken for geological purposes, in order to provide enough material for subsequent analyses. At several sites, up to two additional cores were also taken for biological purposes, to provide representative bulk samples of surficial sediment.

Following push-coring, vibrocores were taken on several dives. In general, two cores were collected per site, in order to provide a duplicate that could be stored for later core logging and scanning under controlled laboratory conditions, and one core that could be opened on board for photographing, description and sub-sampling, which was important to guide subsequent decisions over sampling. In all cases, the shorter vibrocore was chosen for splitting on board, and the longer core was archived. In some instances, a third core was taken, if one had been compromised during collection (e.g. dropped during recovery). Each vibrocore was inserted during two to three drives, until resistance impeded any further sediment penetration. In most instances, it was possible to penetrate the core close to the full length of the aluminium core tube. The first dives used 1.5 m tubes, but this was later switched to 2 m tubes in an effort to get greater core recovery. Where successful, this resulted in core lengths that were typically between 1-1.5 m. Penetration depth could be gauged visually from the ROV, and for the first few dive sites it was found that the recovered length was tens of centimetres less than expected, implying either sediment loss or compression. Given that soft, unconsolidated nature of the surface muds, it is likely that compression was affecting the recovered cores, and various adjustments were made to coring conditions during the first few dives. These included collecting duplicate cores with and without the top valve, which made no identifiable impact on recovered core length. When the valve was removed, recovery was still good and cores weren’t identifiably affected by sediment loss at the top of the core during ROV retrieval, but nor did this result in longer recovered cores. As such, valves were left on in subsequent dives. A second modification that was tested was to the core catchers, in an effort to reduce stiffness and ease initial penetration of the sediment. This appeared to result in some improvement to core length, and a modified form of the core catcher, with shorter teeth, was adopted thereafter. This was effective except in sandy sediment, where sediment loss, particularly at station 022, was observed during recovery, potentially affected by the relatively looser core aperture structure.

When coring, if the seafloor was too disturbed by prior sampling, the ROV was lifted and moved by a few metres to an area of clean seafloor. Finally, scoop bags were collected using the manipulator arm, to retrieve bulk samples of surficial sediment for biological purposes. These canvas bags, on a metal frame, were numbered and stored in a crate on the base of the ROV, adjacent to the push cores. Each bag was dragged through the surface sediment with the manipulator arm, potentially recovering several kilograms of sediment. Three to four bags were typically collected. In some instances, visibility or the nature of the seafloor hindered recovery.

Throughout each ROV dive, electronic and paper logs were recorded of seafloor conditions and the sampling sequence, including any notable observations. Biological observations were also logged from the camera streams throughout each dive.

Table 4: ROV dive and sampling summary (see Appendix C for a full sampling summary of FKt240902)

Station number	SOI ROV Dive number	Location	Coordinates	Water depth (m)	Niskin bottles	Vibro cores	Push cores	Scoop bags
001	S0703	Reloncaví Fjord inner basin	-41.560157, -72.33159	197	2	3	4	4
002	S0704	Reloncaví Fjord middle basin	-41.677618, -72.401345	212	4	3	3	0
003	S0705	Southern Golfo de Ancud	-42.355775, -72.966682	244	3	2	6	4
004	S0706	Chulin channel	-42.559526, -72.96126	229	2	2	5	4
005	S0707	Rayas Delta 1	-42.785656, -72.877841	145	2	1 (failed)	0	4
006	S0708	Rayas Delta 2	-42.768558, -72.871144	139	2	1	0	4
007	S0709	Rayas Delta 3	-42.742297, -72.862839	131	2	3	0	2
009	S0710	West of Chaitén Bay	-42.851944, -72.903384	134	2	2	6	5
011	S0711	Central Chaitén Bay	-42.895057, -72.850521	128	2	3	5	0
012	S0712	Chaitén Bay N Side	-42.878000, -72.809004	105	2	2	4	0
013	S0713	Basin to far west of Chaitén	-42.890467, -73.080583	196	2	2	5	4
016	S0714	Chaitén delta front central upper slope	-42.914449, -72.751420	93	2	2	0	0
017	S0715	Chaitén delta front central mid slope	-42.908434, -72.779745	114	2	2	5	3
018-019	S0716	Platform margin N of Yelcho outflow	-42.921532, -72.799098	118	2	4	6	0
022	S0717	Channel N of Yelcho delta	-42.926852, -72.811582	170	2	2	3	1
023	S0718	Basin 1 W of Yelcho channel	-42.934765, -72.859799	252	2	2	6	4
025	S0719	Basin 2 W of Yelcho channel	-42.942227, -72.924678	236	2	2	3	0
026-029	S0720	Simpson Canyon outflow	-44.231714, -75.796282	3435	4	4	6	3
030-032	S021	Simpson Canyon feeder channel	-44.114967, -74.992036	856	3	2	5	5
034	S022	Basin offshore Yanteles and Melimoyu	-43.710918, -73.083127	198	3	2	5	4

5.4 Geological sample processing

In addition to the sampling conducted during ROV dives (summarised above in Section 5.3), seafloor samples were also collected via a van-Veen grab and a gravity corer deployed from the rear of the ship (see Appendix C for a full sampling summary). The grab was used either when a larger volume of sample was targeted, or to target coarse grained sediment that was likely to be too coarse to core. Seven grab sites were sampled in total, all successfully retrieving material. These comprised four sites at locations on the a gravel-dominated dune facies offshore the Rayas river system and along the shore to the south, two sites on the front of the Chaitén delta (which were mud dominated), and one site at the head of the Simpson Canyon system, to target the upstream basin-filling sediment. A gravity corer with a 3-m core barrel was also taken on board, to offer the potential for deeper core penetration and as an alternative system in place of vibrocoring. In the event, this was only deployed for sampling at two sites, and did not recover any deeper sediment than that achieved through vibrocoring. One site was a repeat of station 013, retrieving a slightly shorter core (1.08 m) than that taken on the ROV dive, and one was to the south of the Corcovado Gulf, recovering a 62 cm core.

Following recovery, geological samples were processed as follows. VIbrocores were labelled with the site name and in sequence of collection (A, B, C). Each was removed vertically from the ROV and an end cap placed on the core tube base (the core catchers were riveted to the core tube and remained in place). Tube tops were then cut systematically to the top of the sediment, measuring the water by displacement until the top surface was exposed. A top cap was then added, with foam used for packing in the case of any gaps. All cores were then sealed with tape and placed upright in cold storage ahead of any further processing. For all sites where duplicate cores were collected, the shorter core was then selected for splitting on board. The aluminium tube was cut down each side, the core split with wire, and the surfaces cleaned ahead of description. One core half was selected for photographing, with photos taken above a horizontal sliding rack, and the second core half described by visual logging and then subsampled for a range of purposes. Visually and sedimentologically distinct layers marking a departure from the background (e.g. tephra fall deposits or other event beds) were sampled where identified, either targeting complete layers or, for thicker or graded units, multiple intervals. When present, macroscopic materials suitable for radiocarbon dating (e.g. shell or vegetation fragments) were separately sampled into a vial and then refrigerated at 4 °C.

From the split vibrocores, sediment was then sampled at regular intervals for:

- Microbial diversity and mercury measurements (two separate samples), generally at 10 cm intervals or bounding specific layers of interest, with samples sealed in a cryotube and stored after sampling in a freezer at -80 °C.
- For subsequent isotopic analysis (C, N), micropalaeontological (e.g. diatoms, foraminifera) and grainsize analysis (separate samples), generally 2-cm sections taken at 10 cm intervals, and then refrigerated at 4 °C.
- Sedimentologically distinct layers, interpreted as volcaniclastic horizons, were subsampled based on visual logging, dried in an oven at 40 °C for 24 hours, and then stored at room temperature.

Layers of interest (both for volcaniclastic and micropalaeontological purposes) were frequently examined as smear slides, to guide sampling strategies and interpretation. Dried volcaniclastic samples, especially those considered to represent fall deposits, were also analysed, after drying, using a portable XRF (pXRF) for chemical analysis of major and trace elements. All samples were retained for subsequent laboratory analysis, and duplicates were taken to be stored and analysed separately by science team members.

In general, three push cores were selected from each ROV dive for geological sampling. The longest core or that which, based on visual ROV observations, was least disturbed upon recovery, was selected for sub-coring, with a narrower PVC tube inserted down the centre of the push core to retain an intact core section. These tubes were sealed and then stored vertically, refrigerated at 4 °C. The residual sediment around the margin of this secondary core was then sampled and bagged, generally at 5 cm intervals. From either this or one of the remaining push cores, surface water samples were also retained in an acid-cleaned vial, and the top 1-2 cm of sediment was then sampled separately and stained with Rose Bengal, before washing and sieving to pick foraminifera. Samples were then taken at 5-cm intervals for sieving and picking to extract foraminifera for future radiocarbon dating. Any macroscopic materials suitable for radiocarbon dating (e.g. shells) were retained separately. The remaining push cores (generally two cores) were then subsampled at 1-cm slices through the full length of the push core, with bagged samples refrigerated at 4 °C. Small sub-samples were also generally taken from one push core for mercury and microbial diversity sampling (from the top 1-cm and then at 5-cm intervals), and stored in criotubes alongside the similar samples taken from the split vibrocores.

At some sites, if the ROV scoop bage samples recovered material of geological interest (e.g. volcaniclastic sediment or lithic clasts), these were sampled separately as a bulk bag of near surface sediment.

Samples collected via the van-veen grab were generally recovered as bulk sediment samples, although where the grab recovered muddy sediment, a sub-core was also taken in order to preserve any stratigraphic structure within the grab. Multiple duplicates of the bulk grab-sample were generally taken, and then placed in cold storage alongside the vibrocores.

The two gravity cores, once recovered onto the deck, were kept as intact cores, stored in a similar way to the vibrocores. The core liner was cut to length and then sealed, before being stored vertically at 4 °C. Core catcher samples were retained separately as bagged samples.

5.5 Biological sample processing

Once the ROV was on board the ship, scoop bags were removed from the storage crate and processed in the *Falkor (too)* “HydroLab” laboratory. The sediment from the Scoop bags was sieved with sieves with a mesh opening of 1, 0.5 and 0.3 mm. The organisms found were separated and saved in a 50 ml Falcon tube, while the remaining sediment on the 0.3 mm sieve was saved as “residue” in a plastic container with 80% ethanol. From the four Scoop bags, 3 replicas of waste and 4 Falcon tubes with benthic organisms were obtained, which were stored in the cold lab at 4°C.

From push cores targeted for biological sampling (generally two push cores per site, but not taken for all ROV sites, because the purpose for this sampling was to obtain a wide geographic coverage), the upper 5-cm of the sediment column was sampled, and from these, 4 replicas were obtained for geochemical analysis (organic matter, carbon isotopes, chlorophyll and grain size). The replicas were wrapped in metallic foil and then placed in plastic bags, and stored in a freezer at -30°C in the HydroLab.

For the qualitative meiofauna study, a small sample was taken from one of the “Scoop bags” and stored with 5% formalin. For the study of dinoflagellate cysts, a small sample was taken from three different scoop bags, which were then wrapped in aluminum foil and stored in the ColdLab at 4°C.

5.5 ADCP, CTD and water sampling

The R/V *Falkor (too)* is equipped with bottom and water column sonars that operate at multiple frequencies. For measure the speed of the current in the water column sampling in the study area, two different frequency Acoustic Doppler Current Profilers (ADCPs) were used. The 300 kHz Teledyne Workhorse Acoustic Doppler Current Profiler allowed us to obtain better resolution of surface layers down to 125 m, while the 38 kHz Teledyne Ocean Surveyor Acoustic Doppler Current Profiler provided better resolution for deeper layers (up to 1000 m). Data collection was continuous during the vessel's movement, except when the ship stopped at stations for ROV dives or Oceanographic Rosette casts. Regarding the analysis of ocean current data, the R/V *Falkor (too)* has efficient preliminary processing of space-time graphs over 1.5-day periods, averaging the data every 15 minutes. These graphs display the U component (E-W), V component (N-S), backscatter, the percentage of good data, and the vessel’s speed and heading.

The R/V *Falkor (too)* is equipped with a Sea-Bird Electronics 911plus (Table 5) CTD system mounted on a rosette capable of holding 24 Niskin bottles, each with a capacity of 12 liters. Before each deployment, the system was inspected to ensure it was functioning correctly and that all cables and connectors were free from damage or wear and that all communication systems were operational. The CTD was lowered using a J-frame from the port-side hangar door (MacArtney MASH 10,000 Winch, spooled with 0.322" electromechanical cable), to an initial depth of 5 meters for 3-5 minutes to stabilize the sensors. After stabilization, the rosette was brought back to the surface before beginning the descent, up to 10 meters above the maximum station depth, indicated by the altimeter. Real-time data was continuously monitored to detect any anomalies, and deployment stopped immediately if any issues were detected.

Table 5: Sensors Installed on the Sea-Bird Electronics 911 Plus CTD

Sensor System	Hydrographic Parameter
Sea-Bird Electronics Model 45 and SBE 38	Sea Water Temperature, Conductivity
WET Labs ECO-FLS	Fluorescence
AFT-pH Solar Radiation Sensors	pH
WET Labs C-Star Transmissometer	Transmissivity
Valeport Minisvs	Sound Velocity

At the time of the rosette cast, two 12 L Niskin bottles were collected at the point of maximum depth reached by the rosette. The depth indicating the highest concentration of fluorescence (chlorophyll-a fluorescence maximum) in the same water column profile was determined from the data feed, and two additional Niskin bottles collected at this estimated maximum fluorescence depth. This estimation of the fluorescence maximum makes it possible to relate living populations (diatoms and other organisms) to the seafloor assemblages. Samples were extracted from the niskin bottles following recovery of the rosette onto deck, with one sample generally taken from the seafloor and from the chlorophyll-a maximum, and decanted into either acid cleaned bottles or vials, then sealed and refrigerated at 4 °C ahead of post-cruise analysis.

Seafloor water samples were also collected during each ROV dive, as described above, using Niskin bottles mounted on the ROV. These were collected in the same way as those taken on the rosette, stored in cleaned bottles or vials for post-cruise isotopic analysis or for biological analysis (these samples were strained through a 38 micron mesh on collection).

6. Preliminary Results

6.1 Marine geomorphology and sedimentary processes: bathymetry and sub-bottom profiling

A total of ~2700 km^2 of MBES data and 3325 km of SBP profiles were acquired during the cruise (Fig. 4). MBES data is generally of good quality with little to no noise or diffractions and allow geomorphological characterization of seabed features at metre-scale. The SBP29 data shows good penetration into the subsurface, ranging from 40 ms to 80 ms which is between ~30 and 60 m below seafloor (see example image shown in Fig. 5), except for areas where coarse-grained sediments, bedrock, or steep slopes scatter the transmitted energy and distort the proper imaging of the subsurface. These data provide useful information to identify sediment and depositional types. In acoustic reflection theory, high amplitude reflectors (imaged with dark colours in black to white scale) typically represent high acoustic impedance, indicating denser, coarse-grained sediments with higher sediment velocity, while low-amplitude reflectors (light-colours) represent low acoustic impedance indicating fine-grained and porous sediments with higher water saturations.

The sediment depositional types predominantly formed by bottom currents and identified by their reflection characters include: mass transport deposits (MTDs), turbidites, contourites, sand dunes and waves, channels and moats, and erosional surfaces and truncations. MTDs are characterised by their lobate-shape geomorphology with transparent or low amplitude chaotic internal reflections that are interbedded with higher amplitude moderate-to well-stratified units representing turbidites. In the Rayas, Blanco and Chaitén delta areas, SBP data show moats and contouritic drift deposits that can be defined by their mounded internal reflection patterns (mounded drifts). Internally, they show moderate-to-high amplitude reflections. Through the south, they are incised by channels, and cycling episodes of incision and filling are also observed. From the Rayas delta through the south, numerous contouritic deposits including sand dunes and sand waves are observed on the seafloor topography. The main surveyed areas characteristics are described below.

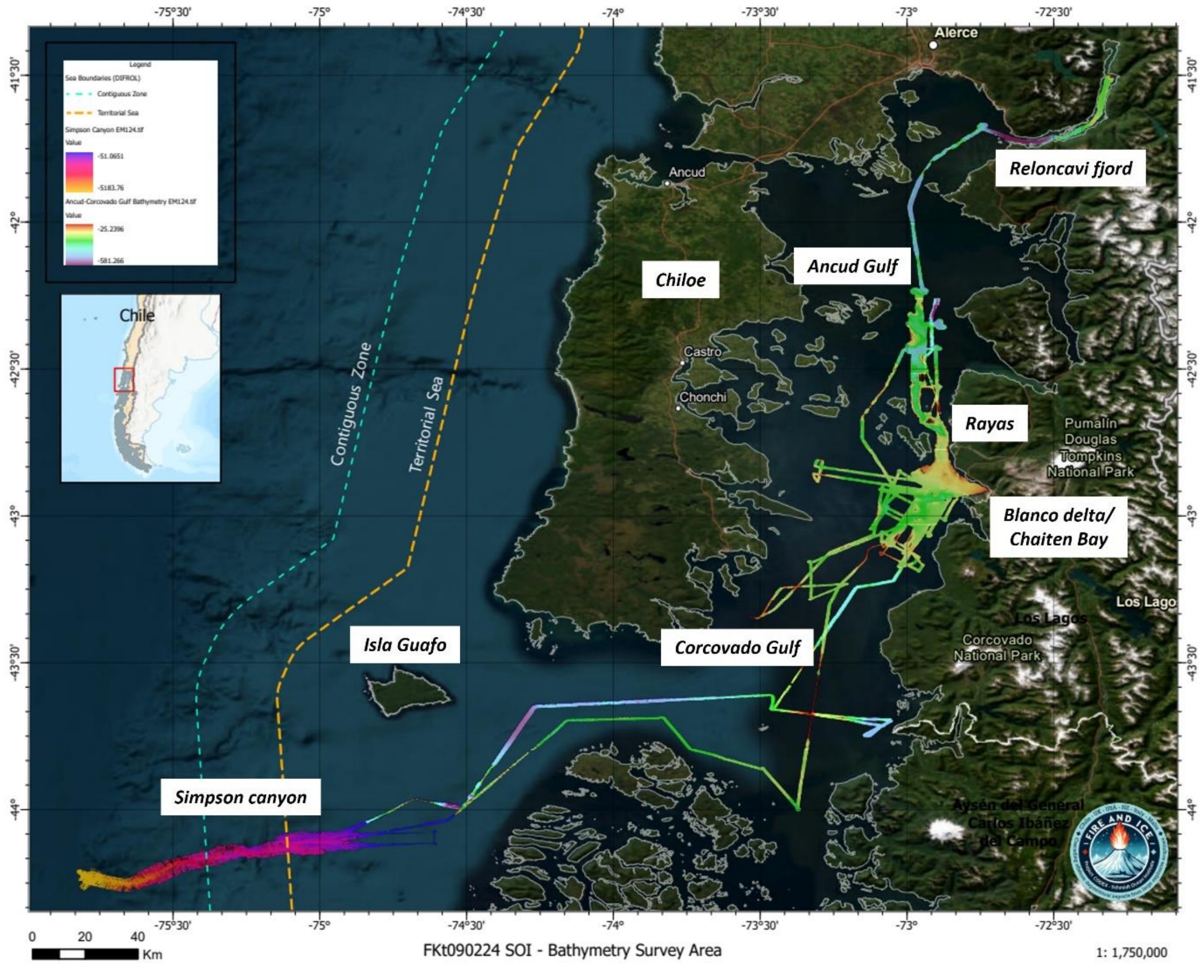


Fig. 4: Total bathymetric coverage from FKt240902. Sub-areas, discussed in the sections below, are labelled.

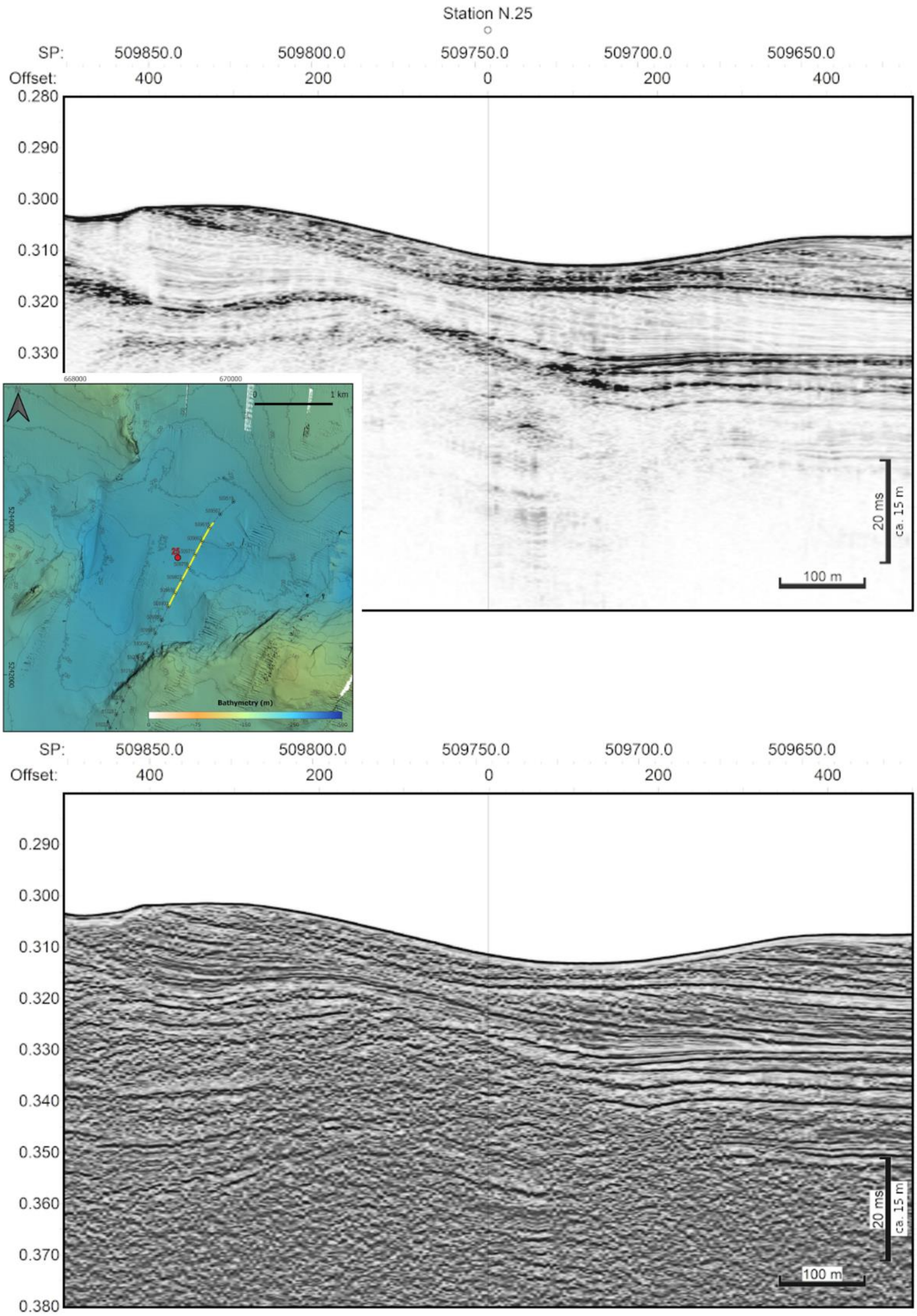


Fig. 5: Example sub-bottom profile from FK4240902, from Station 025, west of Chaitén Bay in the northern Corcovado gulf (line position shown in inset map). The profiles show the typical basin infill that characterises much of the survey area. The upper panel shows the acquired sub-bottom profiles with minimal processing, and the lower panel a processed version with higher gain. A set of profiles collected across each ROV dive site is shown in Appendix G.

Reloncaví Fjord
The first stage of FKt240902 covered the Reloncaví Fjord, which was surveyed for a total mapped area of 90 km^2 (Fig. 6). The MBES data show a bathymetric range between 40 and 400 m, with the shallowest part in the north and the deepest in the south of the fjord. The fjord is 41.5 km-long, with an average width of 3 km, with surface sediment features including MTDs, debris fans and sediment waves. The most prominent near-surface MTD is located in the centre of the fjord and it shows three rounded shaped scars of average width between 300 and 600 metres. These three scars are coalescent and potentially suggest a rotational landslide. Evidence of blocky debris is also observed between 800 and 1000 m south-west of the landslide complex. Three large debris fans are also located in the central and southern part of the Reloncaví Fjord, all of them on the southern margin of the fjord, with minor fans observed in between the major features. The average slope of the largest fan ranges between 16% to 24%, with a width of 1.2 km and an average surface extent of 1.94 km^2. The northern edge of this fan is limited by a 4 km erosional channel, which shows evidence of 'cyclic steps', suggesting the presence of gravity flows in the area. In addition, we observe gullies eroding the southern sector of the fan, which corroborate the occurrence of gravity flows in the area. Sediment waves are also observed in the Reloncaví Fjord, in particular in relation with the erosional channel.

The north-central sector of the Fjord is characterised by three topographic aligned heights which potentially represent volcanic intrusions and/or evidence of glacial deposits. The SBP sections in the fjord reveal at least 3 successions of MTDs, which are defined by their blanking reflection characteristics, interbedded with well layered sediments.

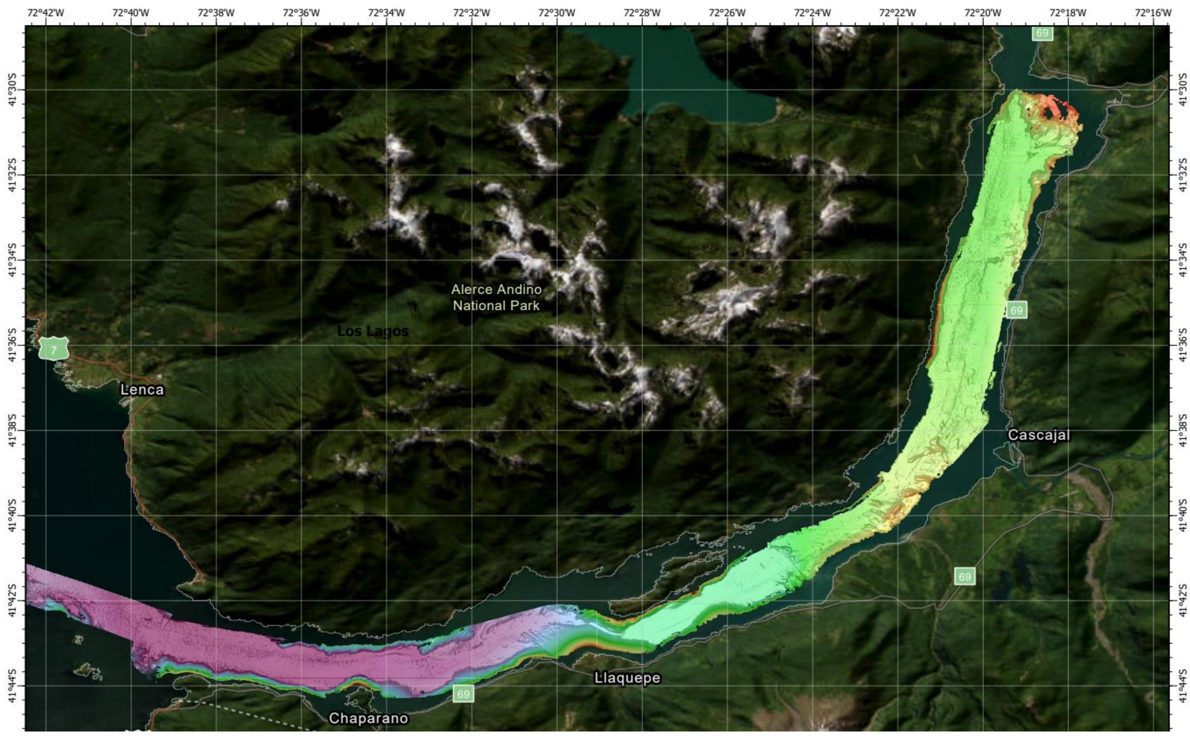


Fig. 6: Bathymetry collected in the Reloncaví Fjord during FKt240902.

Ancud Gulf and Rayas
Following surveying in the Reloncaví Fjord, FKt240902 progressed southwards on a long transect across the Ancud Gulf and towards Chaitén Bay, passing the outflow of the Rayas river in a narrow strait (Canal Desertores) between Isla Talcan and the mainland, with this section here referred to as the Rayas sector. The Rayas sector was surveyed for a total of 290 km^2, starting from the Ancud Gulf and progressing southwards to the Rayas delta. The average bathymetric range of the seafloor in this area is between 67 and 293 m depth. This

area is characterised by topographic highs that range between 50 and 70 m depth. Sediment waves and cyclic steps can be observed within channels, particularly north of Isla Talcan and towards Isla Chulin, with a line of barchanoid dunes of different sizes trending NW-SE, from the Rayas outflow towards the Chulin channel. These dunes transition into a coast-parallel field of longitudinal dunes, over 10.6 km long, located seaward of the Rayas Delta and extending south along the coastline into the north side of Chaitén Bay, with some individual dune features having a length over 1 km. Sub-bottom profiles sow contouritic deposition within the channels north of the Rayas outflow, including detached mounded drifts, moats and plastered drifts.

Blanco delta and Chaitén Bay

South of the Rayas, the bay immediately west of Chaitén town was extensively surveyed in a grid, given its particular relevance for the primary cruise objectives (Fig. 7). We refer to this area as Chaitén Bay, with the delta system offshore Chaitén town referred to as the Blanco delta (note that the Yelcho river also enters this bay to the south). A total of 126 km^2 was surveyed in this area. The northern sector is characterised by a gently inclined surface, with seafloor depths between -130 and -70 m, and a relatively featureless seafloor. Backscatter images show longitudinal erosional features extending in places for several kilometres, in ENE, N, and NNW directions, which may be related to sub-glacial erosion linked to ice-sheet advance or retreat. These are most prominent in the NW of this area (Fig. 7).

Offshore Chaitén town, the delta front to a depth of ~100 m preserves hummocky features and multiple tapering transparent deposits in SBPs. To the south, a prominent 1-km wide channel to the west of Chaitén town and north-west of the Yelcho outflow, broadly aligned E-W, feeds into several small basins separated by bathymetric highs, forming the deepest seafloor in this region. The seafloor in the channel shows cyclic steps and broad dune-like features extending onto the elevated platform north of the channel.

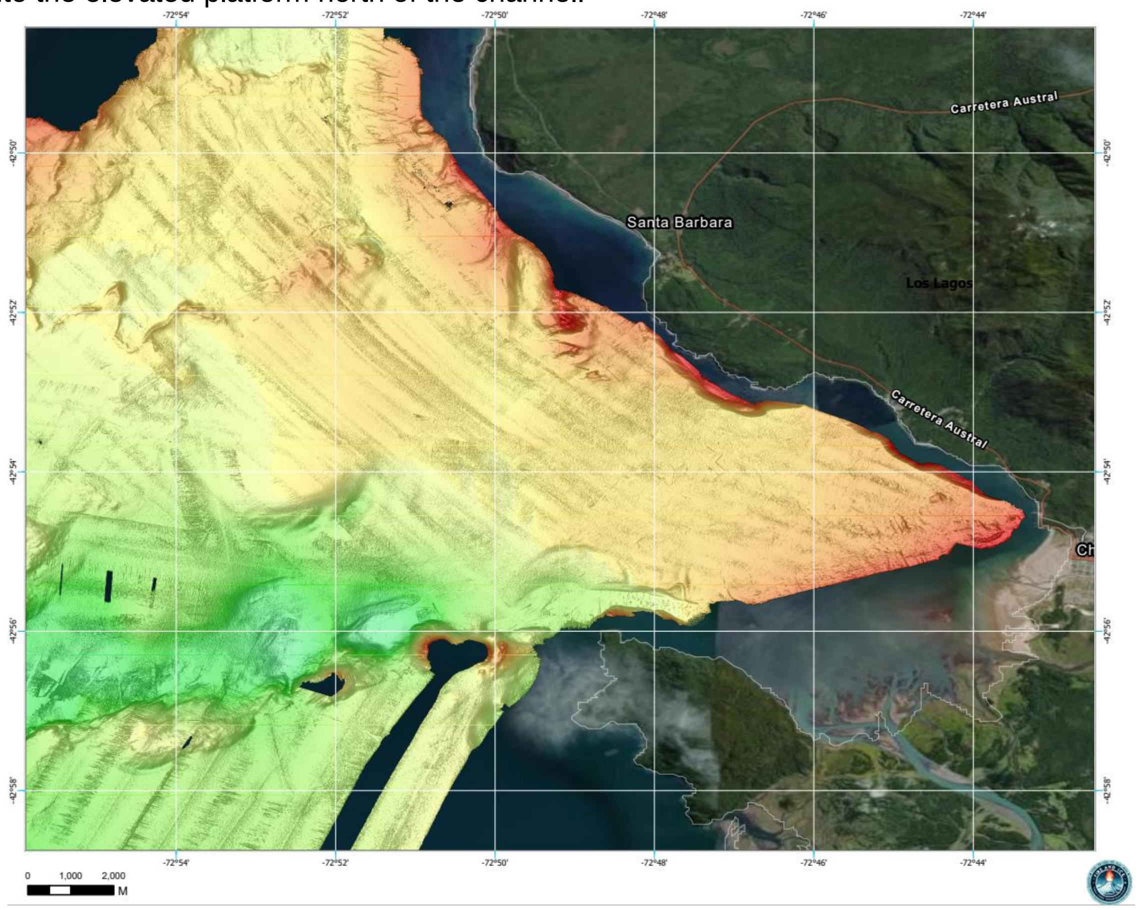


Fig. 7: Bathymetric coverage in Chaitén Bay collected during FKt240902.

Corcovado Gulf
West of Chaitén bay, coverage is more limited, but a broad grid of lines was collected in the northern Corcovado gulf, highlighting several basins with relative highs between these, and extensive contouritic features within basins, with well-layered sediment accumulations in many of the deeper areas. This series of exploratory lines covers approximately 120 km^2. A number of ROV dives and cores were collected through this area, but without the dense coverage of the southern Rayas and Blanco delta/Chaitén Bay areas.

Long transects were taken through the southern Corcovado gulf and out to the Isla Guafo, crossing over a wide elevated platform in the southern Corcovado gulf. SBPs and bathymetry suggest this is a relatively hard surface and potentially preserves glacial features. Thick, well-layered sediment accumulations occur in the deeper parts of the gulf west of this feature and in the channels to the south and east (which connect to the fjords to the south).

Simpson Canyon
The Simpson Canyon was surveyed in the later part of the cruise, in a change of scheulde linked to adverse weather conditions (which necessitated a transect to the channel sooner than planned, and then a return route via the Corcovado Gulf rather than on the Pacific Ocean side of Chiloe). Poor weather and heavy sea conditions compromised the data acquisition of both the EM124 and the SBP29. The EM712 was not used in this area due to depth range (with the canyon extending to over 3500 m. Approximately 80 km^2 were surveyed in this areat. Unfortunately, the poor data acquisition inhibits detailed geomorphic interpretations of the features in this area.

6.2 Sedimentology and stratigraphy: core samples

As described in Section 5, selected cores were opened on board, with the remainder kept in storage for later core scanning and sub-sampling. Here, we describe initial observations from those cores opened on board, supplemented with observations made while sub-sampling the push-cores, on the seafloor via the ROV cameras, or through the van-Veen grab samples. A brief geographic description of each sampling region is followed by a summary of the volcaniclastic stratigraphy. A summary of all geological samples recovered is provided in Table 6 below, showing recovered lengths and noting the main characteristics of each core and site.

Reloncaví Fjord
Six vibracores were collected from within Reloncaví Fjord, three at station 001 in the inner basin and three at station 002 in the middle basin (all repeated cores from the same location). Of these, one from each site was opened on board. The core from 001 comprises brown-grey silty clay with faint laminations in parts, with little variation except for one prominent cm-scale dark grey volcaniclastic sand around 50 cm depth. The push core recovered similar silty clay to the dominant sediment in the vibrocore, similar to the material observed on the seafloor. A comparable stratigraphy was present in the core opened from station 002, but with a volcaniclastic sand (inferred to correlate with that at 001) slightly shallower (around 34 cm) and thicker (2.5 cm) and coarser (Fig. 8).

Table 6 (3 pages): Summary of all core and grab sampling on FKt240902.

	Station	Location	Vibrocores	Recovered length (m)	Status	Summary (volcaniclastic)	Push core - sub core and sampling	Other samples/notes
Reloncavi	001	Reloncavi inner basin	001-A	0.97	Archived		D (24 cm); B sub-sampled	
			001-B	0.79	Split, sub-sampled	Same as 001-C		
			001-C	0.76	Split, sub-sampled	Dark medium ash, 2.5 cm, at 50 cm; reworked above, no other visible units		
	002	Reloncavi middle basin	002-A	0.95	Archived		A (18cm); B, C sub-sampled	
			002-B	0.55	Archived			
			002-C	0.91	Split, sub-sampled	Dark medium coarse ash, 3-cm, at 35 cm; no other visible units		
Ancud	003	Golfo de Ancud	003-A	0.73	Split, sub-sampled	No visible units; slight variation in grain size	F (21 cm); B, D, E sub-sampled	
			003-B	0.89	Archived			
	004	Chulin channel	004-A	0.89	Archived		A (23 cm); C, E sub-sampled;	
			004-B	0.81	Split, sub-sampled	Multiple sub-cm fine-sand/silt layers through upper 50 cm, and a prominent 4-cm pale grey very fine ash at 40 cm		
Rayas	005	Rayas delta (outer, central)				Pebbly hard seafloor with patchy rippled surfaces of volcaniclastic dark and light sand		Scoop bags A, B, C - bulk pebble and sediment samples
	006	Rayas delta (central)	006-A	0.23	Archived	Gravel substrate, limited core recovery; pebbly seafloor (mixed volcanic) with clay patches, and overlying rippled dunes of dark and light volcaniclastic sand and gravel		Scoop bags A, B, D (bulk sand, picked pebbles); C (clay substrate)
	007,008	Rayas delta (central; dune facies)	007-B	0.57	Archived	Rippled dunes of dark and light volcaniclastic sand and gravels		007: Scoop bags A, B (bulk gravel; picked pumices; wood); 008: van-Veen grab - bulk sediment samples and wood
			007-C	0.35	Split, sub-sampled	Alternating dark/light (i.e. pumice poor/rich) coarse volcaniclastic sands/gravels on cm-scale		
	010	Dune facies S of Rayas delta				Volcaniclastic sands		010-A: van-Veen, bulk sand samples and wood
	020	S of Rayas delta, dune facies				Volcaniclastic sands		020-A: van-Veen, bulk sand samples; 2 sub cores
	021	W of Rayas delta, dune facies				Volcaniclastic sands and pebbles		021-A: van-Veen, bulk pebbles and bulk sand samples
Chaiten Bay	009	Glacially scoured seafloor, S of Rayas/W of	009-A	0.8	Archived	Hard clays and cobbles below surface sediments	C (19.5 cm); B, D sub-sampled	
			009-B	0.39	Split, sub-sampled	Hard clay base, then shell fragment layer and overlying dark mud		
	011	Outer Chaiten Bay (central)	011-A	1.59	Archived		C (23 cm); A, B, D, E sub-sampled	
			011-B	0.37	Archived (compromised)			
			011-C	1.22	Split, sub-sampled	Silty muds with patchy lamination and mm-scale grey lenses, potentially volcaniclastic but no prominent visible layers		

Station	Location	Vibrocores	Recovered length (m)	Status	Summary (volcaniclastic)	Push core - sub core and sampling	Other samples/notes
012	Chaiten Bay N side	012-A	1.38	Archived			
		012-B	1.22	Split, sub-sampled	Multiple sub-cm grey silt layers throughout core; one prominent 5-cm very fine pale grey ash at 42 cm	B (22 cm); A, C, D sub-sampled	
014	Chaiten delta front, lower				Homogenous fluidal mud		014-A: van-Veen, bulk mud samples; mud-sub core
015	Chaiten delta front, mid-slope				Homogenous fluidal mud		015-A: van-Veen, bulk mud samples
016	Chaiten delta front, central upper slope	016-A	1.53	Archived			
		016-B	1.05	Split, sub-sampled	73 cm of dark organic-rich laminated muds, then remainder comprising pale grey fine ash interbedded with darker mud rich layers, some coarser with sparse pumice		
017	Chaiten delta front, central mid slope	017-A	1.2	Archived		D (22 cm); A, C sub-sampled	
		017-B	1.04	Split, sub-sampled	Very coarse 4cm dark volcaniclastic layer near top, but mud dominated for upper 40 cm, organic rich, then pale grey to white ash dominated below, multiple parallel layers on cm scale, streaked with dark organic rich layers throughout, more mud-rich in lowest part of the core		
018	Platform N of Yelcho outflow (dune crest)	018-A	1.46	Archived		A (19 cm); B, C sub-sampled	
		018-B	1.01	Split, sub-sampled	4 cm pale grey fine ash at 14 cm, with sub-cm ashy layers in muds above; thin sub-cm pale lenses in deeper core and one-dark layer, but no further prominent units		
019	Platform N of Yelcho outflow (dune trough	019-A	1.45	Archived		C (18.5 cm); A, B sub-sampled	Push core pale grey ash below 10 cm upper mud
		019-B	1.24	Split, sub-sampled (top 50 cm may be compromised)	4cm pale grey fine ash at top (may be better recovered in push cores), and multiple sub-cm pale layers through deeper core, with two cm-scale dark ash layers near base		
022	Channel N of Yelcho outflow	022-A	0.56	Split, sub-sampled	Several normally graded coarse sand to fine sand layers, dark and light (some pumice rich), coarse at base	A (23.5 cm); B, C sub-sampled	SB-022-A: Scoop sample of sand fallen out of core during recovery - bulk volcaniclastic sand sample
		022-B	0.68	Archived	Sand observed pouring out of core (most material lost; upper parts may be disrupted)		
023	First basin W of Yelcho channel	023-A	1.12	Split, sub-sampled	6 cm pale grey fine ash near top of core (4 cm; see also push cores); and a dark medium ash (2.5 cm) at 22 cm; no visible units deeper in core	C (22 cm); D (22.5 cm); A, B sub-sampled; ash bulk sample separated from E and F	Push core pale ash present below seafloor mud; SB-023-A: pumice clast separated from scoop bag; bulk ash also separated from push cores
		023-B	1.3	Archived			

	Station	Location	Vibrocores	Recovered length (m)	Status	Summary (volcaniclastic)	Push core - sub core and sampling	Other samples/notes
	025	Second basin W of Yelcho channel	025-A	1.03	Split, sub-sampled	No structures or visible units in upper part of core, then normally graded below 50 cm, to medium coarse sand with adundant shell fragments near base and angular mixed grains at base/core catcher	C (23.5 cm); A, B sub-sampled	
			025-B	1.21	Archived			Sieved core catcher sample, dark coarse-sand to gravel
	013	N Corcovado gulf, basin to far W of Chaiten	013-A	1.37	Archived		A (21 cm); B, C sub-sampled	
			013-B	1.28	Split, sub-sampled	Sandier lower part, more foram rich, grading up to silts, weakly laminated in parts, no visible volcaniclastic layers		
	024	N Corcovado gulf, basin to far W of Chaiten	GC-024-A	1.08	Archived	Same as 013		
S Corcovado	034	Basin offshore Yanteles and Melimoyu	034-A	1.07	Archived		B (15 cm); C (14 cm); A sub-sampled	
			034-B	0.93	Split, sub-sampled	Generally structureless silts, with at least two dark fine sands on cm scale, likely volcaniclastic		
	035	W of Corcovado Gulf platform	GC-035-A	0.62	Archived			
	026	Simpson Canyon outflow (1)	026-A	0.41	Archived		A (20 cm); B sub-sampled	
	027	Simpson Canyon outflow (2)	027-A	0.55	Split, sub-sampled	Repeated sequence of dark normally graded sands on several cm-scale, separated by several cm of silt, 7 sandy units in total	A (23.5 cm)	
	028	Simpson Canyon outflow (3)	028-A	0.77	Archived		A (15 cm)	
	029	Simpson Canyon outflow (4)	029-A	0.195	Archived		A (17.5 cm); B sub-sampled	
	030	Simpson Canyon feeder channel (1)						SB-030-A: clay with pebbles (surface sample)
	031	Simpson Canyon feeder channel (2)						Bio samples only (scoop bags and push cores)
	032	Simpson Canyon feeder channel (3)	032-A	0.87	Archived		B (21 cm), A, C sub-sampled	
			032-B	0.66	Split, sub-sampled	Silty clay with three interbedded cm-scale dark sandy beds, with erosional bases		
	033	E of Simpson Canyon						033-A: van-Veen, bulk sediment samples, 2 sub-cores

Ancud Gulf and Rayas

The Ancud Gulf was not a priority target, given the expected routing of sediment from the Chaitén eruption through Chaitén Bay, but two sites were targeted to constrain potential sediment routing from the Rayas outflow and to the north. The first site was more distal from the Rayas, in an isolated basin north of a set of glacial channels. The core at this station (003) preserved no visible distinctive layers, comprising greenish-grey silty clays to fine sands/silts, with faint laminations on a mm-scale in places. The push core recovered similar material. Further south, a site at a margin of a prominent N-S channel (here referred to as the Chulin channel; 004) recovered brown-grey silts to fine sands, with occasional bivalve fragments but little structure or grading, except for a prominent ~4-cm thick pale grey volcaniclastic very fine silt, characteristic of a tephra (ash) fall deposit (Fig. 8). Other pale mm-scale layers are also present in the core, potentially representing additional volcaniclastic inputs.

The first region surveyed and sampled south of the Ancud Gulf was the narrow channel west of the Rayas river outflow. Initial surveys showed an area of flat seafloor west of a N-S orientated dune field perpendicular to the river mouth, which sub-bottom profiles indicated to comprise parallel-layered units, with an eroded upper surface. An ROV dive on this surface showed a seafloor of rounded pebbles and cobbles of mixed lithologies, lying upon and in cases partially embedded within a firm pale-grey clay. The surface was partially covered with a thin layer of dark grey sands, inferred to originate from recent material transported from the Rayas river (and matching the appearance of the sediment making up the dune field). Vibrocores and push cores could not penetrate this surface, but the pebbles were samples using the ROV scoop bags. A second ROV dive on the margin of the dune field showed a similar hard pebbly substrate, and a single short core was collected within this. The margin of the dunes showed rippled dark volcaniclastic sands and gravels rich in a pale pumice component, sampled via scoop bags. A further ROV dive to the north, within the dunes, collected cores within these gravels. One of these was split and comprised multiple beds of pumice- and lithic-rich volcaniclastic gravels, parallel bedded on a several centimetre scale. The dune field, which extended parallel to the shoreline, south of the Rayas delta and onto the north side of Chaitén bay, was sampled at three further van-Veen grab sites, recovering mixed samples of volcaniclastic gravels, rich in dense dark grey lithic clasts and sub-rounded white pumices. These grab samples also recovered several pieces of woody debris.

Blanco delta and Chaitén bay

South of the narrow channel east of the Rayas outflow, seafloor with similarly high backscatter characteristics continued, bound on its southern side by a convoluted low-lying bank. East and south of this, the seafloor had lower backscatter and was smooth surfaced. Sub-bottom profiles show a clear change across this boundary, with tens of metres of parallel-bedded sediments in the lower backscatter region, suggesting long-lived sediment accumulation, contrasting with lower penetration and discontinuous layered units in the higher backscatter region. This facies, which continued north to the Rayas channel, suggests an erosional surface that is bypassed by present-day sedimentation, consistent with the strong N-S currents observed through this area, and with the cobble- and pebble-rich surface observed in the ROV dives offshore the Rayas diver. Similar observations were made at station 009, at the NW margin of Chaitén Bay. The ROV dive here showed a soft brown mud, with large cobbles protruding in places, overlying a hard surface that could not easily be penetrated by the vibrocorer (and inferred to be similar to the surface observed offshore the Rayas river). A short core in this area recovered homogeneous grey muds ending in a layer of shelly debris and hard clay fragments. Backscatter data revealed km-scale lineations on this surface, tens of metres across, which may be related to the movement of grounded ice sheets in this area, suggesting that the clay hardground exposed at the seafloor in this region may be a postglacial surface that has not subsequently been buried by sediment.

