

REF.: APRUEBA TRATO DIRECTO

RESOLUCIÓN EXENTA N° 2086

SANTIAGO, 26 DE NOVIEMBRE DE 2024

VISTOS:

La Ley N° 21.045 que crea el Ministerio de las Culturas, las Artes y el Patrimonio; el D.F.L. N° 35 de 2017; el D.F.L. N° 5.200, ambos del Ministerio de Educación, el D. S. N° 2 de 2023, del Ministerio de las Culturas, las Artes y el Patrimonio, que designa Directora Nacional del Servicio Nacional del Patrimonio Cultural; Resolución N° 7, de 2019 de la Contraloría General de la República; el artículo 8° letra d), de la Ley N° 19.886 de Bases sobre Contratos Administrativos de Suministro y Prestación de Servicios; el artículo 10° N°4 del D.S. 250/ 2004, del Ministerio de Hacienda, Reglamento de la Ley N° 19.886; la Ley N°19.799 de 2002, del Ministerio de Economía, Fomento y Reconstrucción, sobre documentos electrónicos, firma electrónica y servicios de certificación de dicha firma, y

CONSIDERANDO:

1.- Que, el Museo Regional de Atacama, dependiente del Servicio Nacional del Patrimonio Cultural, reúne colecciones de ciencias naturales, arqueología, paleontología, de historia regional y una importante colección bibliográfica e iconográfica, entre otras. En la actualidad se encuentra en etapa de ejecución de la museografía para la nueva exhibición permanente, la que incorpora temas de interés regional, como son la historia, diversidad, medioambiente, comunidades locales, pueblos originarios, entre otros.

2.- Que, el Instituto Milenio de Oceanografía (IMO), RUT N° 65.090.637-3, el año 2018 llevó a cabo una exitosa expedición a la Fosa de Atacama alcanzando un importante hito científico: la inmersión del vehículo submarino Lander Audacia, realizando observaciones y toma de muestras a más de 8 mil metros en el océano profundo. En esta expedición, además, se identificó una nueva especie para la Región de Atacama, bautizada "*Eurythenes atacamensis*", la que estará representada en la nueva exhibición permanente. En el año 2022, el instituto IMO realizó la expedición llamada Atacama Hadal donde, a bordo del sumergible "Limiting Factor", se logró el primer viaje tripulado a la Fosa de Atacama.

3.- Que, conforme a lo señalado en el Informe Técnico de la Encargada del Área de Exhibiciones de la Subdirección Nacional de Museos y en el contexto de la investigación y elaboración del guion de la sala 5 dedicada a la Biodiversidad Marina, la Unidad Técnica se reunió con el instituto IMO, quien dio cuenta del taller "*Exploración del Océano profundo*" realizado el año 2016, en donde trabajaron distintas condiciones medioambientales del mar y del océano profundo, como la alta presión. Para enseñarlo de manera práctica, cada niño y niña pintó y personalizó su propio vaso de plumavit para que, durante la siguiente expedición, estos fueran sumergidos y expuestos al efecto de la presión hidrostática. De esta manera, los vasos se comprimieron, volviendo a la superficie de un tamaño considerablemente menor al que tenían de manera natural, manteniendo su forma y, por supuesto, los dibujos y diseños realizados por los niños y niñas previamente. Este es un claro y evidente ejemplo visual del impacto de la presión sobre los materiales y de las dificultades y desafíos tecnológicos que los científicos deben enfrentar para estudiar el océano profundo.

4.- Que, el IMO es actualmente la única institución con acceso a la fosa de Atacama y lidera un proyecto FONDEQUIP que permitió instalar en la Fosa de Atacama un Sistema Integrado de Observación del Océano Profundo para la Investigación en Geociencias (IDOOS), el que estará vigente hasta el año 2027. Este sistema implica la instalación de varios sensores en la Fosa de Atacama, ubicados a distintas profundidades, entre los 4000 y 8000 metros, abarcando el suelo oceánico, pero también la columna de agua. Asimismo, el IMO cuenta con la aprobación del convenio folio EQY200033 correspondiente al Concurso de Equipamiento Científico y Tecnológico Mayor de la Subdirección Centros e Investigación Asociativa, mediante la Resolución N° N°12278/2020, con fecha 30-11-2020, el que estará vigente hasta el año 2027, y que se adjunta a la documentación.