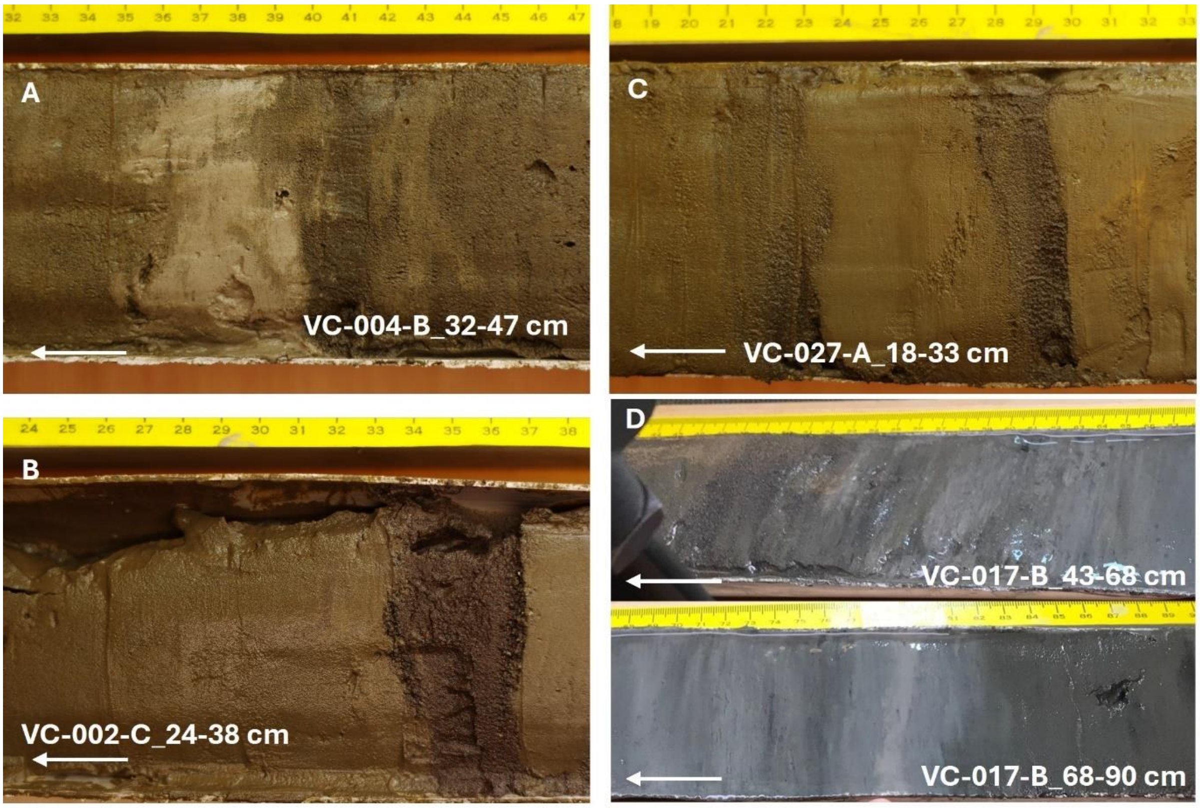


Fig. 8: Examples of discrete sediment layers, recording individual events, observed in vibrocores recovered in FKt240902. A: a pale, felsic fine ash deposit, interpreted as a tephra fall deposit, in the southern Ancud Gulf; B: a dark, mafic deposit, likely a tephra fall deposit, in the Reloncaví fjord; C: two dark sands, grading upwards and with sharp bases, likely turbidites, at the outflow of the Simpson Canyon; D: a sequence of multi-layered pale to mid-grey volcaniclastic deposits, rich in glassy clasts, on the lower slope of the Chaitén (Blanco) delta, potentially derived from secondary laharic inputs.

Within the rest of Chaitén bay, the thick sediments were generally easily cored, with several ROV dives throughout the bay. The station west of 009, in the low-backscatter facies, recovered monotonous grey muds with no well developed structures or visible volcaniclastic layers. Closer to the Blanco outflow, and on the north side of the bay (beyond the eastern limit of the dune field), station 012 preserved a greenish-brown mud with several sub-cm pale volcaniclastic silts, with one prominent 5-cm thick pale grey unit, very similar in appearance to that seen in the Chulin channel at station 004.

Closer to the Blanco delta, sub-bottom profiles revealed multiple tapering transparent units forming the outer delta margin, with thin parallel-bedded discontinuous sediment layers on its upper surface. Seafloor with this facies continued to water depths of ~50 m, the shallowest area surveyed. With the expectation that the sediment on the delta front may be coarse, two van-Veen grabs were taken in this shallow region (stations 014 and 015), but these recovered homogenous fluidal mud, suggesting a thick mud accumulation on the delta surface. ROV dives (016 and 017) slightly lower on the delta front penetrated into volcaniclastic sediments; high levels of suspended sediment in this area resulted in very poor visibility and hindered direct seafloor observations. The vibrocore from 016 preserved organic-rich muds in its upper part, and was rich in grey volcaniclastic sand and silt, with white pumiceous fragments, in its lower part. 017 preserved a well layered sequence of dark organic-rich muds, pale grey muds and volcaniclastic silts and sands, bedded on a cm-scale, with multiple repetitions of white to mid-grey volcaniclastic layers in the lower part of the core.

To the south of the Blanco delta, an E-W channel extending west from the northern margin of the Yelcho river outflow, forms a prominent feature in the bathymetry at the southern edge of Chaitén bay. The first ROV dive in this region (stations 018 and 019) sampled the crest and trough of a dune on the platform north of the channel margin. Beneath a thin veneer of soft brown surficial mud, the seafloor here preserves a several-cm layers of pale volcaniclastic fine sand, inferred to represent the sediment input from the Chaitén 2008 eruption. This layer is prominent in push cores sampled at this site, and at the top of vibrocores. Deeper in these cores are several thinner volcaniclastic horizons, on mm- to cm-scale, and generally pale grey but with some darker grey layers. South of this site, an ROV dive within the channel (022), which shows dune like features suggesting strong currents, penetrated pale grey volcaniclastic medium to coarse sands, beneath a thin brown mud veneer. These sands were poorly recovered by the vibrocorer, with extensive loss of sediment from the core base observed on core extraction, suggesting loose and poorly consolidated sand. Recovered material showed these to comprise coarse pumice and lithic sands. To the west, the channel continued into a series of isolated basins, two of which were sampled (023 and 025). At 023, a prominent 6-cm thick pale grey volcaniclastic silt was present near the top of the core, with a second, darker grey volcaniclastic horizon deeper in the core. The core from 025 did not preserve any visible volcaniclastic horizons, but ended in a coarse angular gravel with a mix of shell and lithic fragments.

Corcovado Gulf

Beyond Chaitén Bay, the expanse of the Corcovado Gulf could not be surveyed extensively. One ROV site at the north of the gulf, to the far west of Chaitén Bay, in sequence of very well bedded sediment, recovered generally structureless brownish-grey muds, rich in foraminifera, without visible volcaniclastic layers (station 013 and gravity cored at station 024). Much further south, a single ROV site targeted the channels east of the prominent raised platform in the southern Corcovado Gulf, which are fed by river outflows draining Yanteles and Melimoyu volcanoes (station 034). A vibrocore opened at this site preserved grey muds with two cm-scale dark volcaniclastic medium sands. One further core was taken west of the Corcovado Gulf platform (station 035), using a gravity corer, and was not opened on board.

Simpson Canyon

Six vibracores were collected from within the Simpson Canyon region, four from the canyon outflow (at stations 026, 027, 028 and 029) and two from within the canyon feeder channel (both at Station 032), collected on two separate ROV dives. Because of the much deeper water in this region, the ROV dives lasted several hours and a different sampling strategy was adopted, taking transects across the seafloor to make observations at multiple locations within a single dive. From the canyon outflow, one of the vibrocores (027) was opened on board, and revealed several dark grey sands with sharp based, interbedded with pale brown silts to fine sands, potentially representing multiple turbidites. A similar stratigraphy was observed on the core opened from site 032, from the upper channel of the canyon.

Summary of volcaniclastic stratigraphy

One of the main objectives of the Fire and Ice expedition was to recover volcaniclastic deposits from the Chaitén 2008 eruption. In addition to capturing deposits from this eruption, several other events linked to eruptions from a range of volcanic sources are also present within the core samples, likely originating via a range of primary (e.g. tephra fall) and secondary (e.g. lahars or other processes remobilising volcanic sediment) volcanic and sedimentary processes, and derived both from Chaitén and from other regional volcanoes. All volcaniclastic deposits identified within the cores split on board are shown below in Fig. 9, indicating core depths, layer colour, and other clastic units.

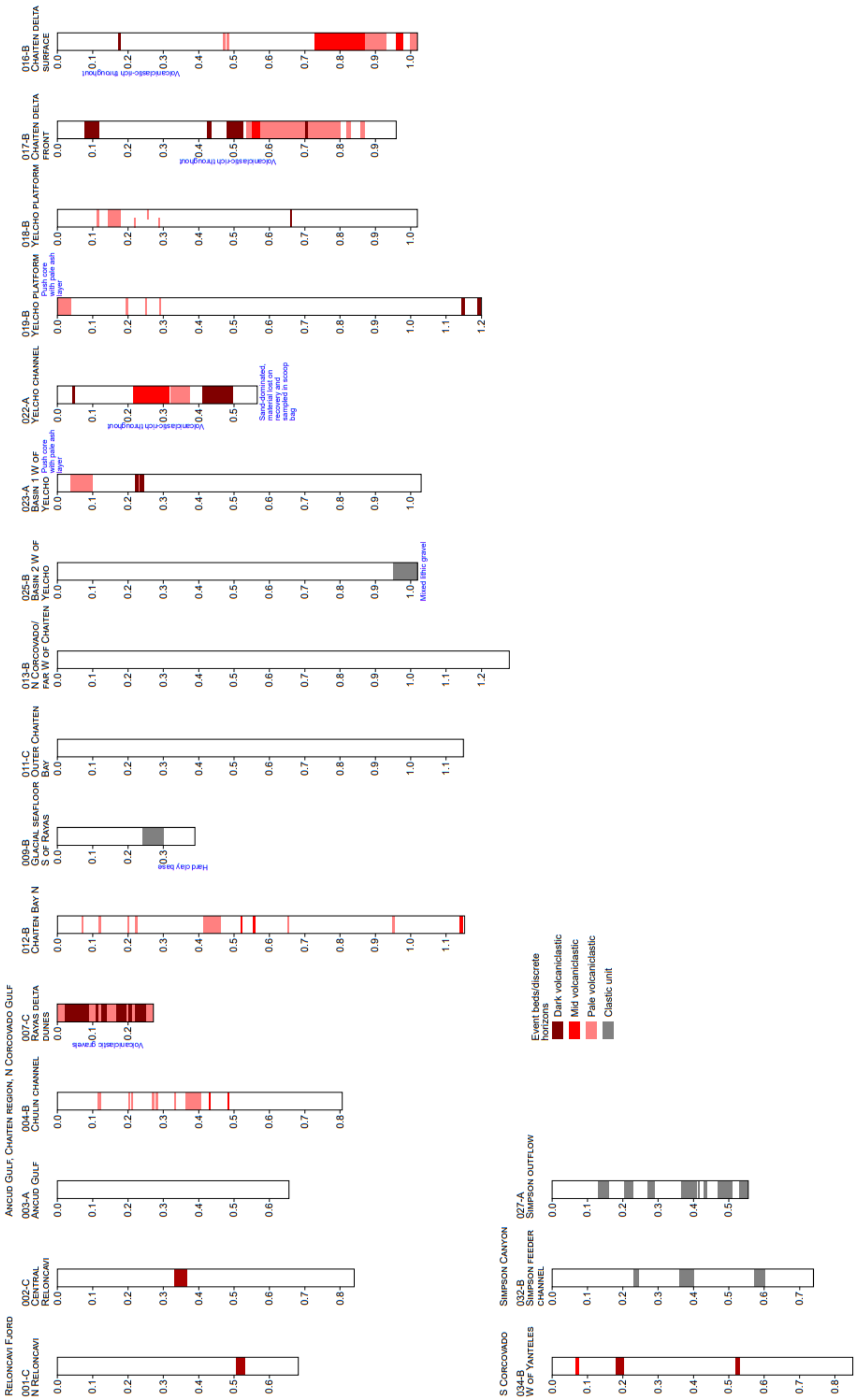


Fig. 9: Summary of volcaniclastic horizons observed in cores collected on FKt240902.

Individual volcaniclastic units were examined on board using smear slides, and some dried samples were also analysed by pXRF to obtain an initial indication of composition. The pXRF provided a silica content, but these are not precise. The values in Table 7, below, should therefore be taken as indicative of relative differences in silica content rather than a precise indicator of bulk composition. Table 7 provides descriptions of the prominent fine-grained volcaniclastic layers shown in Fig. 9, based on macroscopic layer characteristics and smear slide observations. Other samples of background sediment (e.g. core 011-C) were also examined and found to have a volcaniclastic component (e.g. in 011-C, mafic and felsic vesicular clasts observed in laminations throughout the core), suggesting persistent input of volcaniclastic material even where macroscopic event layers are not identifiable.

Table 7: Descriptions of fine-grained macroscopic volcaniclastic layers (Fig. 9).

Core	Region	Volcaniclastic layer description	Initial inferred depositional process	Smear slide description	pXRF silica composition (with layer depth)
VC-001-C	Reloncaví Fjord inner basin	Dark medium to very fine ashy sand. Laminated at base, normal grading towards top	Mafic tephra fall deposit, potentially reworked	Light brown microcryst-rich and orange- brown palagonitised glass shards, scoriaceous particles and clear, highly vesicular pumiceous shards.	48-49 cm: 39.34% SiO2 52-52.5 cm: 30.46 %SiO2
VC-002-C	Reloncaví Fjord middle basin	Dark medium volcaniclastic sand, coarser at base and top (Fig. 8).	Mafic tephra fall deposit, potentially correlated to layer in VC-001-C	Clear to light brown dense microcryst-rich shards, some palagonitised (orange brown), clear vesicular glass shards and scoriaceous coarse particles	33.5-34 cm: 33.42 %SiO2 34.5-35.5 cm: 40.48 %SiO2
VC-003-A	South Golfo de Ancud	No visible deposits	N/A	Infrequent fresh and altered brown glass shards, some light brown vesicular shards with microcrysts	N/A
VC-004-B	South Ancud Gulf, Chulin Channel	Several distinct very fine light grey ash layers, one particularly prominent (Fig. 8).	Potential primary tephra fall or lahar deposit from felsic source	Very fine ash beds dispersed through core, consisting of platy to cuspate glass shards and pumice; ash bed at 38 cm comprised of >95% glass	11.5-12.5 cm: 36.71% SiO2 33-33.5 cm: 50.51% SiO2 36.5-40 cm: 53.53% SiO2 48.5-49 cm: 43.00% SiO2
VC-011-C	Chaitén Bay west	Fine laminations throughout - volcanic component not visible by eye	Background deposition containing volcaniclastic input	Several layers comprising coarse grained pumice and silicic shards, fresh brown dense and vesicular mafic glass, slightly altered light brown microlite-rich glass	N/A
VC-012-B	Chaitén Bay north side	Several distinct light grey very fine ash layers containing some small darker crystals	Potential primary fall or lahar deposit from felsic source	Abundant fine-medium cuspate felsic glass shards and coarser pumice dispersed through core; primary 95% ash bed at 45 cm; mafic shards (fresh brown, light brown scoriaceous and orange brown altered mafic glass) in lower half of core.	41.5-46.5 cm: 68.54% SiO2
VC-016-B	Chaitén Delta, front central upper slope	Several distinct very fine light grey ash layers	Secondary lahar inputs and/or fall deposit input	Small platy-cuspate silicic shards to coarse pumice grains throughout the core; ash dominated (80-90% glass) beds at 94.5 cm and 100.5 cm	87-93 cm: 70.02% SiO2 93-96 cm: 66.68% SiO2 100-102 cm: 68.27% SiO2 CC: 64.14% SiO2
VC-017-B	Chaitén Delta, front central mid slope	Varied dark and pale ashy layers	Repetitive secondary lahar inputs and/or fall deposit input	Light grey-white ash beds comprise blocky, platy to cuspate silicic glass shards; ash dominated beds (>95% glass) at 56 cm and 79 cm;	58-60 cm: 52.03% SiO2 68-70 cm: 53.59% SiO2 70-71 cm: 55.84% SiO2

				beds containing dense to scoriaceous mafic glass at 48 cm, 43 and 10 cm.	73-75 cm: 67.52% SiO2 -78-80 cm: 61.50% SiO2
VC-018-B	Platform margin N of Yelcho outflow	Very fine to fine light grey to white ashy layers	Secondary lahar deposit from felsic source (e.g. Chaitén 2008?)	Correlated to 019-B (see description below)	15.6-17cm: 56.33% SiO2
VC-019-B	Platform margin N of Yelcho outflow	Several very fine white to light grey discontinuous ash layers. Two layers of black fine to medium ash at base (one within CC).	Secondary lahar deposit from felsic source (e.g. Chaitén 2008?); other felsic fall deposits or laharic inputs? More mafic source for basal layers?	Pale ash beds contain platy-cuspate shards. Black ash layers comprise vesicular light grey-brownish and denser light brown, partially palagonitised mafic glass shards with bed at 115cm being >95% brownish vesicular to scoriaceous mafic glass shards	0-4 cm: 59.28% SiO2
VC-022-A	Channel north of Yelcho Delta	Varied volcaniclastic sands throughout the core	Reworked volcaniclastic deposits following ?laharic input	N/A	5-48 cm: 51.77% SiO2 35.5 cm: 54.83% SiO2
VC-023-A	First basin west of Yelcho Channel (south Chaitén Bay)	Varied ashy layers throughout the core	Fall deposits and/or laharic input	Pale felsic ash beds in top half, including prominent shallow layer, comprise blocky to cuspate clear shards and pumice grains. Dark mafic ash layer in lower part of core.	4-9 cm: 73.04% SiO2 9-10 cm: 63.02% SiO2
VC-025-A	Basin further west of Yelcho Channel (south west Chaitén Bay)	No visible layers; basal mixed gravel	Debris flow/mass-transport event?	N/A	N/A
VC-034-B	Basin offshore Yanteles and Melimoyu	Varied volcaniclastic layers through the core	Fall deposits	Minor light brown mafic glass with phenocrysts to orange-brown dense palagonised mafic glass	N/A

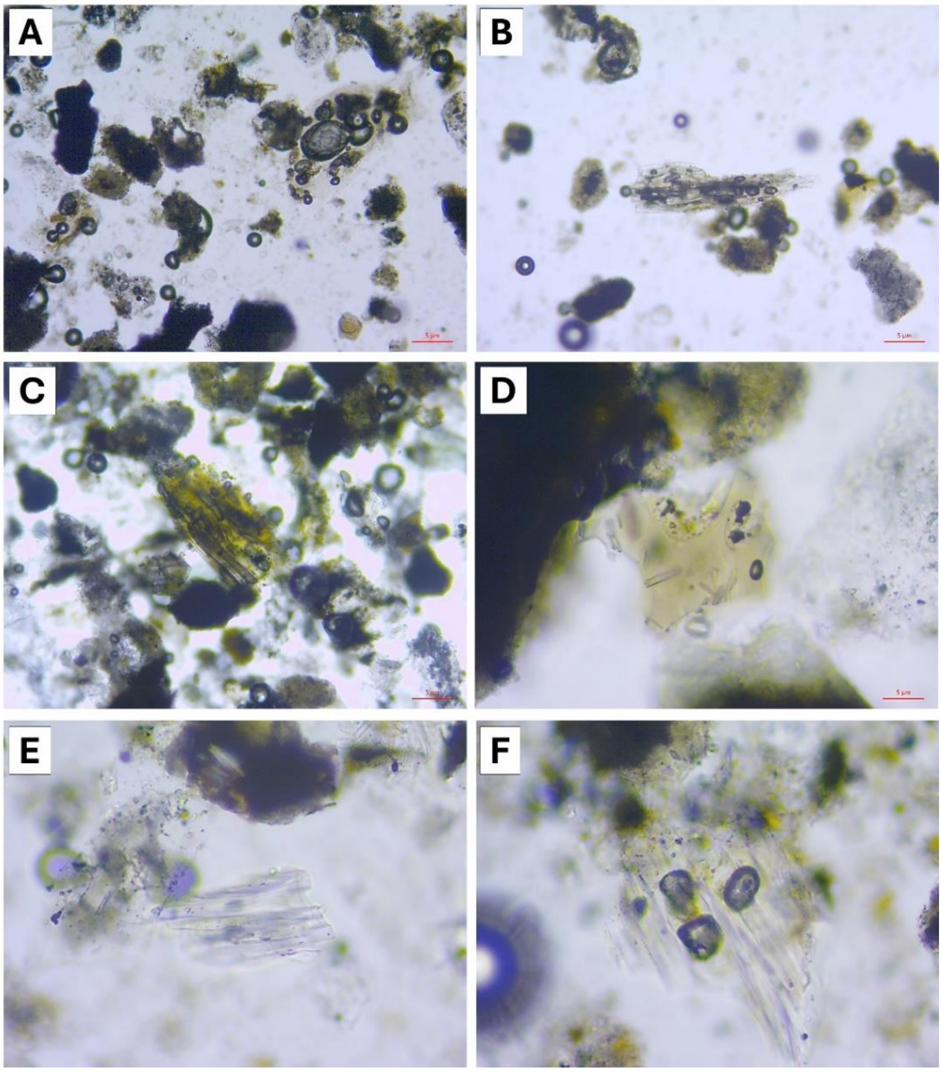


Fig. 10: Photos of FKt240902-VC-001-C glass shards sampled between 45-52.5 cm depth. Glass shards in the core range from light-brown very vesicular mafic shards (A-C), light brown vesicular phenocryst-bearing mafic shards with thicker bubble walls (D) to clear, highly vesicular pumiceous shards (E-F) and show different degrees of devitrification/alteration.

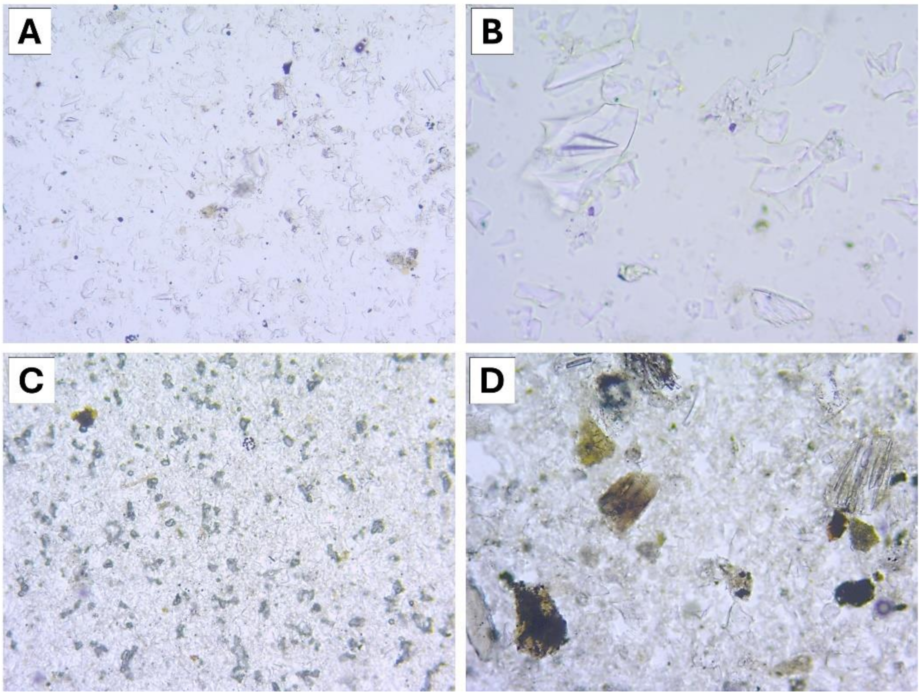


Fig. 11: Photos of silicic glass shards found in several layers throughout FKt240902-VC-004-B. A-B) Thin bed of pure fine to medium ash comprised of cuspate, platy to blocky shards found at 43 cm depth. C) Cuspate to blocky shards found within a several cm-thick bed of pure very fine ash between 41-36.5 cm depth. D) Thin ash bed at 33 cm depth comprising silicic shards and pumice as well as other components, potentially reworked material from thick ash bed below.

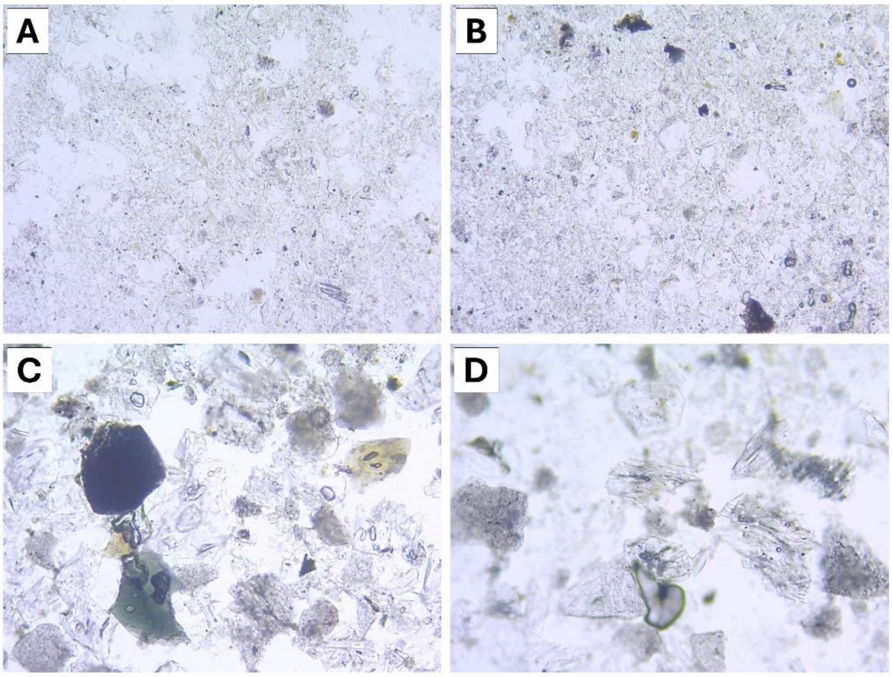


Fig. 12: Photos of silicic glass shards found in several layers throughout FKt240902-VC-016-B. A) Platy to blocky silicic shards and pumice found in a light grey ash bed between 93-96 cm depth. B) A thin very fine grey ash layer (at 100 cm depth) comprises similar glass and organic components. C-D) In contrast, a distinct yellow brown-grey ash bed found at 96.6-99 cm depth contains much coarser and mostly pumiceous silicic glass shards as well as crystals and a small proportion of mafic shards.

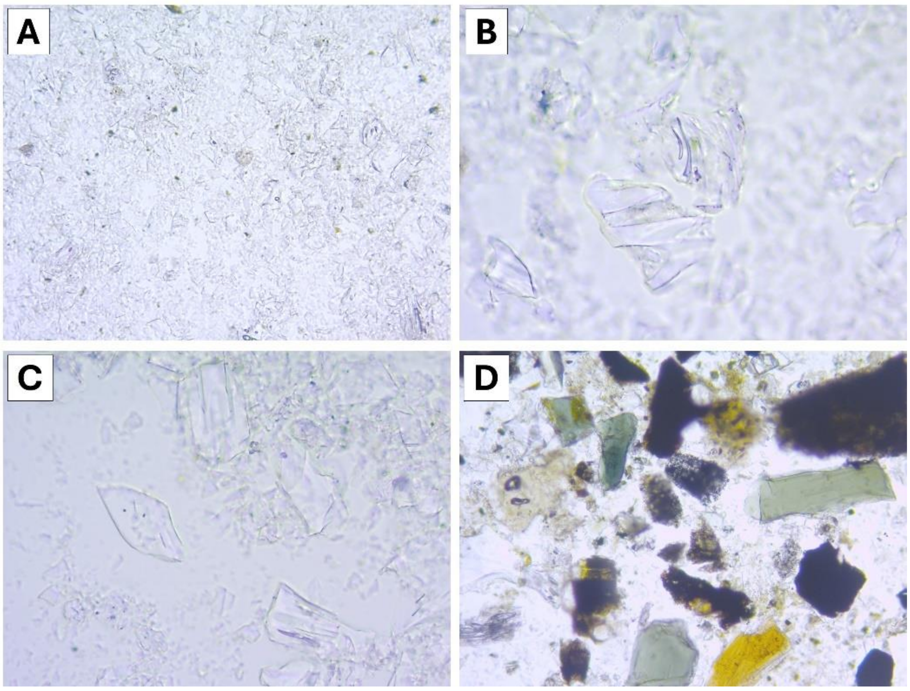


Fig. 13: Photos of components found in several volcaniclastic layers in FKt240902-VC-017-B. A-B) Blocky, platy and cuspate silicic shards making up a pure, very fine white ash bed at 79 cm depth. C) Similar glass shards are found in a pure, pale grey-white fine ash bed at 56 cm depth. D) In contrast, a several cm-thick coarse to very coarse dark ash bed at 10 cm depth comprises a mixture of mostly dense to scoriaceous mafic glass as well as (silicic) pumice, lithics and crystals.

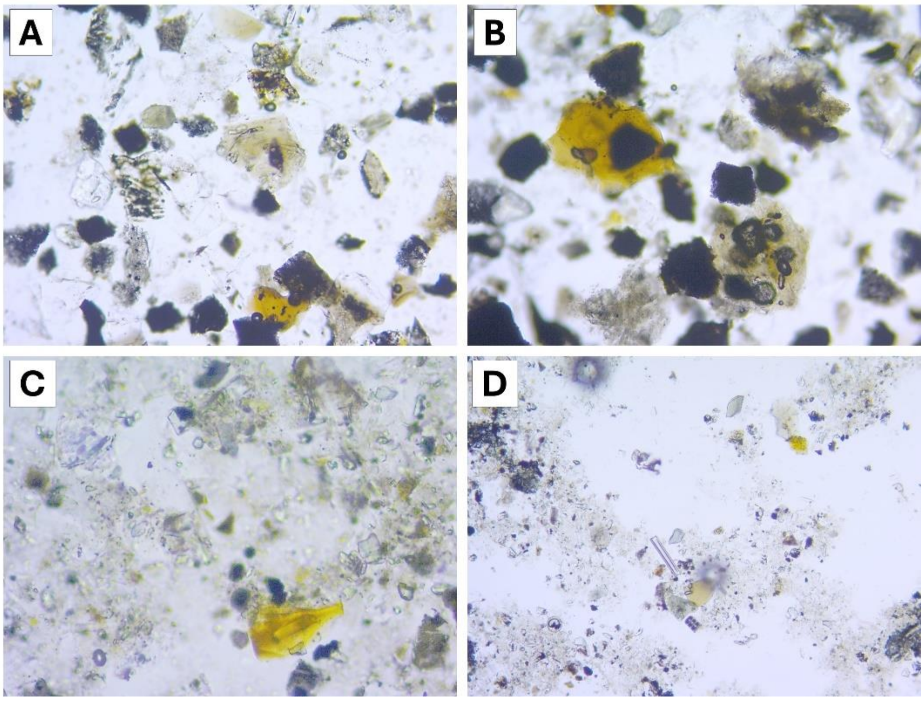


Fig. 14: Photos of components found in FKt240902-VC-034-B. A-B) A slightly coarser bed at 19 cm depth comprises mostly volcanic and opaque lithics and crystals with minor light brown mafic glass with phenocrysts and orange-brown dense palagonitised mafic glass. C-D) A thin dark bed at 7 cm within organic mud contains rare silt- to sand-sized orange-brown glass as well as some lithics and crystals.

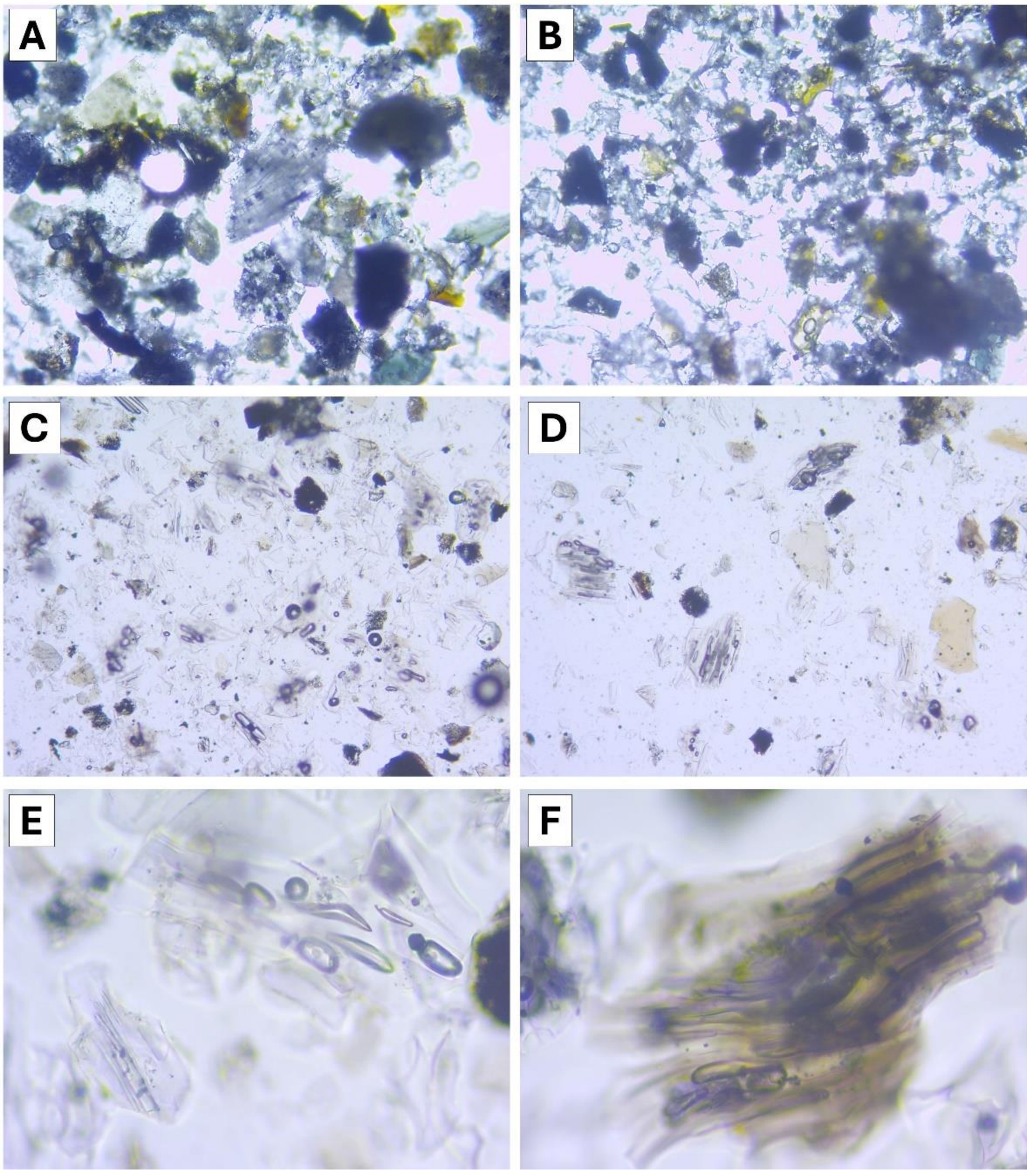


Fig. 15: Photos of glass shards observed in two black ash layers within FKt240902-VC-019-B. A-B) A black fine-medium ash bed found at 119 cm depth is predominantly made up of vesicular light grey-brownish and denser light brown, partially palagonitised mafic glass shards as well as crystals and lithics. C-F) In contrast, an overlying homogenous black fine ash layer (115 cm) is almost exclusively comprised of clear to brownish vesicular to scoriaceous mafic glass shards and crystals.

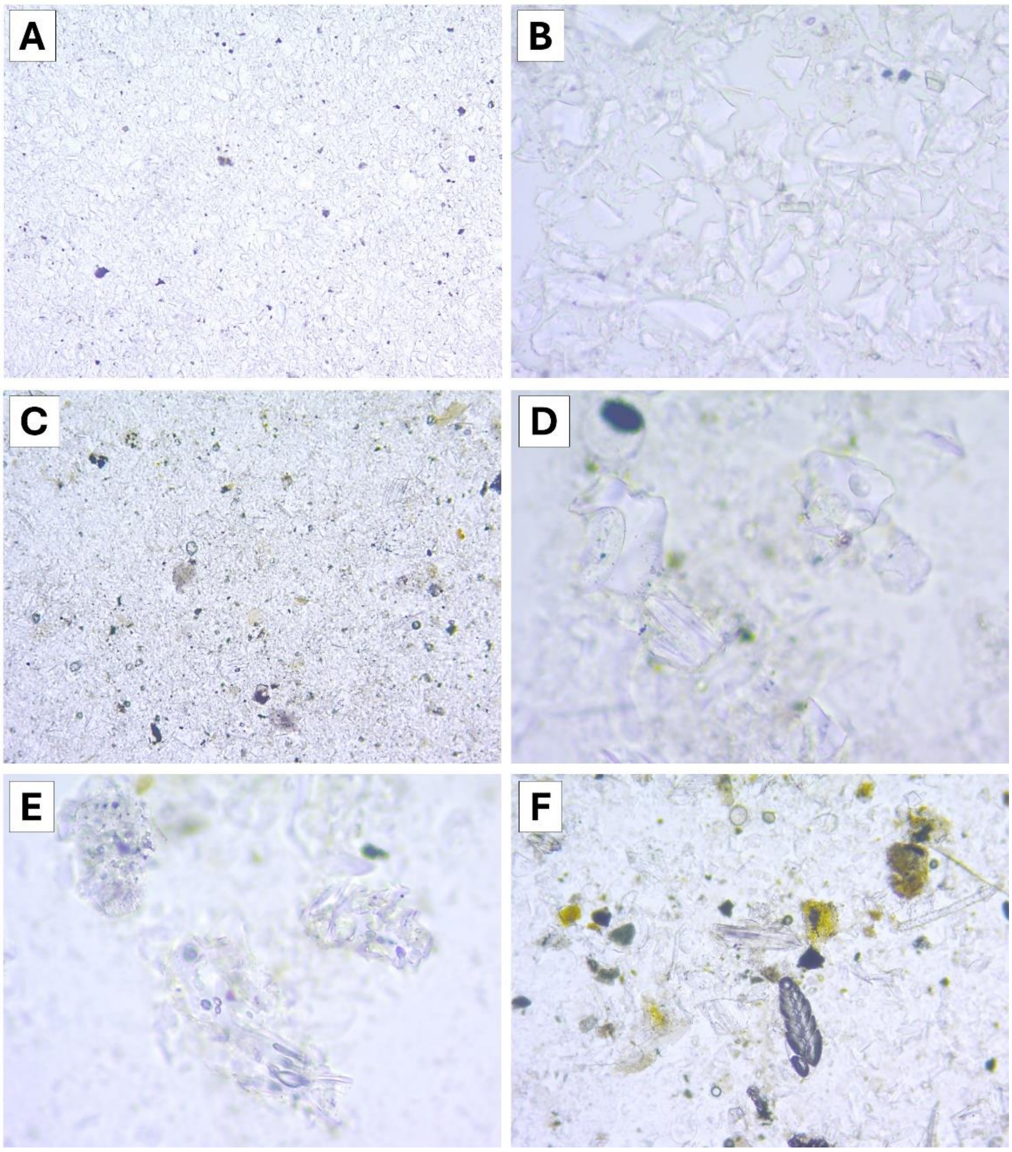


Fig. 16: Photos of glass shards from ash-rich deposits in FKt240902-VC-023-A. A thin very fine-fine white ash bed is found between 9.5-10 cm depth almost exclusively made up of mostly blocky to cuspate silicic glass shards (A-B). It is overlain by 5.5 cm of potentially reworked material, dominated by silicic glass shards and pumice with minor lithics, crystals and organic components (C). Glass shards from this layer are similar to the one below and range from blocky, platy and cuspate to pumiceous (D-E). A light brown organic mud tops the core sequence, comprising a large proportion of reworked volcanic ash from below (F).

6.3 Oceanography

Reloncaví Fjord

The data collection period for this area was from September 2 at 16:50 to September 3 at 23:58 (UTC) in 2024, where a temperature fluctuating between 10.6 and 11.2°C was observed, indicated by the current vectors (Fig. 17). At the beginning of the time series at the mouth of the fjord, the currents indicated a northwesterly direction with higher velocity toward the west (0.2 m/s) and a strong backscatter signal (160-200), which decreased as the vessel advanced toward the head of the fjord (120) at the surface. By around 00:00 on September 3, near the Puelo River inflow, the direction of the currents shifted eastward (0.2 m/s) with higher velocity northward (0.2 m/s) in the surface layer. Around 07:00 on the same day, near the Cochamó River outflow, currents had velocities of 0.1 m/s in an east-west direction, predominantly northward at the surface (~25 m) and southward below. Afterward, the vessel returned from the head of the fjord at 19:12 hrs, with currents predominantly southwestward (0.2 m/s). During this period, an increase in backscatter signal (80) was observed between 75 and 100 meters of depth (Fig. 17).

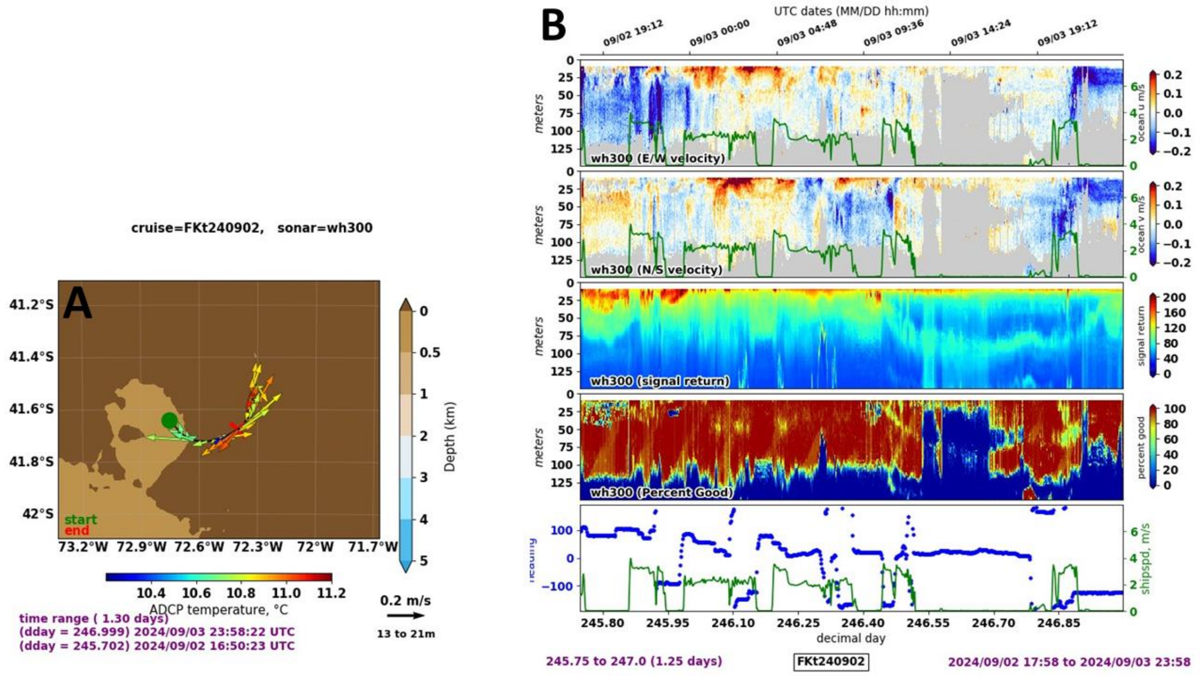


Fig. 17: Map of Reloncaví Fjord, with a vector plot showing 15-minute averages of ocean velocity in a shallow layer over the past 1.2 days. The green point indicates the start of the cruise track, and the red 'X' marks the end of the sampling period (A). Temporal analysis with 15-minute averages of U and V components, backscatter, acceptable percentage of collected data, and the ship's speed and heading (B) down to a depth of 125 meters using a 300 kHz ADCP.

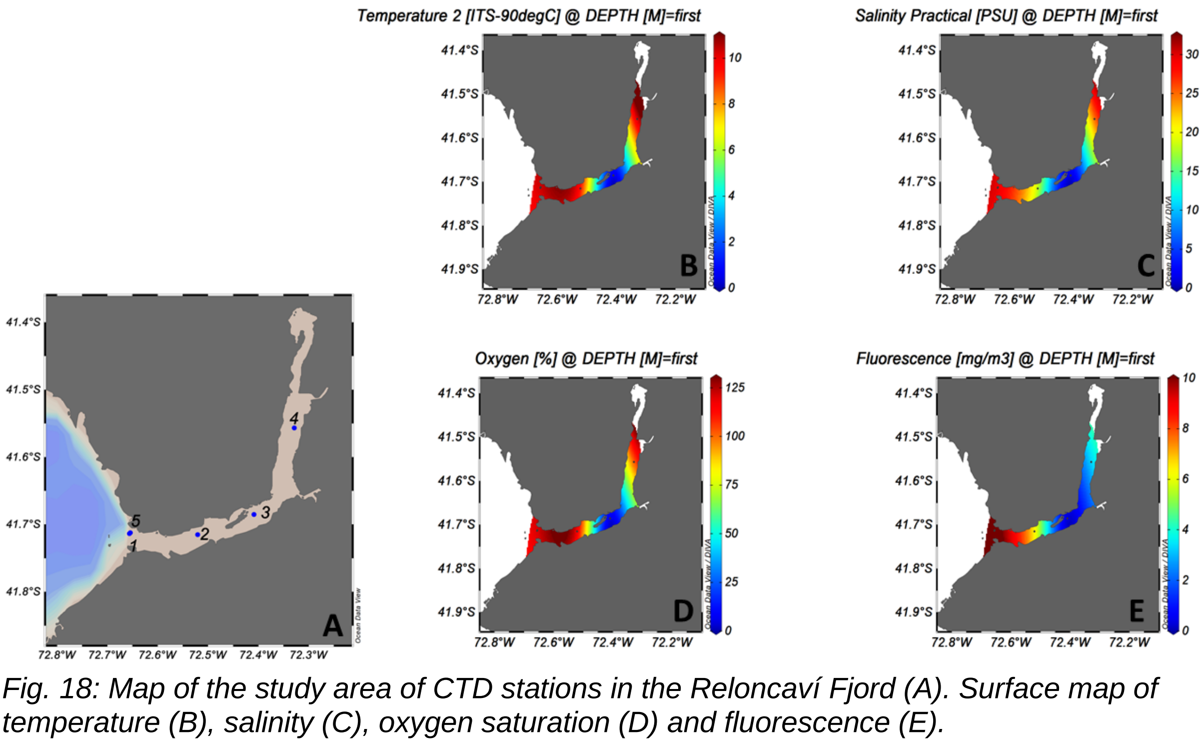


Fig. 18: Map of the study area of CTD stations in the Reloncaví Fjord (A). Surface map of temperature (B), salinity (C), oxygen saturation (D) and fluorescence (E).

The surface analysis of the hydrographic conditions within the Reloncaví Fjord showed higher temperatures (11°C) at both the mouth and head of the fjord, as well as higher salinity (30 PSU) and oxygen saturation (125%). On the other hand, at the center of the fjord, the minimum temperature was 0°C, with lower salinity (0 PSU) and lower oxygen saturation (Fig. 18B,C,D). Fluorescence was also minimal at the center of the fjord (0 mg/m3), with an increasing gradient towards the head (4 mg/m3), reaching a maximum at the mouth of the fjord (10 mg/m3) (Fig. 18E).

Regarding the hydrographic conditions for the Reloncaví Fjord (Fig. 19A), the temperature fluctuated between 8-12°C, reaching a minimum at the surface near the discharge of the Puelo River. Additionally, a stable 11°C isotherm was observed at a depth of 40 meters (Fig. 19B). Salinity showed a wide range of variation, with a minimum of 26 PSU at the surface and near the freshwater inflows from the Petrohué, Cochamó, Puelo, and Blanco rivers, increasing in salinity with depth to 33 PSU (Fig. 19C). Since these fjord and channel zones in Chile receive a large input of freshwater, salinity allows us to define the presence of water masses. In this case, we identified the Estuarine Water Mass (EW) at the surface, followed by the Modified Subantarctic Water Mass (MSAAW) and finally the Subantarctic Water Mass (SAAW). Oxygen saturation was lower (40%) at the mouth of the fjord below 40 meters depth and higher at the surface (120%) (Fig. 19C). This latter observation can be related to primary productivity and oxygen consumption, with the highest fluorescence concentration in the same area (5 mg/m3) (Fig. 19E).

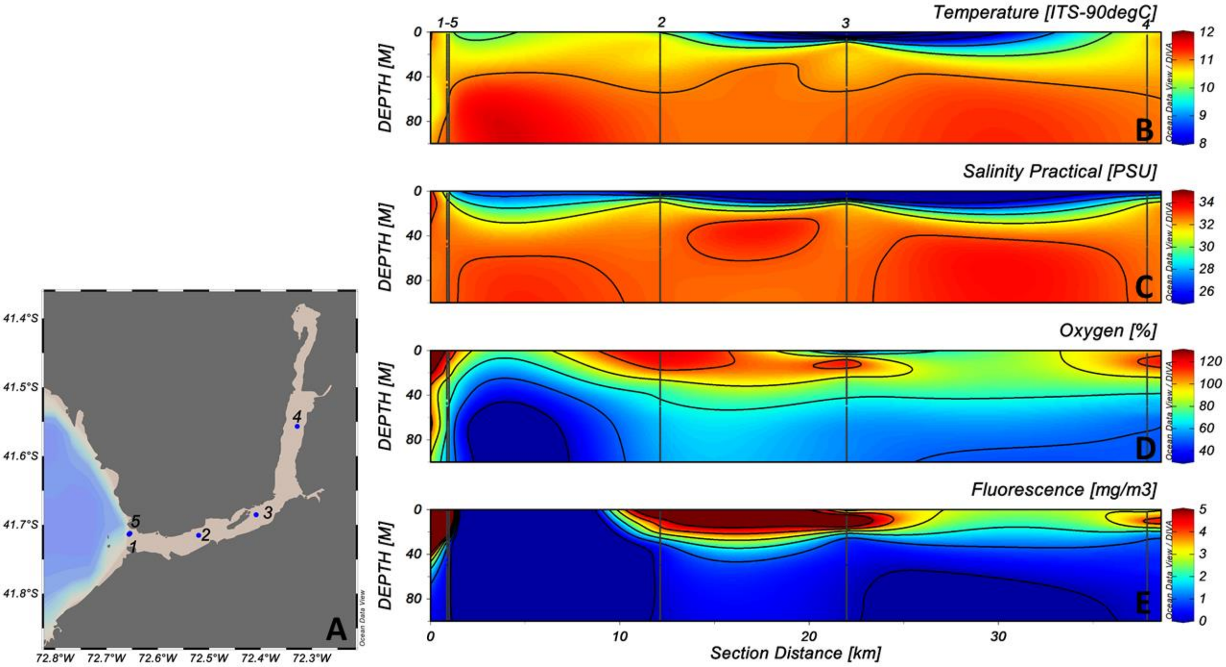


Fig. 19: Map of the CTD stations study area in the Reloncaví Fjord (A). Temporal analysis of CTD sets of temperature (B), absolute salinity (C), oxygen saturation (D) and fluorescence (E) up to 100 m depth.

Rayas and Chaitén Bay

The data collection period for the channel adjacent to the Rayas river mouth was from September 6 at 11:58 to September 7 at 23:58 (UTC) in 2024, where a temperature fluctuating between 10 and 10.4°C was observed, indicated by the current vectors with predominant northward and southward direction at the surface (Fig. 20A). Ocean currents showed significant directional variability for both components in ~5-hour periods along the north-south axis, with maximum velocities exceeding 0.8 m/s. The period began with a dominant southward flow, which later shifted northward. For the V component, maximum velocities reached 0.3 m/s, with a slight predominance toward the west. Lastly, backscatter showed a stronger signal in the surface layer (~20 m) and at 125 meters, with persistent variability toward the end of the time series (Fig. 20B).

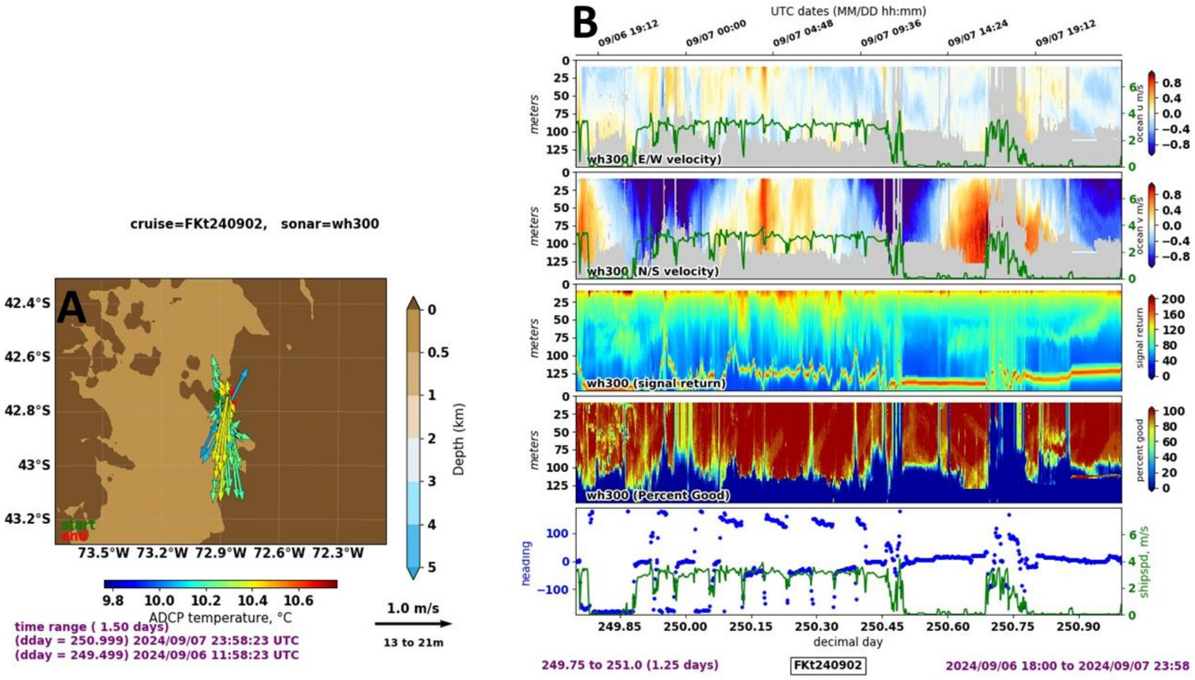


Fig. 20: Map of the channel opposite the Rayas river outflow, with a vector plot showing 15-minute averages of ocean velocity in a shallow layer over the past 1.2 days. The green point indicates the start of the cruise track, and the red 'X' marks the end of the sampling period (A). Temporal analysis with 15-minute averages of U and V components, backscatter, acceptable percentage of collected data, and the ship's speed and heading (B) down to a depth of 125 meters using a 300 kHz ADCP.

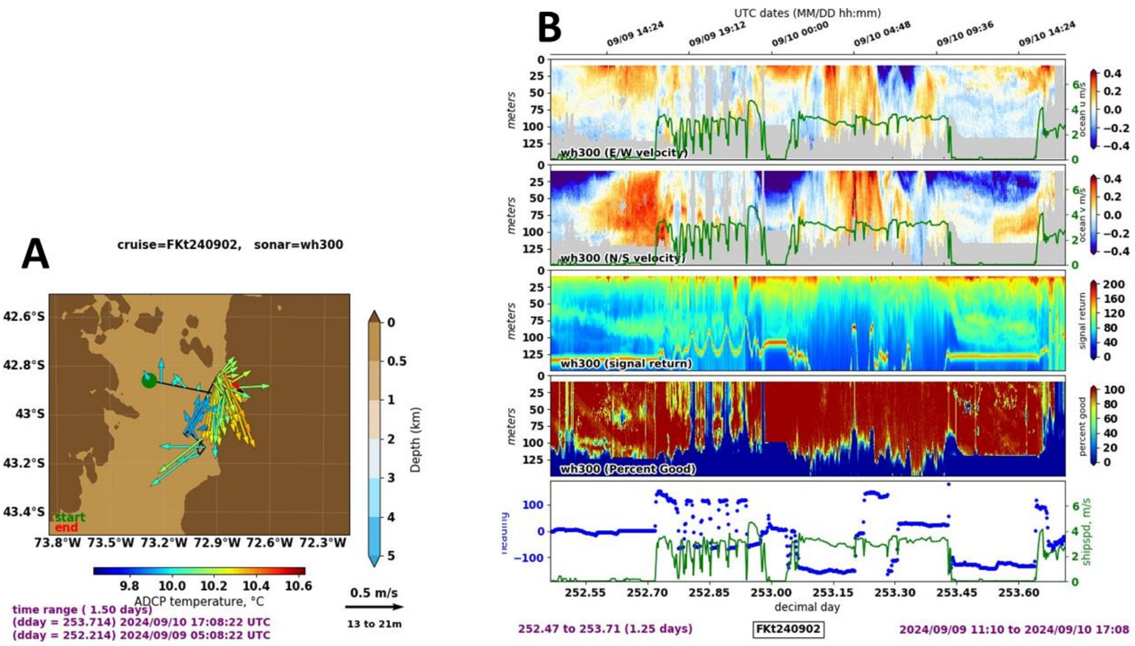


Fig. 21: Map of Chaitén delta with a vector plot showing 15-minute averages of ocean velocity in a shallow layer over the past 1.2 days. The green point indicates the start of the cruise track,

and the red 'X' marks the end of the sampling period (A). Temporal analysis with 15-minute averages off U and V components, backscatter, acceptable percentage of collected data, and the ship's speed and heading (B) down to a depth of 125 meters using a 300 kHz ADCP.

The data collection period for the Chaitén bay area was from September 9 at 05:08 to September 10 at 17:08 (UTC) in 2024, where a temperature range of 9.9 to 10.4°C was observed, indicated by each vector with predominant northeasterly and southeastward direction at the surface, mainly in Chaitén (Fig. 21A). The marine currents in the U component (E-W) predominantly flowed eastward with velocities of 0.2 m/s, mainly from the surface down to 50 m depth. In contrast, a westward dominance (0.2 m/s) was observed in the deeper layer (50-100 m). For the V component (N-S), there was significant variability throughout the water column in terms of direction, with faster southward velocities (0.4 m/s) at the surface and relatively slower northward velocities (0.3 m/s) from 0 to 125 m depth. Regarding the backscatter, a signal of 180 dB was recorded in the surface layer, decreasing with depth to 60 dB, although at 125 m there was an intermittent signal of 160 dB (Fig. 21B)

The surface analysis of the hydrographic conditions in the Chaitén area showed a temperature variation range between 9.5 and 10.5°C (Fig. 22B). Salinity was lower near the mouths of the Blanco and Yelcho Rivers (29 PSU), with a gradient increasing to a maximum of 33 PSU towards the west, indicating the presence of the Estuarine Water Mass (EW) and the Modified Subantarctic Water Mass (MSAAW), respectively (Fig. 22C). Oxygen saturation was higher (105%) north of Chaitén near the coast, indicating supersaturation in that area, gradually decreasing towards the west to 90% saturation (Fig. 22D). Fluorescence was slightly higher near the coastal edge (1-1.5 mg/m3), decreasing towards the west to 0 mg/m3 (Fig. 22E).

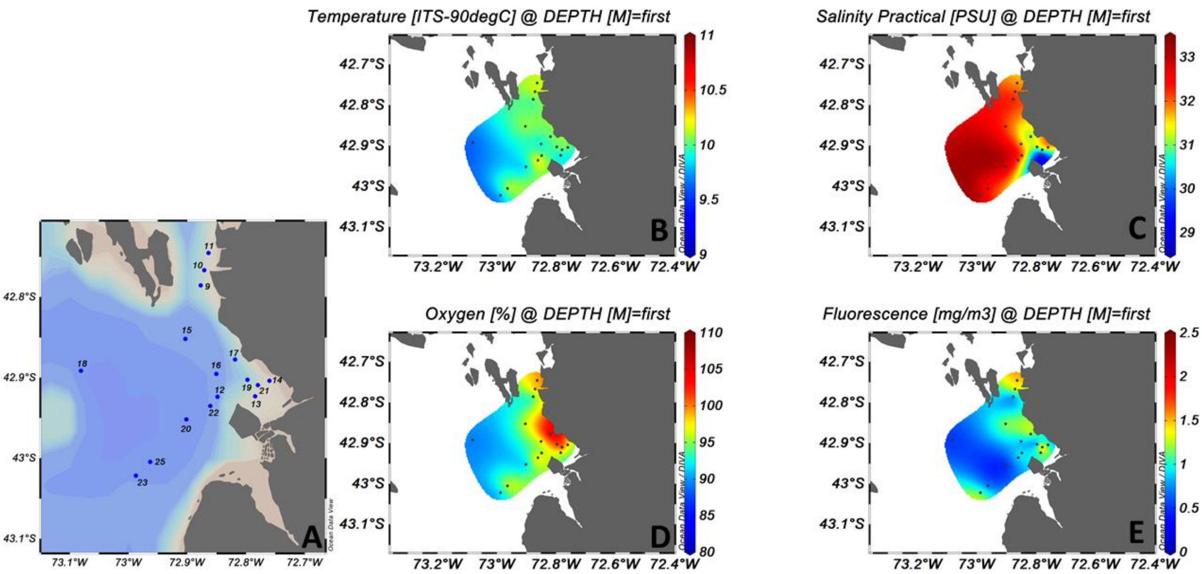


Fig. 22: Map of the study area of CTD stations in Chaitén (A). Surface map of temperature (B), salinity (C), oxygen saturation (D) and fluorescence (E).

Regarding the hydrographic conditions near Chaitén (Fig. 23A), a gradient of lower temperature (10°C) is observed near the coast of Chaitén, reaching a maximum of 10.4°C throughout the section (Fig. 23B). A similar pattern occurs with salinity, with a lower salinity input (31 PSU), defining the Estuarine Water Mass (EW), the Modified Subantarctic Water Mass (MSAAW), and the Subantarctic Water Mass (SAAW) (33 PSU) towards the west (Fig. 23C). Oxygen saturation recorded a maximum of 105% in the surface layer, which gradually decreased with depth to 80% at 100 meters (Fig. 23D). Fluorescence for this section did not present a defined pattern, but some stations at the surface showed higher concentrations (2 mg/m3), which decreased with depth (0 mg/m3) (Fig. 23E).

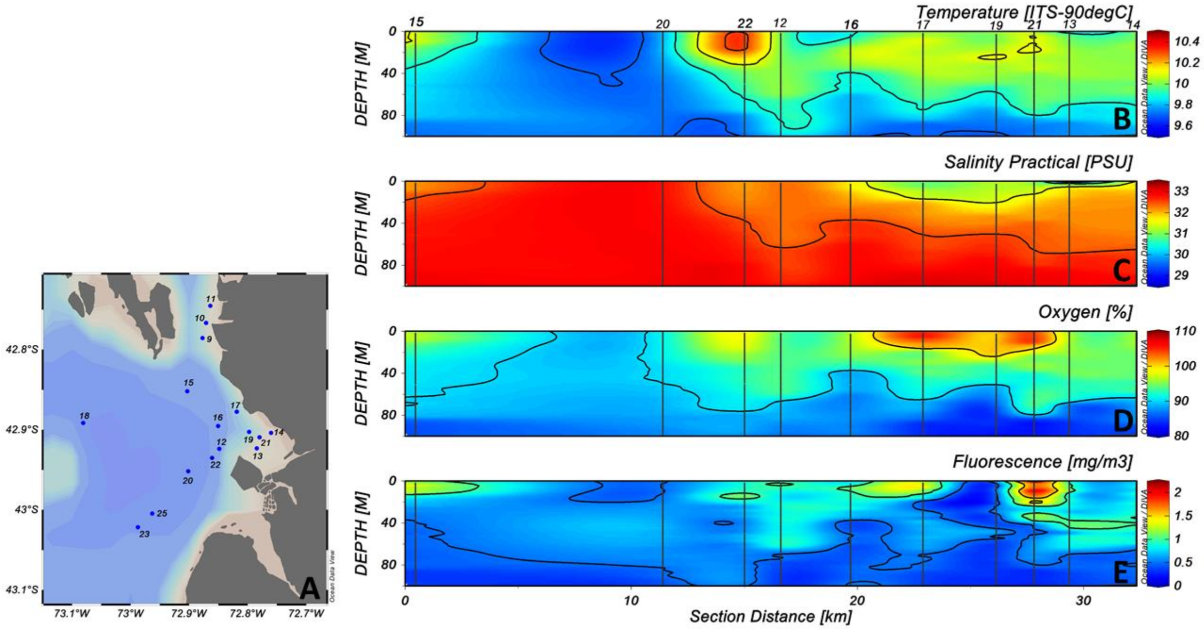


Fig. 23: Map of the study area of CTD stations in Chaitén (A). Temporal analysis of CTD hauls of temperature (B), absolute salinity (C), oxygen saturation (D) and fluorescence (E) up to 100 m depth.

Ancud Gulf, Corcovado Gulf and waters to Simpson Canyon (inland sea of Chiloé)

The data collection period for the Ancud Gulf area was from September 3rd at 11:58 to September 4th at 23:58 (UTC) in 2024,where a temperature fluctuating between 10 and 11°C was observed, indicated by the current vectors (Fig. 24A). Marine currents at the start of the time series from the Reloncaví Fjord show a dominant southwest direction (0.2 m/s). On September 4th at 02:00, outside the mouth of the Reloncaví Fjord, the direction shifted eastward in the U component and northward in the V component. At the same time, a stronger surface backscatter signal (200 dB) was observed, which decreased with increasing depth (75 m). Later, current velocities increased towards the south (0.3 m/s), and then, at 09:36 on September 4th, a drastic change in direction to the north (0.6 m/s) and a predominant westward direction (0.2 m/s) was observed. Simultaneously, for this period, an increase in the signal from the surface to a depth of 100 m over time was observed, though not uniformly, returning in the same way to the surface (80 dB) (Fig. 24B).

Further south, around the northern Desertores Archipelago, the data collection period was from September 4 at 11:58 to September 5 at 23:58 (UTC) in 2024, where a temperature fluctuating between 10.1 and 10.6 °C is observed, indicated by the current vectors, mainly along the north-south axis of the Desertores Archipelago (Fig. 25A). Ocean currents showed significant variability in direction in periods of approximately 4 hours for both components. Specifically, maximum recorded velocities for the U component were 0.3 m/s, while for the V component they ranged from 0.4 to 0.5 m/s. This can be directly related to the strong tidal influence in the area. In terms of backscatter, a stronger signal was observed in the surface layer (>160 dB), which decreased (~80 dB) following a "plume" pattern as depth increased (100 m) (Fig. 25B).

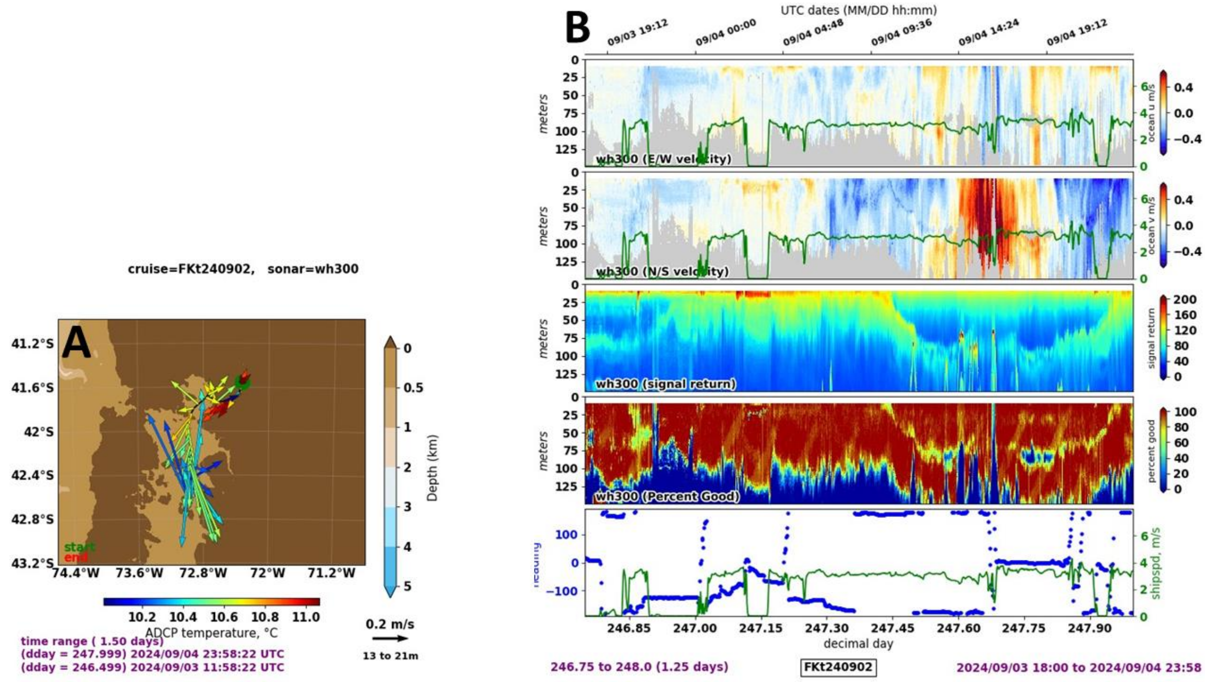


Fig. 24: Map of Reloncaví Fjord, Ancud Gulf, and Desertores Archipelago, with a vector plot showing 15-minute averages of ocean velocity in a shallow layer over the past 1.2 days. The green point indicates the start of the cruise track, and the red 'X' marks the end of the sampling period (A). Temporal analysis with 15-minute averages of U and V components, backscatter, acceptable percentage of collected data, and the ship's speed and heading (B) down to a depth of 125 meters using a 300 kHz ADCP.

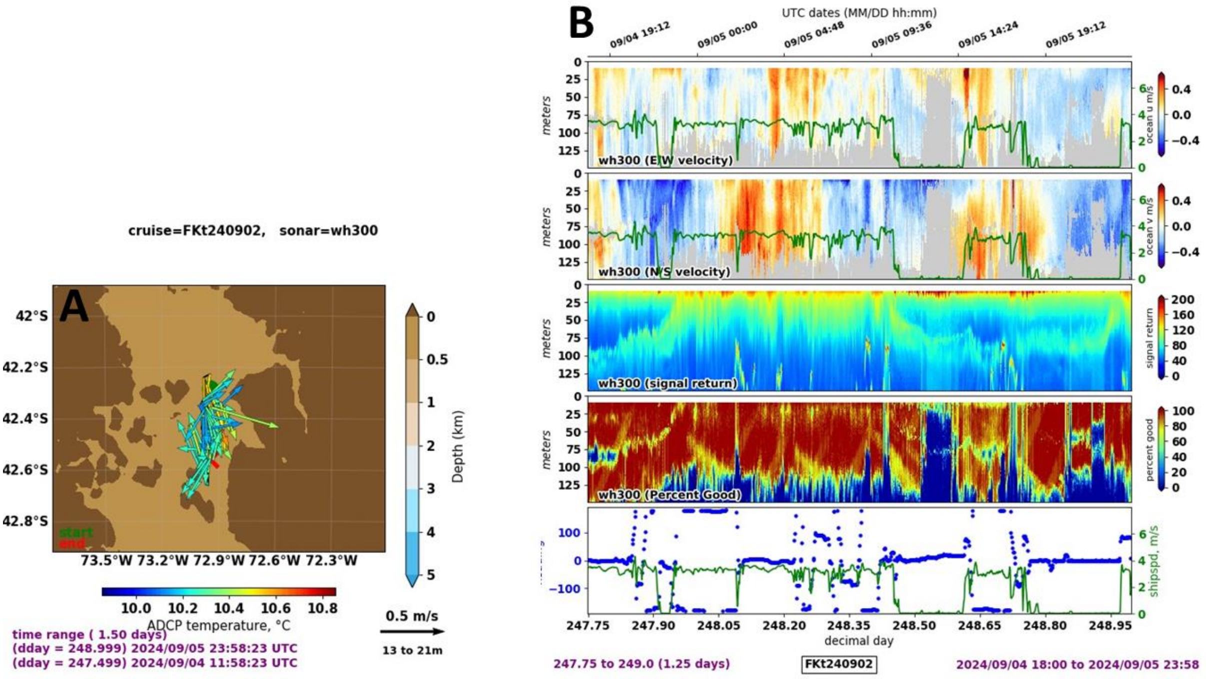


Fig. 25: Map of Desertores Archipelago, with a vector plot showing 15-minute averages of ocean velocity in a shallow layer over the past 1.2 days. The green point indicates the start of the cruise track, and the red 'X' marks the end of the sampling period (A). Temporal analysis with 15-minute averages of U and V components, backscatter, acceptable percentage of

collected data, and the ship's speed and heading (B)down to a depth of 125 meters using a 300 kHz ADCP.

The data collection period for the northern Corcovado Gulf (Chaitén-Quellón) was from September 14 at 11:56 to September 15 at 23:56 (UTC) in 2024, where a temperature range between 9.6 and 10.4°C was observed, determined by the color of each vector, which simultaneously indicate a predominance of southeast, southwest, and northeast directions at the surface level (Fig. 26A). The marine currents showed a defined variability pattern in 5-hour periods throughout the entire water column, starting toward the southwest (0.2 m/s), then shifting to the northeast (0.2 m/s), followed by a higher speed (0.4 m/s) toward the southwest, continuing this variation during the sampling period. The backscatter showed a stronger signal (160 dB) in the surface layer, decreasing (80 dB) with depth down to 75 m (Fig. 26B).

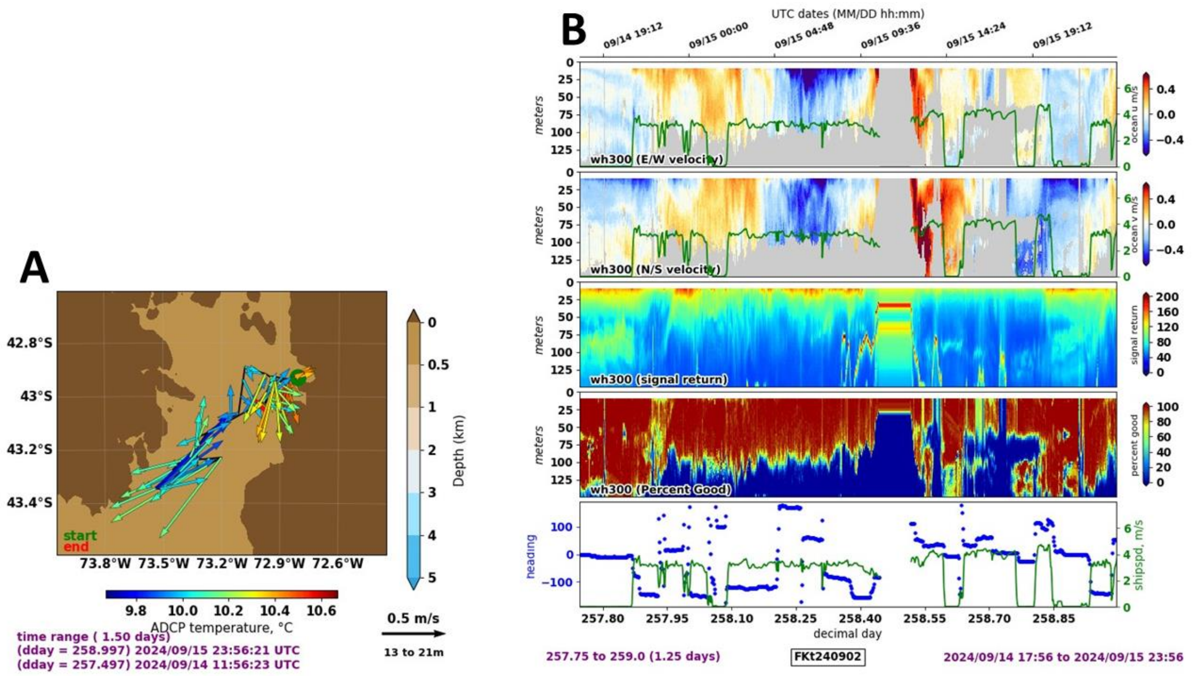


Fig. 26: Map of northern Corcodado Gulf (Chaitén-Quellón) with a vector plot showing 15-minute averages of ocean velocity in a shallow layer over the past 1.2 days. The green point indicates the start of the cruise track, and the red 'X' marks the end of the sampling period (A). Temporal analysis with 15-minute averages of U and V components, backscatter, acceptable percentage of collected data, and the ship's speed and heading (B) down to a depth of 125 meters using a 300 kHz ADCP.

A further dataset was collected from Chaitén Bay, through the Corcovado Gulf to the Isla Guafo channel, from September 15 at 12:24 to September 16 at 23:54 (UTC) in 2024, where a temperature range between 9.5 and 10.4°C was indicated at surface level, with the direction of the vectors predominantly toward the northeast and southwest (Fig. 27A). In the time series, marine currents showed a defined variability pattern in 5-hour periods with changes in direction throughout the vertical structure of the water column (0-125 m), starting toward the southwest (0.4 m/s) and shifting to the northeast (0.4 m/s). At the same time, maximum speeds of 0.8 m/s were reached, with a predominance of the U component toward the west and the V component (N-S) toward the south by the end of the time series. The backscatter in the water column showed greater intensity (120 dB) at the surface, which decreased with depth (60 dB) (Fig. 27B).

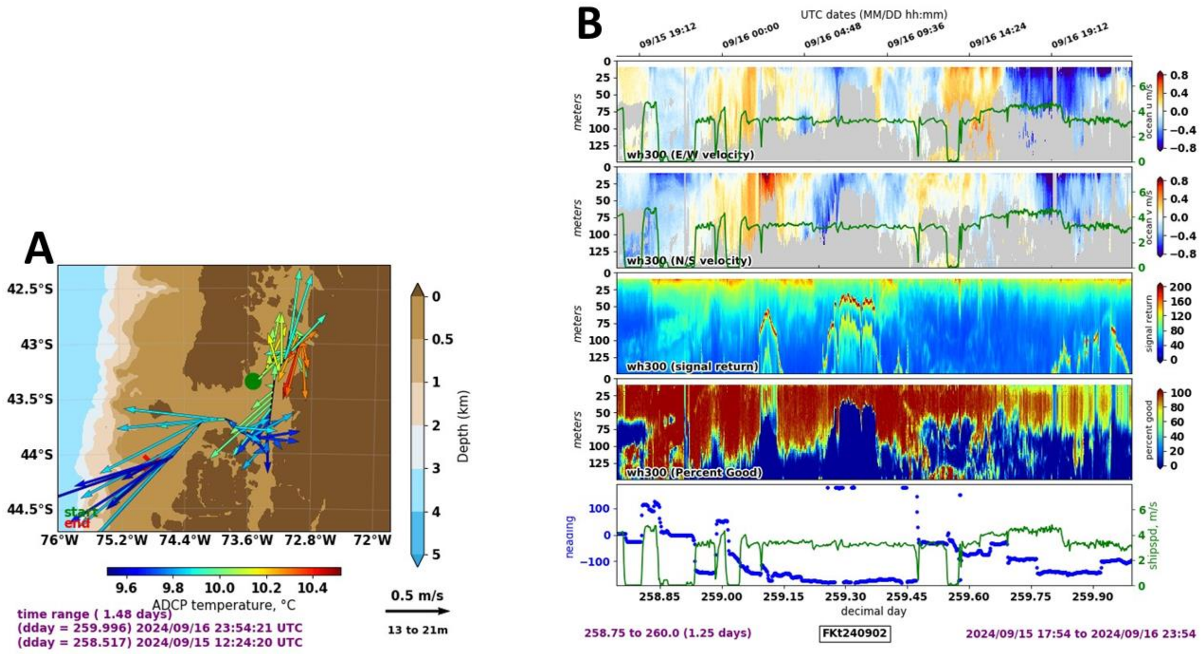


Fig. 27: Map of the Corcovado Gulf through to the Isla Guafo channel, with a vector plot showing 15-minute averages of ocean velocity in a shallow layer over the past 1.2 days. The green point indicates the start of the cruise track, and the red 'X' marks the end of the sampling period (A). Temporal analysis with 15-minute averages of U and V components, backscatter, acceptable percentage of collected data, and the ship's speed and heading (B) down to a depth of 125 meters using a 300 kHz ADCP.

For the Simpson Canyon, the data collection period was from September 17 at 11:54 to September 18 at 23:54 (UTC) in 2024, where a temperature range between 9.2 and 9.8°C was indicated by the color of the vector at the surface level (Fig. 28A). At the beginning of the time series corresponding to the accretion zone of Simpson Canyon on the continental slope, marine currents up to 100 m were dominated by a northwest direction (0.1 m/s), then shifted to the southeast (0.2 m/s), followed by a maximum speed of over 0.4 m/s toward the west. This variability in direction continued with speeds of 0.2 m/s. The backscatter maintained a pattern of higher intensity in the surface layer (160 dB), decreasing with depth (75 m) and by the end of the time series at the surface at the head of Simpson Canyon (Fig. 28B).

The surface analysis of the hydrographic conditions for the Inland Sea of Chiloé showed a maximum temperature in the Reloncaví Fjord (12°C), which gradually decreased to 9°C towards the south at the Boca del Guafo, with a minimum at the center of the Reloncaví Fjord (2°C) and 7°C at the mouth of the Comau Fjord at the same time (Fig. 29B). Salinity was at its lowest (15 PSU) in the center of the Reloncaví and the mouth of the Comau, gradually increasing to 33-35 PSU towards the Reloncaví Sound and further south (Fig. 29C). Oxygen saturation was highest (130%) in the Reloncaví Sound, indicating a supersaturated environment, decreasing to between 90-100% towards the south (Fig. 29D). Fluorescence was highest in the Reloncaví Sound (10 mg/m3), with minimum concentrations observed uniformly at the surface from the Desertores Archipelago to the south (0 mg/m3) (Fig. 29E)

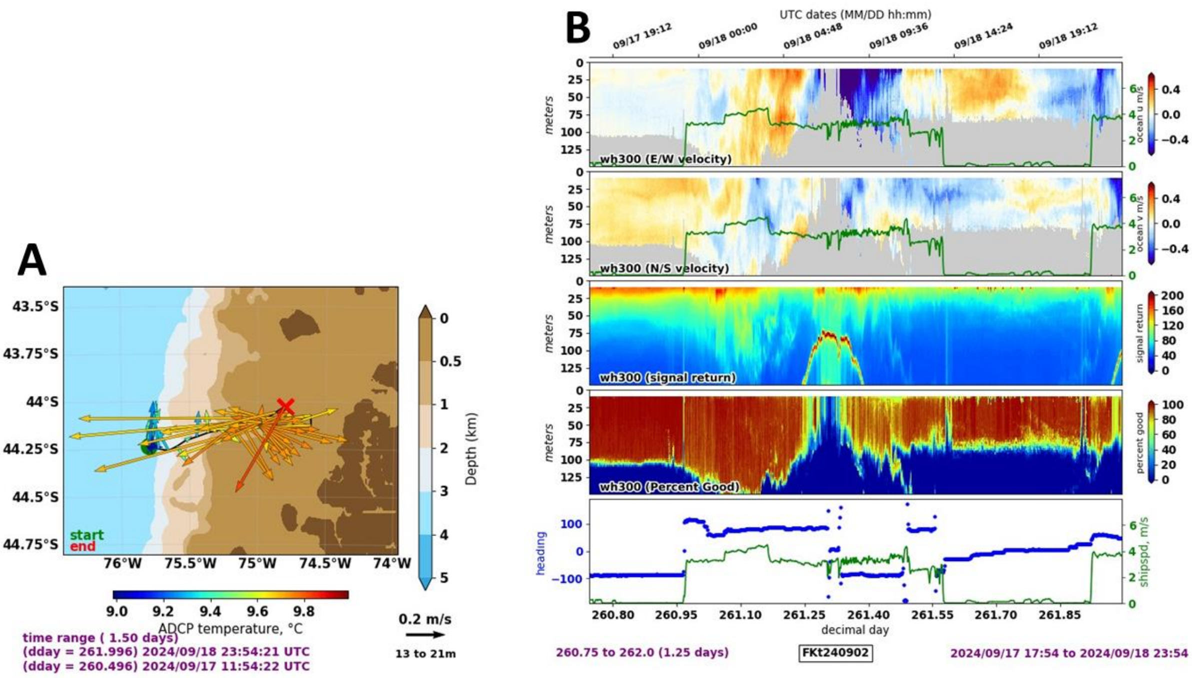


Fig. 28: Map of Simpson Canyon with a vector plot showing 15-minute averages of ocean velocity in a shallow layer over the past 1.2 days. The green point indicates the start of the cruise track, and the red 'X' marks the end of the sampling period (A). Temporal analysis with 15-minute averages of U and V components, backscatter, acceptable percentage of collected data, and the ship's speed and heading (B) down to a depth of 125 meters using a 300 kHz ADCP

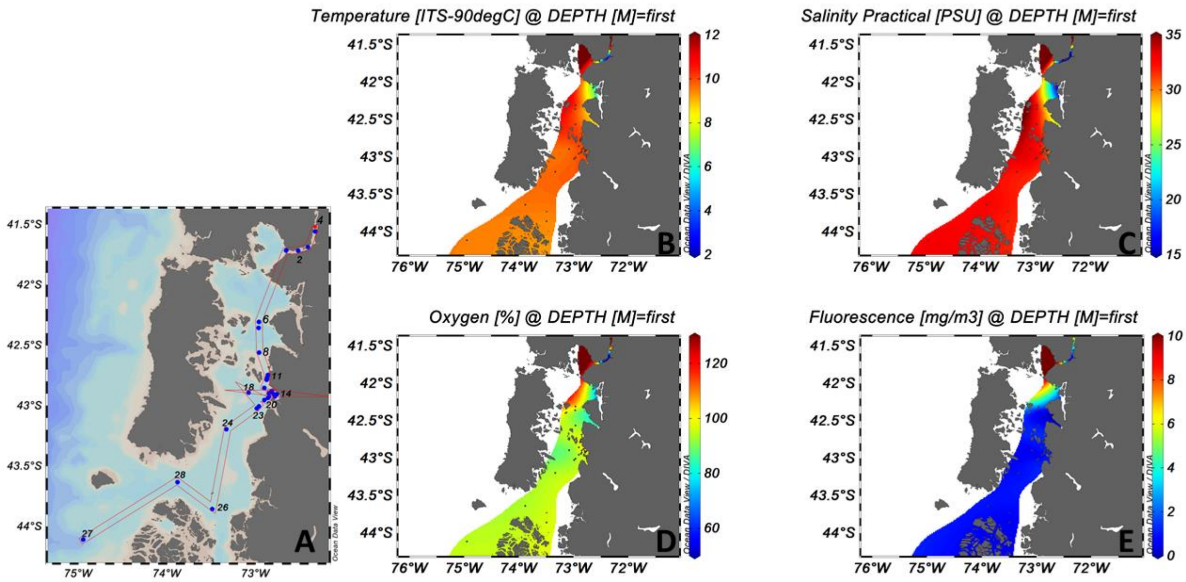


Fig. 29: Map of the study area of CTD stations in the inland sea of Chiloé (A). Surface map of temperature (B), salinity (C), oxygen saturation (D) and fluorescence (E).

Regarding the hydrographic conditions in the Inner Sea of Chiloé (Fig. 30A), a gradient of higher temperature (11°C) corresponding to the Reloncaví Fjord zone is observed, which decreases towards the south and remains homogeneously at 9°C throughout the water column (Fig. 30B). Salinity showed lower values at the surface (0-20 m) of ~28.5 PSU, determining the presence of the Estuarine Water Mass (EW) for the Reloncaví Fjord zone. At greater depths and from the Chaitén area, surface salinity increased to 32 PSU with the Modified Subantarctic Water Mass (MSAAW) up to 33 PSU corresponding to the Subantarctic Water Mass (SAAM) (Fig. 30C). Oxygen saturation showed a pattern with a wide range of variation (50-130%) from the surface to 100 meters in the Reloncaví Fjord zone. From the Desertores Archipelago, oxygen saturation varied between 80-90% (Fig. 30D). Fluorescence in the Reloncaví zone was highest in the surface layer (2.5 mg/m3), gradually decreasing towards the south with a variable isoline of 0 mg/m3 in the water column (Fig. 30E).

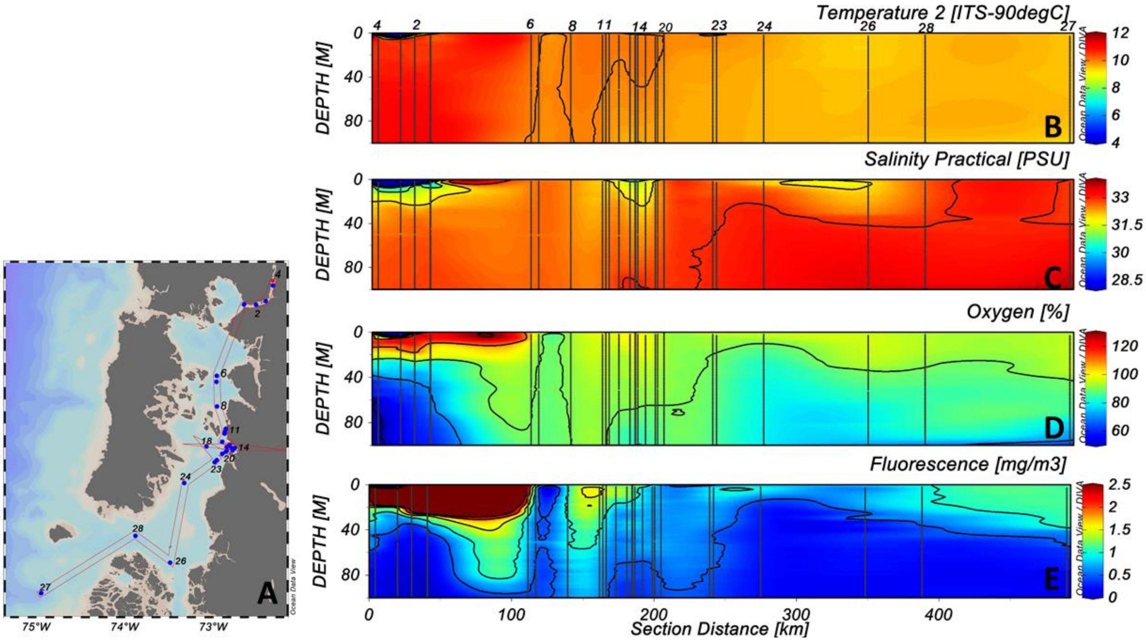


Fig. 30: Map of the study area of CTD stations in the inland sea of Chiloé (A). Temporal analysis of CTD hauls of temperature (B), absolute salinity (C), oxygen saturation (D) and fluorescence (E) up to 100 m depth.

6.4 Marine biology

Biological samples were recovered as described in Section 5 from ROV scoop bags and, in a small number of instances, via ROV push-coring or the ROV suction sampler, with a small number of samples also recovered via the van-Veen grabs. Following sieving and processing, the total number of samples collected is summarised as follows:

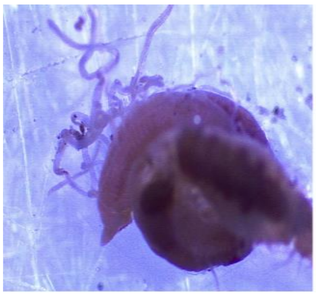
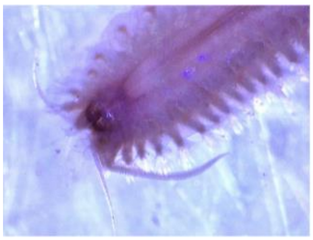
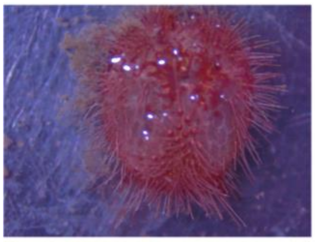
- 11 × 500 ml plastic bottles with approximately 30 g of sediment each for qualitative meiofauna studies, fixed with 5% formalin.
- 33 × 300 ml plastic bottles with approximately 15 g of segment each for studies of dinoflagellate cysts, refrigerated at 4°C and fixed with seawater.
- 34 × 500 ml plastic bottles with approximately 30 g of sediment each for biological studies of benthic macrofauna.
- 40 × Falcon tubes of 14 ml with benthic invertebrates for taxonomy study.
- 30 × packages of approximately 30 g of sediment for biochemical studies (granulometry, organic matter, isotopes, chlorophyll), frozen at -30°C.

Benthic invertebrates were separately sampled as follows, with examples of the most abundant families shown in Table 8.

- Annelida: 240 specimens.

- Arthropoda: 160 specimens
- Mollusca: 60 specimens
- Echinodermata: 16 specimens
- Cnidaria: 3 specimens.

Table 8: Photographed examples of the most abundant invertebrate families sampled on FKt240902.

	**Kingdom:** Animalia **Phylum:** Annelida **Class:** Polychaeta **Order:** Terebellida **Family:** Cirratulidae		**Kingdom:** Animalia **Phylum:** Annelida **Class:** Polychaeta **Order:** Terebellida **Family:** Cirratulidae
	**Kingdom:** Animalia **Phylum:** Annelida **Class:** Polychaeta **Order:** Phyllodocida **Family:** Sigalionidae		**Kingdom:** Animalia **Phylum:** Echinodermata **Class:** Echinoidea
	**Kingdom:** Animalia **Phylum:** Arthropoda **Class:** Malacostraca **Order:** Amphipoda		**Kingdom:** Animalia **Phylum:** Annelida **Class:** Polychaeta **Order:** Eunicida **Family:** Lumbrineridae
	**Kingdom:** Animalia **Phylum:** Annelida **Class:** Polychaeta **Order:** Phyllodocida **Family:** Sigalionidae		**Kingdom:** Animalia **Phylum:** Annelida **Class:** Polychaeta **Order:** Eunicida **Family:** Onuphidae
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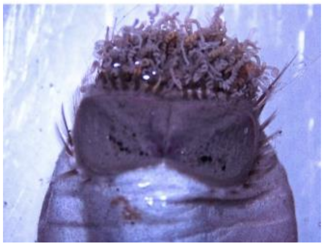
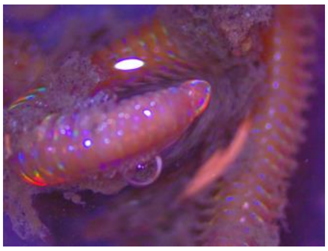
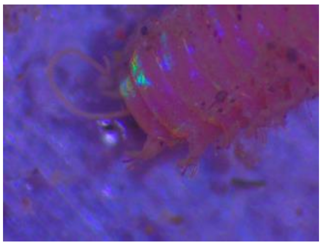
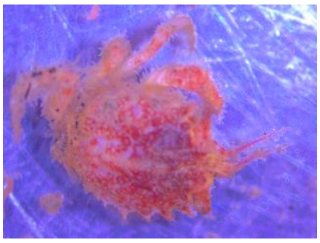
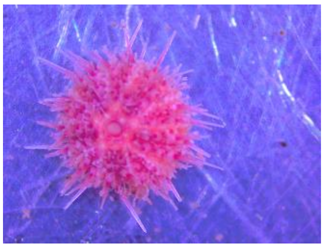
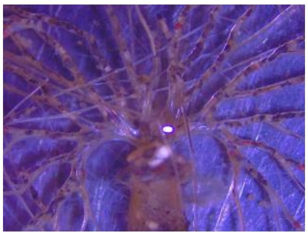
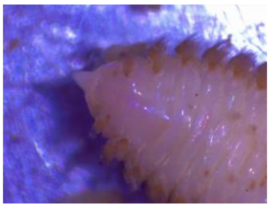
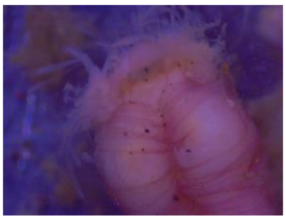
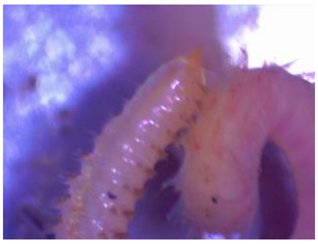
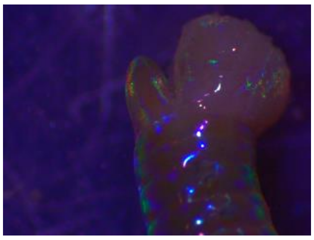
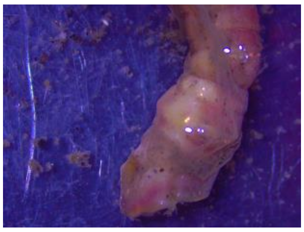
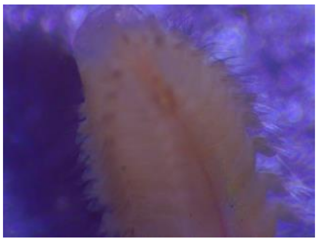
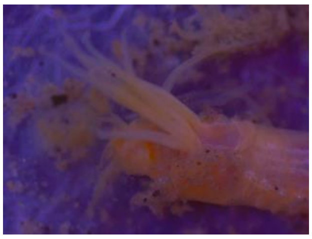
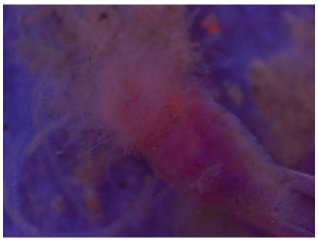
	**Kingdom:** Animalia **Phylum:** Annelida **Class:** Polychaeta **Order:** Terebellida **Family:** Sternaspidae		**Kingdom:** Animalia **Phylum:** Annelida **Class:** Polychaeta **Order:** Eunicida **Family:** Lumbrineridae
	**Kingdom:** Animalia **Phylum:** Mollusca **Class:** Bivalvia		**Kingdom:** Animalia **Phylum:** Annelida **Class:** Polychaeta
	**Kingdom:** Animalia **Phylum:** Mollusca **Class:** Gastropoda **Order:** Neogastropoda **Family:** Nassariidae **Genus:** *Nassarius*		**Kingdom:** Animalia **Phylum:** Arthropoda **Subphylum:** Crustacea
	**Kingdom:** Animalia **Phylum:** Echinodermata **Class:** Echinoidea		**Kingdom:** Animalia **Phylum:** Annelida **Class:** Polychaeta **Order:** Eunicida **Family:** Lumbrineridae
	**Kingdom:** Animalia **Phylum:** Mollusca **Class:** Gastropoda **Order:** Caenogastropoda *incertae sedis* **Family:** Epitoniidae **Genus:** *Epitonium*		**Kingdom:** Animalia **Phylum:** Annelida **Class:** Polychaeta **Family:** Maldanidae
	**Kingdom:** Animalia **Phylum:** Annelida **Class:** Polychaeta **Order:** Terebellida **Family:** Terebellidae **Genus:** *Lanice*		**Kingdom:** Animalia **Phylum:** Mollusca **Class:** Gastropoda **Order:** Neogastropoda **Family:** Nassariidae **Genus:** *Nassarius*

	**Kingdom:** Animalia **Phylum:** Annelida **Class:** Polychaeta **Order:** Eunicida **Family:** Onuphidae		**Kingdom:** Animalia **Phylum:** Annelida **Class:** Polychaeta **Order:** Phyllodocida **Family:** Phyllodocidae
	**Kingdom:** Animalia **Phylum:** Echinodermata **Class:** Ophiuroidea **Order:** Ophiurida **Family:** Ophiuridae **Genus:** *Ophiura*		**Kingdom:** Animalia **Phylum:** Annelida **Class:** Polychaeta **Order**: Phyllodocida **Family:** Hesionidae
	**Kingdom:** Animalia **Phylum:** Echinodermata **Class:** Ophiuroidea **Order:** Ophiurida **Family:** Ophiuridae **Genus:** *Ophiura*		**Kingdom:** Animalia **Phylum:** Mollusca **Class:** Gastropoda
	**Kingdom:** Animalia **Phylum:** Annelida **Class:** Polychaeta **Order:** Terebellida **Family:** Terebellidae		**Kingdom:** Animalia **Phylum:** Annelida **Class:** Polychaeta **Order:** Eunicida **Family:** Lumbrineridae
	**Kingdom:** Animalia **Phylum:** Echinodermata **Class:** Ophiuroidea **Order:** Euryalida **Family:** Gorgonocephalidae **Genus:** *Gorgonocephalus* **Species:** *Gorgonocephalus chilensis*		**Kingdom:** Animalia **Phylum:** Mollusca **Class:** Gastropoda **Order:** Neogastropoda **Family:** Mengeliidae **Genus:** *Oenopota*
	**Kingdom:** Animalia **Phylum:** Annelida **Class:** Polychaeta **Family:** Capitellidae		**Kingdom:** Animalia **Phylum:** Annelida **Class:** Polychaeta
	**Kingdom:** Animalia **Phylum:** Annelida **Class:** Polychaeta **Order:** Terebellida		**Kingdom:** Animalia **Phylum:** Annelida **Class:** Polychaeta **Order:** Eunicida **Family:** Lumbrineridae

	**Kingdom:** Animalia **Phylum:** Annelida **Class:** Polychaeta **Family:** Capitellidae		**Kingdom:** Animalia **Phylum:** Annelida **Class:** Polychaeta **Order:** Phyllodocida **Family:** Nephtyidae
	**Kingdom:** Animalia **Phylum:** Annelida **Class:** Polychaeta **Order:** Eunicida **Family:** Lumbrineridae		**Kingdom:** Animalia **Phylum:** Echinodermata **Class:** Ophiuroidea **Order:** Ophiurida **Family:** Ophiuridae **Genus:** *Ophiura*
	**Kingdom:** Animalia **Phylum:** Annelida **Class:** Polychaeta **Family:** Maldanidae		**Kingdom:** Animalia **Phylum:** Arthropoda **Class:** Malacostraca **Order:** Stomatopoda
	**Kingdom:** Animalia **Phylum:** Annelida **Class:** Polychaeta **Order:** Phyllodocida **Family:** Nephtyidae		**Kingdom:** Animalia **Phylum:** Echinodermata **Class:** Holothuroidea
	**Kingdom:** Animalia **Phylum:** Annelida **Class:** Polychaeta		**Kingdom:** Animalia **Phylum:** Echinodermata **Class:** Holothuroidea **Order**: Elasipodida **Family**: Elpidiidae **Genus**: *Scotoplanes*
	**Kingdom:** Animalia **Phylum:** Annelida **Class:** Polychaeta **Order:** Terebellida **Family:** Terebellidae		**Kingdom:** Animalia **Phylum:** Cnidaria **Class:** Octocoralia **Order**: Scleralcyonacea **Family**: Reniliidae **Gender**: *Renilla*

7. Outreach, Education and Science Communication Programme Results

7.1 Community engagement

A crucial aspect of our outreach strategy was the continuous and close engagement with the community of Chaitén. Over the course of the project, a strong connection with local schools and the broader community was developed and led by Rodrigo Fernandez and Colombina Valdés, who travelled to the Chaitén Science Fair ahead of the cruise, in May 2024, to present the Fire and Ice project and share insights on both geological science and marine biology. This first face-to-face interaction allowed the team to establish key connections with local educators, students, and community leaders.

Following this initial visit, the team continued this engagement (e.g. Rodrigo Fernandez providing ongoing mentorship to students on various scientific projects) and worked with participants from SERNAGEOMIN (Constanza Perales and Paola Peña) to arrange numerous Zoom meetings with community members to carefully plan the ship tour event for the students, ensuring that all logistical and educational aspects were covered. During the cruise, engagement with numerous regional schools was supported by the participation in the cruise of schoolteacher Danny Leviñanco, who led several live events with student groups. Looking forward, the team plans to build on these engagements by organizing an interactive museum exhibit, showcasing the work conducted onboard with biological and geological samples for the community to explore, in addition to attending the 2025 Science Fair in Chaitén. Danny Leviñanco plans to create an educational curriculum, which results from the cruise can feed into, thus providing content relevant to schools in the Chaitén district. This is designed around the theme of "How does science connect with education?". This multigrade curriculum (covering grades 1-6) aims to integrate small scientific project, including content such as the identification of intertidal macrofauna and sediment types from local islands or territories, and will incorporate science (scientific method, remote support from scientists), arts (scientific drawing, bibliographic research on zoology), and cultural themes (cultural expressions and their link to the science of the territory).

Additionally, the team prepared social media content to be shared on Instagram, TikTok, and YouTube, ensuring that the outreach efforts continued for 2 to 3 months after the expedition concludes.

7.2 Chaitén town visit

As part of the project, a guided tour aboard the Falkor (Too) was organized for 84 students and 10 teachers from 16 schools in the Chaitén district. The tour was divided into four student groups and one group of 13 local officials, along with 4 officers from the Chilean Navy. The visitors were split across several groups, with each visit lasting approximately 1 hour and 30 minutes and including five key stations: the ROV SuBastian station, the Geology Lab, the Wet Lab, the Biology Lab, and the Geophysics Lab. The full science team was involved in the programme and in engaging with the visitors across the different stations. Additionally, the tour featured the ship’s bridge, where an art station was set up, offering the students a unique interactive experience. Each child received a segment of an artwork by Jill Pelto, the first artwork from the project created on the ship. When each child collected their individual piece, the full artwork came together like a puzzle, forming a collective masterpiece.

This visit was made possible through the logistical support of the Chilean Navy and the Department of Municipal Education (DEM) of Chaitén, and it was conducted on a dedicated scientific workday. The vessel was adorned with artwork created by students from the region's island schools, including maps reflecting their local land and seascapes, giving the ship a unique territorial identity.

To enhance the educational experience, students received educational materials donated by SERNAGEOMIN (books and posters) as well as other gifts provided by the scientific team. These included 3D-printed models of marine organisms and souvenirs from the Schmidt Ocean Institute, leaving the students with tangible memories of their experience. Additionally, audiovisual material was recorded throughout the tour to document the event.

This outreach event underscored the project's commitment to fostering a connection between science and the local community, demonstrating the strong commitment to community engagement, environmental education, and the promotion of scientific curiosity among students from remote areas. It also highlighted the project's dedication to fostering lasting connections between science and local culture. With the active involvement of scientists, educators, and local authorities, the event was a remarkable success, making it a key element of our outreach and ensuring a broader impact that extends beyond the immediate scientific objectives.

This experience underscores the unique role the Falkor (too) can play in inspiring the next generation of scientists and environmental stewards. With continued support and funding, we are confident that future opportunities like this can further strengthen ties between research and local communities, enhancing educational outreach and scientific engagement in remote regions.

7.3 Ship-to-shore programme

Over the course of this expedition a total of 21 Ship-to-Shore connections were successfully completed, engaging with both Chilean and international audiences of varying ages, in Chile, Brazil, the US, UK and New Zealand. A large number of the science team were involved with leading individual activities in the programme. This was a record number of connections for SOI. A full breakdown of the schedule and audiences is provided in Appendix E.

The aim of these connections was to provide insights into life onboard a scientific marine research vessel. As part of this Scientists introduced the Fire and Ice project and gave tours of the ship’s facilities, including the Geology Lab, Wet Lab, Biology Lab, Geophysics Lab, Mission Control Room and ROV SuBastian. Each connection ended with the opportunity to ask questions. Prior to each call, schools from the UK and New Zealand received a pre-recorded 20 minute video to introduce students to scientific marine research, the variety of data and sample collection techniques onboard, as well as the main aims of the expedition. These schools were then kept up-to-date throughout the expedition via weekly virtual postcards.

A distinctive feature of these connections was the involvement of both scientists and crew members, showcasing not only the scientific operations but also the daily life and teamwork essential to life at sea. By blending scientific insights with human elements, the sessions bridged the gap between science and society. This connection aimed to inspire students, particularly those from remote or extreme regions, to pursue higher education and a scientific path, highlighting their natural environments as potential "living laboratories." In this context, the Chaitén region stands out as a prime example of such a natural laboratory. Furthermore, each Ship-to-Shore connection with local schools incorporated a territorial focus, fostering a sense of local identity and pride. This was enhanced by the participation of Danny Leviñanco, an expert in the cultural and pedagogical aspects of the region. Schools from a wide range of geographical settings in the region participated, including those from peninsular, insular, coastal, mountain, and urban areas. A total of 15 schools from Chaitén’s Department of Municipal Education (DEM), as well as a subsidized school from the Comau Peninsula (Huequi), were involved. Additionally, two school groups from Ushuaia, Argentina, participated, further broadening the geographical and cultural scope of the outreach program.

These connections not only served as an educational platform but also fostered meaningful exchanges between scientists, crew members, students, and educators, ensuring that the scientific experience aboard Falkor (too) reached and resonated with diverse communities.

7.4 Artist-at-Sea

Jill Pelto was the Artist at Sea on this expedition, and her primary objective was to create a series of watercolour paintings that communicate the research being done. She also led two Ship-to-Shore sessions with schools in the U.S., did a solo live-stream with SOI of her painting on board, and built plans for future engagement around this project.

Jill was able to effectively learn about, discuss, and participate in the science. She worked in a collaborative way with the team so that she was prepared to tell the story of their work through her paintings. Jill completed two paintings on board and is working on two additional paintings that will be finished within the couple of months following the expedition. Across the four paintings she highlighted: how the team collect water and sediment samples, what they find in sediment cores, how they use bathymetry and sub-bottom profiles, and lastly a landscape incorporating a narrative about the region of study, science data from the project, and local cultural symbols. To undertake this, Jill received a lot of support from the research team, as well as the science communication team. She created her work at a fixed space in the main lab on board, which allowed her to be immersed in the daily sampling.

Jill plans to give at least one artwork to SOI, as per her contract, and up to three pieces. This will be decided upon completion of the final two artworks. She plans to share high-resolution images of all completed work with SOI and the science team. Jill also will pursue sending copies (print reproductions) of one of her paintings to the 16 Chaitén-area schools that came aboard the Falkor (too) so that they are able to see her representation of their region.

Finally, after the expedition, Jill will give a seminar at the USGS Cascades Volcano Observatory in Washington state. She will speak about her time as the Artist at Sea and give an overview of the research being done and how she shared it through the visuals of her paintings.

8. Summary and future work

The FKt240902 expedition collected a wide range of geological, geophysical, biological and oceanographic data and samples, meeting all of the project's primary objectives, in addition to achieving the outreach and community engagement aims of the project. The survey has provided the most extensive high resolution bathymetric and geophysical dataset currently available from the region, highlighting a complex submarine landscape shaped by previous glaciations, and with current day sediment transport strongly influenced by currents. This results in a more complex set of sedimentary regimes than was envisaged at the start of the project, with areas of no present-day sediment accumulation – such as offshore the Rayas river outflow, where the present day seafloor preserved drowned subglacial features – through to channels and basins with complex bedforms and thick sediment accumulations, including contourites and dune fields. This complexity has resulted in a routing of the Chaitén 2008 eruption sediment that will require further work to unravel, but the expedition has collected the samples and observations that will enable this. Initial observations show that beyond the submerged delta front offshore the Blanco river and Chaitén town, sediment is routed along the south side of Chaitén bay, bypassing the central bay, producing deposits through the channel north of the Yelcho river and into basins further west. Further work is needed on the push-core and vibrocore samples to trace how far this sedimentary signature of the eruption extends. Offshore the Rayas river system, the pattern of sedimentation is different, due to the very strong prevailing currents. Sands and gravels from the eruption are trapped within the coast-parallel dune systems, which extend for many kilometres to the north and south. The finer sediment must be transported beyond this area, but its fate is yet to be confirmed. The samples collected during the survey will enable us to better understand this routing of sediment, providing for the first time an understanding of the impacts of this major eruption on the marine environment. Tracing the extent and transport of the volcanic sediment will both enable us to evaluate how such events impact marine ecosystems and their potential to impact marine infrastructure, and will also allow us to better reconstruct past eruptions from their submarine deposits. Our observations indicate that the Chaitén 2008 submarine deposits share many characteristics with tephra fall deposits, and distinguishing between the two is unlikely to be straightforward in distal, ash-grade layers. Submarine lahar-derived deposits of this type are important to recognise, with value as an archive of past events, but also with the potential to be misleading if inferred to be tephra fall deposits. A better understanding of how to identify such events is thus important and will ultimately enable more accurate reconstructions of regional eruption histories. Our core samples, despite being relatively short, have already shown the presence of multiple volcaniclastic event beds that hold strong potential for understanding past eruptive activity. Our sub-bottom profiles show many regions of much thicker sediment accumulations, which may hold strong prospects for developing longer post-glacial eruption histories.

To understand the impact and transport of sediment following regional eruptive events, our observations not only allow us to use the Chaitén 2008 eruption as a key exemplar, but provide initial datasets to test our understanding using other events, particularly those from Calbuco affecting the Reloncavi fjord. Additional observations in the southern Corcovado gulf extend this dataset to regions influenced by other volcanoes, while our geophysical and geological data will also enable us to understand sediment provenance and routing more distally, into the Corcovado gulf and beyond, through the continental margin at the Simpson Canyon. The cores from the Simpson Canyon indicate a highly active system, with multiple event deposits within less than one metre of sediment.

The expedition also collected an extensive set of marine biological data and observations in this little studied region, with particular value due to the wide geographic range of the data, extending from fjord and coastal regions into more open water, and out to the continental margin. By integrating this with our geological and oceanographic data, the results will enable a clearer understanding of the diversity of marine ecosystems in the region, and their potential vulnerability to volcanic and other processes. Finally, the oceanographic data provides a similarly extensive set of observations that has highlighted the importance of integrating knowledge of currents and present-day sediment transport conditions to interpret the sampled deposits and to reconstruct past events.

To take this work forward, the science team are working on various elements of the data and seeking funding to support additional analyses. The cores are currently archived in cold storage in Chile, awaiting scanning planned for later in 2025, to be followed by splitting and sub-sampling that will enable more detailed evaluations of volcaniclastic stratigraphies and sedimentary structures. Chronological information will be important to evaluate sedimentation rates and determine the ages of event layers, as well as to test potential correlations. An initial set of radiocarbon dating is currently planned, and will inform further analyses later in 2025. Granulometric and sedimentological observations will help further interpret the nature of deposits within the cores, and geochemical data (e.g. volcanic glass chemistry) will help test correlations and identify volcanic sources. Micropalaeontological and isotopic work will add to the understanding of present and past environments, environmental change, and provide further chronological constraints. The biological and oceanographic datasets will be integrated with other regional observations to add to our knowledge of present marine environments, extending the outputs from the project.

The outreach activities from FKt240902 reached an unusually large national and international audience for a marine scientific research project, and formed a major element of the expedition. The approach taken provides an example that we hope can be extended to other future projects, particularly in terms of local community engagement. To promote ongoing impacts of this work, we aim to continue working with communities in Chaitén, with plans to present results at the 2025 science fair and to embed this within future onshore science research projects in the region.

All electronic data (e.g. ROV dive images, bathymetry, oceanographic data) obtained in the project will be made available both via the Schmidt Ocean Institute online data archives or via publicly accessible marine data repositories. Physical samples are currently in storage for ongoing analyses at various institutions associated with the science team, with long-term archiving planned in Chile to ensure accessibility of the materials. Analytical results will be published in accessible formats and wherever possible submitted to open-access databases, to ensure that the data from this project is as widely available as possible to support future scientific research in the region.

9. Acknowledgements

The FKt240902 science team would like to thank the captain and crew of Falkor (too) for everything they did throughout the cruise in support of this project, and for all of their efforts in enabling the full range of activities described in this report. We would also like to thank all of the SOI staff involved in the project before, during and after the cruise, for everything that they did to facilitate this project. We are grateful for the permissions provided for this research via the permits issued by SHOA and SUBPESCA. We thank the Chilean Navy and the Department of Municipal Education (DEM) of Chaitén for their input and support with the outreach programme and particularly in allowing the ship visit to take place, and all those from the wider regional community of Chaitén who had input to associated activities within this project. We are also grateful for the support of SERNAGEOMIN in facilitating this project and the transport of equipment and samples before and after the cruise, and to the support of our individual institutions in enabling the participation of all the science team.

10. References

Bertrand, S., Daga, R., Bedert, R., and Fontijn, K., 2014. Deposition of the 2011-2013 Cordon Caulle tephra (Chile, 40 S) in lake sediments: Implications for tephrochronology and volcanology. Journal of Geophysical Research 119, 2555-2573.

Carrillo, U. and Diaz Villanueva, V., 2021. Impacts of volcanic eruptions and early recovery in freshwater environments and organisms. Biological Reviews 96, 2546-2560.

Castruccio, A., Clavero, J., Segura, A., Samaniego, P., Roche, O, Le Pennec, J.-L., and Droguett, B., 2016. Eruptive parameters and dynamics of the April 2015 sub-Plinian eruptions of Calbuco volcano (southern Chile). Bulletin of Volcanology 78, 62.

Huybers, P., and Langmuir, C., 2009. Feedback between deglaciation, volcanism, and atmospheric CO_2. Earth and Planetary Science Letters 286, 479-491.

Kutterolf, S., Schindlbeck, J.C., Jegen, M., Freundt, A., and Straub, S.M., 2019. Milankovitch frequencies in tephra records at volcanic arcs: The relation of kyr-scale cyclic variations in volcanism to global climate changes. Quaternary Science Reviews 204, 1-16.

Lara, L.E., 2010. The 2008 eruption of the Chaitén volcano, Chile: a preliminary report. Andean Geology, 36, 125-130.

Le Friant, A. ,Deplus, C., Boudon, G., Sparks, R.S.J., Trofimovs, J., and Talling, P., 2009. Submarine deposition of volcaniclastic material from the 1995-2005 eruptions of Soufriere Hills volcano, Montserrat. Journal of the Geological Society 166, 171-182.

Major, J.J., Pierson, T.C., Dinehard, R.L., and Costa, J.E., 2000. Sediment yield following severe volcanic disturbance – A two-decade perspective from Mount St. Helens. Geology 28, 819-822.

Major, J.J., Crisafulli, C.M., Frenzen, P., and Bishop, J., 2009. After the disaster: The hydrogeomorhic, ecological, and biological responses to the 1980 eruption of Mount St. Helens, Washington. The Geological Society of America Field Guide 15, 24 pp.

Major, J.J., Bertin, D., Pierson, T.C., Amigo, A., Iroume, A., Ulloa, H., and Castro, J., 2016. Extraordinary sediment delivery and rapid geomorphic response following the 2008-2009 eruption of Chaitén volcano, Chile. Water Resources Research 52, 5075-5094.

Pierson, T.C., Major, J.J., Amigo, A., and Moreno, H., 2013. Acute sedimentation response to rainfall following the explosive phase of the 2008-2009 eruption of Chaitén volcano, Chile. Bulletin of Volcanology 75, 723.

Rawson, H., Pyle, D.M., Mather, T.A., Smith, V.C., Fontijn, K., Lachowycz, S.M., and Naranjo, J.A., 2016. The magmatic and eruptive response of arc volcanoes to deglaciation: Insights from southern Chile. Geology 44, 251-254.

Rodrigo, C., 2008. Submarine topography in the Chilean North Patagonian channels. Progress in the oceanographic knowledge of Chilean inner waters, from Puerto Montt to Cape Horn. N. Silva and S. Palma (eds.), Comite Oceanografico Nacional, Valparaiso, 19-23.

Rodrigo, C., Fernandez, M., Contardo, X., and Fernandez, R., 2022. Geomorphology and sedimentary features of the Simpson Submarine Canyon (44 S), southern Chilean margin. Latin American Journal of Aquatic Research 50, 767-774.

Ulloa, H., Iroume, A, Picco, L., Korup, O., Lenzi, M.A., Mao, L., and Ravazzolo, D., 2015. Massive biomass flushing despite modest channel response in the Rayas River following the 2008 eruption of Chaitén volcano, Chile. Geomorphology 250, 397-406.

Ulloa, H., Iroume, A., Picco, L., Mohr, C.H., Mazzorana, B., Lenzi, M.A., and Mao, L., 2016. Spatial analysis of the impacts of the Chaitén volcano eruption (Chile) in three fluvial systems. Journal of South American Earth Sciences 69, 213-225.

Valdivia, J.C., 2014. Fan-Delta progradation following 2008 Chaitén volcano eruption, Chile. University of Auckland MSc thesis.

Vergara-Jara, M.J., Hopwood, M.J., Browning, T.J., Rapp, I., Torres, R., Reid, B., Achterberg, E.P., and Iriarte, J.L., 2021. A mosaic of phytoplankton responses across Patagonia, the southeast Pacific and the southwest Atlantic to ash deposition and trace metal release from the Calbuco volcanic eruption in 2015. Ocean Science 17, 561-578.

Wall Palmer, D., Jones, M.T., Hart, M.B., Fisher, J.K., Smart, C.W., Hembury, D.J., Palmer, M.R., and Fones, G.R., 2011. Explosive volcanism as a cause for mass mortality in pteropods. Marine Geology 282, 231-239.

Watt, S.F.L., Pyle, D.M., Mather, T.A., Martin, R.S., and Matthews, N.E., 2009. Fallout and distribution of volcanic ash over Argentina following the May 2008 explosive eruption of Chaitén, Chile. Journal of Geophysical Research 114, B04207.

Watt, S.F.L., Pyle, D.M., and Mather, T.A., 2013. The volcanic response to deglaciation: Evidence from glaciated arcs and a reassessment of global eruption records. Earth-Science Reviews 122, 77-102.

APPENDICES

Appendix A: Station List

Date	Location	Station Number	Deployment type	Water depth (m)	Latitude	Longitude
03/09/2024	Reloncavi Fjord inner basin	1	ROV001	197	-41.560158	-72.331588
03/09/2024	Reloncavi Fjord middle basin	2	ROV002	212	-41.677616	-72.401347
05/09/2024	S Golfo de Ancud	3	ROV003	244	-42.355772	-72.966685
05/09/2024	Chulin channel	4	ROV004	229	-42.559523	-72.961259
06/09/2024	Rayas Delta 1	5	ROV005	145	-42.785677	-72.877867
07/09/2024	Rayas Delta 2	6	ROV006	139	-42.76858	-72.871109
07/09/2024	Rayas Delta 3	7	ROV007	131	-42.742302	-72.862842
07/09/2024	Rayas Delta 4 (same location as Rayas Delta 3)	8	Van-Veen Grab 1	121	-42.744952	-72.863498
09/09/2024	Blanco West 1	9	ROV008	134	-42.851944	-72.903384
09/09/2024	S Rayas dunes S	10	Van-Veen Grab 2	110	-42.832098	-72.856597
10/09/2024	Blanco West 2	11	ROV009	128	-42.895059	-72.850518
10/09/2024	Blanco N Side	12	ROV010	106	-42.878002	-72.809004
11/09/2024	Basin to far west of Chaiten	13	ROV011	196	-42.890467	-73.080583
11/09/2024	Chaiten delta front lower	14	Van-Veen Grab 3	108	-42.909941	-72.763155
12/09/2024	Chaiten delta front mid slope	15	Van-Veen Grab 4	100	-42.913806	-72.753636
12/09/2024	Chaiten delta front central upper slope	16	ROV012	93	-42.914563	-72.751548
13/09/2024	Chaiten delta front central mid slope	17	ROV013	114	-42.908434	-72.779746
13/09/2024	Platform margin N of Yelcho outflow, large dune features (crest)	18	ROV014	119	-42.921528	-72.799093
13/09/2024	Platform margin N of Yelcho outflow, large dune features (trough)	19	ROV014	122	-42.919762	-72.8038
13/09/2024	S of Rayas outflow, dune facies	20	Van-Veen Grab 5	131	-42.807342	-72.862426
14/09/2024	W of Rayas delta, buried dune facies	21	Van-Veen Grab 6	122	-42.769842	-72.863025
14/09/2024	Channel N of Yelcho delta	22	ROV015	170	-42.926852	-72.811582
14/09/2024	Basin 1 W of Yelcho channel	23	ROV016	252	-42.93477	-72.859792
15/09/2024	Basin to far west of Chaiten (same site as station 013)	24	Gravity core 1	198	-42.890175	-73.080702
15/09/2024	Basin 2 W of Yelcho channel	25	ROV017	236	-42.942227	-72.924678
17/09/2024	Simpson Canyon outflow (1)	26	ROV018	3435	-44.231714	-75.796282
17/09/2024	Simpson Canyon outflow (2)	27	ROV018	3438	-44.231563	-75.797798
17/09/2024	Simpson Canyon outflow (3)	28	ROV018	3439	-44.226971	-75.811525
17/09/2024	Simpson Canyon outflow (4)	29	ROV018	3435	-44.226668	-75.812771
18/09/2024	Simpson Canyon feeder channel (1)	30	ROV019	879	-44.114514	-74.995417
18/09/2024	Simpson Canyon feeder channel (2)	31	ROV019	811	-44.11486	-74.983912
18/09/2024	Simpson Canyon feeder channel (3)	32	ROV019	807	-44.108549	-74.971518
19/09/2024	Basin E of Simpson Canyon/Canal Guafo	33	Van-Veen Grab 7	228	-43.993984	-74.516211
19/09/2024	Basin offshore Yanteles and Melimoyu	34	ROV020	199	-43.71091	-73.083139
19/09/2024	West of Corcovado Gulf platform	35	Gravity core 2	132	-43.658994	-73.456788

Appendix B: ROV dive plan summary of targets

SOI ROV-dive code	Station number(s)	Geographic location	Target
S0703	001	Reloncaví Fjord inner basin	Targeting basin sediment in the upper Reloncaví Fjord. This is a distinct inner basin of the fjord, fed by two rivers to the north. The site has been selected based on bathymetry and sub-bottom profiles, targeting a region of well-stratified undisturbed sediments. The aim is to retrieve intact sediments to determine basin sediment inputs, including from the Calbuco volcano and specifically the imprint of the 2015 Calbuco eruption. Sample targets are: bottom water, push cores for seabed interface, push cores for infauna, vibrocores (x 2), scoop bags for infauna.
S0704	002	Reloncaví Fjord intermediate basin	Targeting basin sediment in the central Reloncaví Fjord, south of the Palena river outflow. This is a distinct deep part of the fjord, isolated from the inner basin by relatively higher seafloor off the Palena river. The site has been selected based on bathymetry and sub-bottom profiles, targeting a region of well-stratified undisturbed sediments approximately 500 m above (NE) of a scalloped erosional headwall on the seabed. The site shows relative compression of the stratigraphy and has been targeted to maximise the stratigraphic range. The aim is to retrieve intact sediments to determine basin sediment inputs, including from the Calbuco volcano and the other sediment sources feeding the Reloncaví fjord. Sample targets are: bottom water, push cores for seabed interface, push cores for infauna, vibrocores (x 2), scoop bags for infauna.
S0705	003	Golfo de Ancud channel	Targeting sediment routes into the Ancud Gulf from the south. The seafloor is channelised with varied topography. Sediment routes are poorly constrained, but there are potential signals from the river systems to the south (Rayas river) offshore Chaitén. This is the most distal target region, prior to subsequent dives moving southwards towards the Rayas outflow. The site shows a thick accumulation of parallel bedded sediment.
S0706	004	Chulin channel	Targeting sediment routes towards the Ancud Gulf from the south, in the prominent channel east of Isla Chulin. This channel deepens to the north with a range of erosional structures. The target site has been selected towards the eastern side of the channel, based on sub-bottom profiles, in a region of parallel bedded sediment. The target is closer to Chaitén than the previous ROV dive, potentially with a more direct sediment route for sediment outflow from the Rayas river system.
S0707	005	Rayas Delta 1	Targeting sediment forming the Rayas delta. Sub-bottom profiles have shown multiple packages which can be targeted on a transect across the delta margins, to reach progressively older units. This site is targeting the youngest unit visible on the profile acquired overnight. Packages are transparent and we are expecting sandier sediments than at the previous dive sites.
S0708	006	Rayas Delta 2 (immediately W of central delta front)	Targeting sediment forming the Rayas delta. Sub-bottom profiles and bathymetry show gullied slops E-W in the central delta, with a distinct fabric to regions N and S, and undulating seafloor to the north along the delta margins, NW of the present-day outflow. The site has been selected at a marginal point where potential changes in seafloor morphology can be examined on a short transect. Backscatter in this area suggests an influence of recent sedimentation off the active delta.
S0709	007	Rayas Delta 3 (at margin of dune facies extending from N side of delta front)	Targeting sediment forming the Rayas delta. Sub-bottom profiles and bathymetry show a distinctive dune facies along the northern margin of the delta, which an orientation contrasting with the E-W alignment of the delta front structures further south. The target of this dive is to determine the nature of the sediment sources and structures in this region of the delta, building on the previous dive in the central delta front.
S0710	009	Blanco West 1 (in high backscatter region with lineations and parallel-bedded substrate)	Targeting sediment routes south of the Rayas delta and west of the Blanco/Yelcho river systems. This area shows a sharp change in backscatter with a broadly N-S boundary. To the E the seafloor is higher backscatter and less variable, while to the west – on this site – the seafloor is higher backscatter with cross cutting lineations. The characteristics are comparable with those west of the Rayas delta and the dive will test change in a southwards direction, as well as investigating the lineations. Sub-bottom profiles show a parallel bedded substrate with transparent features, some of which are buried and some of which appear to

			coincide with shallow ridges forming some of the lineations (other lineations are negative features). The dive will test the nature of the seafloor and potential origins of the surface structures.
S0711	011	Blanco West 2 (in lower backscatter region east of previous site)	Targeting sediment routes south of the Rayas delta and west of the Blanco/Yelcho river systems. This area shows a sharp change in backscatter with a broadly N-S boundary. To the E the seafloor is higher backscatter and less variable, while to the west the seafloor is higher backscatter with cross cutting lineations. This dive targets the easter region. It will investigate the parallel bedded stratified sediments visible in sub-bottom profiles in this area, which appear to be younger than the substrate at the prior dive site.
S0712	012	Blanco N side (marginal region on N side of bay)	Targeting sediment routes west of the Blanco/Yelcho river systems. This area is on the north side of this system and expected to show stronger influence from the Blanco sediment sources. Samples here will allow testing of sediment routes across this area, and the connection of these to dune systems that extend from this area round to the Rayas delta.
S0713	013	Basin to far west of Chaitén	Targeting sediment accumulation rates and sources in the basins west and south of Chaitén. This area sits within an elongate E-W basin to the far west of Chaitén, which sub-bottom profiles show to have thick accumulations of well stratified sediments. Parts show erosional features; this region has been selected as the area with the youngest accumulations. Samples here will allow testing of sediment routes across this area, and the connection of these systems to different sedimentary sources.
S0714	016	Chaitén delta central, upper slope	Targeting the upper slope of the Blanco delta front in its central region. The site has been selected as the top of an upper transparent unit descending from the front of the Chaitén delta system. Structures suggest this material is sourced from the Blanco river, but adjacent stratigraphy may also have influence from the Yelcho river. The site has been selected to target the transparent part of the delta frontal units, aiming to use the vibrocorer to extend beyond the mud that was sampled with the grab.
S0715	017	Chaitén delta central, mid slope	Targeting the mid to lower slope of the Blanco delta front in its central region, downslope from the previous dive site and in a distinct unit (but still a transparent unit) observed in sub-bottom profiles, before a stratified sequence is entered below the delta margins (the target of ROV011). The site has been selected as the top of an lower transparent unit descending from the front of the Chaitén delta system. Structures suggest this material is sourced from the Blanco river, but adjacent stratigraphy may also have influence from the Yelcho river. The site has been selected to target the transparent part of the delta frontal unit, aiming to use the vibrocorer to extend beyond the mud that was sampled with the grab.
S0716	018, 019	Platform N of Yelcho outflow	Targeting the high backscatter region with dune-like beforms north of the Yelcho outflow. This is on the margin of a platform west of the Blanco outflow and north of the Yelcho outflow. It has been selected to target coarse material in this high-backscatter facies, and to understand sediment input at the south side of Chaitén bay. A transect has been suggested to target lower backscatter regions across the dune structure.
S0717	022	Yelcho channel	Targeting the channel N of the Yelcho delta, forming a relatively deep, narrow route for sediment to the west. The channel floor has large undulating bedforms through this region. The core site is at the westerly edge of these, before the channel opens out slightly to basins to the west. The site has been selected to recover sediment from within the channel and understand input sediments and routes on the south side of Chaitén bay, fed by the Yelcho system, and the input of the Blanco to this southward route.
S0718	023	Basin 1 W of Yelcho Channel	Targeting the outflow routes W of the Yelcho channel and Chaitén Bay. The previous dive site has identified sandy units in the channel with volcaniclastic input. This is the next downstream basin beyond the channel; the site is aiming to identify sediment routing into this channel and the downstream evolution of units derived from the Blanco/Yelcho systems.
S0719	025	Basin 2 W of Yelcho Channel	Targeting the outflow routes W of the Yelcho channel and Chaitén Bay. The previous dive site has was in a deeper basin W of Yelcho, and recovered a shallow ash-rich unit a few centimetres in thickness. This basin is further W and slightly more elevated, but shows thick sediment accumulations. The site

			aims to identify the extent of Chaitén deposit sedimentation via the southward routes.
S0720	026, 027, 028, 029	Simpson Canyon outflow	The site is targeting the most distal sediment pathways in the study region, in a fan at the base of the Simpson Canyon, which cuts through the continental slope to the margin of the Pacific. The area has existing mapping data on which the site has been picked, with additional SBP profiles collected overnight to pick the specific site. The fan that is deposited at the mouth of the canyon shows undulating large bedforms and the main target is a transect across this region with associated sampling.
S0721	030, 031, 032	Simpson Canyon upper channels	The site is targeting sediment sources that feed the Simpson Canyon, particularly those from the Chiloe Sea. This site has been selected in one of the subsidiary and northern channels, rather than the larger channel further south, aiming to target less mixed sediment sources. The site is a terrace that may accumulate overbank deposits. The main target is geological but it also offers an opportunity to identify biological communities in the upper parts of the Simpson Canyon and at intermediate depths between the previous ROV dives and the rest of the study area.
S0722	034	Basin in SE Corcovado Gulf, offshore Yanteles and Melimoyu volcanoes	The site is targeting sediment sources in the southern parts of the Corcovado Gulf, where several basins are partially connected around the east side of a platform. Sub-bottom profiles suggest complex feeder systems and distinct accumulation rates between basins. This site has been selected as a relatively more isolated and distinct system that appears to be predominantly fed from the NE. It will provide an indication of potential for accumulating eruption related deposits from the nearby volcanoes of Yanteles and Melimoyu.

Appendix C: Sampling Summary

Cruise	Date (UTC)	Geographic name	Station	Deployment type number	SOI ROV dive code (if applicable)	Method	Sample name	Water depth	Latitude	Longitude	C	Temperature	Salinity	Sampling notes	Recovered sample (e.g. cm length)	Subsampling summary
FKt240902	3/9/24	Reloncavi Fjord inner basin	001	ROV001	S0703	Niskin	FKt240902-RW-001-A	197	-41.560158	-72.33159	3.73	11.24	32.976	2 mins after landing on bottom	Successful	2 vials and 2 bottles
FKt240902	3/9/24	Reloncavi Fjord inner basin	001	ROV001	S0703	Niskin	FKt240902-RW-001-B	197	-41.560154	-72.33159	3.73	11.24	32.976	7 mins after landing	Successful	None
FKt240902	3/9/24	Reloncavi Fjord inner basin	001	ROV001	S0703	Push core	FKt240902-UC-001-A	197	-41.560157	-72.33159	3.73	11.24	32.976	Short sample; challenging to recover	None	No - sample failed and lost during push core extraction
FKt240902	3/9/24	Reloncavi Fjord inner basin	001	ROV001	S0703	Push core	FKt240902-UC-001-B	198	-41.560155	-72.33159	3.73	11.24	32.976	Good recovery at first try	18 cm	Sampled at 1 cm intervals
FKt240902	3/9/24	Reloncavi Fjord inner basin	001	ROV001	S0703	Push core	FKt240902-UC-001-C	198	-41.560157	-72.33159	3.73	11.24	32.975	Short sample	None	No - sample failed and lost during push core extraction
FKt240902	3/9/24	Reloncavi Fjord inner basin	001	ROV001	S0703	Push core	FKt240902-UC-001-D	198	-41.560155	-72.33159	3.73	11.24	32.975	Good recovery	24 cm	Archive sub-core and remainder sampled at 5 cm intervals
FKt240902	3/9/24	Reloncavi Fjord inner basin	001	ROV001	S0703	Vibracore	FKt240902-VC-001-A	199	-41.560156	-72.33157	3.73	11.24	32.974	Full penetration; successful recovery	97 cm	Archived, with core-catcher
FKt240902	3/9/24	Reloncavi Fjord inner basin	001	ROV001	S0703	Vibracore	FKt240902-VC-001-B	199	-41.560207	-72.33155	3.73	11.24	32.974	Full penetration; fell horizontal during recovery	79 cm	Split, logged and sub-sampled
FKt240902	3/9/24	Reloncavi Fjord inner basin	001	ROV001	S0703	Vibracore	FKt240902-VC-001-C	200	-41.56017	-72.33152	3.73	11.24	32.974	Full penetration; fell horizontal during recovery	76 cm	Split, logged and sub-sampled
FKt240902	3/9/24	Reloncavi Fjord inner basin	001	ROV001	S0703	Scoop bag	FKt240902-SB-001-A	201	-41.560306	-72.33148	3.73	11.24	32.974	Successful recovery	Full bag	Sieved and sub-sampled for biology
FKt240902	3/9/24	Reloncavi Fjord inner basin	001	ROV001	S0703	Scoop bag	FKt240902-SB-001-B	201	-41.560313	-72.3315	3.73	11.24	32.973	Successful recovery	Full bag	Sieved and sub-sampled for biology
FKt240902	3/9/24	Reloncavi Fjord inner basin	001	ROV001	S0703	Scoop bag	FKt240902-SB-001-C	201	-41.560337	-72.33153	3.73	11.25	32.973	Successful recovery	Full bag	Sieved and sub-sampled for biology
FKt240902	3/9/24	Reloncavi Fjord inner basin	001	ROV001	S0703	Scoop bag	FKt240902-SB-001-D	201	-41.560373	-72.33154	3.73	11.24	32.973	Successful recovery	Full bag	Sieved and sub-sampled for biology
FKt240902	3/9/24	Reloncavi Fjord middle basin	002	ROV002	S0704	Niskin	FKt240902-RW-002-A	208	-41.677588	-72.40153	3.72	11.15	32.964	5 m above seafloor	Successful	Vial and bottle
FKt240902	3/9/24	Reloncavi Fjord middle basin	002	ROV002	S0704	Niskin	FKt240902-RW-002-B	212	-41.677616	-72.40135	3.72	11.15	32.964	On seafloor	Successful	2 vials and bottle
FKt240902	3/9/24	Reloncavi Fjord middle basin	002	ROV002	S0704	Push core	FKt240902-UC-002-A	212	-41.677618	-72.40135	3.72	11.15	32.963	Good recovery	18 cm	Archive sub-core and remainder sampled at 2 cm intervals
FKt240902	3/9/24	Reloncavi Fjord middle basin	002	ROV002	S0704	Push core	FKt240902-UC-002-C	212	-41.677616	-72.40135	3.72	11.16	32.964	Good recovery	17 cm	Sliced at 1 cm intervals
FKt240902	3/9/24	Reloncavi Fjord middle basin	002	ROV002	S0704	Push core	FKt240902-UC-002-B	212	-41.677618	-72.40135	3.72	11.15	32.964	Good recovery	15 cm	Sliced at 1 cm intervals
FKt240902	3/9/24	Reloncavi Fjord middle basin	002	ROV002	S0704	Vibracore	FKt240902-VC-002-A	210	-41.677586	-72.40136	3.72	11.15	32.964	Collected without top valve, full penetration, successful recovery	95 cm	Archived, with core-catcher
FKt240902	3/9/24	Reloncavi Fjord middle basin	002	ROV002	S0704	Vibracore	FKt240902-VC-002-B	211	-41.677691	-72.40131	3.72	11.15	32.963	Collected without top valve, full penetration, successful recovery	55 cm	Archived, with core-catcher
FKt240902	3/9/24	Reloncavi Fjord middle basin	002	ROV002	S0704	Vibracore	FKt240902-VC-002-C	211	-41.677605	-72.40154	3.72	11.15	32.963	Collected without top valve, full penetration, successful recovery	91 cm	Split, logged and sub-sampled
FKt240902	3/9/24	Reloncavi Fjord middle basin	002	ROV002	S0704	Niskin	FKt240902-RW-002-C	205	-41.67758	-72.40155	3.72	11.14	32.965	Test - sample not retained	N/A	N/A
FKt240902	3/9/24	Reloncavi Fjord middle basin	002	ROV002	S0704	Niskin	FKt240902-RW-002-D	186	-41.677531	-72.40151	3.72	11.15	32.963	Test - sample not retained	N/A	N/A
FKt240902	5/9/24	S Golfo de Ancud	003	ROV003	S0705	Niskin	FKt240902-RW-003-A	240	-42.355789	-72.96674	3.59	9.94	32.75	5 m above seafloor	Successful	2 vials
FKt240902	5/9/24	S Golfo de Ancud	003	ROV003	S0705	Niskin	FKt240902-RW-003-B	244	-42.355772	-72.96669	3.59	9.94	32.749	On seafloor, 2 minutes after landing	Successful	2 vials and 1 bottle
FKt240902	5/9/24	S Golfo de Ancud	003	ROV003	S0705	Niskin	FKt240902-RW-003-C	244	-42.355772	-72.96669	3.59	9.94	32.75	On seafloor, 2 minutes after landing	Successful	1 vial, sieved
FKt240902	5/9/24	S Golfo de Ancud	003	ROV003	S0705	Push core	FKt240902-UC-003-A	244	-42.355775	-72.96668	3.59	9.94	32.75	Half full	Bulk sample for biology	
FKt240902	5/9/24	S Golfo de Ancud	003	ROV003	S0705	Push core	FKt240902-UC-003-B	244	-42.355772	-72.96668	3.59	9.94	32.75	Good sample	12 cm	0-1cm for rose bengal; 1-12 cm slice samples; Hg samples every 5 cm
FKt240902	5/9/24	S Golfo de Ancud	003	ROV003	S0705	Push core	FKt240902-UC-003-C	244	-42.35577	-72.96669	3.59	9.94	32.75	Half full	Bulk sample fo	Bulk sample
FKt240902	5/9/24	S Golfo de Ancud	003	ROV003	S0705	Push core	FKt240902-UC-003-D	244	-42.355779	-72.96668	3.59	9.94	32.75	Good recovery	14 cm	2 surface water vials; sliced at 1 cm
FKt240902	5/9/24	S Golfo de Ancud	003	ROV003	S0705	Push core	FKt240902-UC-003-E	244	-42.355777	-72.96669	3.59	9.94	32.75	40% recovery	10 cm	Sliced at 1 cm
FKt240902	5/9/24	S Golfo de Ancud	003	ROV003	S0705	Push core	FKt240902-UC-003-F	244	-42.355779	-72.96668	3.59	9.94	32.75	70% recovery	21 cm	Archive sub-core taken; remainder 0-1 cm and then 5cm intervals sampled
FKt240902	5/9/24	S Golfo de Ancud	003	ROV003	S0705	Vibracore	FKt240902-VC-003-A	244	-42.355776	-72.96669	3.59	9.94	32.75	Full penetration; successful recovery	73 cm	Split and sub-sampled; core catcher
FKt240902	5/9/24	S Golfo de Ancud	003	ROV003	S0705	Vibracore	FKt240902-VC-003-B	246	-42.355777	-72.96665	3.59	9.94	32.75	Full penetration; successful recovery	89 cm	Archive + core catcher
FKt240902	5/9/24	S Golfo de Ancud	003	ROV003	S0705	Scoop bag	FKt240902-SB-003-A	246	-42.355776	-72.96666	3.59	9.94	32.75	Successful recovery	Full bag	Sieved and sub-sampled for biology
FKt240902	5/9/24	S Golfo de Ancud	003	ROV003	S0705	Scoop bag	FKt240902-SB-003-B	245	-42.35582	-72.96657	3.59	9.94	32.75	Successful recovery	Full bag	Sieved and sub-sampled for biology
FKt240902	5/9/24	S Golfo de Ancud	003	ROV003	S0705	Scoop bag	FKt240902-SB-003-C	244	-42.355826	-72.96659	3.59	9.94	32.75	Successful recovery	Full bag	Sieved and sub-sampled for biology
FKt240902	5/9/24	S Golfo de Ancud	003	ROV003	S0705	Scoop bag	FKt240902-SB-003-D	244	-42.355845	-72.96656	3.59	9.94	32.749	Successful recovery	Full bag	Sieved and sub-sampled for biology
FKt240902	5/9/24	Chulin channel	004	ROV004	S0706	Niskin	FKt240902-RW-004-A	229	-42.559513	-72.96126	3.59	9.96	32.715	On seafloor, 2 minutes after landing	Successful	Vial and bottle
FKt240902	5/9/24	Chulin channel	004	ROV004	S0706	Niskin	FKt240902-RW-004-B	229	-42.559527	-72.96126	3.59	9.96	32.715	On seafloor, 2 minutes after landing	Successful	2 vials
FKt240902	5/9/24	Chulin channel	004	ROV004	S0706	Push core	FKt240902-UC-004-A	229	-42.559526	-72.96126	3.59	9.96	32.716	Good recovery	23 cm	Archive sub-core; surface water vials; remainder 0-1 cm then 5 cm intervals
FKt240902	5/9/24	Chulin channel	004	ROV004	S0706	Push core	FKt240902-UC-004-B	229	-42.559523	-72.96126	3.59	9.96	32.713	Full recovery but some disturbance up sides to top	Bulk sample fo	Biology
FKt240902	5/9/24	Chulin channel	004	ROV004	S0706	Push core	FKt240902-UC-004-C	229	-42.559525	-72.96126	3.59	9.96	32.716	Good recovery	23 cm	Rose bengal (top cm) then 1 cm slices

FKt240902	5/9/24	Chulin channel	004	ROV004	S0706	Push core	FKt240902-UC-004-D	229	-42.559522	-72.96126	3.59	9.96	32.71	Some disturbance of top during recovery; top of push core then sheared off later in dive; sediment still present so sample retained	Bulk sample fo	Biology
FKt240902	5/9/24	Chulin channel	004	ROV004	S0706	Push core	FKt240902-UC-004-E	229	-42.559523	-72.96126	3.59	9.96	32.675	Good recovery	18 cm	Sliced at 1 cm intervals
FKt240902	5/9/24	Chulin channel	004	ROV004	S0706	Vibracore	FKt240902-VC-004-A	229	-42.559517	-72.96126	3.59	9.96	32.677	Full penetration; successful recovery	89 cm	Archived, with core-catcher
FKt240902	5/9/24	Chulin channel	004	ROV004	S0706	Vibracore	FKt240902-VC-004-B	228	-42.559455	-72.96128	3.59	9.96	32.674	Full penetration; successful recovery	81 cm	Split, logged and sub-sampled
FKt240902	5/9/24	Chulin channel	004	ROV004	S0706	Scoop bag	FKt240902-SB-004-A	228	-42.559461	-72.96129	3.59	9.96	32.674	Successful recovery	Full bag	Sieved and sub-sampled for biology
FKt240902	5/9/24	Chulin channel	004	ROV004	S0706	Scoop bag	FKt240902-SB-004-B	228	-42.559458	-72.96129	3.59	9.96	32.672	Successful recovery	Full bag	Sieved and sub-sampled for biology
FKt240902	5/9/24	Chulin channel	004	ROV004	S0706	Scoop bag	FKt240902-SB-004-C	228	-42.559414	-72.96136	3.59	9.96	32.672	Successful recovery	Full bag	Sieved and sub-sampled for biology
FKt240902	5/9/24	Chulin channel	004	ROV004	S0706	Scoop bag	FKt240902-SB-004-D	228	-42.559414	-72.96136	3.59	9.96	32.672	Successful recovery (NB: not recorded in SeaLog; same location as previous scoop bag used)	Full bag	Sieved and sub-sampled for biology
FKt240902	6/9/24	Rayas Delta 1	005	ROV005	S0707	Niskin	FKt240902-RW-005-A	142	-42.785681	-72.87786	3.59	9.82	32.828	5 m off seafloor	Successful	Vial and bottle
FKt240902	6/9/24	Rayas Delta 1	005	ROV005	S0707	Niskin	FKt240902-RW-005-B	145	-42.785677	-72.87787	3.59	9.82	32.831	On seafloor	Successful	2 vials
FKt240902	6/9/24	Rayas Delta 1	005	ROV005	S0707	Vibracore	FKt240902-VC-005-A	145	-42.785676	-72.78688	3.59	9.82	32.8	Could not penetrate; hard pebbly later beneath rippled sand cover on seafloor	0 cm (CC only)	Core-catcher sample only; no recovered core
FKt240902	6/9/24	Rayas Delta 1	005	ROV005	S0707	Scoop bag	FKt240902-SB-005-A	145	-42.785656	-72.87784	3.59	9.81	32.853	Successful recovery - pebbly seafloor facies (with rippled sand drape)	Full bag	Rose bengal sample; bag of pebbles, rest sampled for biology
FKt240902	6/9/24	Rayas Delta 1	005	ROV005	S0707	Scoop bag	FKt240902-SB-005-B	146	-42.785677	-72.87784	3.59	9.81	32.853	Successful recovery - mix of local sandy and pebbly debris	Full bag	Bulk sample; pebbles
FKt240902	6/9/24	Rayas Delta 1	005	ROV005	S0707	Scoop bag	FKt240902-SB-005-C	145	-42.786122	-72.87783	3.59	9.81	32.9	Successful recovery- sandy seafloor facies	Full bag	Rose bengal sample; bulk bag of shells; pebbles; leaf; bulk sample of sediment
FKt240902	6/9/24	Rayas Delta 1	005	ROV005	S0707	Scoop bag	FKt240902-SB-005-D	144	-42.785709	-72.87801	3.59	9.77	32.932	Successful recovery - targeting biology	Basket star	Sampled
FKt240902	7/9/24	Rayas Delta 2	006	ROV006	S0708	Niskin	FKt240902-RW-006-A	137	-42.768632	-72.87106	3.57	9.93	32.614	5 m off seafloor	Successful	2 vials
FKt240902	7/9/24	Rayas Delta 2	006	ROV006	S0708	Niskin	FKt240902-RW-006-B	139	-42.76858	-72.87111	3.57	9.91	32.634	On seafloor	Successful	2 vials and bottle
FKt240902	7/9/24	Rayas Delta 2	006	ROV006	S0708	Vibracore	FKt240902-VC-006-A	133	-42.768418	-72.87028	3.58	9.91	32.645	Good penetration into gravelly substrate (1.5 m)	27 cm - poor re	Core archived; core catcher sample
FKt240902	7/9/24	Rayas Delta 2	006	ROV006	S0708	Scoop bag	FKt240902-SB-006-A	139	-42.768558	-72.87114	3.57	9.91	32.638	Successful - rippled sand	Full bag	Bulk sample and picked pebbles sample
FKt240902	7/9/24	Rayas Delta 2	006	ROV006	S0708	Scoop bag	FKt240902-SB-006-B	139	-42.768552	-72.87116	3.58	9.91	32.642	Successful - rippled sand with pebbly patches (underlying)	Full bag	Bulk sample and picked pebbles sample; + bulk sample for biology
FKt240902	7/9/24	Rayas Delta 2	006	ROV006	S0708	Scoop bag	FKt240902-SB-006-C	139	-42.768533	-72.87071	3.58	9.91	32.64	Pale grey patches among pebbly surface, weathering into subrounded blocks with internal layering; cohesive and fine grained (clay?)	Single soft bloc	Single sample; smear slide taken
FKt240902	7/9/24	Rayas Delta 2	006	ROV006	S0708	Scoop bag	FKt240902-SB-006-D	136	-42.768376	-72.8702	3.57	9.92	32.631	Successful - bulk gravelly sand from dune feature, following short transect E	Full bag	Bulk sample + bulk sample for biology
FKt240902	7/9/24	Rayas Delta 3	007	ROV007	S0709	Niskin	FKt240902-RW-007-A	126	-42.742311	-72.86293	3.58	9.85	32.772	5 m off seafloor	Successful	1 vial
FKt240902	7/9/24	Rayas Delta 3	007	ROV007	S0709	Niskin	FKt240902-RW-007-B	131	-42.742302	-72.86284	3.58	9.85	32.772	On seafloor	Successful	2 vials and bottle
FKt240902	7/9/24	Rayas Delta 3	007	ROV007	S0709	Vibracore	FKt240902-VC-007-A	131	-42.742298	-72.86283	3.58	9.86	32.773	Successful penetration (approx 1.2 m)	Loose material	None - just core-catcher, no core
FKt240902	7/9/24	Rayas Delta 3	007	ROV007	S0709	Vibracore	FKt240902-VC-007-B	131	-42.742312	-72.86283	3.58	9.86	32.777	Successful penetration (approx 1.7 m)	57 cm core; str	Core (archived) plus core catcher)
FKt240902	7/9/24	Rayas Delta 3	007	ROV007	S0709	Vibracore	FKt240902-VC-007-C	129	-42.742413	-72.86248	3.58	9.86	32.792	Successful penetration (approx 1.7 m)	35 cm core; top	Just core
FKt240902	7/9/24	Rayas Delta 3	007	ROV007	S0709	Scoop bag	FKt240902-SB-007-A	131	-42.742297	-72.86284	3.58	9.85	32.773	Rippled dark sand, discontinuous cover on pumice-rich gravel below; bulk sample; E-W orientated ripples	Full bag	Bulk samples x 2 and picked pumices
FKt240902	7/9/24	Rayas Delta 3	007	ROV007	S0709	Scoop bag	FKt240902-SB-007-B	131	-42.742307	-72.86283	3.58	9.85	32.787	Pumice-rich patch with several stick fragments and one large stick (picked up separately with manipulator arm); notable absence of life	Full bag plus 4	Sticks; bulk sample; picked pumices; one worm (bio sample)
FKt240902	7/9/24	Rayas Delta 4 (same location as	008	Van-Veen (	NA	Grab	FKt240902-GS-008-A	121	-42.744952	-72.8635	-	-	-	Successful deployment; full grab; 145 m wire out; deployed 22:55 UTC	Full grab	4 large bulk bags and one long piece of wood
FKt240902	9/9/24	Blanco West 1	009	ROV008	S0710	Niskin	FKt240902-RW-009-A	130	-42.851965	-72.90346	3.6	9.69	33.094	5 m off seafloor	Successful	Unsampled
FKt240902	9/9/24	Blanco West 1	009	ROV008	S0710	Niskin	FKt240902-RW-009-B	134	-42.851956	-72.90338	3.6	9.69	33.095	On seafloor	Successful	2 vials and bottle

FKt240902	9/9/24	Blanco West 1	009	ROV008	S0710	Push core	FKt240902-UC-009-A	134	-42.851944	-72.90338	3.6	9.69	33.096	Successful, close to full tube	Bulk sample for	Bulk sample
FKt240902	9/9/24	Blanco West 1	009	ROV008	S0710	Push core	FKt240902-UC-009-B	134	-42.851949	-72.90338	3.6	9.69	33.096	Successful, close to full tube	18 cm	Sliced at 1 cm intervals
FKt240902	9/9/24	Blanco West 1	009	ROV008	S0710	Push core	FKt240902-UC-009-C	134	-42.851951	-72.90338	3.6	9.69	33.096	Successful, good recovery, full tube	19.5 cm	0-1 cm for rose bengal; archive sub-core taken; remainder sampled at 5 cm intervals
FKt240902	9/9/24	Blanco West 1	009	ROV008	S0710	Push core	FKt240902-UC-009-D	134	-42.851945	-72.90378	3.6	9.69	33.097	Successful, good recovery, full tube	21 cm	Sliced at 1 cm intervals
FKt240902	9/9/24	Blanco West 1	009	ROV008	S0710	Push core	FKt240902-UC-009-E	134	-42.851949	-72.90379	3.6	9.69	33.097	Disturbed on collection, close to full tube	Bulk sample for	Bulk sample
FKt240902	9/9/24	Blanco West 1	009	ROV008	S0710	Scoop bag	FKt240902-SB-009-A	134	-42.851947	-72.90338	3.6	9.69	33.096	Successful recovery	Full bag	Sieved and sub-sampled for biology
FKt240902	9/9/24	Blanco West 1	009	ROV008	S0710	Scoop bag	FKt240902-SB-009-B	134	-42.851947	-72.90338	3.6	9.69	33.096	Successful recovery	Full bag	Sieved and sub-sampled for biology
FKt240902	9/9/24	Blanco West 1	009	ROV008	S0710	Scoop bag	FKt240902-SB-009-C	134	-42.851946	-72.90338	3.6	9.69	33.097	Successful recovery	Full bag	Sieved and sub-sampled for biology
FKt240902	9/9/24	Blanco West 1	009	ROV008	S0710	Scoop bag	FKt240902-SB-009-D	134	-42.851946	-72.90338	3.6	9.69	33.097	Successful recovery	Full bag	Sieved and sub-sampled for biology
FKt240902	9/9/24	Blanco West 1	009	ROV008	S0710	Scoop bag	FKt240902-SB-009-E	134	-42.851946	-72.90338	3.6	9.69	33.097	Worm specimen targeted	Single specime	Sampled
FKt240902	9/9/24	Blanco West 1	009	ROV008	S0710	Vibracore	FKt240902-VC-009-A	134	-42.851959	-72.90334	3.6	9.69	33.096	Good penetration; slow, with resistance through much of core, inserted over 1 m	80 cm	Archived (no core catcher)
FKt240902	9/9/24	Blanco West 1	009	ROV008	S0710	Vibracore	FKt240902-VC-009-B	134	-42.851946	-72.90332	3.6	9.71	33.093	Hit hard surface at about 30 cm, no further penetration. A second attempt was performed to see if another site would penetrate and to provide material for examination on board ship, even if the stratigraphy would be compromised. However, on the second attempt the core passed through the soft upper layer with no penetration into the hard lower part (subsequent splitting shows the core catcher blocked with hard clay and loose pebbles in the holder, implying this was blocking further penetration; the core is likely therefore usable and representative, despite the second attempt).	39 cm	Split and subsampled; core catcher (pebble/rock fragments)
FKt240902	9/9/24	Blanco West 1	009	ROV008	S0710	Push core	FKt240902-UC-009-F	133	-42.851038	-72.90109	3.6	9.7	33.091	A final push core attempted at end of transect, but the core is compromised as the holder was full of sediment. The seafloor here was soft with the core able to penetrate fully (similar to the starting point). No sample taken though.	None	NA
FKt240902	9/9/24	S Rayas dunes S	010	Van-Veen (	NA	Grab	FKt240902-GS-010-A	110	-42.832098	-72.8566	-	-	-	115 m wire out; slack (123 kg); paid out to 120 m; 146 kg on leaving seafloor, max 220 kg on way up.	Full grab	Bulk bags of sand; separate wood fragments (water turbid, indicating clay fraction present)
FKt240902	10/9/24	Blanco West 2	011	ROV009	S0711	Niskin	FKt240902-RW-011-A	123	-42.895059	-72.85052	3.6	9.7	33.123	5 m off seafloor	Successful	2 vials
FKt240902	10/9/24	Blanco West 2	011	ROV009	S0711	Niskin	FKt240902-RW-011-B	128	-42.895059	-72.85052	3.61	9.68	33.16	On seafloor	Successful	2 vials and bottle
FKt240902	10/9/24	Blanco West 2	011	ROV009	S0711	Push core	FKt240902-UC-011-A	128	-42.895057	-72.85052	3.61	9.68	33.166	Over penetration, full sample	21 cm	Lower quality sample; sliced at 1 cm intervals
FKt240902	10/9/24	Blanco West 2	011	ROV009	S0711	Push core	FKt240902-UC-011-B	128	-42.895056	-72.85052	3.61	9.68	33.166	Full sample	21 cm	Lower quality sample; sliced at 1 cm intervals
FKt240902	10/9/24	Blanco West 2	011	ROV009	S0711	Push core	FKt240902-UC-011-C	128	-42.895056	-72.85052	3.61	9.68	33.168	Full sample	23 cm	Archived sub-core; remaining 0-1 cm separated for Rose Bengal then 5 cm intervals
FKt240902	10/9/24	Blanco West 2	011	ROV009	S0711	Push core	FKt240902-UC-011-D	128	-42.895055	-72.85052	3.61	9.68	33.167	Full sample	18 cm	Sliced at 1 cm intervals
FKt240902	10/9/24	Blanco West 2	011	ROV009	S0711	Push core	FKt240902-UC-011-E	127	-42.895055	-72.85052	3.61	9.68	33.168	Full sample	20 cm	Sliced at 1 cm intervals; 1st cm for Rose Bengal
FKt240902	10/9/24	Blanco West 2	011	ROV009	S0711	Vibracore	FKt240902-VC-011-A	128	-42.895034	-72.85052	3.61	9.68	33.156	Full penetration	159 cm	Archived
FKt240902	10/9/24	Blanco West 2	011	ROV009	S0711	Vibracore	FKt240902-VC-011-B	127	-42.894938	-72.85037	3.61	9.68	33.163	Compromised core; went in diagonally, very poor recovery	37 cm	Archived
FKt240902	10/9/24	Blanco West 2	011	ROV009	S0711	Vibracore	FKt240902-VC-011-C	128	-42.89518	-72.85029	3.61	9.69	33.166	Good recovery	122 cm	Split, logged and sub-sampled
FKt240902	10/9/24	Blanco West 2	011	ROV009	S0711	Scoop bag	FKt240902-SB-011-A	128	-42.895179	-72.8503	3.61	9.7	33.166	Full bag	Bulk sample of	Bulk sample taken
FKt240902	10/9/24	Blanco West 2	011	ROV009	S0711	Scoop bag	FKt240902-SB-011-B	128	-42.89518	-72.85029	3.61	9.69	33.164	Full bag	Bulk sample of	Bulk sample taken
FKt240902	10/9/24	Blanco N Side	012	ROV010	S0712	Niskin	FKt240902-RW-012-A	101	-42.87798	-72.80901	3.6	9.69	33.122	5 m above seafloor	Successful	2 vials
FKt240902	10/9/24	Blanco N Side	012	ROV010	S0712	Niskin	FKt240902-RW-012-B	106	-42.878002	-72.809	3.6	9.69	33.145	On seafloor	Successful	2 vials and bottle
FKt240902	10/9/24	Blanco N Side	012	ROV010	S0712	Push core	FKt240902-UC-012-A	105	-42.878	-72.809	3.6	9.69	33.146	Good recovery	19 cm	0-1 cm for Rose Bengal, then at 1 cm slices

FKt240902	10/9/24	Blanco N Side	012	ROV010	S0712	Push core	FKt240902-UC-012-B	106	-42.878	-72.809	3.61	9.71	33.147	Good recovery	22 cm	Archived sub-core, remainder 0-1 cm for Rose Bengal, then at 5 cm intervals and samples of surface water
FKt240902	10/9/24	Blanco N Side	012	ROV010	S0712	Push core	FKt240902-UC-012-C	106	-42.878	-72.809	3.61	9.71	33.146	Shorter recovery	13.5 cm	1 cm slices
FKt240902	10/9/24	Blanco N Side	012	ROV010	S0712	Push core	FKt240902-UC-012-D	106	-42.878	-72.809	3.61	9.72	33.145	Good recovery	14 cm	1 cm slices and Hg sample every 5 cm
FKt240902	10/9/24	Blanco N Side	012	ROV010	S0712	Vibracore	FKt240902-VC-012-A	106	-42.877999	-72.809	3.61	9.71	33.144	Full penetration	138 cm	Archived; core-catcher
FKt240902	10/9/24	Blanco N Side	012	ROV010	S0712	Vibracore	FKt240902-VC-012-B	105	-42.877974	-72.80887	3.6	9.68	33.142	Full penetration	122 cm	Split and sub-sampled; no core catcher sample
FKt240902	11/9/24	Basin to far west of Chaiten	013	ROV011	S0713	Niskin	FKt240902-RW-013-A	192	-42.890467	-73.08058	3.61	9.68	33.227	5 m above seafloor	Successful	2 vials
FKt240902	11/9/24	Basin to far west of Chaiten	013	ROV011	S0713	Niskin	FKt240902-RW-013-B	196	-42.890467	-73.08058	3.62	9.68	33.233	On seafloor	Successful	2 vials and bottle
FKt240902	11/9/24	Basin to far west of Chaiten	013	ROV011	S0713	Push core	FKt240902-UC-013-A	196	-42.890467	-73.08058	3.62	9.68	33.232	Full penetration	21 cm	Archive sub-core; 0-1 cm for Rose Bengal, remainder at 5 cm intervals.
FKt240902	11/9/24	Basin to far west of Chaiten	013	ROV011	S0713	Push core	FKt240902-UC-013-B	196	-42.890467	-73.08058	3.62	9.68	33.232	Full penetration	21.5 cm	water sample, 0-1 cm for Rose Bengal, remainder sliced at 1 cm intervals
FKt240902	11/9/24	Basin to far west of Chaiten	013	ROV011	S0713	Push core	FKt240902-UC-013-C	196	-42.890467	-73.08058	3.62	9.68	33.231	Full penetration	21.5 cm	Sliced at 1 cm intervals and Hg samples at 5 cm intervals
FKt240902	11/9/24	Basin to far west of Chaiten	013	ROV011	S0713	Push core	FKt240902-UC-013-D	196	-42.890467	-73.08058	3.62	9.68	33.232	Full penetration	Bulk sample for	Bulk sample
FKt240902	11/9/24	Basin to far west of Chaiten	013	ROV011	S0713	Push core	FKt240902-UC-013-E	196	-42.890467	-73.08058	3.61	9.68	33.232	Full penetration but disrupted on recovery	Bulk sample for	Bulk sample
FKt240902	11/9/24	Basin to far west of Chaiten	013	ROV011	S0713	Scoop bag	FKt240902-SB-013-A	196	-42.890467	-73.08058	3.62	9.68	33.231	Successful recovery	Full bag	Sieved and sub-sampled for biology
FKt240902	11/9/24	Basin to far west of Chaiten	013	ROV011	S0713	Scoop bag	FKt240902-SB-013-B	196	-42.890467	-73.08058	3.61	9.68	33.231	Successful recovery	Full bag	Sieved and sub-sampled for biology
FKt240902	11/9/24	Basin to far west of Chaiten	013	ROV011	S0713	Scoop bag	FKt240902-SB-013-C	196	-42.890467	-73.08058	3.61	9.67	33.232	Successful recovery	Full bag	Sieved and sub-sampled for biology
FKt240902	11/9/24	Basin to far west of Chaiten	013	ROV011	S0713	Scoop bag	FKt240902-SB-013-D	196	-42.890467	-73.08058	3.61	9.67	33.232	Successful recovery	Full bag	Sieved and sub-sampled for biology
FKt240902	11/9/24	Basin to far west of Chaiten	013	ROV011	S0713	Vibracore	FKt240902-VC-013-A	196	-42.890434	-73.08051	3.61	9.68	33.23	Full penetration	137 cm	Archive
FKt240902	11/9/24	Basin to far west of Chaiten	013	ROV011	S0713	Vibracore	FKt240902-VC-013-B	196	-42.890386	-73.08035	3.62	9.67	33.242	Full penetration	128 cm	Split and sub-sampled
FKt240902	11/9/24	Chaiten delta front lower	014	Van-Veen	NA	Grab	FKt240902-GS-014-A	108	-42.909941	-72.76316	-	-	-	Full grab sample	Full of homoger	Top sampled; several bulk samples of mud; 1 push sub-cores taken (16.5 cm)
FKt240902	12/9/24	Chaiten delta front mid slope	015	Van-Veen	NA	Grab	FKt240902-GS-015-A	100	-42.913806	-72.75364	-	-	-	Full grab sample	Full of homoger	Bulk samples of mud
FKt240902	12/9/24	Chaiten delta front central upper	016	ROV012	S0714	Niskin	FKt240902-RW-016-A	89	-42.914449	-72.75142	3.58	9.89	32.686	5 m off seafloor	Successful	2 vials
FKt240902	12/9/24	Chaiten delta front central upper	016	ROV012	S0714	Niskin	FKt240902-RW-016-B	93	-42.914563	-72.75155	3.58	9.83	32.807	On seafloor (very turbid)	Successful	2 vials and bottle
FKt240902	12/9/24	Chaiten delta front central upper	016	ROV012	S0714	Vibracore	FKt240902-VC-016-A	93	-42.914562	-72.75155	3.58	9.83	32.813	Full penetration	153 cm	Archived and core-catcher
FKt240902	12/9/24	Chaiten delta front central upper	016	ROV012	S0714	Vibracore	FKt240902-VC-016-B	93	-42.914767	-72.75148	3.58	9.85	32.765	Full penetration	105 cm	Split and sub-sampled
FKt240902	13/9/24	Chaiten delta front central mid slo	017	ROV013	S0715	Niskin	FKt240902-RW-017-A	110	-42.908365	-72.77979	erroneous	9.71	erroneous	5 m above seafloor	Successful	2 vials
FKt240902	13/9/24	Chaiten delta front central mid slo	017	ROV013	S0715	Niskin	FKt240902-RW-017-B	114	-42.908434	-72.77975	erroneous	9.7	erroneous	On seafloor	Successful	2 vials and bottle
FKt240902	13/9/24	Chaiten delta front central mid slo	017	ROV013	S0715	Push core	FKt240902-UC-017-A	114	-42.908434	-72.77975	erroneous	9.7	erroneous	Good recovery	19 cm	0-5 cm, split, half for biology; other half for sediments, sliced at 1 cm, and continuing for rest of core
FKt240902	13/9/24	Chaiten delta front central mid slo	017	ROV013	S0715	Push core	FKt240902-UC-017-B	114	-42.908434	-72.77974	erroneous	9.7	erroneous	Good recovery	Bulk sample for	Biology bulk sample
FKt240902	13/9/24	Chaiten delta front central mid slo	017	ROV013	S0715	Push core	FKt240902-UC-017-C	114	-42.908434	-72.77974	erroneous	9.7	erroneous	Good recovery	16 cm	Sliced at 1 cm
FKt240902	13/9/24	Chaiten delta front central mid slo	017	ROV013	S0715	Push core	FKt240902-UC-017-D	114	-42.908434	-72.77974	erroneous	9.7	erroneous	Good recovery	22 cm	Archive sub-core, plus 0-1 cm for Rose Bengal, remainder sliced at 5 cm, plus 2 water samples
FKt240902	13/9/24	Chaiten delta front central mid slo	017	ROV013	S0715	Push core	FKt240902-UC-017-E	114	-42.908435	-72.77974	erroneous	9.7	erroneous	Very poor recovery	3 cm - insufficie	None
FKt240902	13/9/24	Chaiten delta front central mid slo	017	ROV013	S0715	Scoop bag	FKt240902-SB-017-A	114	-42.908434	-72.77974	erroneous	9.69	erroneous	Successful recovery	Full bag	Sieved and sub-sampled for biology
FKt240902	13/9/24	Chaiten delta front central mid slo	017	ROV013	S0715	Scoop bag	FKt240902-SB-017-B	115	-42.908435	-72.77974	erroneous	9.7	erroneous	Successful recovery	Full bag	Sieved and sub-sampled for biology
FKt240902	13/9/24	Chaiten delta front central mid slo	017	ROV013	S0715	Scoop bag	FKt240902-SB-017-C	115	-42.908435	-72.77975	erroneous	9.69	erroneous	Successful recovery (note only three bags collected)	Full bag	Sieved and sub-sampled for biology
FKt240902	13/9/24	Chaiten delta front central mid slo	017	ROV013	S0715	Vibracore	FKt240902-VC-017-A	114	-42.908455	-72.77974	erroneous	9.69	erroneous	Full penetration, soft, with some resistance near base and silty dark sand in core catcher	120 cm	Archive core plus core catcher
FKt240902	13/9/24	Chaiten delta front central mid slo	017	ROV013	S0715	Vibracore	FKt240902-VC-017-B	116	-42.908459	-72.77471	erroneous	9.71	erroneous	Full penetration, soft, with limited resistance at the base	104 cm	Split and sub-sampled
FKt240902	13/9/24	Platform margin N of Yelcho outfl	018	ROV014	S0716	Niskin	FKt240902-RW-018-A	113	-42.921521	-72.79922	3.61	9.67	33.181	5 m above seafloor	Successful	2 vials
FKt240902	13/9/24	Platform margin N of Yelcho outfl	018	ROV014	S0716	Niskin	FKt240902-RW-018-B	119	-42.921528	-72.79909	3.61	9.68	33.19	On seafloor	Successful	2 vials and bottle
FKt240902	13/9/24	Platform margin N of Yelcho outfl	018	ROV014	S0716	Push core	FKt240902-UC-018-A	118	-42.921532	-72.7991	3.61	9.68	33.191	Good recovery; NB: irregular grey ash at base, also visible in other push cores at station	19 cm	Archive sub-core, 0-1 cm for Rose Bengal, remainder every 5 cm plus basal sample and 2 water samples.
FKt240902	13/9/24	Platform margin N of Yelcho outfl	018	ROV014	S0716	Push core	FKt240902-UC-018-B	118	-42.921533	-72.7991	3.61	9.68	33.191	Good recovery	13 cm	0-1 cm Rose Bengal, remainder at 1 cm slices, Hg every 5 cm
FKt240902	13/9/24	Platform margin N of Yelcho outfl	018	ROV014	S0716	Push core	FKt240902-UC-018-C	118	-42.921535	-72.7991	3.61	9.68	33.191	Good recovery	14 cm	Sliced at 1 cm
FKt240902	13/9/24	Platform margin N of Yelcho outfl	018	ROV014	S0716	Vibracore	FKt240902-VC-018-A	118	-42.921535	-72.7991	3.61	9.68	33.189	Full penetration, some resistance in lower 10-20 cm (soft mud through remainder, pushed through without vibration)	146 cm	Archive + core catcher
FKt240902	13/9/24	Platform margin N of Yelcho outfl	018	ROV014	S0716	Vibracore	FKt240902-VC-018-B	118	-42.921535	-72.79906	3.61	9.67	33.191	Full penetration, some resistance at very base (soft mud through remainder, pushed through without vibration)	101 cm	Core catcher; core split and sub sampled

FKt240902	13/9/24	Platform margin N of Yelcho outfl	019	ROV014	S0716	Push core	FKt240902-UC-019-A	122	-42.919762	-72.8038	3.61	9.67	33.191	Good recovery	14 cm	Sliced at 1 cm
FKt240902	13/9/24	Platform margin N of Yelcho outfl	019	ROV014	S0716	Push core	FKt240902-UC-019-B	122	-42.919762	-72.8038	3.61	9.67	33.191	Good recovery	18.5 cm	Sliced at 1 cm, 0-1 cm for Rose Bengal, Hg every 5 cm
FKt240902	13/9/24	Platform margin N of Yelcho outfl	019	ROV014	S0716	Push core	FKt240902-UC-019-C	122	-42.919763	-72.8038	3.61	9.67	33.192	Good recovery; below 10 cm rich in pale grey ash (also in other push cores)	18.5 cm	Archive sub-core, 0-1 cm for Rose Bengal, remainder every 5 cm
FKt240902	13/9/24	Platform margin N of Yelcho outfl	019	ROV014	S0716	Vibracore	FKt240902-VC-019-A	122	-42.919763	-72.8038	3.61	9.67	33.189	Full penetration, soft mud, some resistance at base (compacted clay in core catcher); top potentially disturbed with approx. 20 cm mud on seafloor	145 cm	Archive plus core-catcher
FKt240902	13/9/24	Platform margin N of Yelcho outfl	019	ROV014	S0716	Vibracore	FKt240902-VC-019-B	121	-42.919742	-72.80381	3.61	9.67	33.189	Top may be compromised (initial drive to 50 cm in hole A, before moving ROV); full penetration, soft mud, some resistance at base (compacted clay in core catcher)	124 cm	Core catcher; core split and sub sampled (note tube cut too low, top 1 cm separately bagged)
FKt240902	13/9/24	S of Rayas outflow, dune facies	020	Van-Veen (	NA	Grab	FKt240902-GS-020-A	131	-42.807342	-72.86243	-	-	-	Full grab sample	Large volume c	Biology samples separated; several bags of bulk sand; 2 push sub-cores taken
FKt240902	14/9/24	W of Rayas delta, buried dune fa	021	Van-Veen (	NA	Grab	FKt240902-GS-021-A	122	-42.769842	-72.86303	-	-	-	Partial grab sample	Successful rec	Bulk pebbles and bulk sand
FKt240902	14/9/24	Channel N of Yelcho delta	022	ROV015	S0717	Niskin	FKt240902-RW-022-A	166	-42.927014	-72.81144	3.61	9.67	33.209	5 m off seafloor	Successful	2 vials
FKt240902	14/9/24	Channel N of Yelcho delta	022	ROV015	S0717	Niskin	FKt240902-RW-022-B	170	-42.926813	-72.81143	3.61	9.67	33.211	On seafloor	Successful	2 vials and bottle
FKt240902	14/9/24	Channel N of Yelcho delta	022	ROV015	S0717	Push core	FKt240902-UC-022-A	170	-42.926852	-72.81158	3.61	9.67	33.211	Full penetration, sed-water interface not well preserved	23.5 cm	Archive sub-core; rose bengal 0-1 cm; remainder at 5 cm slices
FKt240902	14/9/24	Channel N of Yelcho delta	022	ROV015	S0717	Push core	FKt240902-UC-022-B	170	-42.926851	-72.81158	3.61	9.67	33.212	Full penetration, sed-water interface not well preserved	19 cm	1 cm slices
FKt240902	14/9/24	Channel N of Yelcho delta	022	ROV015	S0717	Push core	FKt240902-UC-022-C	170	-42.926852	-72.81158	3.61	9.67	33.211	Full penetration, good recovery	16 cm	1 cm slices; water sample; rose bengal
FKt240902	14/9/24	Channel N of Yelcho delta	022	ROV015	S0717	Vibracore	FKt240902-VC-022-A	170	-42.926852	-72.81158	3.61	9.67	33.211	Sand observed falling out of base of core throughout recovery; full penetration, resistance in lower 1 cm; final core much shortened, suggesting that majority of sand unit was lost on recovery	56 cm	Core catcher; core split and sub-sampled
FKt240902	14/9/24	Channel N of Yelcho delta	022	ROV015	S0717	Vibracore	FKt240902-VC-022-B	170	-42.926852	-72.81158	3.61	9.68	33.208	Sand observed falling when lifted out (also likely to have fallen back into hole), so core was left in the clamp and pushed against the gate. This slightly improved recovery relative to A	68 cm	Archived plus core catcher
FKt240902	14/9/24	Channel N of Yelcho delta	022	ROV015	S0717	Scoop bag	FKt240902-SB-022-A	171	-42.926861	-72.81159	3.61	9.67	33.214	A scoop to recover the sand that had fallen out from vibracore A. This was mixed extensively with seafloor mud; sample was sieved at 250 microns to recover the sand component, but this is likely contaminated with organic material from the clay.	Sieved sedimen	Archived bulk volcaniclastic sand separated from mud
FKt240902	14/9/24	Basin 1 W of Yelcho channel	023	ROV016	S0718	Niskin	FKt240902-RW-023-A	248	-42.934766	-72.85978	3.61	9.68	33.192	5 m off seafloor	Successful	2 vials
FKt240902	14/9/24	Basin 1 W of Yelcho channel	023	ROV016	S0718	Niskin	FKt240902-RW-023-B	252	-42.93477	-72.85979	3.61	9.68	33.191	On seafloor	Successful	2 vials and bottle
FKt240902	14/9/24	Basin 1 W of Yelcho channel	023	ROV016	S0718	Push core	FKt240902-UC-023-A	252	-42.934765	-72.8598	3.61	9.68	33.193	Stratified, with grey ash layer; good recovery	13.5 cm	1 cm slices; rose bengal; water sample
FKt240902	14/9/24	Basin 1 W of Yelcho channel	023	ROV016	S0718	Push core	FKt240902-UC-023-B	252	-42.934766	-72.8598	3.61	9.68	33.191	Good recovery; stratified (as all other push cores at this site; pale white sediment is visible below seafloor mud when disturbed)	15.5 cm	1 cm slices plus bung sample
FKt240902	14/9/24	Basin 1 W of Yelcho channel	023	ROV016	S0718	Push core	FKt240902-UC-023-C	252	-42.93477	-72.8598	3.61	9.68	33.19	Good recovery	22 cm	Archived sub-core; rose bengal 0-1 cm; remainder sampled in 5 cm slices
FKt240902	14/9/24	Basin 1 W of Yelcho channel	023	ROV016	S0718	Push core	FKt240902-UC-023-D	252	-42.934771	-72.85981	3.61	9.68	33.192	Good recovery	22.5 cm	Additional archived sub-core taken
FKt240902	14/9/24	Basin 1 W of Yelcho channel	023	ROV016	S0718	Push core	FKt240902-UC-023-E	252	-42.934771	-72.85981	3.61	9.68	33.19	Overflowed from top when inserted into holder	Bulk sample fo	Ash separated and combined as bulk ash sample with the same layed from F
FKt240902	14/9/24	Basin 1 W of Yelcho channel	023	ROV016	S0718	Push core	FKt240902-UC-023-F	252	-42.934771	-72.85981	3.61	9.68	33.191	Some disturbance on recovery	Bulk sample fo	Ash separated (see entry for E)
FKt240902	14/9/24	Basin 1 W of Yelcho channel	023	ROV016	S0718	Scoop bag	FKt240902-SB-023-A	252	-42.934768	-72.85981	3.61	9.68	33.191	Successful recovery	Full bag	Pumice clast recovered and separately sampled (2.5 cm diameter); sieved and sub-sampled for biology
FKt240902	14/9/24	Basin 1 W of Yelcho channel	023	ROV016	S0718	Scoop bag	FKt240902-SB-023-B	251	-42.934766	-72.85981	3.61	9.68	33.193	Successful recovery	Full bag	Sieved and sub-sampled for biology
FKt240902	14/9/24	Basin 1 W of Yelcho channel	023	ROV016	S0718	Scoop bag	FKt240902-SB-023-C	252	-42.93477	-72.85981	3.61	9.68	33.187	Successful recovery	Full bag	Sieved and sub-sampled for biology
FKt240902	14/9/24	Basin 1 W of Yelcho channel	023	ROV016	S0718	Scoop bag	FKt240902-SB-023-D	252	-42.934769	-72.85981	3.61	9.68	33.183	Successful recovery	Full bag	Sieved and sub-sampled for biology

FKt240902	14/9/24	Basin 1 W of Yelcho channel	023	ROV016	S0718	Vibracore	FKt240902-VC-023-A	251	-42.934772	-72.85981	3.61	9.68	33.175	Very little resistance until lower part (no vibration until end); 1.8 m penetration	112 cm	Split and sub-sampled; plus core catcher
FKt240902	14/9/24	Basin 1 W of Yelcho channel	023	ROV016	S0718	Vibracore	FKt240902-VC-023-B	251	-42.934752	-72.85984	3.61	9.68	33.182	Very little resistance, pushed all the way in, full penetration (1.8 m)	130 cm	Archive plus core catcher
FKt240902	15/9/24	Basin to far west of Chaiten (sam	024	Gravity cor	NA	Gravity core	FKt240902-GC-024-A	198	-42.890175	-73.0807	-	-	-	Successful operation; descended at 30 m/min, paused for 1 min at 50 m above seafloor, then descended at 50 m/min until tension spiked; paid out 15 m further and then recovered. Mud on core barrel to 1.5 m; recovered core shorter, with firm sand in core nose. Water washed out through core catcher on deck, suggesting some sediment loss/slumping in core liner.	108 cm	Archive core plus core catcher and core nose samples
FKt240902	15/9/24	Basin 2 W of Yelcho channel	025	ROV017	S0719	Niskin	FKt240902-RW-025-A	235	-42.942222	-72.92467	3.62	9.67	33.226	5 m off seafloor	Successful	1 vial
FKt240902	15/9/24	Basin 2 W of Yelcho channel	025	ROV017	S0719	Niskin	FKt240902-RW-025-B	236	-42.942227	-72.92468	3.62	9.67	33.226	On seafloor	Successful	2 vials and bottle
FKt240902	15/9/24	Basin 2 W of Yelcho channel	025	ROV017	S0719	Push core	FKt240902-UC-025-A	236	-42.942227	-72.92468	3.62	9.67	33.226	Good recovery, 70% full, intact	15.5 cm	1 cm slices
FKt240902	15/9/24	Basin 2 W of Yelcho channel	025	ROV017	S0719	Push core	FKt240902-UC-025-B	236	-42.942227	-72.92468	3.62	9.67	33.226	Good recovery, 75% full, compacted a little on penetration	18.5 cm	Water sample; rose bengal; 1 cm slices
FKt240902	15/9/24	Basin 2 W of Yelcho channel	025	ROV017	S0719	Push core	FKt240902-UC-025-C	236	-42.942227	-72.92468	3.62	9.67	33.226	Full core, compacted due to insertion below seafloor (but water interface remains), 95% full	23.5 cm	Archive sub-core; Rose bengal 0-1 cm; remainder at 5 cm slices
FKt240902	15/9/24	Basin 2 W of Yelcho channel	025	ROV017	S0719	Vibracore	FKt240902-VC-025-A	236	-42.942227	-72.92468	3.62	9.67	33.227	Penetration to 1.8 m, some resistance in lower part, appeared to be losing sediment on extraction (sand falling at base); core catcher and core length is consistent with this (coarse dark sand in core catcher, core is short overall given penetration). Sample had modified (cut) core catcher, so switched to the standard core catcher design on B.	103 cm	Split and sub-sampled
FKt240902	15/9/24	Basin 2 W of Yelcho channel	025	ROV017	S0719	Vibracore	FKt240902-VC-025-B	237	-42.942265	-72.92467	3.62	9.67	33.227	Penetration to 1.8 m, resistance in lower m and on initial extraction, coarse sediment in core catcher, mixed with mud	121 cm	Archive, plus core catcher, plus core-catcher split, sieved at >1 mm (dark angular coarse sand to gravel)
FKt240902	17/9/24	Simpson Canyon outflow (1)	026	ROV018	S0720	Niskin	FKt240902-RW-026-A	3430	-44.231737	-75.79628	3.17	1.77	34.672	5 m above seafloor	Successful	1 bottle
FKt240902	17/9/24	Simpson Canyon outflow (1)	026	ROV018	S0720	Niskin	FKt240902-RW-026-B	3435	-44.231741	-75.79628	3.17	1.77	34.673	On seafloor	Successful	2 bottles and vial
FKt240902	17/9/24	Simpson Canyon outflow (1)	026	ROV018	S0720	Push core	FKt240902-UC-026-A	3435	-44.231714	-75.79628	3.17	1.77	34.675	Good recovery, dark sandy layer visible; xenophyophore	20 cm	Archive sub-core; water sample; 0-1 cm rose bengal; 2 cm slices; xenophyophore
FKt240902	17/9/24	Simpson Canyon outflow (1)	026	ROV018	S0720	Push core	FKt240902-UC-026-B	3435	-44.231723	-75.79629	3.17	1.77	34.672	Good recovery, fine brown mud at top, dark sandy layer, brown-grey mud, back to dark sand at base; xenophyophore	18 cm	0-1 cm rose bengal, 1 cm slices, xenophyophore, water sample
FKt240902	17/9/24	Simpson Canyon outflow (1)	026	ROV018	S0720	Vibracore	FKt240902-VC-026-A	3435	-44.23172	-75.79629	3.17	1.77	34.672	Resistance met around 50 cm - very slow and limited penetration beyond	41 cm	Archive plus core catcher
FKt240902	17/9/24	Simpson Canyon outflow (1)	026	ROV018	S0720	Suction samp	FKt240902-SS-026-A	3435	-44.23172	-75.79629	3.17	1.77	34.672	Biological sampling	6 specimens	Sampled
FKt240902	17/9/24	Simpson Canyon outflow (2)	027	ROV018	S0720	Push core	FKt240902-UC-027-A	3438	-44.231565	-75.79783	3.17	1.76	34.673	Good recovery	23.5 cm	Archive sub-core; water sample; 0-1 cm rose bengal; 2 cm slices
FKt240902	17/9/24	Simpson Canyon outflow (2)	027	ROV018	S0720	Vibracore	FKt240902-VC-027-A	3438	-44.231563	-75.7978	3.17	1.76	34.673	Resistance at around 70 cm, no penetration beyond this	55 cm	Core split and sub-sampled; plus core catcher
FKt240902	17/9/24	Simpson Canyon outflow (3)	028	ROV018	S0720	Push core	FKt240902-UC-028-A	3439	-44.226971	-75.81153	3.17	1.77	34.673	Good recovery	15 cm	Archive sub-core; water sample; 0-1 cm rose bengal; 2 cm slices
FKt240902	17/9/24	Simpson Canyon outflow (3)	028	ROV018	S0720	Vibracore	FKt240902-VC-028-A	3439	-44.226975	-75.81153	3.17	1.77	34.673	Resistance in lower part, no penetration beyond around 1 m	77 cm	Archive plus core catcher
FKt240902	17/9/24	Simpson Canyon outflow (4)	029	ROV018	S0720	Niskin	FKt240902-RW-029-A	3434	-44.226666	-75.81277	3.17	1.77	34.673	On seafloor	Successful	1 bottle
FKt240902	17/9/24	Simpson Canyon outflow (4)	029	ROV018	S0720	Push core	FKt240902-UC-029-A	3435	-44.226668	-75.81277	3.17	1.77	34.672	Good recovery	17.5 cm	Archive sub-core, plus 1 cm samples, water sample and rose bengal (top cm), plus Hg samples

FKt240902	17/9/24	Simpson Canyon outflow (4)	029	ROV018	S0720	Push core	FKt240902-UC-029-B	3435	-44.226667	-75.81277	3.17	1.77	34.672	Slightly disturbed sediment interface and possible contamination in lower part	9 cm	Sliced at 1 cm intervals
FKt240902	17/9/24	Simpson Canyon outflow (4)	029	ROV018	S0720	Vibracore	FKt240902-VC-029-A	3435	-44.226654	-75.81277	3.17	1.77	34.672	A lot of resistance, penetration around 70 cm	19.5 cm	Archive plus core catcher
FKt240902	17/9/24	Simpson Canyon outflow (4)	029	ROV018	S0720	Scoop bag	FKt240902-SB-029-A	3434	-44.226659	-75.81278	3.17	1.77	34.672	Limited recovery	No usable sedi	NA
FKt240902	17/9/24	Simpson Canyon outflow (4)	029	ROV018	S0720	Scoop bag	FKt240902-SB-029-B	3435	-44.226663	-75.81277	3.17	1.77	34.673	Limited recovery	No usable sedi	NA
FKt240902	17/9/24	Simpson Canyon outflow (4)	029	ROV018	S0720	Scoop bag	FKt240902-SB-029-C	3435	-44.226663	-75.81277	3.17	1.77	34.673	Successful	Full bag	Sieved and subsampled for biology
FKt240902	17/9/24	Simpson Canyon outflow (4)	029	ROV018	S0720	Niskin	FKt240902-RW-029-B	1	-44.226866	-75.81355	3.59	9.21	33.453	Intended to be 10 m below surface, but too shallow	Successful	Not retained
FKt240902	18/9/24	Simpson Canyon feeder channel	030	ROV019	S0721	Niskin	FKt240902-RW-030-A	873	-44.114537	-74.99495	3.23	3.81	34.382	5 m above seafloor	Successful	Unsampled (no sediment sampled for context)
FKt240902	18/9/24	Simpson Canyon feeder channel	030	ROV019	S0721	Niskin	FKt240902-RW-030-B	879	-44.114514	-74.99542	3.23	3.8	34.383	On seafloor	Successful	Unsampled (no sediment sampled for context)
FKt240902	18/9/24	Simpson Canyon feeder channel	030	ROV019	S0721	Scoop bag	FKt240902-SB-030-A	856	-44.114967	-74.99204	3.22	3.79	34.383	During transect leaving site and going upslope into steeper part of channel head, visible pebbles eroded around larger rounded boulder; scoop of mud and small pebbles	Small volume ir	Single sample of clay with pebbles (need separating)
FKt240902	18/9/24	Simpson Canyon feeder channel	031	ROV019	S0721	Scoop bag	FKt240902-SB-031-A	811	-44.11486	-74.98391	3.23	3.88	34.373	Successful	Full bag	Sieved and sub-sampled for biology
FKt240902	18/9/24	Simpson Canyon feeder channel	031	ROV019	S0721	Scoop bag	FKt240902-SB-031-B	811	-44.11486	-74.98391	3.23	3.88	34.373	Successful	Full bag	Sieved and sub-sampled for biology
FKt240902	18/9/24	Simpson Canyon feeder channel	031	ROV019	S0721	Scoop bag	FKt240902-SB-031-C	811	-44.114859	-74.98391	3.23	3.89	34.372	Successful	Full bag	Sieved and sub-sampled for biology
FKt240902	18/9/24	Simpson Canyon feeder channel	031	ROV019	S0721	Scoop bag	FKt240902-SB-031-D	811	-44.114861	-74.98391	3.23	3.96	34.364	Successful	Full bag	Sieved and sub-sampled for biology
FKt240902	18/9/24	Simpson Canyon feeder channel	031	ROV019	S0721	Push core	FKt240902-UC-031-A	811	-44.11486	-74.98391	3.23	3.95	34.365	Good recovery, two layers observed (brown top, grey base)	Bulk sample fo	Bulk sample
FKt240902	18/9/24	Simpson Canyon feeder channel	031	ROV019	S0721	Push core	FKt240902-UC-031-B	811	-44.114861	-74.98392	3.23	3.95	34.366	Good recovery	Bulk sample fo	Bulk sample
FKt240902	18/9/24	Simpson Canyon feeder channel	032	ROV019	S0721	Push core	FKt240902-UC-032-A	807	-44.108549	-74.97152	3.24	4.05	34.358	Good recovery	12 cm	Sliced at 1 cm intervals
FKt240902	18/9/24	Simpson Canyon feeder channel	032	ROV019	S0721	Push core	FKt240902-UC-032-B	807	-44.108559	-74.97151	3.24	4.04	34.358	Good recovery	21 cm	Archive sub-core; Hg samples and remainder sliced at 5 cm intervals
FKt240902	18/9/24	Simpson Canyon feeder channel	032	ROV019	S0721	Push core	FKt240902-UC-032-C	807	-44.108555	-74.97151	3.24	4.06	34.356	Good recovery	20 cm	Water sample, rose bengal 0-1 cm, sliced at 1 cm
FKt240902	18/9/24	Simpson Canyon feeder channel	032	ROV019	S0721	Vibracore	FKt240902-VC-032-A	807	-44.108555	-74.97152	3.25	4.1	34.353	Met a lot of resistance after around 50 cm, gradual penetration beyond to over 1 m	87 cm	Archive plus core catcher
FKt240902	18/9/24	Simpson Canyon feeder channel	032	ROV019	S0721	Vibracore	FKt240902-VC-032-B	807	-44.108553	-74.97149	3.25	4.09	34.354	A lot of resistance after 50 cm, very slow penetration beyond; no water in core when recovered, suggesting water had run out of base on ascent.	66 cm	Split and sub-sampled
FKt240902	18/9/24	Simpson Canyon feeder channel	032	ROV019	S0721	Niskin	FKt240902-RW-032-A	807	-44.108557	-74.97149	3.25	4.19	34.346	On seafloor	Successful	2 bottles and vial
FKt240902	19/9/24	Basin E of Simpson Canyon/Can	033	Van-Veen (	NA	Grab	FKt240902-GS-033-A	228	-43.993984	-74.51621	-	-	-	Successful grab, 75% full, lopsided recovery (full of sediment one side; more water on other side), but some structure preserved	75% full	Two sub-push cores, surface bag, bottom bag, two bags of bulk sediment, biological material
FKt240902	19/9/24	Basin offshore Yanteles and Meli	034	ROV020	S0722	Niskin	FKt240902-RW-034-A	190	-43.710797	-73.08334	3.65	9.4	33.877	5 m above seafloor	Successful	1 bottle
FKt240902	19/9/24	Basin offshore Yanteles and Meli	034	ROV020	S0722	Niskin	FKt240902-RW-034-B	199	-43.71091	-73.08314	3.65	9.39	33.882	On seafloor	Successful	2 bottles and vial
FKt240902	19/9/24	Basin offshore Yanteles and Meli	034	ROV020	S0722	Push core	FKt240902-UC-034-A	198	-43.710918	-73.08313	3.65	9.39	33.882	Good recovery, around 50%	11 cm	Sliced at 1 cm intervals, plus Hg samples every 5 cm
FKt240902	19/9/24	Basin offshore Yanteles and Meli	034	ROV020	S0722	Push core	FKt240902-UC-034-B	197	-43.710921	-73.08312	3.65	9.38	33.884	Good recovery, around 50%	15 cm	Archived sub-core plus 1 cm slices
FKt240902	19/9/24	Basin offshore Yanteles and Meli	034	ROV020	S0722	Push core	FKt240902-UC-034-C	197	-43.710923	-73.08311	3.65	9.38	33.885	Good recovery, around 60%	14 cm	Archive sub-core plus 5 cm slices; surface water sample
FKt240902	19/9/24	Basin offshore Yanteles and Meli	034	ROV020	S0722	Push core	FKt240902-UC-034-D	197	-43.710919	-73.08312	3.65	9.38	33.886	Some disturbance, recovery around 60%	Bulk sample fo	Bulk sample
FKt240902	19/9/24	Basin offshore Yanteles and Meli	034	ROV020	S0722	Push core	FKt240902-UC-034-E	197	-43.710919	-73.08312	3.65	9.38	33.886	Good recovery, around 50%	Bulk sample fo	Bulk sample
FKt240902	19/9/24	Basin offshore Yanteles and Meli	034	ROV020	S0722	Scoop bag	FKt240902-SB-034-A	196	-43.710921	-73.08311	3.65	9.38	33.892	Successful	Full bag	Sieved and sub-sampled for biology
FKt240902	19/9/24	Basin offshore Yanteles and Meli	034	ROV020	S0722	Scoop bag	FKt240902-SB-034-B	197	-43.710912	-73.08316	3.65	9.38	33.893	Successful	Full bag	Sieved and sub-sampled for biology
FKt240902	19/9/24	Basin offshore Yanteles and Meli	034	ROV020	S0722	Scoop bag	FKt240902-SB-034-C	197	-43.710915	-73.08311	3.65	9.38	33.893	Successful	Full bag	Sieved and sub-sampled for biology
FKt240902	19/9/24	Basin offshore Yanteles and Meli	034	ROV020	S0722	Scoop bag	FKt240902-SB-034-D	196	-43.710918	-73.08312	3.65	9.38	33.895	Successful	Full bag	Sieved and sub-sampled for biology
FKt240902	19/9/24	Basin offshore Yanteles and Meli	034	ROV020	S0722	Vibracore	FKt240902-VC-034-A	197	-43.710914	-73.08312	3.65	9.38	33.896	Full penetration (1.7 m), very little resistance	107 cm	Archive plus core-catcher
FKt240902	19/9/24	Basin offshore Yanteles and Meli	034	ROV020	S0722	Vibracore	FKt240902-VC-034-B	194	-43.710895	-73.08312	3.65	9.37	33.899	Full penetration (1.7 m), very little resistance	93 cm	Split and sub-sampled
FKt240902	19/9/24	Basin offshore Yanteles and Meli	034	ROV020	S0722	Niskin	FKt240902-RW-034-C	40	-43.710895	-73.08312	-	-	-	40 m above seafloor (approx.; not entered in sealog)		1 vial

FKt240902	19/9/24	West of Corcovado Gulf platform	035	Gravity cor	NA	Gravity core	FKt240902-GC-035-A	132	-43.658994	-73.45679	-	-	-	Successful deployment; from 70 m down, descending at 60 m/min. Wire paid out to 150 m. Max 400 kg tension on pull out. On recovery, limited evidence of mud on outer part. Some water lost from top and base (around liner?); upper part of core disrupted. Core nose a dark fine to medium sand with clay. Lack of penetration may be due to sandy nature of beds. No evidence that core fell.	62 cm	Core nose and core catcher samples, plus archived core

Appendix D: CTD deployments

Cruise	Date (UTC)	CTD number	Water depth (m)	Wind speed (kn)	Wind direction (°)	Wire out (m)	Time in water (UTC)	Latitude	Longitude	Time on seafloor (UTC)	Latitude	Longitude	Time on deck (UTC)	Latitude	Longitude	Deployment notes
FKt240902	02/09/2024	CTD001	458	10.2	232	468.5	18:19:18	-41.713416	-72.655845	19:05:06	-41.7133409	-72.6561717	19:28:57	-41.71341	-72.65584	Mouth of Reloncaví. First cast, connection problems with the winch, it was solved and the descent continued
FKt240902	02/09/2024	CTD002	423	11.5	234.7	420	22:42:47	-41.7149	-72.5209	23:00:06	-41.7149	-72.5208	23:19:59	-41.7149882	-72.5208897	Near the discharge of the Puelo river. Turbidity increases at 240m, 325m, 400m. Increase in oxigen (Steady) ~200m
FKt240902	03/09/2024	CTD003	260	6.9	220.4	257.3	03:56:56	-41.6851318	-72.4086093	04:10:58	-41.685132	-72.4086061	04:25:22	-41.6851382	-72.4086117	Near the discharge of the Cochamó river
FKt240902	03/09/2024	CTD004	202	11.4	55.2	193.5	10:03:34	-41.5565257	-72.3285688	10:14:16	-41.5565253	-72.3285726	10:24:24	-41.5565292	-72.3285632	Middle area of Reloncaví. Turbidity peak at 45 m, 123m, ~145m. Slight increase in oxigen by ~155m
FKt240902	04/09/2024	CTD005	463	15.5	227.2	465.8	03:03:13	-41.7118858	-72.6545667	03:21:55	-41.7121828	-72.6545312	03:41:14	-41.7119405	-72.654686	Outside Reloncaví Fjord
FKt240902	04/09/2024	CTD006	220	3.7	352.7	213.6	22:04:03	-42.3052808	-72.9629956	22:16:15	-42.3053359	-72.9629754	22:28:06	-42.3050442	-72.962977	Desertores archipielago
FKt240902	05/09/2024	CTD007	247	25.8	258.1	240	11:12:13	-42.354912	-72.9680927	11:26:19	-42.3549117	-72.9681232	11:39:58	-42.3549018	-72.9681726	Golfo de Ancud South. We might have had a ..."bump" (feature). We did not observe a clear chl-a max peak (fluorescence) so to keep consistency, we will sample at 10 m. The CTD profiles are incredibly straight, only the turbidity has a few peaks: ~70, 95, 153 and it increase a lot by ~200 m
FKt240902	05/09/2024	CTD008	233	24.2	110.2	231.1	19:06:04	-42.5593504	-72.961851	19:18:50	-42.559304	-72.961836	19:34:35	-42.5591266	-72.961835	Northern Rayas
FKt240902	06/09/2024	CTD009	145	17.7	186.9	144.9	14:45:48	-42.7858494	-72.8772053	15:03:28	-42.7858568	-72.8771947	15:15:13	-42.785857	-72.877194	South Rayas Delta.
FKt240902	07/09/2024	CTD010	140	22	340	144.6	15:54:13	-42.766587	-72.8711229	16:03:47	-42.7662676	-72.870786	16:14:38	-42.766615	-72.870168	Rayas delta. Slightly stratified water column
FKt240902	07/09/2024	CTD011	121	19.2	132.2	119.8	23:41:01	-42.7452612	-72.8636459	23:48:24	-42.7453642	-72.8637329	23:55:57	-42.74629	-72.8633436	Rayas delta 3
FKt240902	08/09/2024	CTD012	198.7	22.6	320.6	not recorded	13:22:32	-42.9234867	-72.848524	13:33:20	-42.923489	-72.848542	13:45:55	-42.923487	-72.848532	S side of Chaiten Bay entrance
FKt240902	08/09/2024	CTD013	107	20.2	341.5	103.1	18:11:41	-42.9228793	-72.784517	18:20:32	-42.9231346	-72.7845479	18:29:25	-42.922912	-72.7846116	Offshore Chaiten
FKt240902	08/09/2024	CTD014	108	16	254.9	99.6	22:34:20	-42.9038391	-72.7600575	22:41:58	-42.903787	-72.760004	20:50:06	-42.903555	-72.759813	Blanco 2
FKt240902	09/09/2024	CTD015	135.7	16.1	10.8	128.6	10:13:49	-42.8517237	-72.9029561	10:22:10	-42.8519601	-72.9031668	10:28:57	-42.8517204	-72.903856	Blanco
FKt240902	10/09/2024	CTD016	129.5	15.4	227.2	119.8	11:23:07	-42.8954287	-72.8506754	11:12:24	-42.8953965	-72.8507035	11:23:27	-42.8954493	-72.8510336	Entrance to Chaiten Bay
FKt240902	11/09/2024	CTD017	114	10.7	17.2	105.8	01:07:36	-42.8774	-72.8184795	01:16:36	-42.8774064	-72.8184831	01:25:20	-42.8771675	-72.8183881	Offshore Chaiten
FKt240902	11/09/2024	CTD018	197	14.5	345.9	194.8	13:52:36	-42.8913858	-73.08093	14:04:13	-42.8914036	-73.0809613	14:16:52	-42.8911556	-73.0808282	Distal Chaiten Basin
FKt240902	12/09/2024	CTD019	127	17.3	350.1	113.8	08:49:30	-42.9025102	-72.7972243	08:58:30	-42.9027415	-72.7973941	09:06:20	-42.9027288	-72.7974	Chaiten near blanco
FKt240902	13/09/2024	CTD020	166.4	17.4	234.4	161	09:14:36	-42.9516418	-72.9016606	09:25:00	-42.951872	-72.901533	09:35:09	-42.9511608	-72.9016791	SW of Chaiten Bay entrance
FKt240902	13/09/2024	CTD021	114	9	277.6	108.4	13:44:37	-42.9094111	-72.7799873	13:52:30	-42.9094466	-72.77963	14:01:35	-42.9094119	-72.7799852	Chaiten near blanco
FKt240902	14/09/2024	CTD022	248.3	23.8	6.1	264	19:55:13	-42.9353846	-72.8602653	20:08:23	-42.9352563	-72.860774	20:21:28	-42.9352271	-72.860663	West of Yelcho channel
FKt240902	15/09/2024	CTD023	195	7.3	246.7	190.6	01:36:30	-43.0215464	-72.9874783	01:47:30	-43.0215021	-72.9874744	01:56:40	-43.0215295	-72.9875099	Transect on the road to Quellon. Mixed water column and no water samples
FKt240902	15/09/2024	CTD024	180	13.2	339	179.2	14:27:24	-43.1947644	-72.3323833	14:42	-43.194762	-73.332293	14:53:13	-43.1947643	-73.3322948	North to outer Yelcho basin. 6 niskin fired
FKt240902	16/09/2024	CTD025	212	8.1	277.1	206.8	00:32:10	-43.004602	-72.9632713	00:41:20	-43.0045559	-72.9631279	00:53:30	-43.0046186	-72.9631967	Near Quellon. Station for water samples of sediments in 3 depths
FKt240902	16/09/2024	CTD026	178.7	9.3	14.2	174.5	13:17:37	-43.8557249	-73.492092	13:28:05	-43.8557249	-73.491746	13:39:24	-43.8556541	-73.4918211	Corcovado Gulf
FKt240902	17/09/2024	CTD027	774	21	348	634.5	01:11:40	-44.1086222	-74.9487341	01:36:45	-44.1086222	-74.9487797	02:04:00	-44.1086604	-74.9489233	Simpson Canyon
FKt240902	18/09/2024	CTD028	206	16.1	17.7	216.9	09:10:10	-43.6316341	-73.8835659	09:24:18	-43.6316942	-73.8843975	09:36:37	-43.6316	-73.8831363	Corcovado Gulf

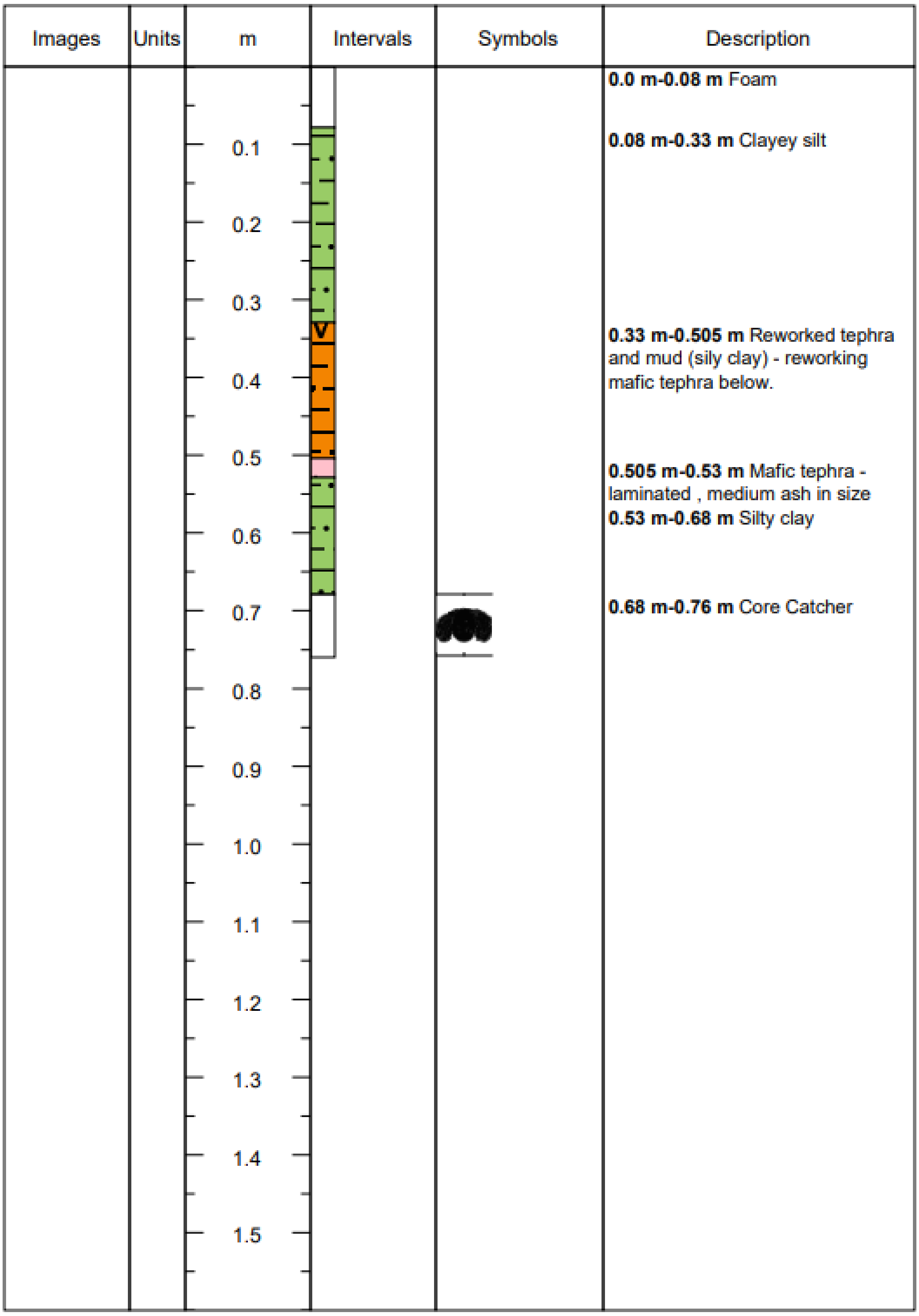
Appendix E: Ship to Shore Schedule

Organization	Date/Time (Ship)	Language	Audience
Chile Schools	September 3rd, 10:30 AM	Spanish	15 elementary and middle schoolers in Chaitén
Purple Sharks Robotics Team	September 3rd, 1 PM	English, Portuguese	Middle schoolers in a robotics club in Brasil, would love emphasis on ROV
Chile Schools Escuela Rural Nueva Esperanza Escuela Rural Chuit Escuela Rural Valle el Frío Escuela Rural Talcán Escuela Particular Reldehue	September 4th, 10 AM	Spanish	9 elementary/middle schoolers from the Chaitén region
Lapworth Lectures, Homeschool Group at Museum	September 5th, 8 AM	English	25 all ages group in the UK
Chile Schools Escuela Rural Chuit Escuela Rural Río Amarillo	September 5th, 10 AM	Spanish	Elementary/middle schoolers from Chaitén
University of Chile - Geology and Geophysics	September 5th, 2:30 PM	Spanish	College Students
Chile and Argentina Schools Escuela Rural el Poyo Escuela Rural Chuit Ushuaia	September 6th, 10 AM	Spanish	Chaitén students
Renaissance Elementary Magnet School	September 6th, 1:45 PM	English	Arts students in Colorado whose teacher works with Jill
Chile Schools Escuela Rural Chana	September 9th, 10 AM	Spanish	Elementary/Middle school students from Chaitén
Verner-Steiner Elementary	September 9th, 1:45-2:45 PM	English	First graders in Alabama
SERNAGEOMIN	September 10th, Noon	Spanish	Adult group affiliated with Chilean geological survey
Chile Schools Escuela Rural Río Amarillo Liceo Peninsular Ayacara Escuela Rural Auteni	September 10th, 3 PM	Spanish	Elementary/middle school students from Chaitén
Birmingham, UK Schools	September 11th, 9 AM Chile Time	English	Two UK schools, ages 14-18

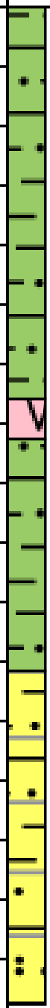
Chaitén Schools Casa de Pesca Escuela Rural Nayahue Escuela Rural Chumelden	September 13th, 10 AM	Spanish	Elementary/Middle school students from Chaitén
The Nueva School	September 13th, 6:15 PM	English	Elementary school students in California whose teachers work with Jill
Lapworth Lectures	September 16th, 1:30 PM	English	All ages in Birmingham, UK
Northridge Middle School	September 16th, 4:15 PM	English	Middle schoolers in Tuscaloosa, Alabama
Chaitén Schools	September 16th, 10AM	Spanish	Young kids from rural school in Chaitén region
Turitea School	September 17th, 6 PM	English	Elementary and middle school students in New Zealand
Lycee Francais Charles de Gaulle	September 18th	English	High school students learning about volcanism and climate change in London
Birmingham, UK Schools	September 20th, 9 AM Chile time	English	Three UK schools, ages 16-18

Appendix F: Summary core logs for vibrocores split on board

VC-001-C

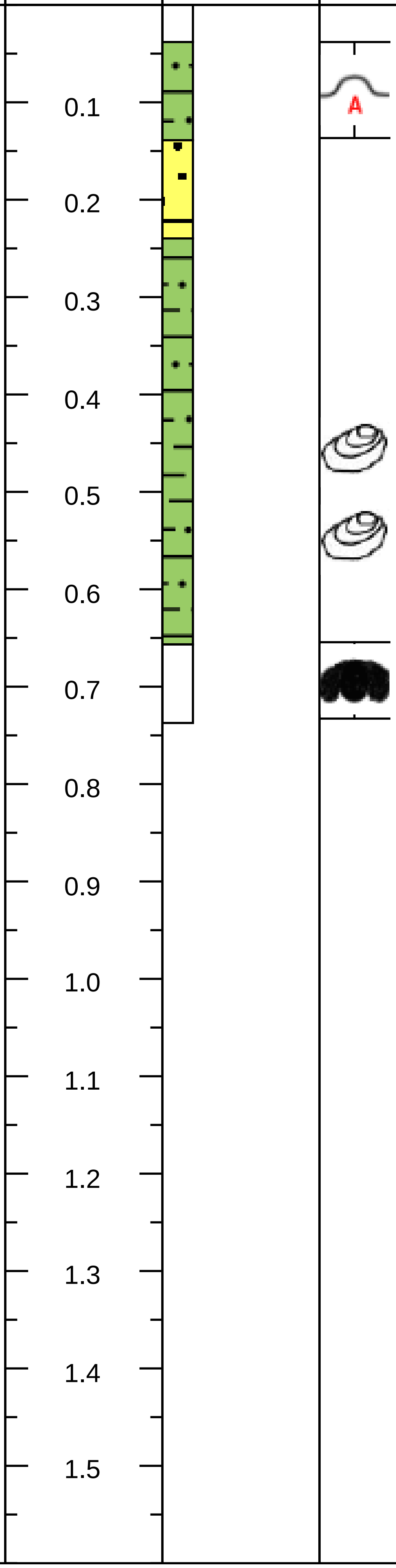


VC-002-C

Images	Units	m	Intervals	Symbols	Description
		0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2 1.3 1.4 1.5			**0.0 m-0.331 m** Silty clay **0.33 m-0.365 m** Mafic fall despoit, with coarse base (35.4-36.1 cm) - higher lithic content and coarse ash to fine lapilli. Finer main body of the fall deposit (33.6-35.4 cm). Coarse, less dense grain/clasts towards the top of the deposit (33.1-33.6 cm). **0.365 m-0.56 m** Silty clay **0.56 m-0.84 m** Silt (laminated)

VC-003-A

Images	Units	m	Intervals	Symbols	Description



0.0 m-0.04 m Foam

0.04 m-0.14 m Silty clay with fine sand; fine laminations - mm scale. (Fine sand - 50%; silt - 50%; clay - 30%)

0.04 m-0.14 m Coring artefact - doming

0.14 m-0.24 m Clayey/silty sand; greenish grey. Darker laminations in mm scale. Gradational contact with unit below. (Fine sand - 50%; silt - 40%; clay - 20%)

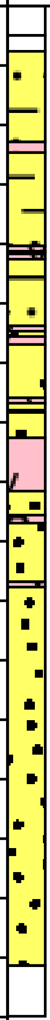
0.24 m-0.658 m Silty clay with fine sand; greenish grey; well sorted; dark laminations - mm scale.(Fine sand - 30%; silt - 45%; clay - 25%)

0.46 m Bivalve

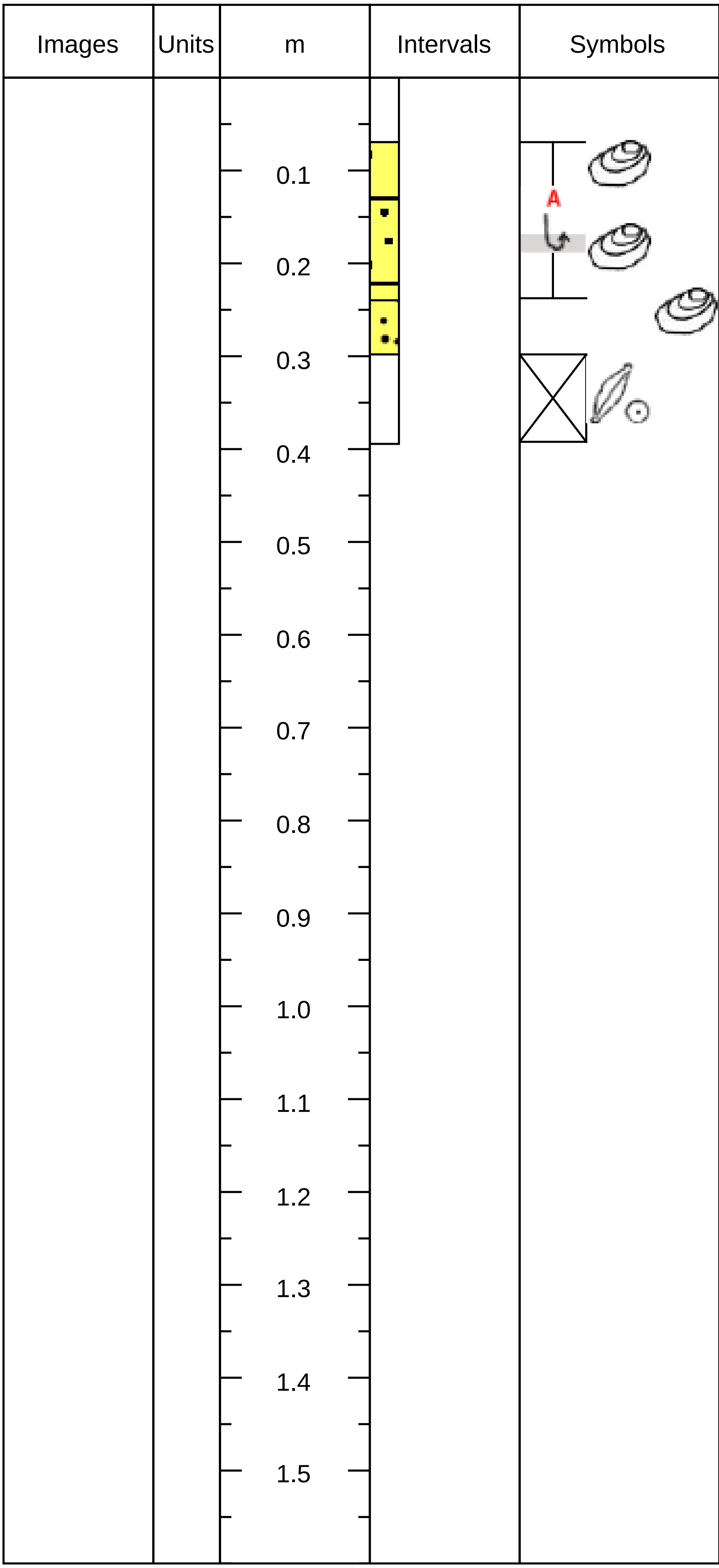
0.55 m Bivalve

0.658 m-0.738 m Core catcher

VC-004-B

Images	Units	m	Intervals	Symbols	Description
		0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2 1.3 1.4 1.5			**0.0 m-0.025 m** Foam **0.025 m-0.04 m** Gap **0.04 m-0.115 m** Sandy clay **0.115 m-0.125 m** Light grey very fine ash - 0.5 cm layer, continuous **0.125 m-0.202 m** Sandy clay **0.202 m-0.207 m** ? Tephra? Yellow fine sand-silt layer **0.208 m-0.21 m** Sandy clay **0.21 m-0.215 m** ? Tephra? Yellow fine sand-silt layer **0.215 m-0.27 m** Sandy clay **0.27 m-0.275 m** ? Tephra? Yellow fine sand-silt layer **0.275 m-0.28 m** Sandy clay **0.28 m-0.285 m** ? Tephra? Yellow fine sand-silt layer **0.285 m-0.33 m** Sandy clay **0.33 m-0.335 m** Felsic ash - likely reworked from tephra layer below - displays similar characteristics. Smear slide: shows very fine ash, fragmented crystals and very small diatoms **0.335 m-0.365 m** Sandy clay **0.365 m-0.41 m** Distinct very fine ash - felsic. Very fine grained clean layer - very distinct. Cuspate, clean shards in smear slide - no structures/homogenous. Co-ignimbriitic ash? **0.41 m-0.43 m** Sand **0.43 m-0.435 m** Medium grey - olive grey thin light layer (fine to medium sand grains). Possible correlation to Michinmahuida deposit, c.25 km east - succession seen in Chaiten museum **0.435 m-0.485 m** Sand **0.485 m-0.49 m** Medium grey - olive grey thin light layer (fine to medium sand grains). Possible correlation to Michinmahuida deposit, c.25 km east - succession seen in Chaiten museum **0.49 m-0.808 m** Sand **0.808 m-0.85 m** Core catcher

VC-009-B

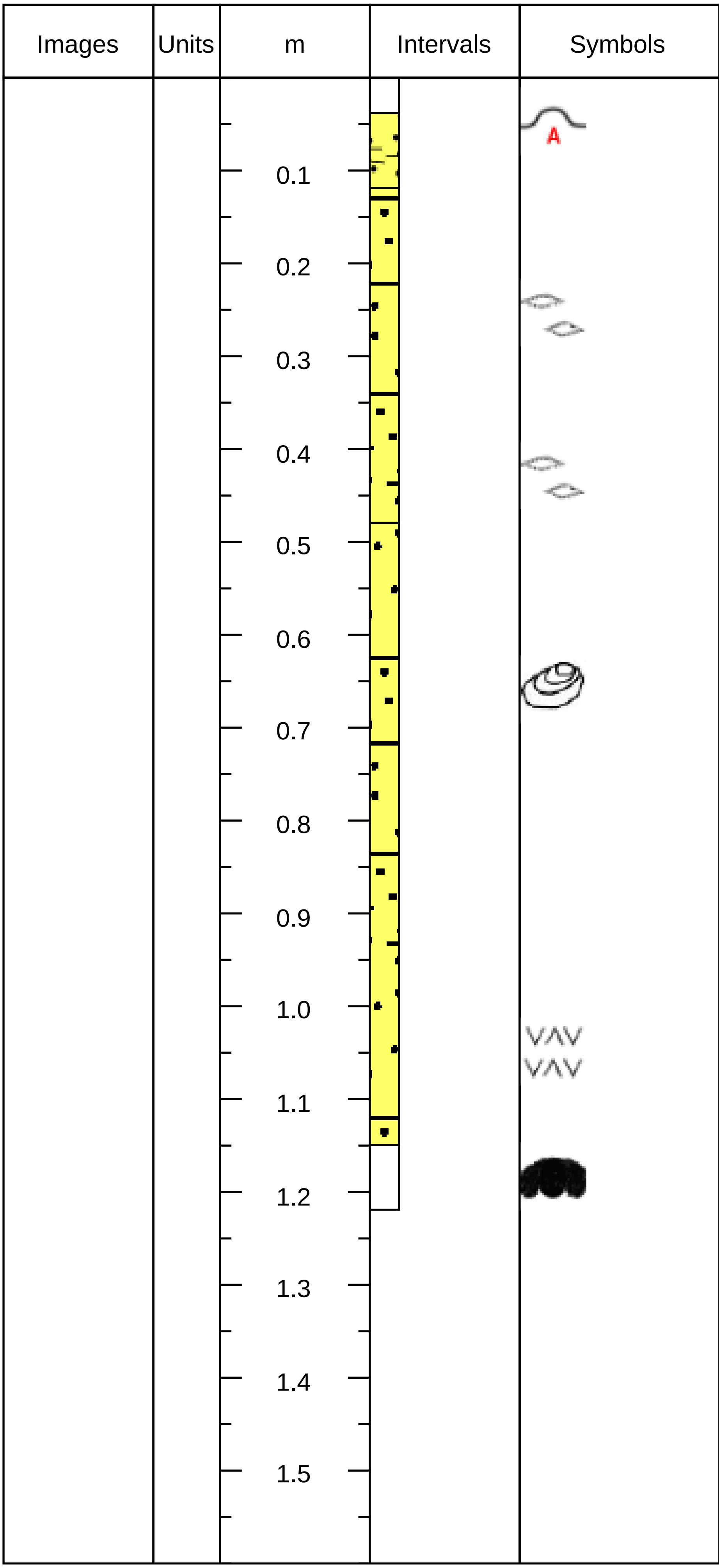


Description

0.0 m-0.07 m Foam

0.07 m-0.24 m Clayey sand; black; diffusely laminated until bottom 1 cm. Lots of coring disturbance. Grades from medium sand to gravel with increased depth.
0.098 m Fragmented bivalve shells
0.07 m-0.24 m Recore croing artefact
0.188 m Fragmented bivalve shells
0.24 m-0.3 m Sandy gravel; dark grey; rich in fragmented bioclasts (shells) although not to be described as a shell hash. Pebbles are angular to rounded; poorly sorted due to a medium sand matrix. Contact with unit above is marked by clear grain size change.
0.258 m Fragmented bivalve shells
0.3 m-0.395 m Core catcher - containing mixed lithologies, inlduing material idnetfied to be resembling the uppermost unit described in this core. Material is dominated by cohesive, indurated dark grey clay.
0.338 m Diatoms present (as seen in smear slides)
0.3 m-0.395 m Core catcher

VC-011-C



Description

0.0 m-0.04 m Foam

0.04 m-0.12 m Silty sand with diffuse balck laminae. The uppermost part (2 cm) is highly disturbed (coring artefact). Matrix is generally homogenous.

0.04 m-0.06 m Coring artefact - doming

0.12 m-0.48 m Clayey-silty sand; grading fom black to olive-grey. Olive-grey lenses and diffuse laminations and lenses occur, particularly observed between 24 and 27 cm and at 43 cm. Contacts wth units above and below are gradational.

0.24 m-0.27 m Lens

0.43 m Lens

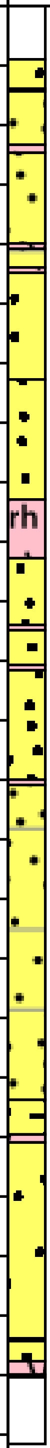
0.48 m-1.15 m Silty-clay medium sand; black in colour; scattered fragments of bivalves. Diffuse laminations (of mud and sand size). Possible ash lens at 105 cm. Contact is gradational with unit above with a slight colour change and increase in maximum sand size marking the boundary between the two units.

0.66 m Bivalve fragments - good 14C candidate. Scattered throughut unit.

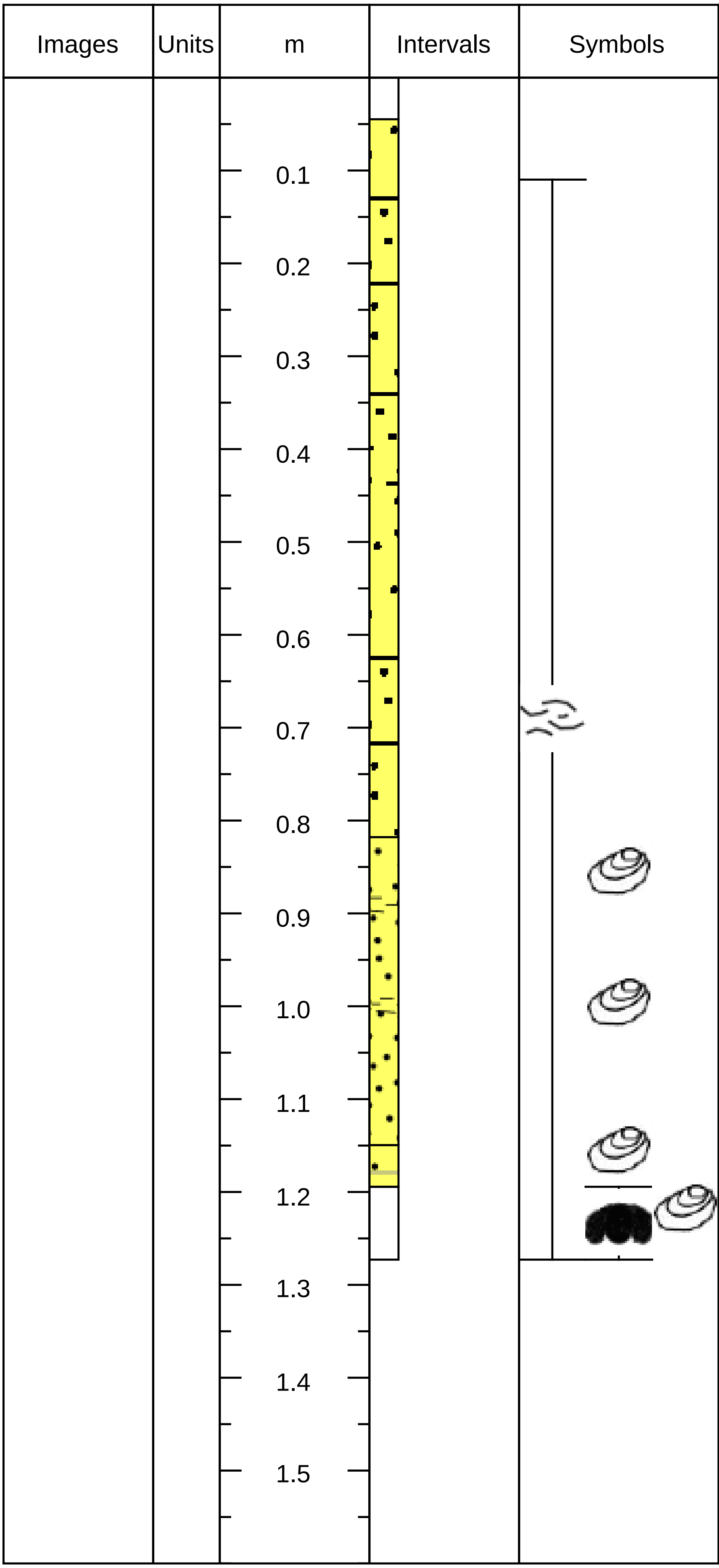
1.05 m Thin ash lens?

1.15 m-1.22 m Core catcher

VC-012-B

Images	Units	m	Intervals	Symbols	Description
		0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2 1.3 1.4 1.5			**0.0 m-0.045 m** Foam **0.07 m-0.073 m** Thin light grey layer **0.072 m-0.118 m** Clayey sand, laminated **0.118 m-0.124 m** ? Tephra? Yellow fine sand-silt layer **0.125 m-0.2 m** Clayey sand, laminated **0.2 m-0.205 m** Thin light grey layer **0.205 m-0.22 m** Clayey sand, laminated **0.22 m-0.225 m** Thin light grey layer **0.225 m-0.315 m** Sand **0.315 m-0.415 m** Sand **0.415 m-0.465 m** Light grey very fine ash. Some small darker crystals (as also observed at VC-004-B). This is possibly directly correlateable. Possible co-ignimbritic fallout **0.465 m-0.52 m** Sand **0.52 m-0.525 m** Grey, ashy continuous bed **0.525 m-0.555 m** Sand **0.555 m-0.56 m** Grey ashy continuous bed **0.65 m-0.655 m** Very thin light ashy layer **0.655 m-0.92 m** Sand, thinly bedded **0.92 m-0.95 m** Sandy clay **0.95 m-0.955 m** Light grey ashy layer **0.955 m-1.14 m** Sandy clay **1.14 m-1.15 m** Light grey ashy layer **1.15 m-1.153 m** Sandy clay **1.152 m-1.21 m** Core catcher

VC-013-B



Description

0.0 m-0.045 m Foam

0.045 m-0.82 m Sandy silty-clay (clay - 15%; silt - 50%; fine sand - 35%); dark brown in colour; well-sorted. Lack of foraminifera in upper 6 cm and sparse foraminifera in the rest of the unit. Normally graded.

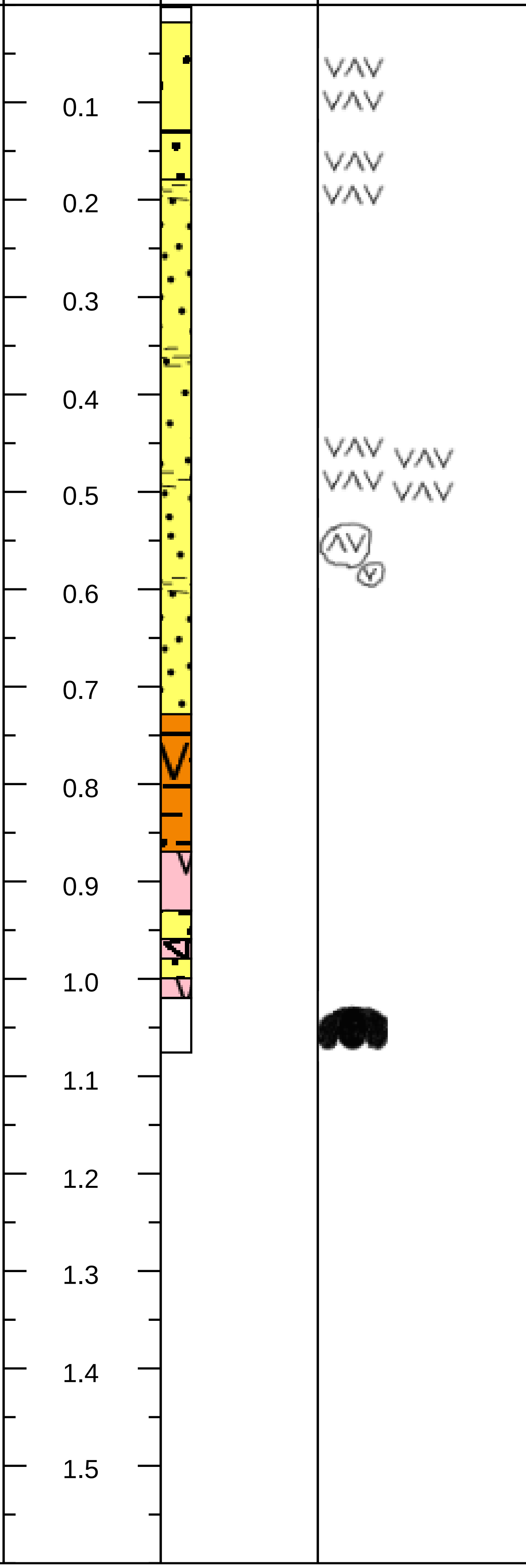
0.11 m-1.275 m Foraminifera

0.82 m-1.15 m Silty-sand with medium sand (silt - 20%; fine sand - 70%; medium sand - 10%); dark brown in colour. High abundance of foraminifera throughout and some bivalves (86 cm and 100 cm). Moderate sorting; gradational contact with unit below.
0.86 m Bivalve
1.0 m Bivalve

1.15 m-1.195 m Fine to medium sand (fine sand - 65%; medium sand - 30%; silt - 5%); very dark brown in colour. High abundance of foraminifera throughout and some bivalves. Moderately sorted and weakly laminated.
1.16 m Bivalve
1.195 m-1.275 m Core catcher - contains sediment (medium - fine sand); massive; contains foraminifera and bivalves.
1.222 m Bivalve

VC-016-B

Images	Units	m	Intervals	Symbols	Description



0.002 m-0.02 m Foam
0.02 m-0.18 m Clayey sand

0.08 m-0.085 m ?? Thin light brown layer. Tephra or soemthing else?

0.175 m-0.18 m ?? Thin black layer. Tephra or soemthing else?
0.18 m-0.73 m Silty sand

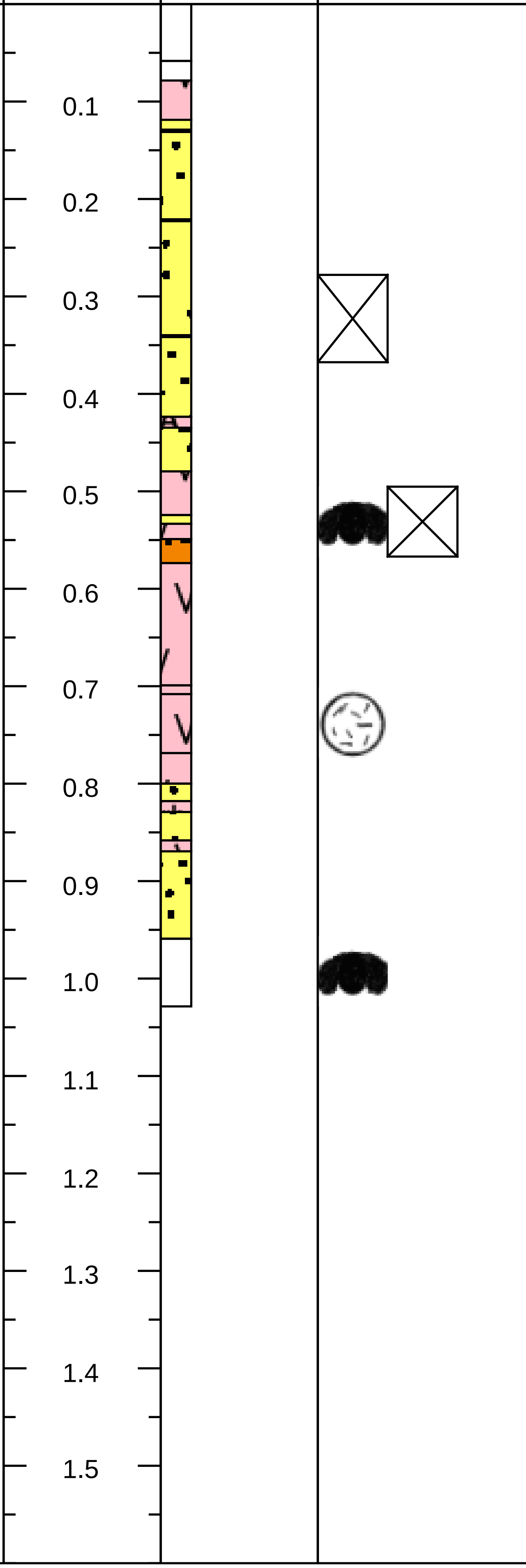
0.47 m-0.475 m ?? Very thin fine light grey layer. Tephra or soemthing else?
0.48 m-0.485 m ?? Very thin fine light grey layer. Tephra or soemthing else?
0.56 m-0.57 m Pumice clast

0.73 m-0.87 m Silty sand - reworked tephra? Dark grey fine sandy ashy material.

0.87 m-0.93 m Very fine light grey ash layer. Sharp upper and lower contacts. At a c. 20 degree angle. Hint of diffuse darker laminations - mostly in the middle.
0.93 m-0.96 m Light brown - grey massive layer.
0.96 m-0.98 m Darker, coarser unit - fine to medium ash with very coarse ash pumice clasts - rounded in shape/scattered
0.98 m-1.0 m Fine sand, yellow to brown in colour. Sharp upper and lower contacts
1.0 m-1.02 m Very fine grained (very fine ash). Light grey in colour. In contact with the core catcher. No laminations, massive and homogenous.
1.02 m-1.08 m Core catcher

VC-017-B

Images	Units	m	Intervals	Symbols	Description



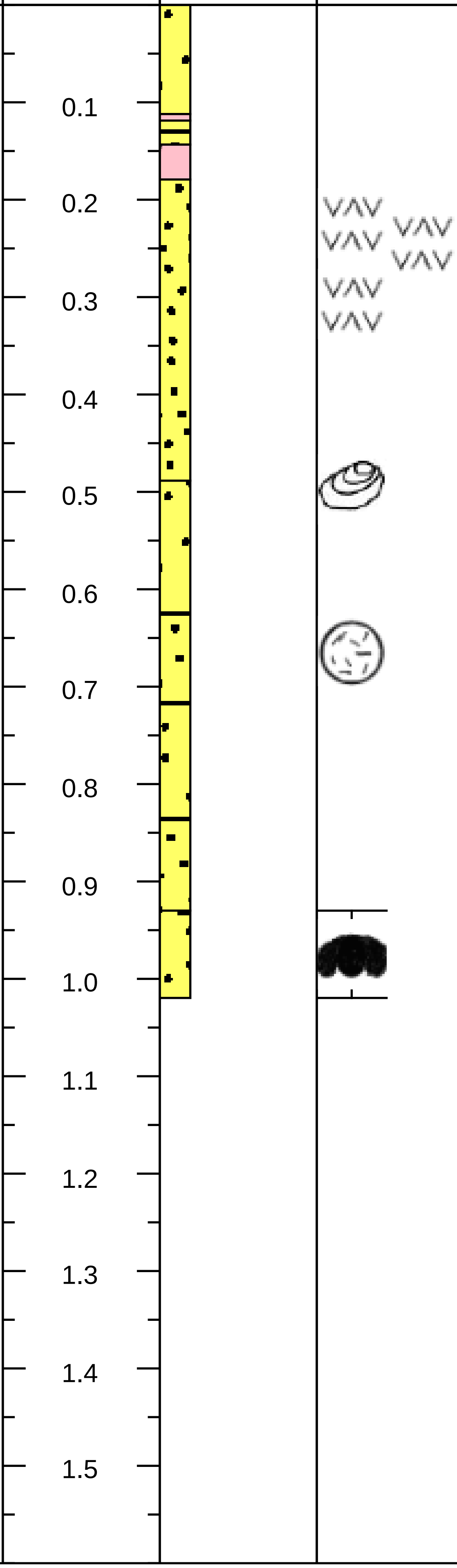
0.0 m-0.06 m Foam

0.06 m-0.08 m Gap
0.08 m-0.12 m Dark, but pumiceous, coarse ash to very coarse ash
0.12 m-0.425 m Sandy clay

0.28 m-0.37 m Scattered pumice, with highest concentration around 30 cm
0.425 m-0.435 m Dark, but pumiceous, coarse ash to very coarse ash
0.435 m-0.48 m Sandy clay
0.48 m-0.525 m Dark (60%), but pumiceous (40%), coarse ash to very coarse ash
0.525 m-0.535 m Sandy clay
0.96 m-0.103 m Core catcher
0.535 m-0.55 m Pale, light grey/white fine ash
0.575 m-0.7 m White, very fine ash.
0.7 m-0.71 m Darker, medium - fine ash layer
0.71 m-0.77 m White, very fine ash grey layer with lots of black carbon
0.77 m-0.8 m White/light grey very fine ash - even finer than parts above. Sharp base
0.82 m-0.83 m Pod of white fine ash
0.86 m-0.87 m Pod of white fine ash
0.96 m-1.03 m Core catcher

VC-018-B

Images	Units	m	Intervals	Symbols	Description



0.0 m-0.112 m Clayey sand

0.112 m-0.12 m Thin (1 cm) dilute white/grey ashy layer. Generally massive.

0.12 m-0.145 m Clayey sand

0.145 m-0.18 m Very fine to to fine light grey to white layer with very fine laminations . Homogenous throughout.

0.18 m-0.49 m Sand with pods of ash

0.22 m-0.23 m Pod of light ash

0.24 m-0.25 m Pod of light ash

0.3 m-0.32 m Pod of light ash

0.49 m-0.93 m Sandy clay

0.48 m-0.52 m Bivalve shells

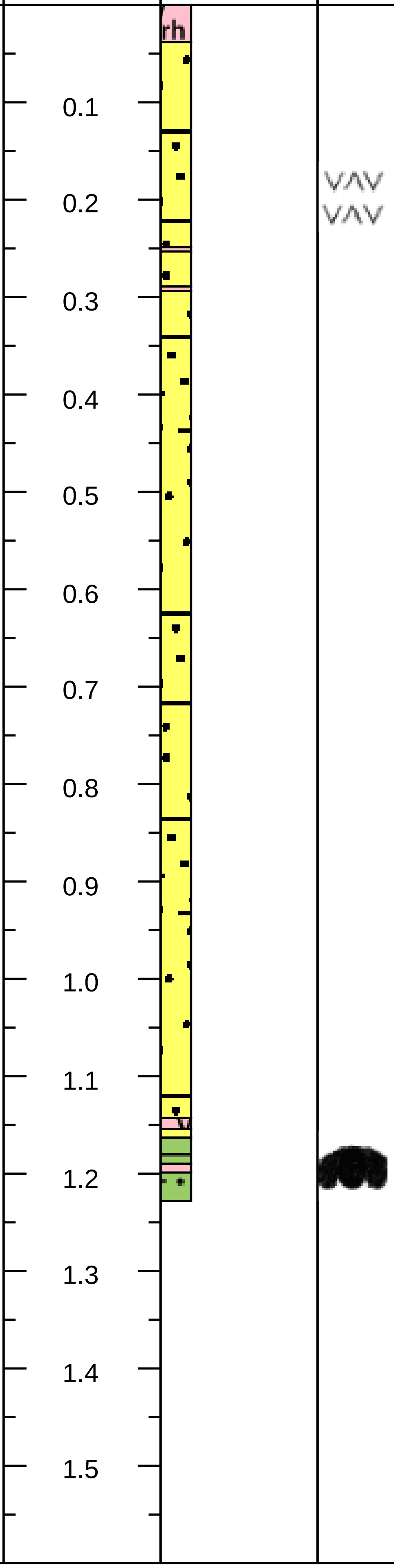
0.66 m-0.67 m Black layer

0.93 m-1.02 m Sandy clay

0.93 m-1.02 m Core catcher

VC-019-B

Images	Units	m	Intervals	Symbols	Description



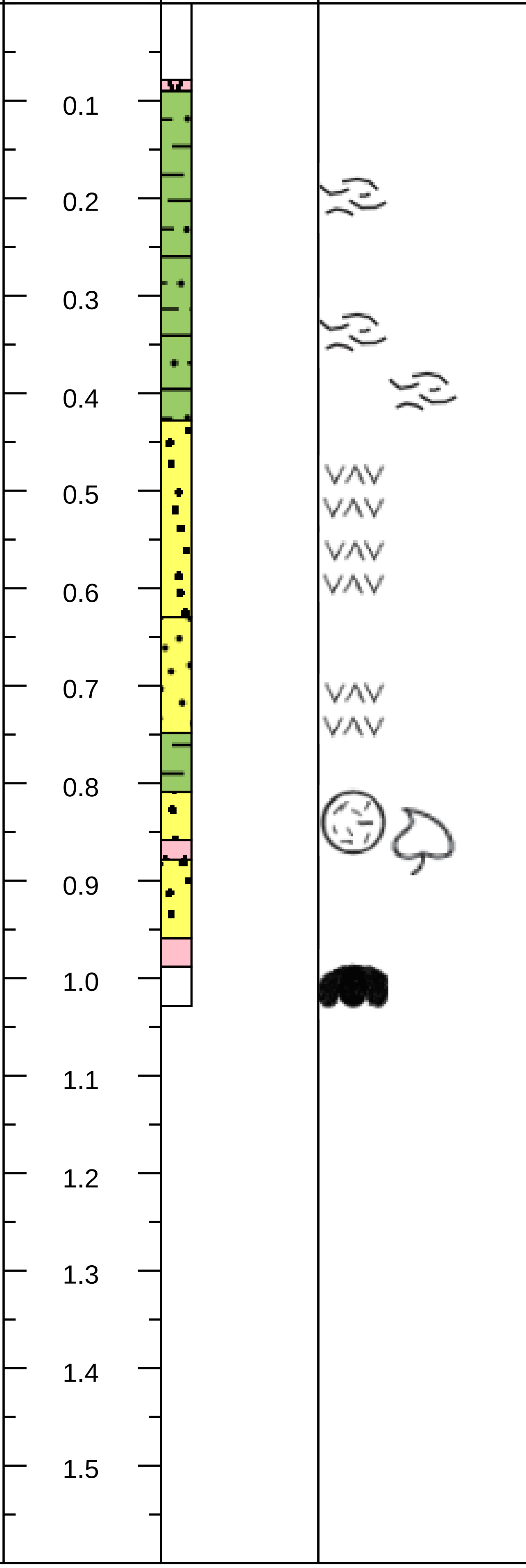
0.0 m-0.04 m Chaiten 2008? Felsic, very fine grey/white ash (mixed in with some mud)
0.04 m-0.25 m Clayey sand with a pod of ash

0.195 m-0.2 m Pod of white/light grey very fine ash
0.255 m-0.29 m Clayey sand
0.29 m-0.295 m Clear thin white/light grey very fine ash with sharp top and base
0.295 m-1.145 m Clayey sand

1.145 m-1.155 m Black medium sand/medium ash - homogenous black material
1.165 m-1.19 m Silty clay
1.19 m-1.2 m Clear dark ashy/tephra layer - medium ash
1.16 m-1.23 m Core Catcher
1.2 m-1.23 m Sily clay

VC-022-A

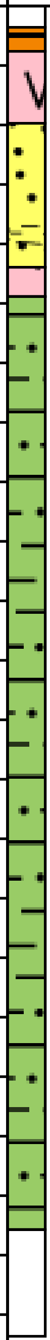
Images	Units	m	Intervals	Symbols	Description



0.0 m-0.08 m Foam

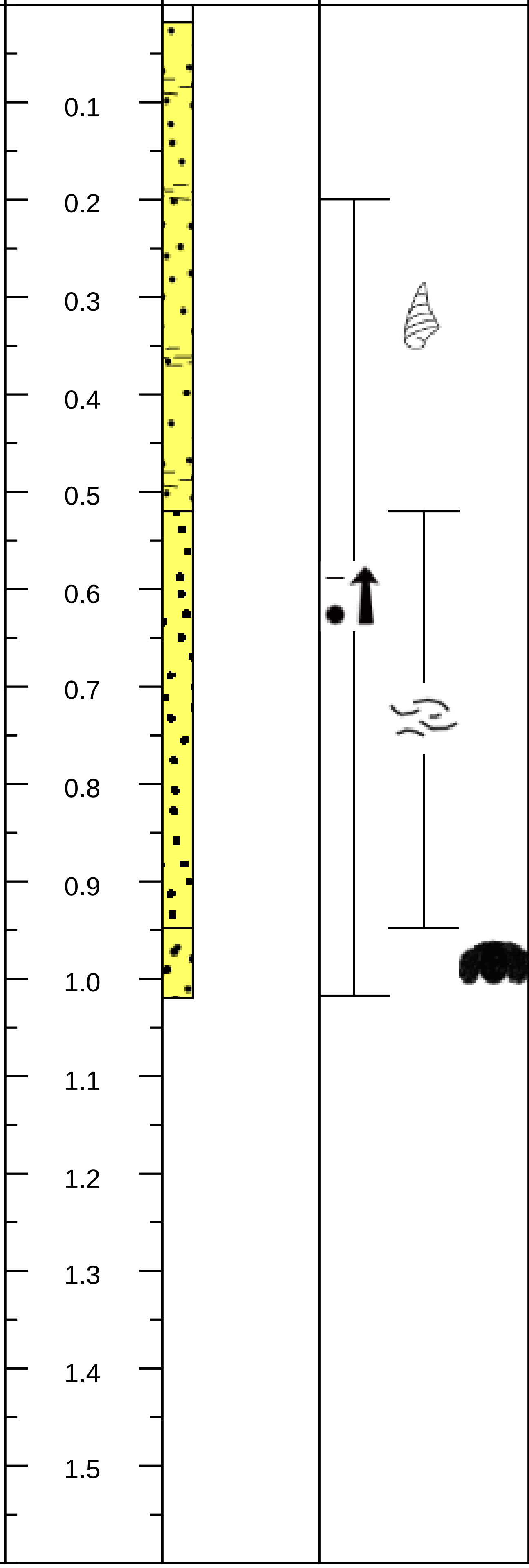
0.08 m-0.09 m Tephra: clast-supported - angular to sub-angular clasts: black (30%); clear/white (50%); orange (2%); brown (8%); crystals (10%). Poorly sorted - coarest pumice grains are 1.5 mm in diameter.
0.09 m-0.43 m Silty clay; matrix-supported; clasts: black (35%); clear/white (55%); red (5%); blue-green crystals (5%). Poorly to moderately sorted.
0.2 m Foraminifera shell
0.34 m Fragmented shells lens
0.4 m Fragmented shells lens
0.43 m-0.63 m Fine to medium clast-supported sand (medum sand in lenses); clasts: black (25%); white (35%); red (5%); grey (2%); brown (10%); green-yellow crystals and clays (15%). Moderately sorted.
0.5 m Pumice lens
0.58 m Pumice lens
0.63 m-0.75 m Multi-layered deposit - varying colours and grain sizes: ~98 cm: light, fine layer followed by a darker and coarser layer containing clasts: black (35%); white/clear (50%); red (10%); brown (5%). Poorly sorted.
0.72 m-0.73 m Light layer - tephra?
0.75 m-0.81 m Silty-clay, matrix-supported with fine laminations. Clasts: white (80%); black (20%). Lower contact is irregular (with the underlying unit).
0.81 m-0.86 m Very fine to fine sand layer; massive; clasts: black (30%); clear/white (50%); red (5%); green-yellow crystals and clays (15%). Moderately to poorly sorted.
0.84 m Charcoal
0.86 m Plant debris - leaf
0.86 m-0.88 m White pumice layer
0.88 m-0.96 m Very fine to fine sand layer; massive; clasts: black (30%); clear/white (50%); red (5%); green-yellow crystals and clays (15%). Moderately to poorly sorted. Irregular (scour?) basal contact with underlying unit.
0.96 m-0.99 m Tephra: fine to medium sandy deposit. Clasts: black (35%); pumiceous (juvenile?, 40%); red (5%); crystals (15%); other (5%). Largest pumice is 5 mm (x-axis).
0.99 m-1.03 m Core Catcher

VC-023-A

Images	Units	m	Intervals	Symbols	Description
					**0.0 m-0.02 m** Foam **0.02 m-0.04 m** Sily clay containing minor reworked tephra from layer below **0.04 m-0.1 m** Chaiten 2008 eruption? White, very fine ash base (9-5-10 cm). Pale, light grey very fine ash. Possible fall at very base with dilute lahar material overlying? **0.1 m-0.22 m** Sandy clay **0.22 m-0.245 m** Michinmueda 1835 AD eruption? Sharp lower contact, med-coarse ash, slightly laminated. Dark clasts are a mix of vesicular and dense volcanics; thin grey white fine ash layer in middle.
		0.1			
		0.2			
		0.3			
		0.4			
		0.5			
		0.6			**0.245 m-1.03 m** Silty clay
		0.7			
		0.8			
		0.9			
		1.0			**1.03 m-1.12 m** Core catcher
		1.1			
		1.2			
		1.3			
		1.4			
		1.5			

VC-025-A

Images	Units	m	Intervals	Symbols	Description



0.0 m-0.02 m Foam
0.02 m-0.52 m Massive silty sand (fine sand - 30%; silt - 60%; clay - 10%); dark olive-grey in colour. Moderately sorted, normally graded.

0.32 m Gastropod

0.52 m-0.95 m Massive sand (fine and medium sand - 75%; silt - 20%; clay - 5%); very dark olive-grey. Shelly frgament observed at 91 cm. Possible subangular quartz fragaments - needs laboratory confirmation. Poorly sorted.
0.2 m-1.02 m Normally graded sediments
0.52 m-0.95 m Shelly fragments

0.95 m-1.02 m Core catcher- coarse sand and anguar pebbles (clastic material)

Appendix G: Sub-bottom profiles for all dive, grab and core sites

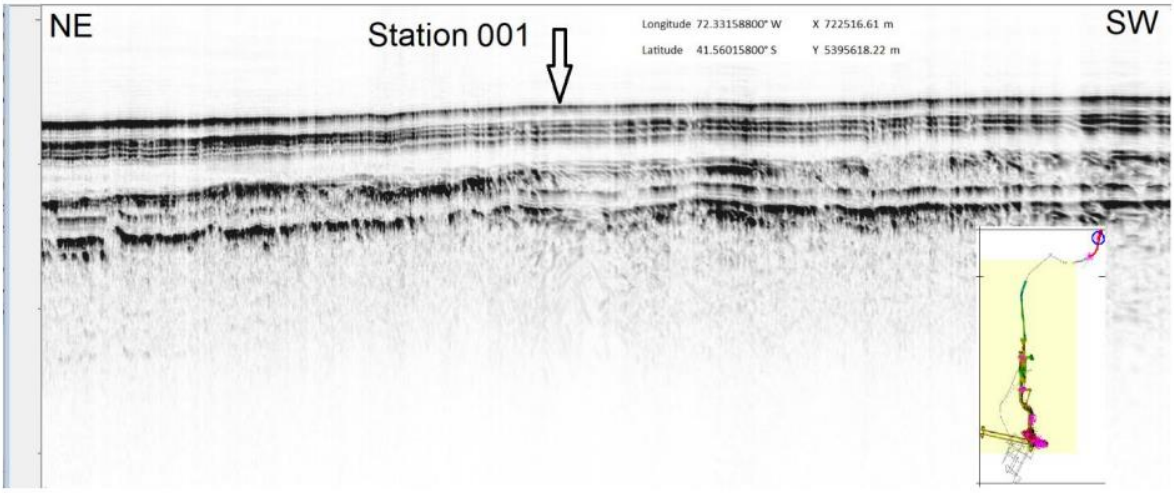


Figure 6.1.1 SBP section crossing the Station 001 in the northernmost area.

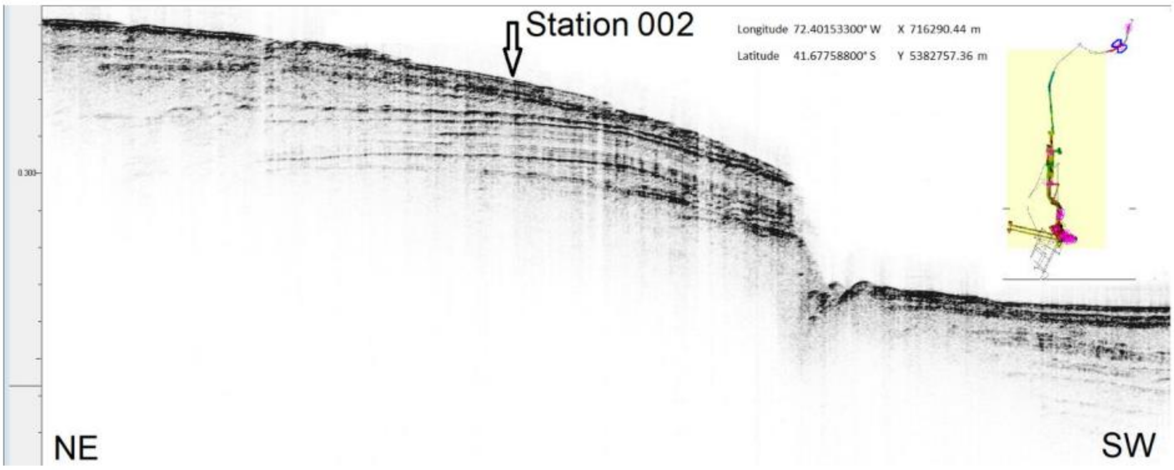


Figure 6.1.2 SBP section crossing the Station 002.

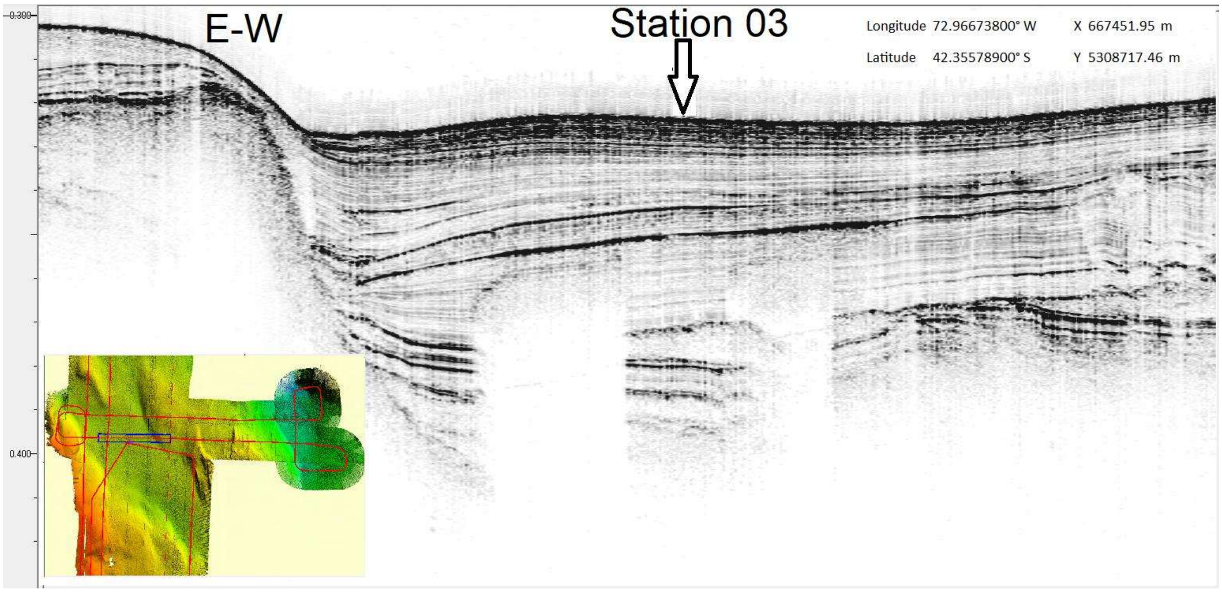


Figure 6.1.3 SBP section crossing the Station 003.

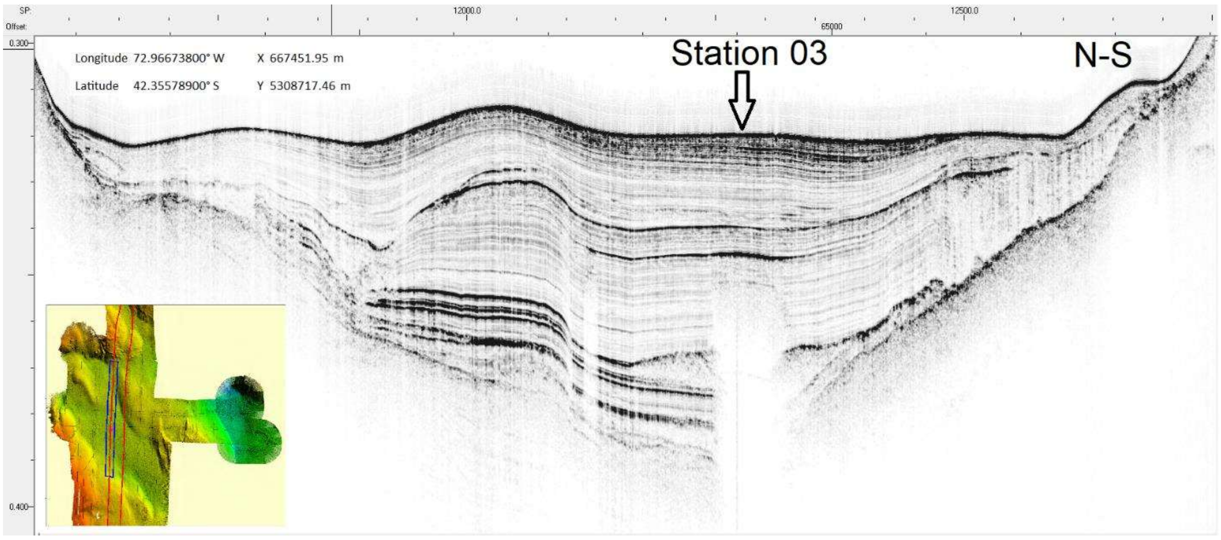


Figure 6.1.4 SBP section crossing the Station 003.

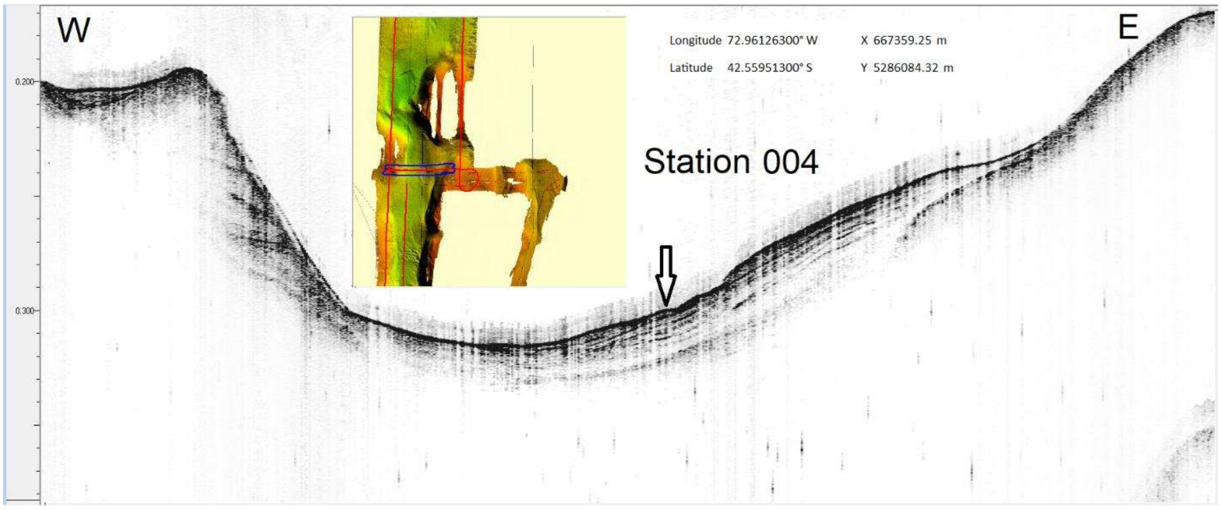


Figure 6.1.5 SBP section crossing the Station 004.

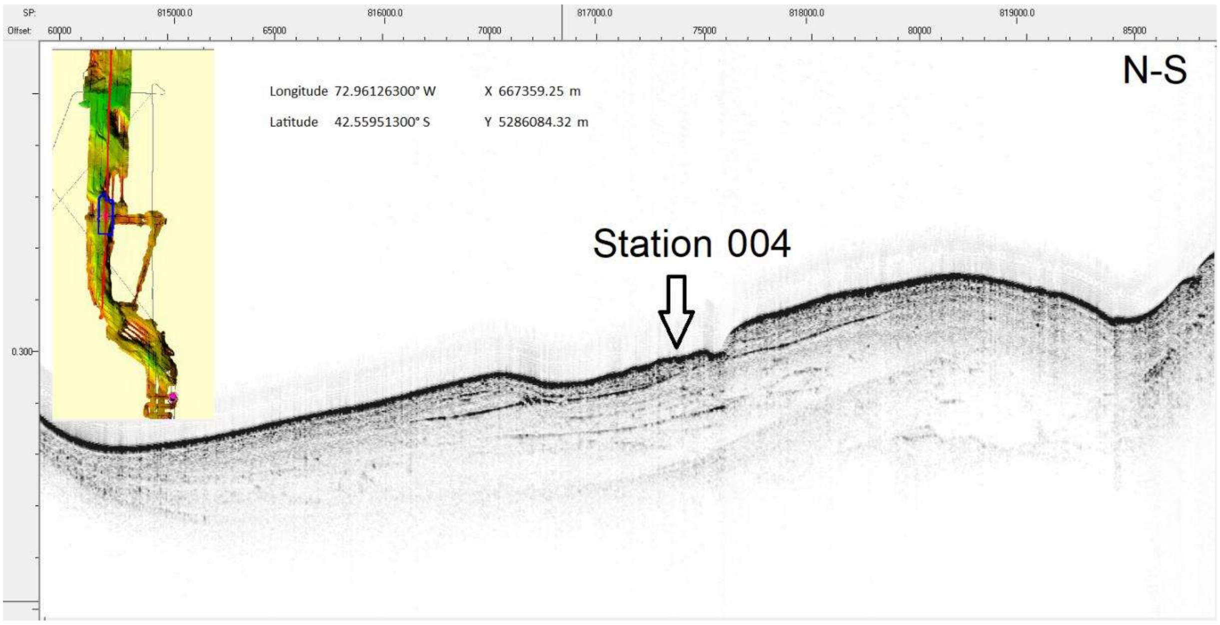


Figure 6.1.6 SBP section crossing the Station 004.

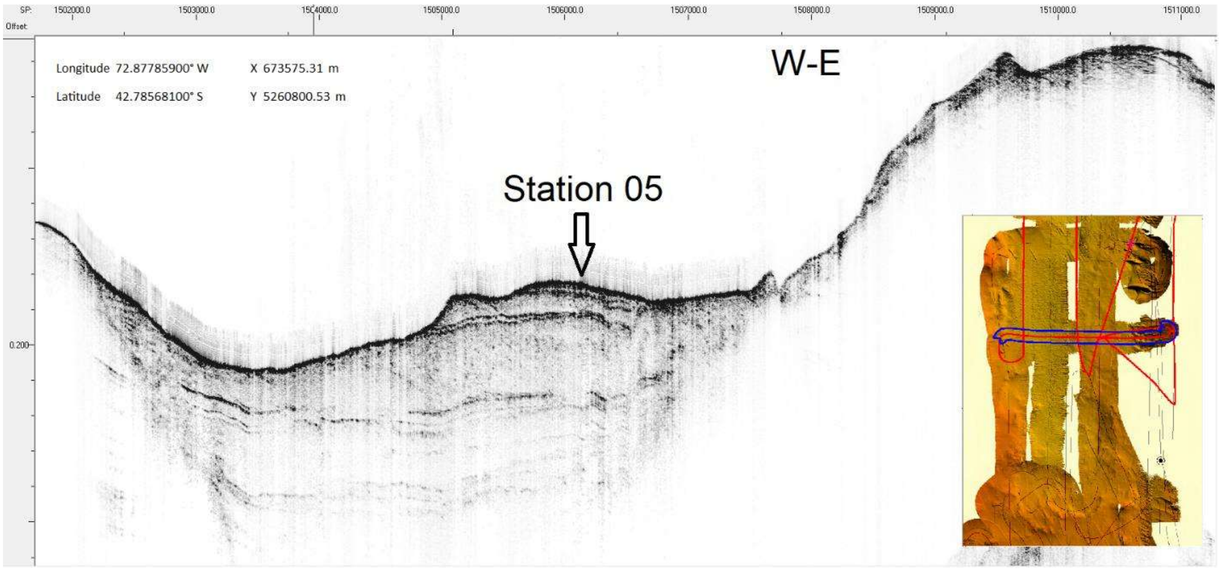


Figure 6.1.7 SBP section crossing the Station 005.

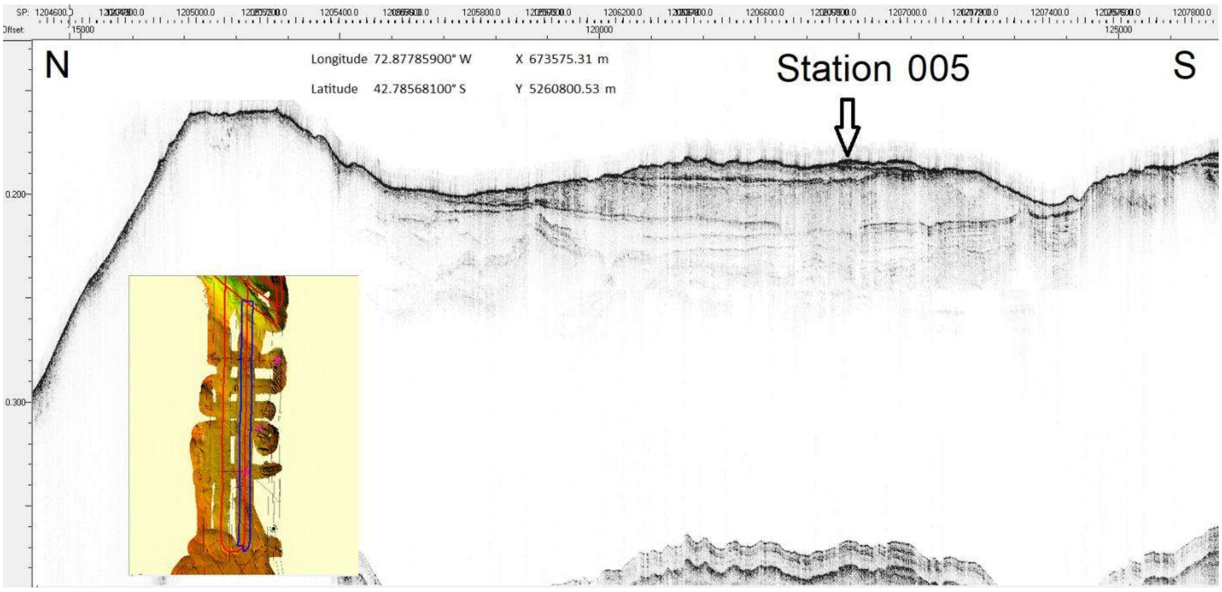


Figure 6.1.8 SBP crossline section transecting the Station 005.

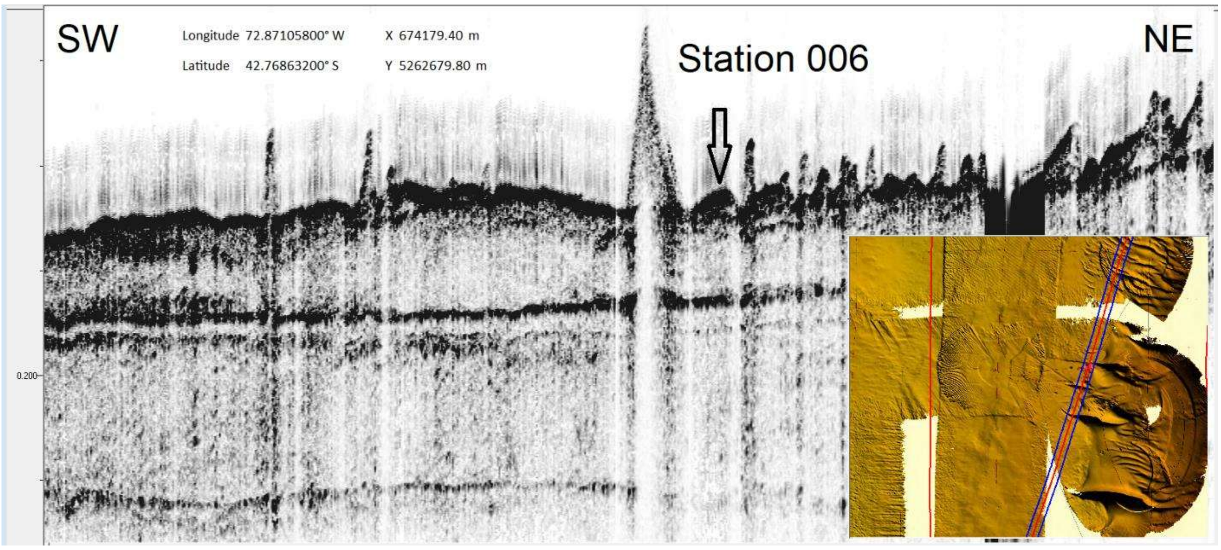


Figure 6.1.9 SBP section crossing the Station 006.

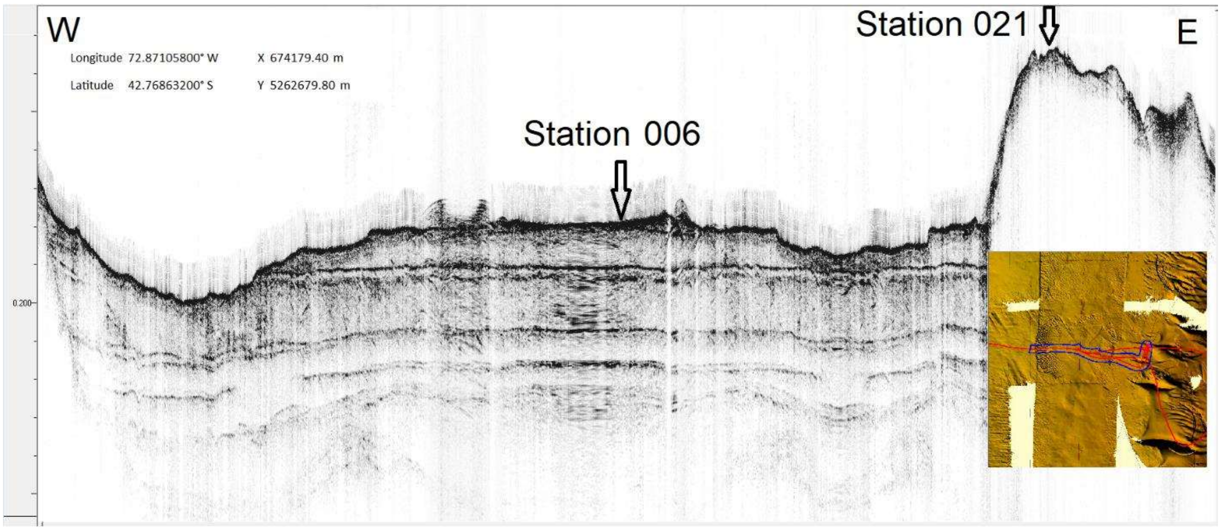


Figure 6.1.10 SBP crossline transecting the Station 006.

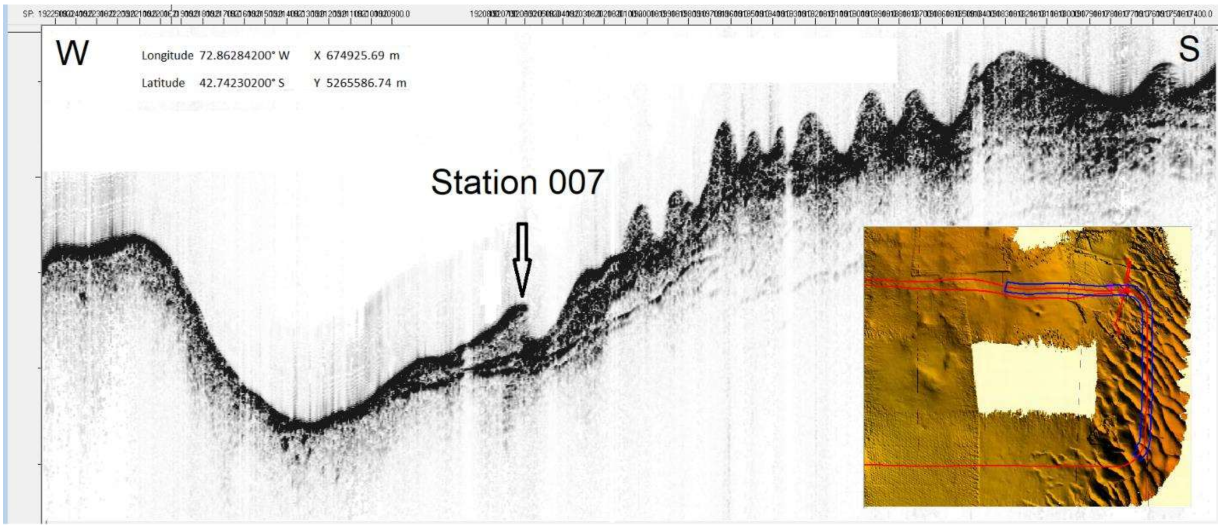


Figure 6.1.11 SBP section crossing the Station 007.

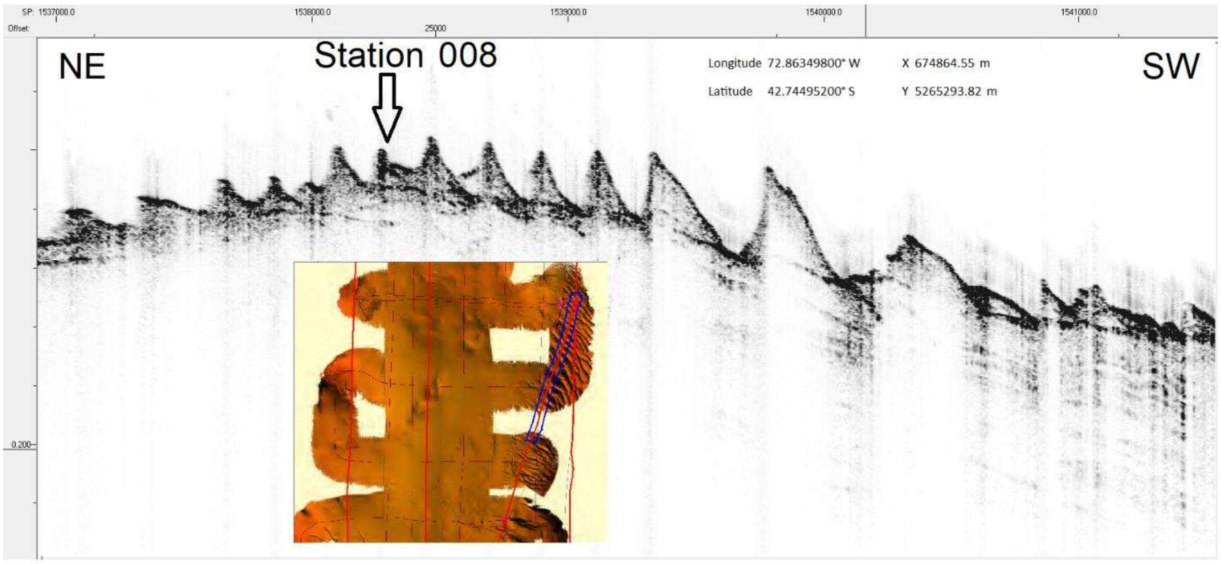


Figure 6.1.12 SBP section crossing the Station 008.

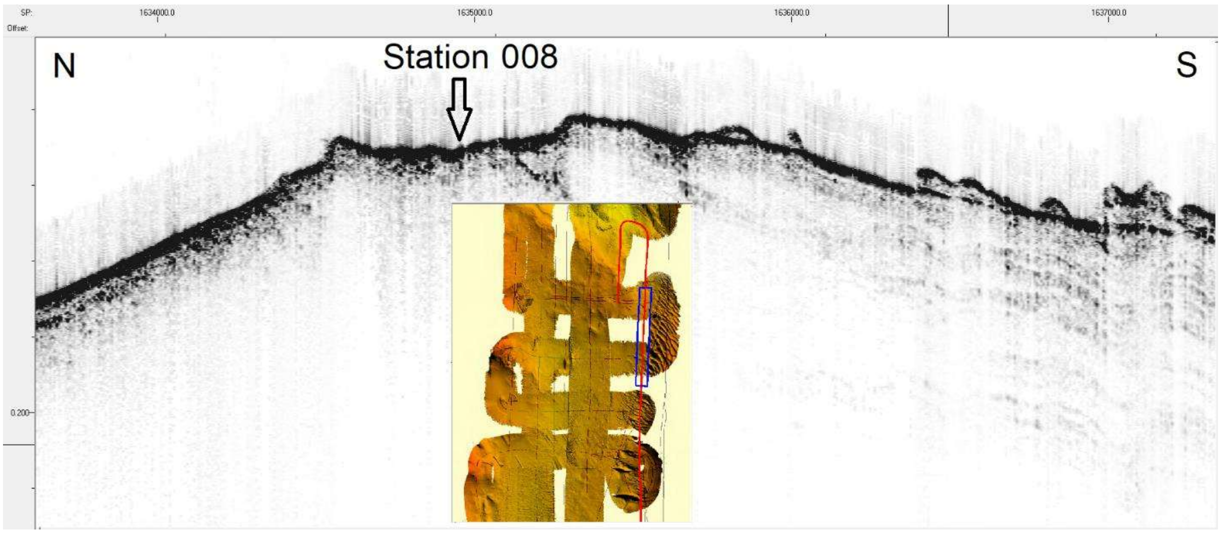


Figure 6.1.13 SBP section with projected location of the Station 008.

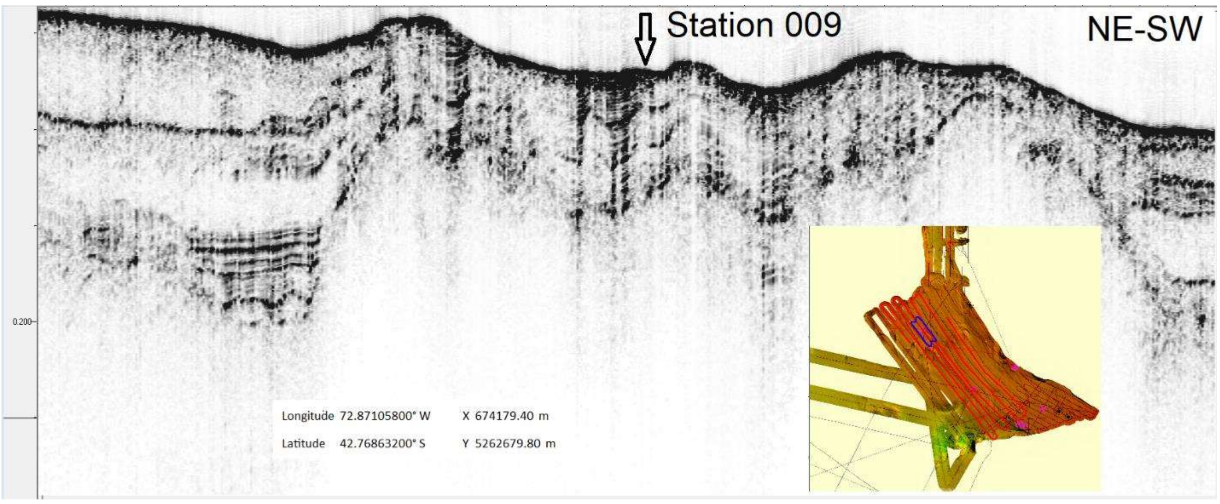


Figure 6.1.14 SBP section crossing the Station 009.

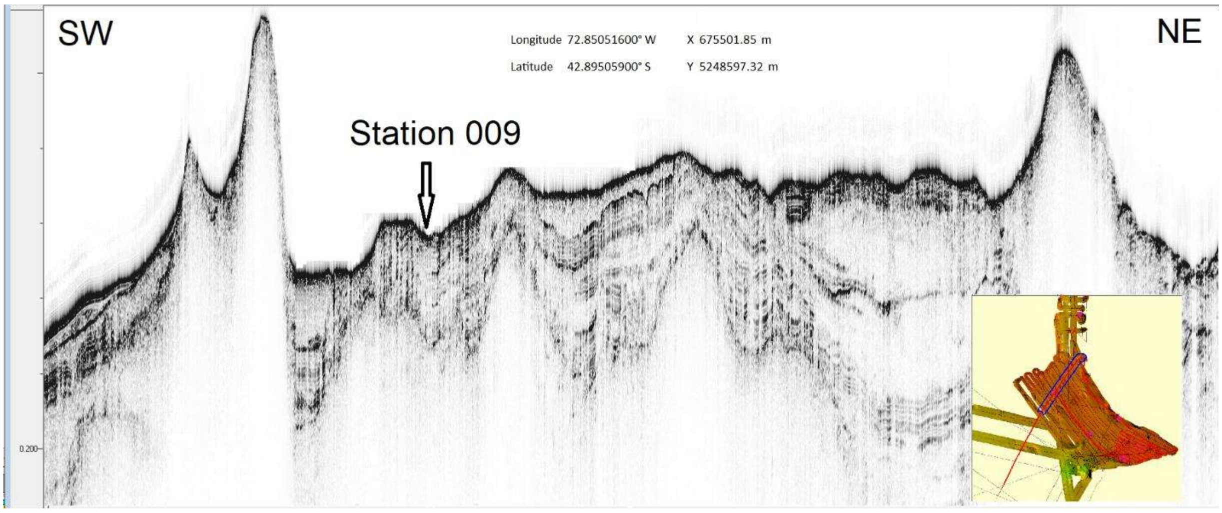


Figure 6.1.15 SBP cross-section transecting the Station 009.

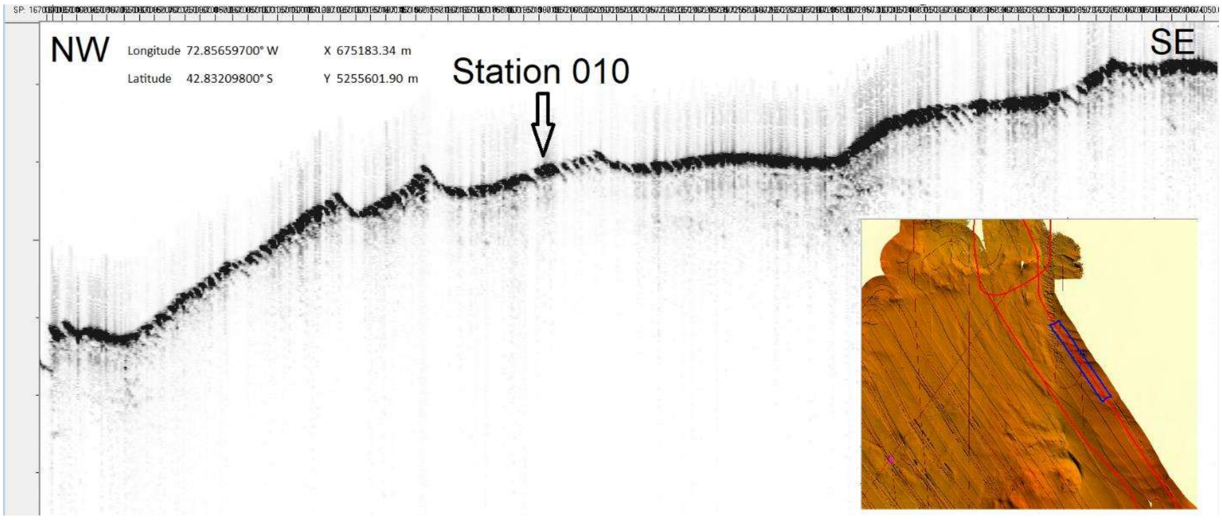


Figure 6.1.16 SBP section crossing the Station 010.

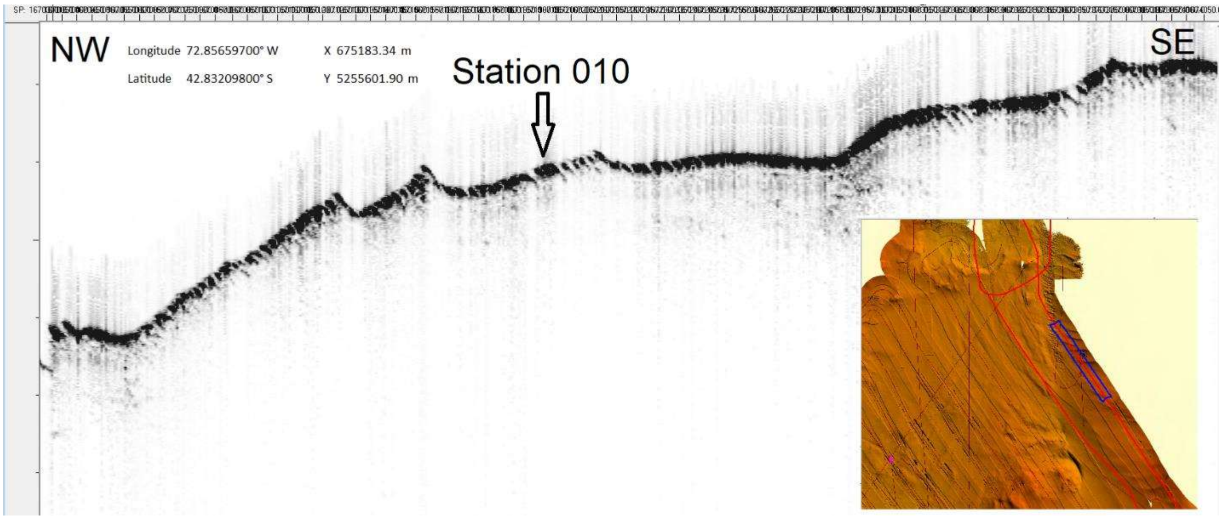


Figure 6.1.17 SBP section transecting over the Station 010.

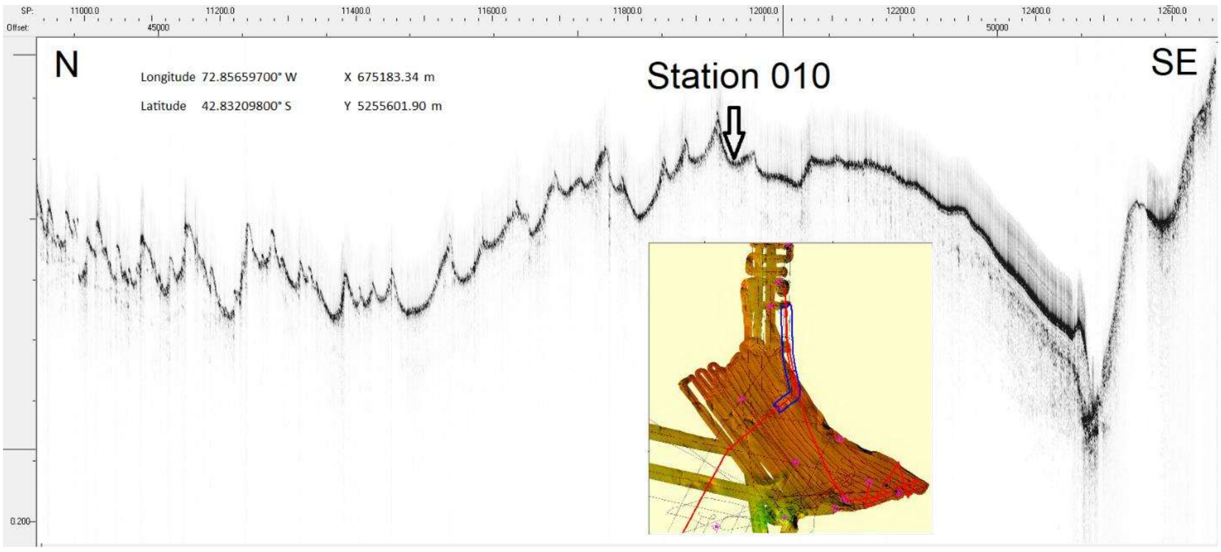


Figure 6.1.18 SBP section transecting over the Station 010.

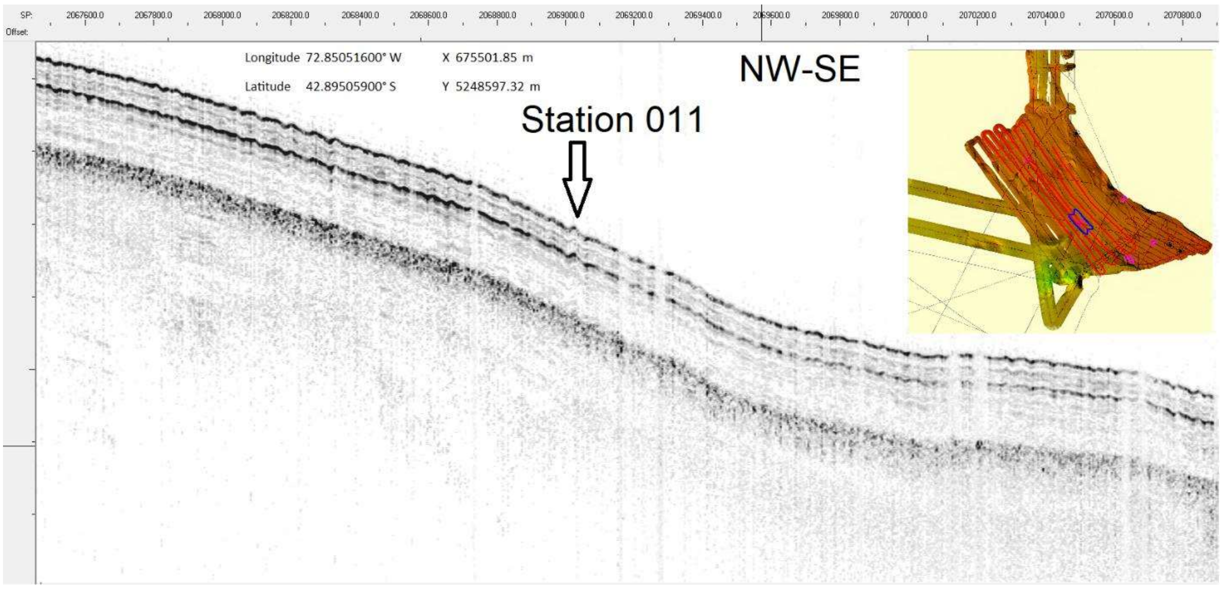


Figure 6.1.19 SBP section crossing over the Station 011.

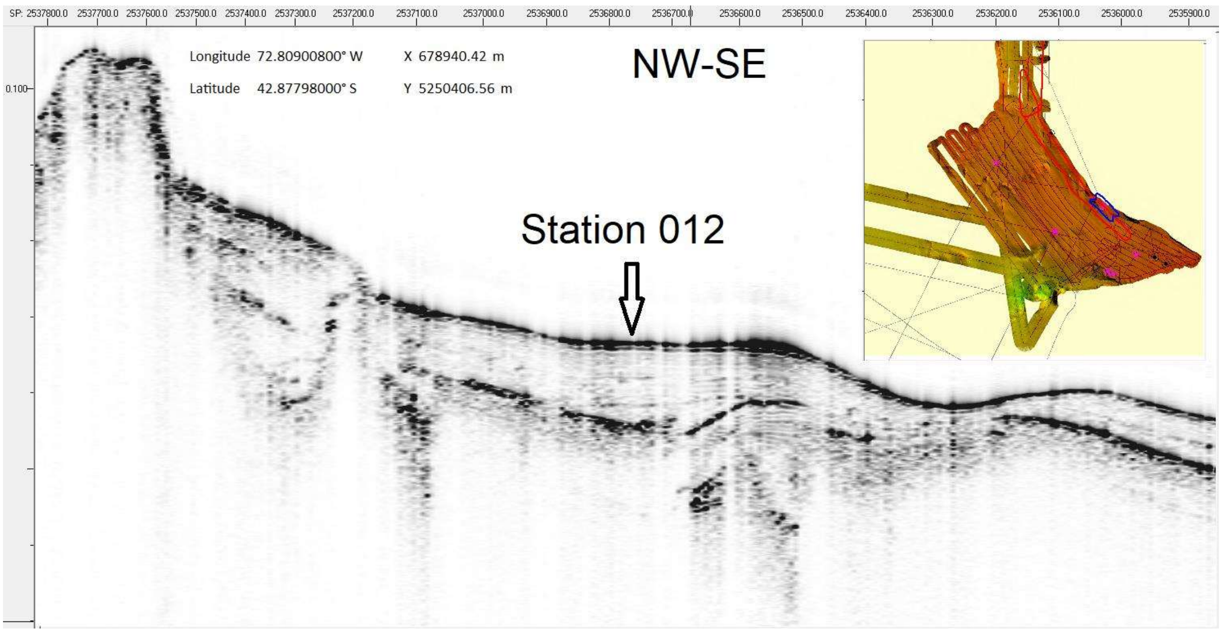


Figure 6.1.20 SBP section crossing over the Station 004.

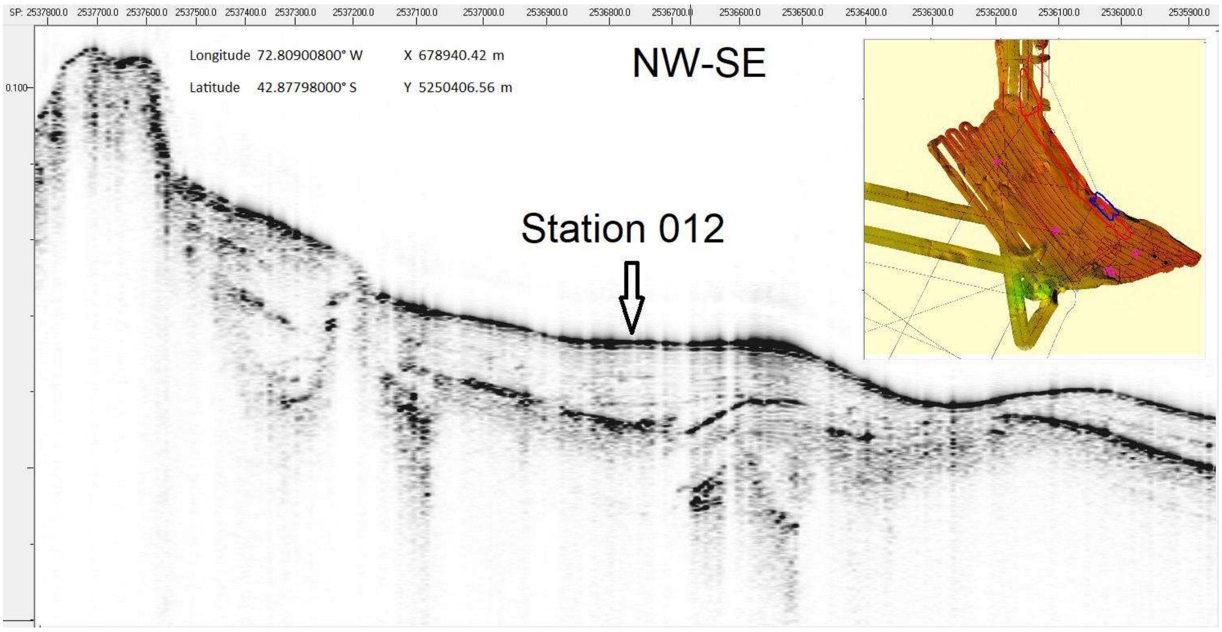
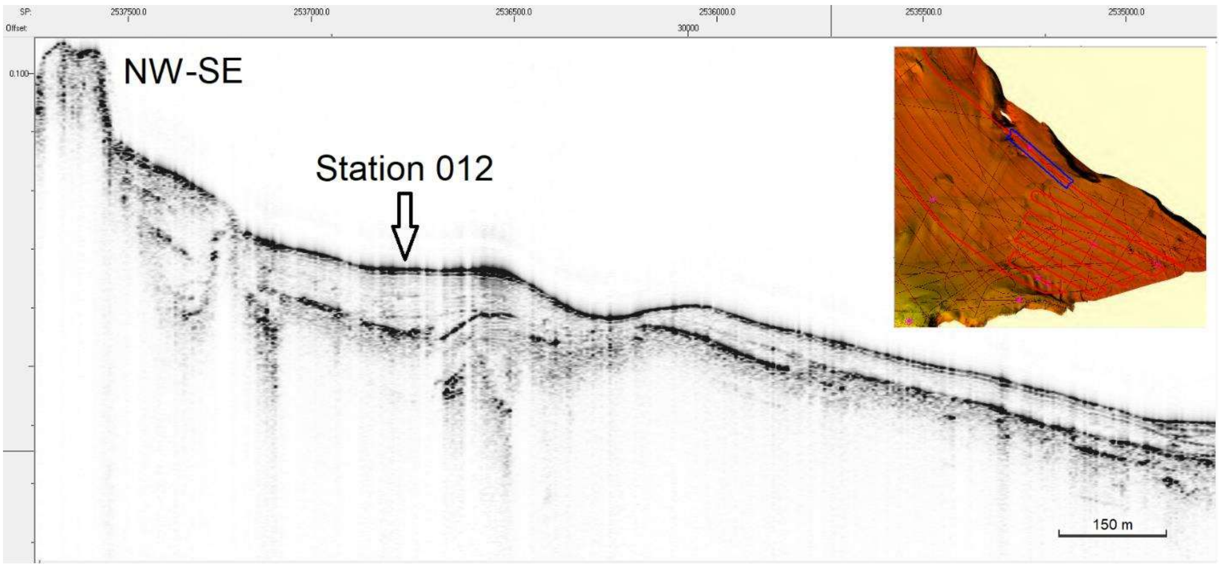


Figure 6.1.21 SBP cross-section transecting the Station 012.



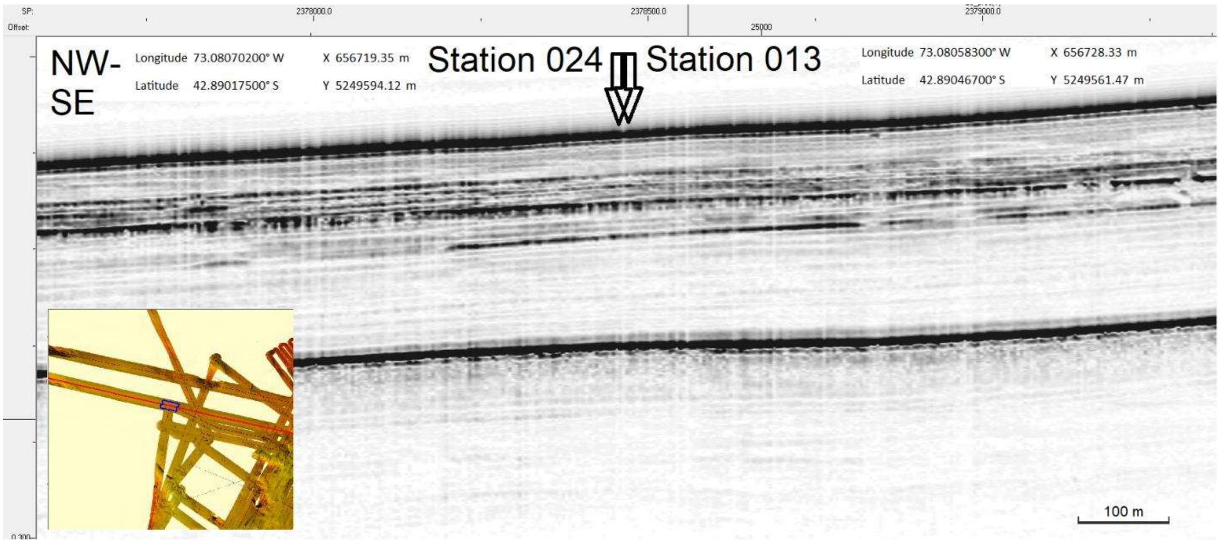


Figure 6.1.22 SBP section transecting the Stations 013 and 024.

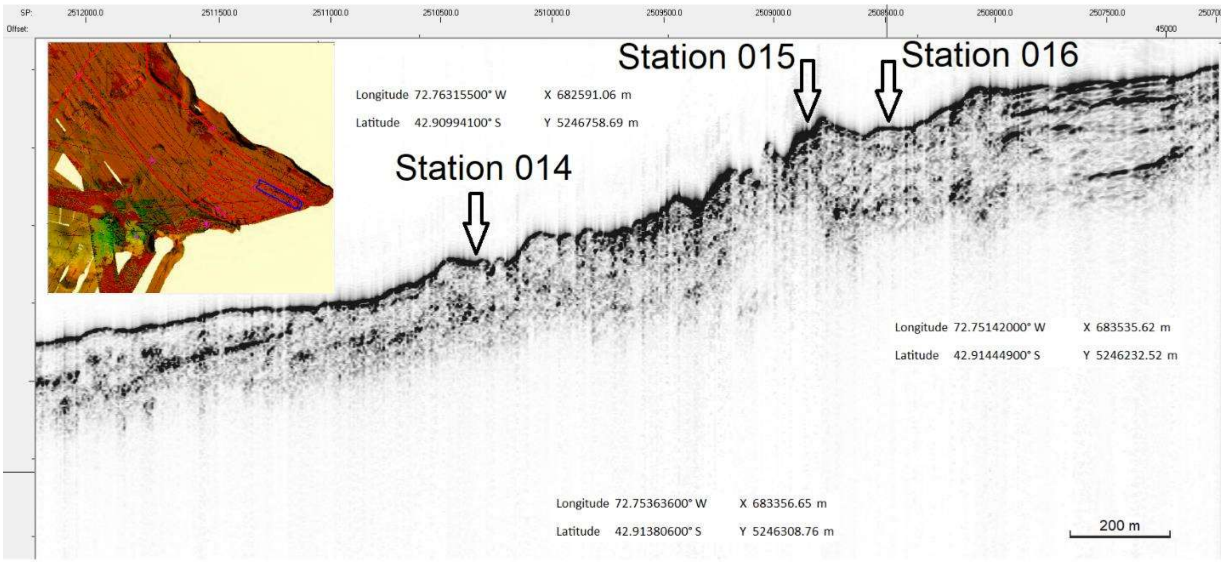


Figure 6.1.23 SBP section transecting the Stations 014, 015 and 016.

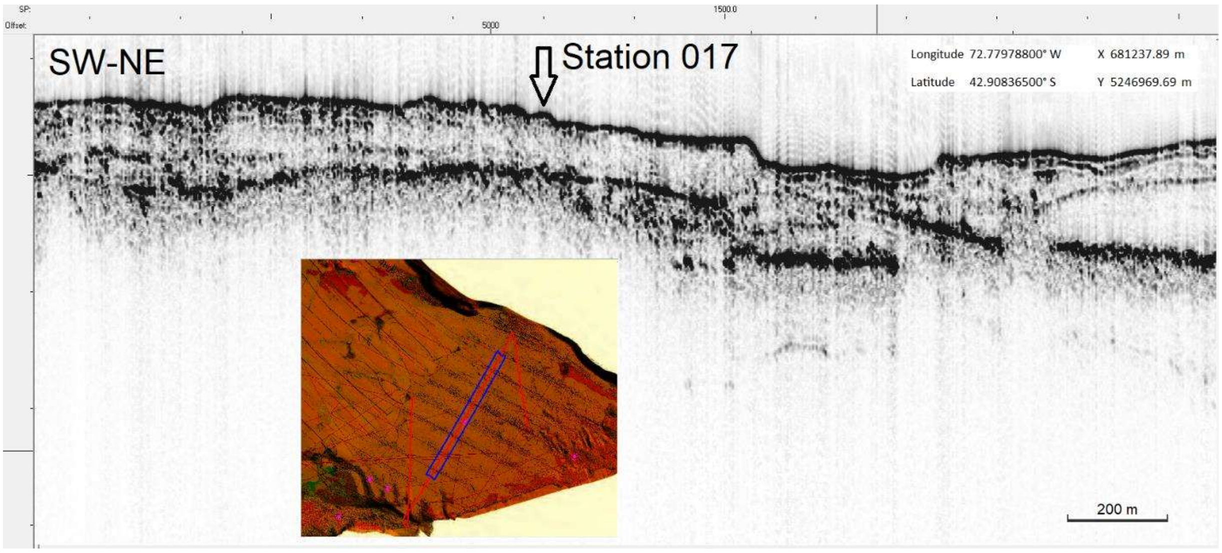


Figure 6.1.24 SBP section crossing the Station 017.

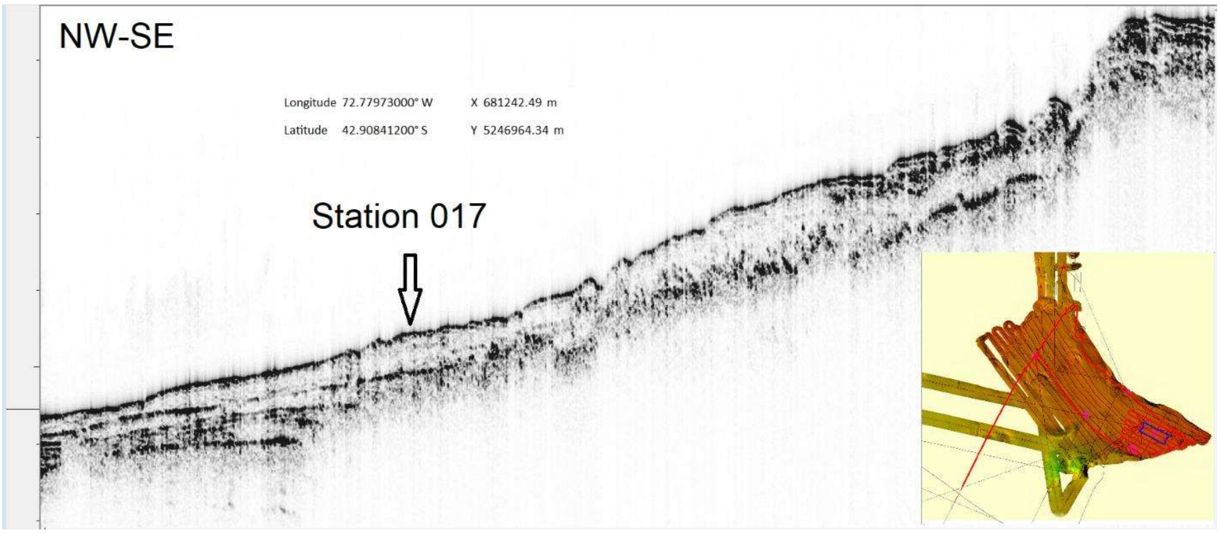


Figure 6.1.25 SBP section crossing the Station 017.

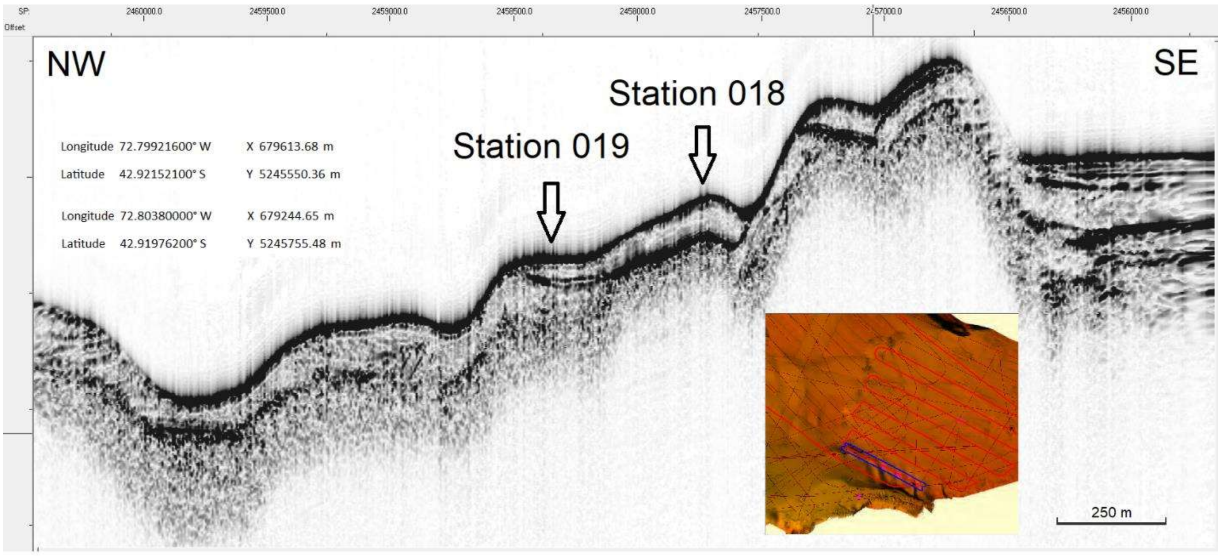


Figure 6.1.26 SBP section crossing the Stations 018 and 19.

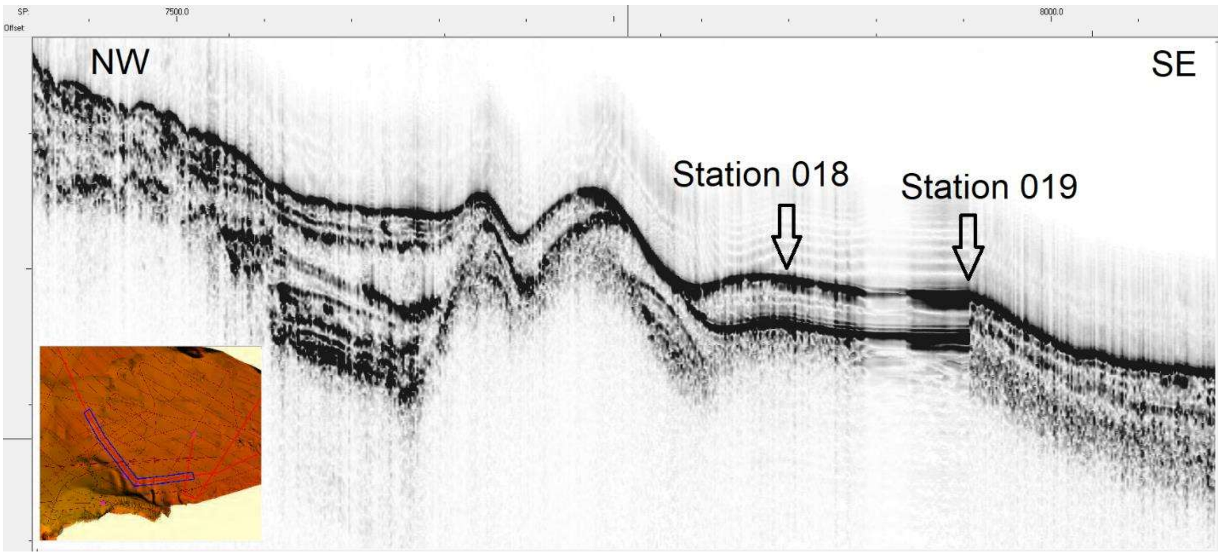


Figure 6.1.27 SBP section crossing the Stations 018 and 019.

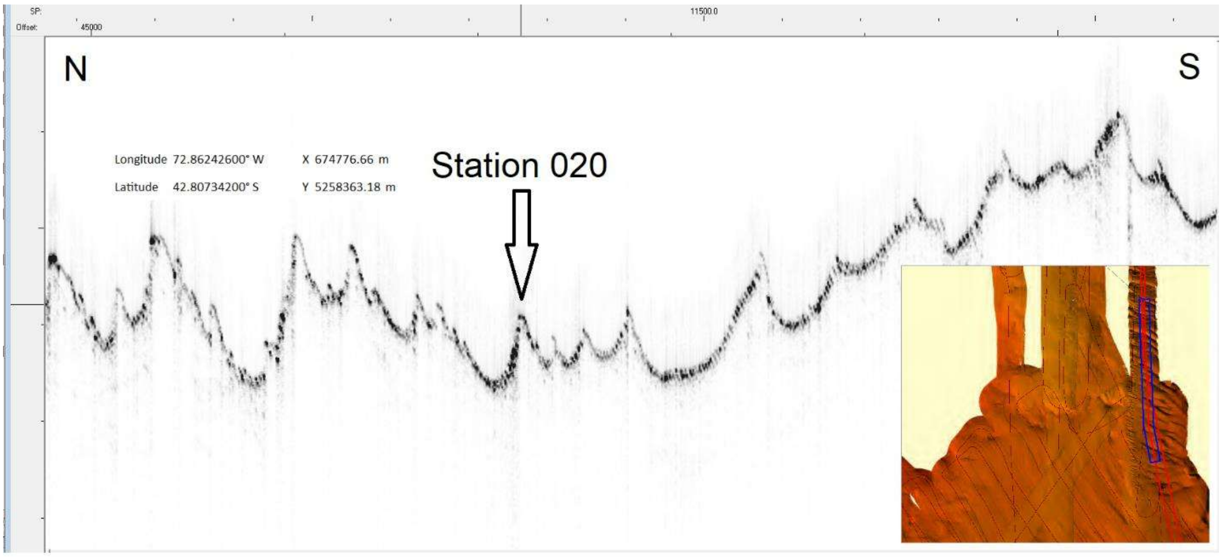


Figure 6.1.28 SBP section crossing the Station 020.

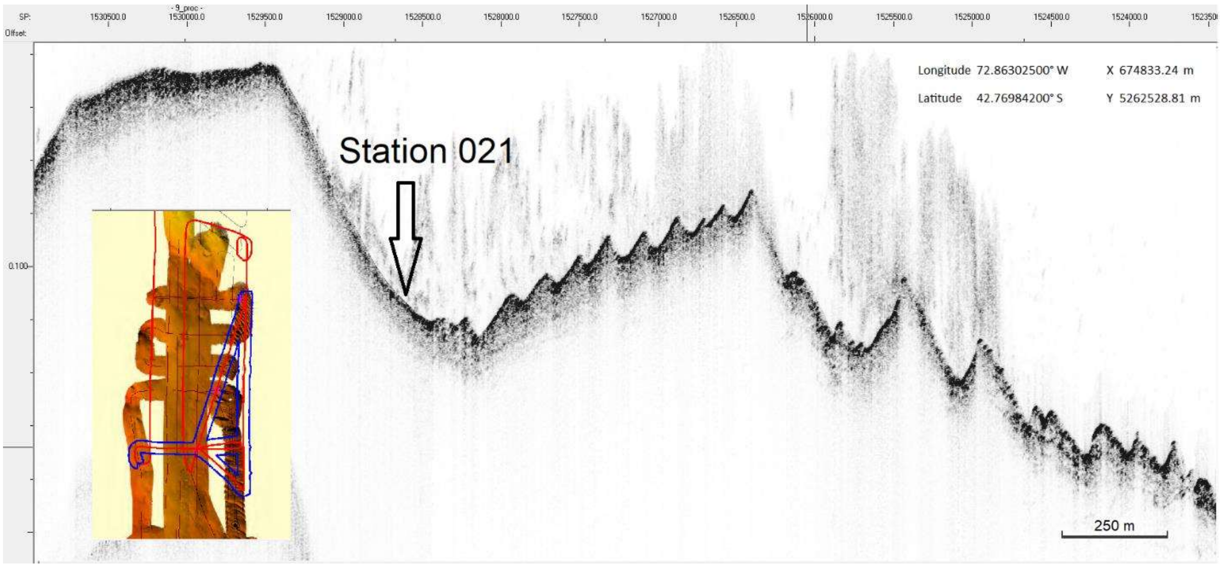


Figure 6.1.29 SBP section crossing the Station 021.

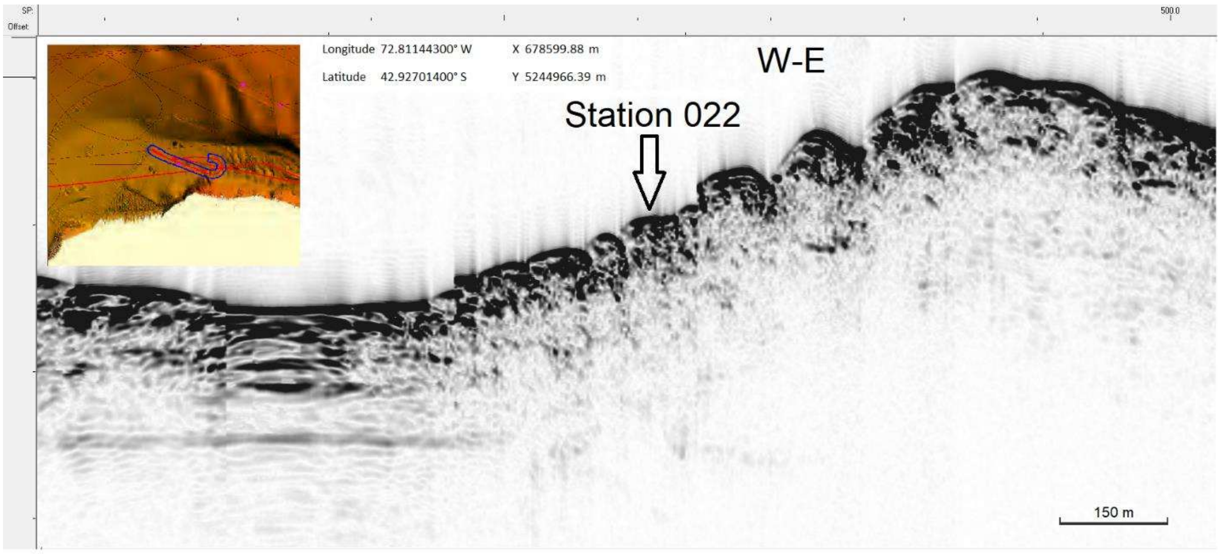


Figure 6.1.30 SBP section crossing the Station 022.

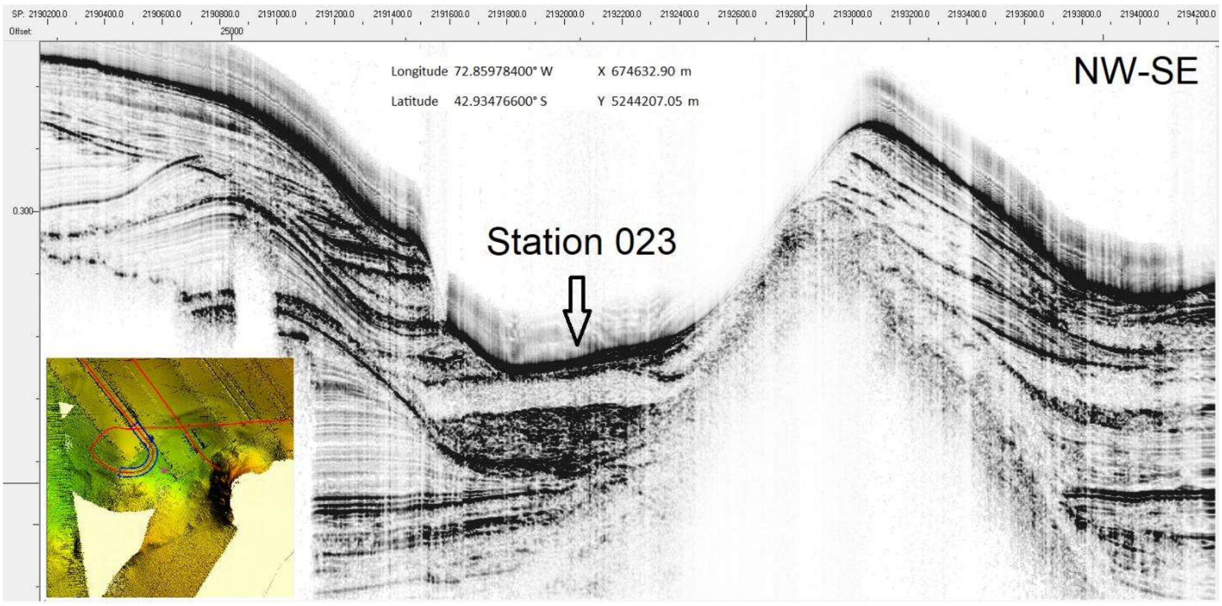


Figure 6.1.31 SBP section crossing the Station 023.

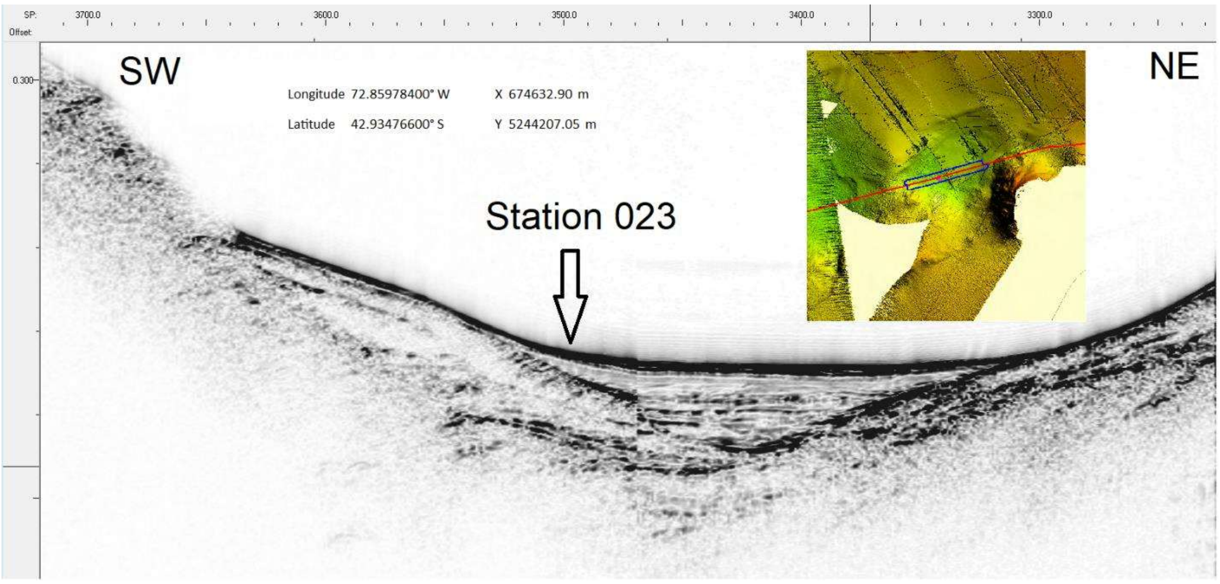


Figure 6.1.32 SBP cross-section transecting the Station 023.

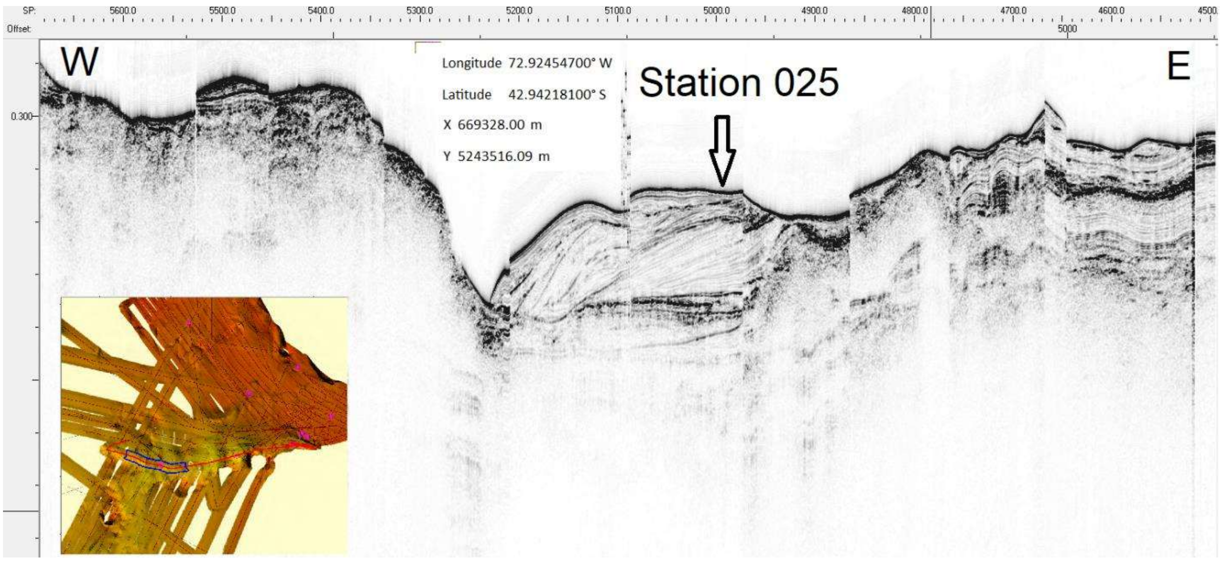


Figure 6.1.33 SBP section crossing the Station 025.

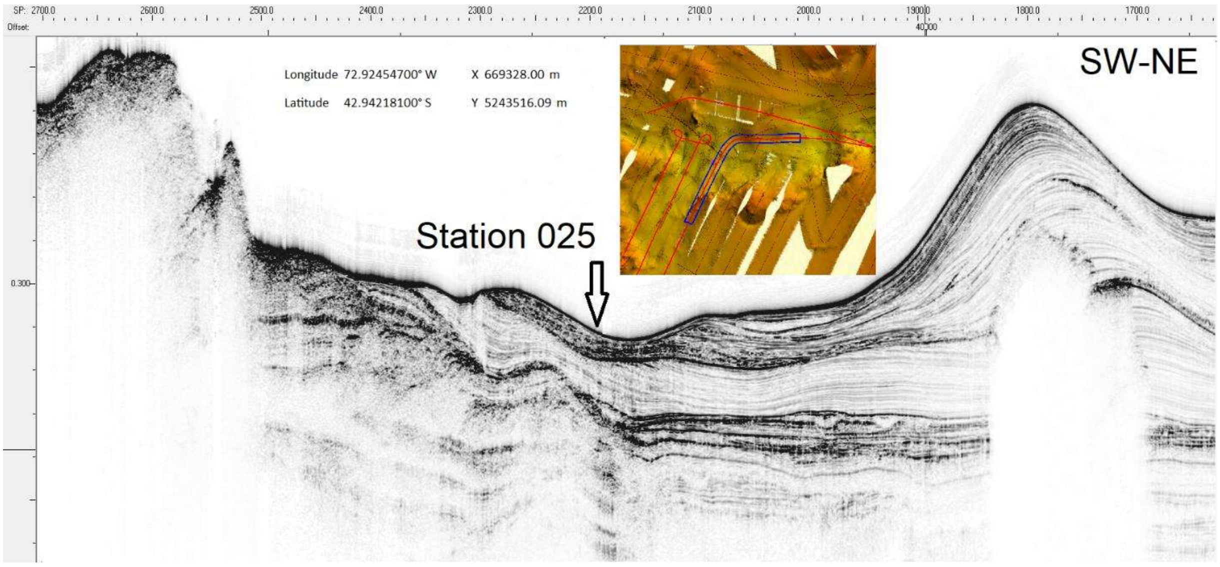


Figure 6.1.34 SBP section crossing the Station 025.

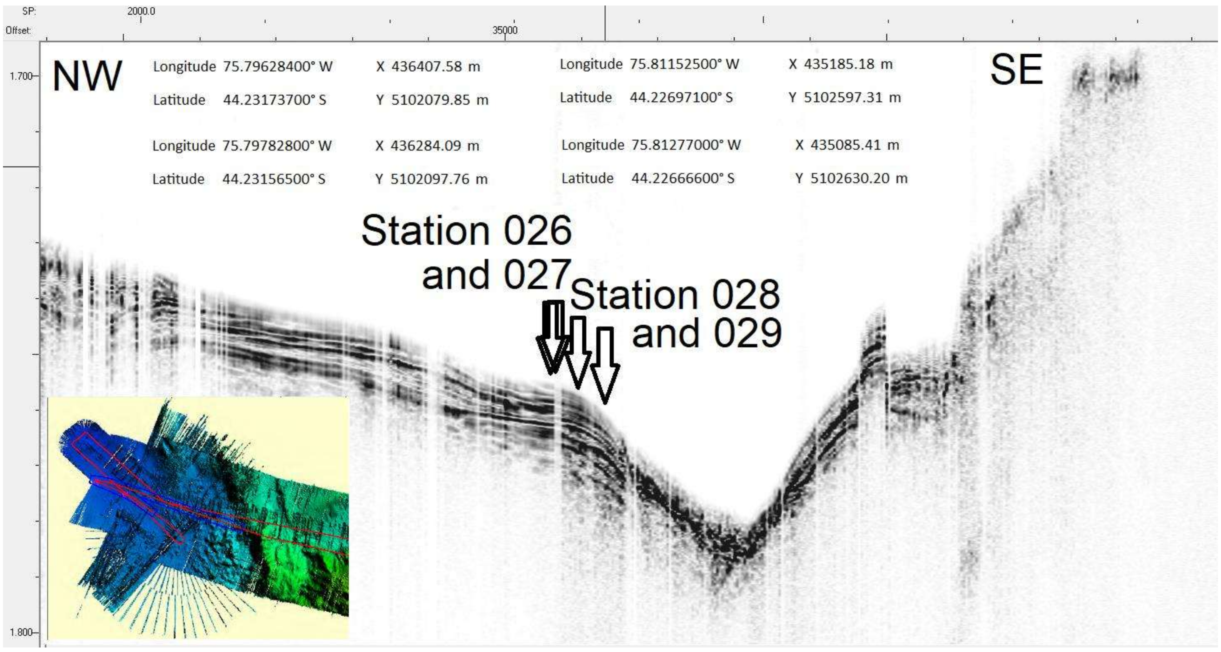


Figure 6.1.35 SBP section crossing the Stations 026, 027, 028 and 029.

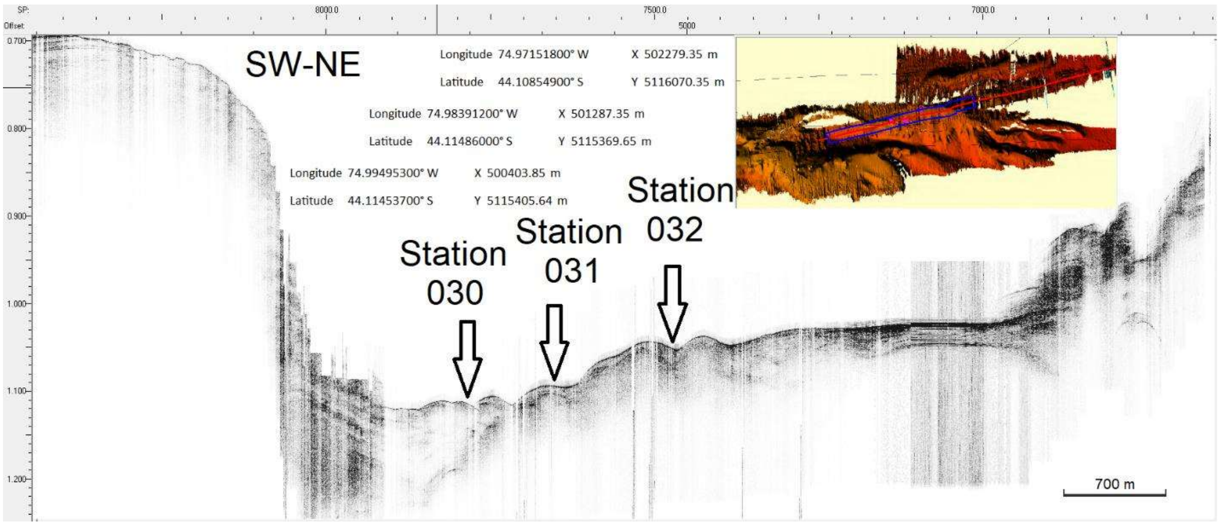


Figure 6.1.36 SBP section crossing the Stations 030, 031 and 032.

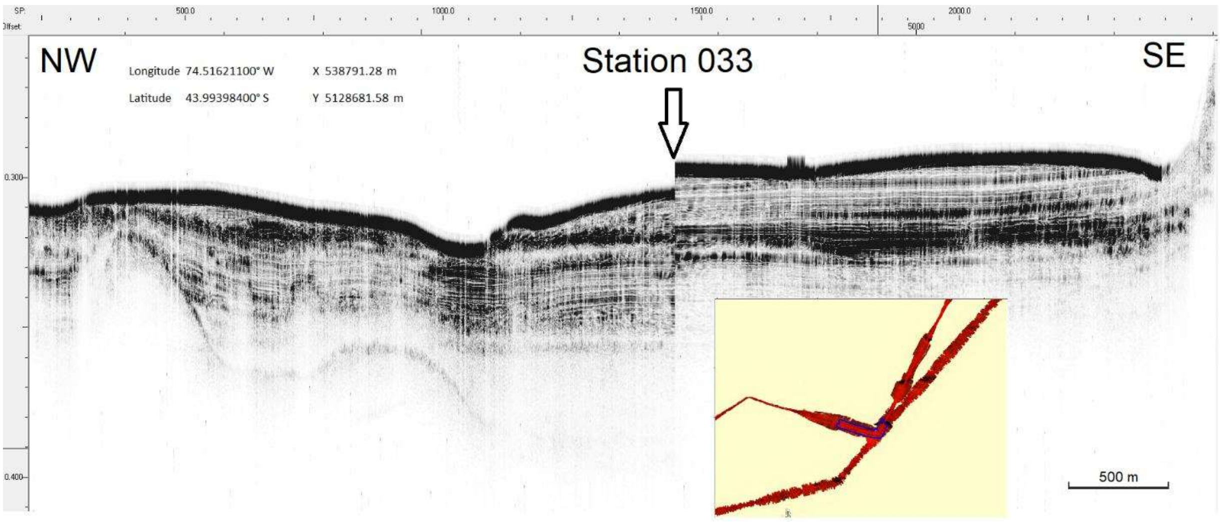


Figure 6.1.37 SBP cross-section transecting the Station 033.

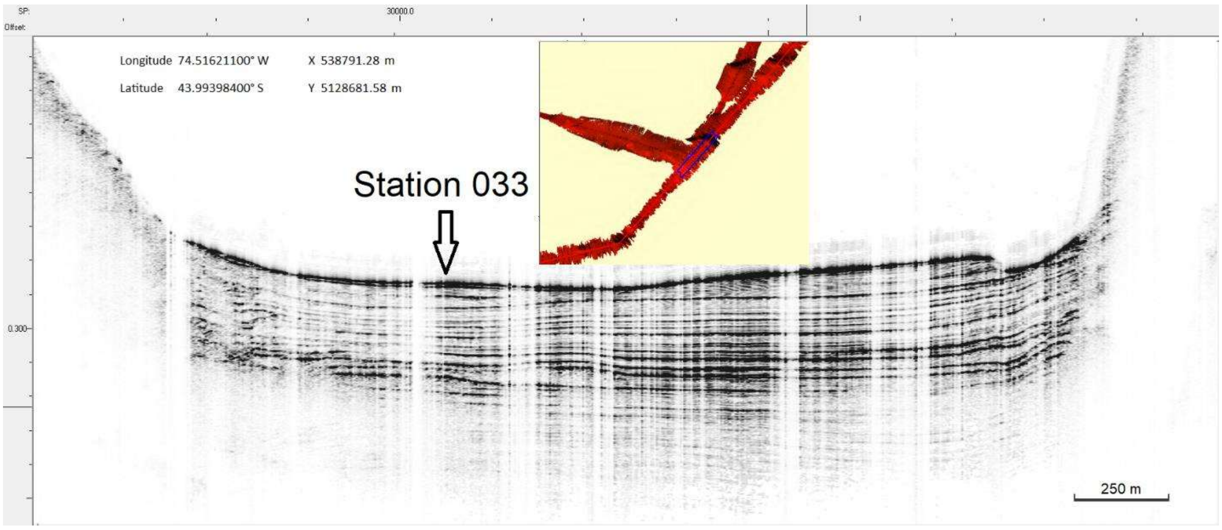


Figure 6.1.38 SBP cross-section transecting the Station 033.

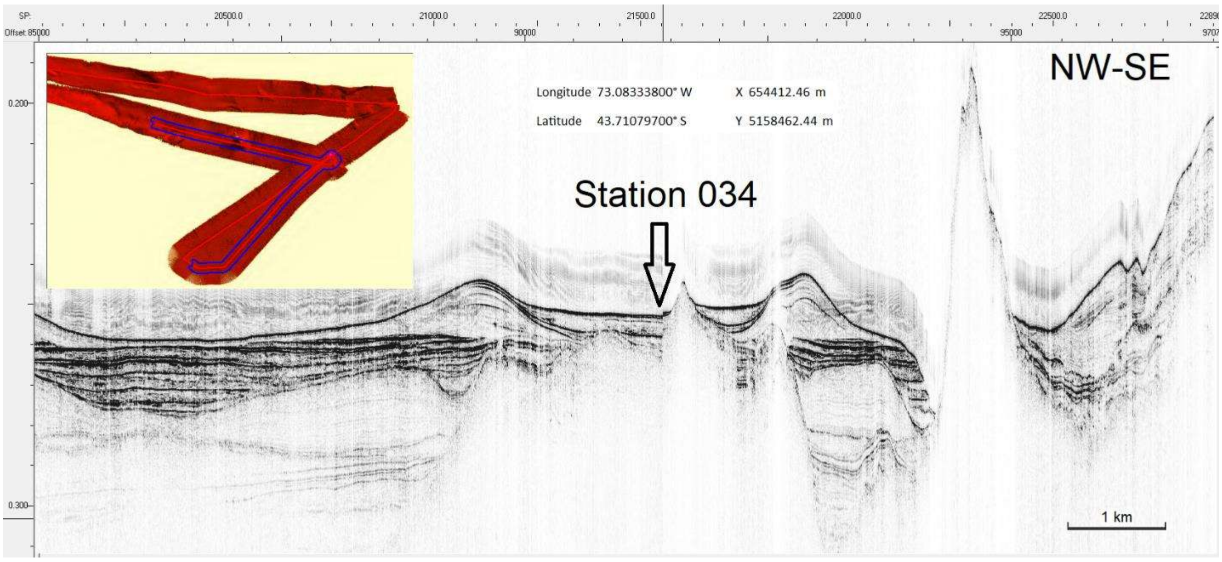


Figure 6.1.39 SBP section crossing the Station 034.

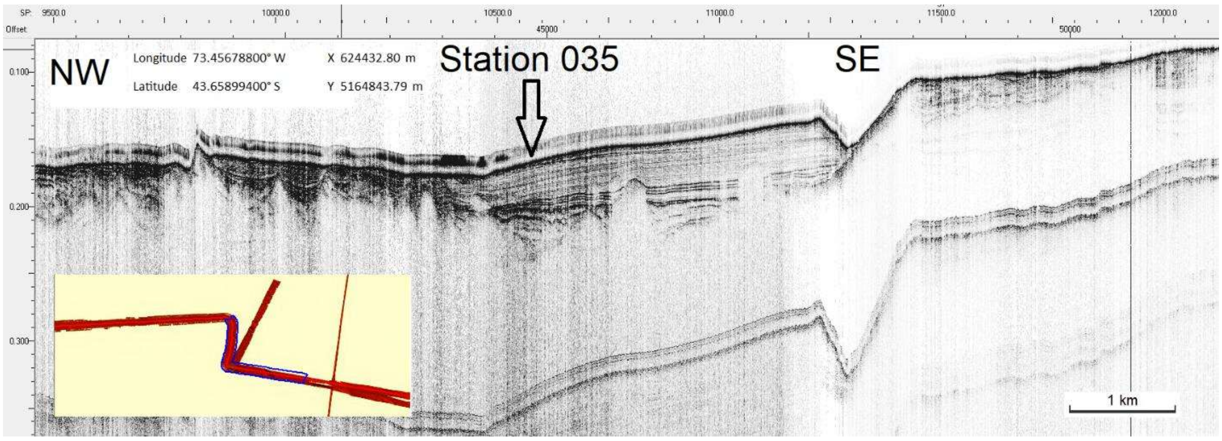


Figure 6.1.40 SBP section crossing the Station 017.