5.- Que, a requerimiento de la Subdirección Nacional de museos se solicitó un presupuesto al oferente Instituto Milenio de Oceanografía (IMO), RUT N° 65.090.637-3, por la realización del taller “*Exploración del Océano profundo*” en la localidad de Caleta de Chañaral y Huasco, que incluya la actividad de pintado de vasos para que estos sean sumergidos en la próxima expedición a la Fosa de Atacama, programada para enero del 2025, que permitan acercar los conocimientos asociado a la biodiversidad marina y que generen un producto que pueda ser parte de la exposición permanente, como son los vasos de plumavit expuestos a la presión hidrostática. La suma del presente servicio es por \$2.000.000.- (dos millones de pesos) IVA incluido.

6.- Que, en vista de lo anterior, del Informe Técnico de la Encargada del Área de Exhibiciones de la Subdirección Nacional de Museos, el que debidamente firmado se adjunta a la presente Resolución y de la cotización aprobada por la unidad técnica, se estima necesario, conveniente e indispensable para los intereses del SERPAT, contratar con el oferente Instituto Milenio de Oceanografía (IMO), RUT N° 65.090.637-3, por la realización del taller “*Exploración del Océano profundo*” en la localidad de Caleta de Chañaral y Huasco para el Museo Regional de Atacama, por la suma de \$2.000.000.- (dos millones de pesos) IVA incluido, ya que fortalece los objetivos de la nueva exhibición permanente del museo, promoviendo la integración experiencias, elementos, colecciones y relatos que incorporan la participación de niños y niñas en el guion y los distintos modos de aprender, y además por tratarse del único proveedor.

RESUELVO:

1°.- **APRUÉBASE** la contratación por Trato Directo con el oferente Instituto Milenio de Oceanografía (IMO), RUT N° 65.090.637-3, por la realización del taller “*Exploración del Océano profundo*” en la localidad de Caleta de Chañaral y Huasco para el Museo Regional de Atacama, por la suma de \$2.000.000.- (dos millones de pesos) IVA incluido.

2°.- **IMPÚTESE** el gasto que demanda la presente resolución, ascendente a la suma de \$2.000.000.- (dos millones de pesos) IVA incluido, con cargo al Proyecto de inversión “Construcción Museo Regional de Atacama, Copiapó”, Código BIP 30356572-0, al Subtítulo 31, Ítem 02, Asignación 002, del presupuesto del Servicio Nacional del Patrimonio Cultural, para el año 2024.



3°.- **PUBLÍQUESE** la presente resolución el Portal del Sistema de Información de Compras y Contratación Pública www.mercadopublico.cl, dentro del plazo de 24 horas desde su emisión.

ANÓTESE, REFRÉNDESE Y PUBLÍQUESE

Nélida Bernardita
Pozo Kudo
2024.11.26 15:32:13
-03'00'

NÉLIDA POZO KUDO
DIRECTORA NACIONAL
SERVICIO NACIONAL DEL PATRIMONIO CULTURAL

JCV/DMF/MRC/ATT/YDL/dts

DISTRIBUCIÓN:

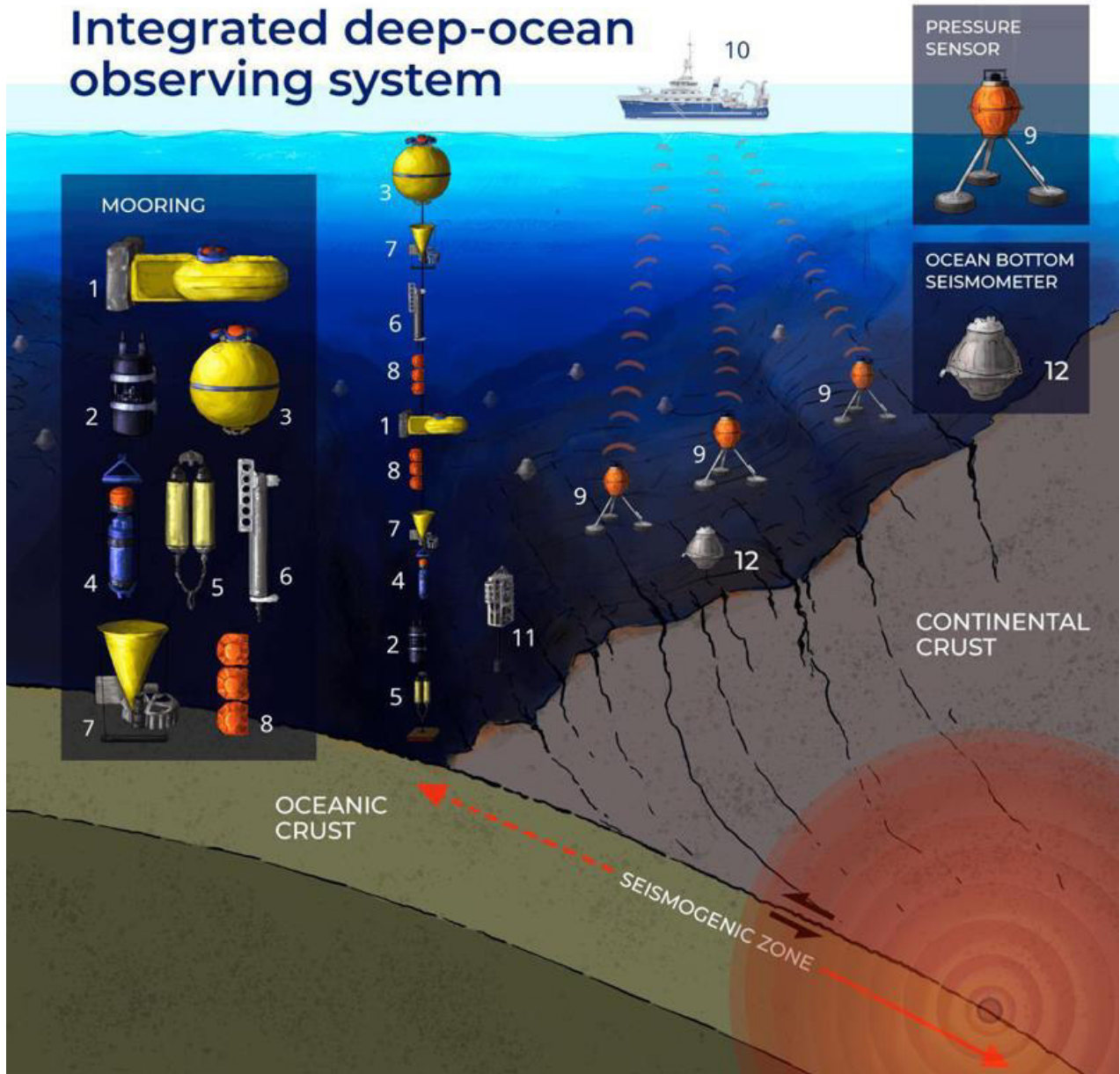
Subdirección Nacional de Museos, SERPAT.
Departamento de Administración y Finanzas, SERPAT.
Unidad de Abastecimiento y Logística, SERPAT.
Secretaría General y Oficina de Partes, SERPAT.



SERPAT
Ministerio de las
Culturas, las Artes
y el Patrimonio

Gobierno de Chile

Integrated deep-ocean observing system



CERTIFICADO DE DISPONIBILIDAD PRESUPUESTARIA N° 52

En Santiago, a 19 de noviembre de 2024, y de conformidad al presupuesto aprobado por el Servicio Nacional del Patrimonio Cultural, por la Ley N° 21.640, vigente del sector público para año el 2024, certifico que a la fecha del presente documento la Subdirección Nacional de Museos, cuenta con el presupuesto por **la realización del taller “Exploración del Océano profundo” en la localidad de Caleta de Chañaral y Huasco para el Museo Regional de Atacama**, mediante Trato Directo, con cargo:

Proyecto de inversión “Construcción Museo Regional de Atacama, Copiapó”, Código BIP 30356572-0, al Subtítulo 31, Ítem 02, Asignación 002.

El acta de autorización se informará en el Portal www.mercadopublico.cl



**ALAN TRAMPE TORREJÓN
SUBDIRECTOR NACIONAL DE MUSEOS
SERVICIO NACIONAL DEL PATRIMONIO CULTURAL**

dts





Servicio Nacional
del Patrimonio
Cultural

Ministerio de las
Culturas, las Artes
y el Patrimonio

DECLARACIÓN JURADA DE NO ENCONTRARSE AFECTO A ALGUNA PROHIBICIÓN PARA CONTRATAR CON EL ESTADO

NOMBRE TRATO DIRECTO: “Exploración del Océano profundo” para el Museo Regional de Atacama

SERVICIO: “Exploración del Océano profundo” para el Museo Regional de Atacama

NOMBRE COMPLETO PROPONENTE: Corporación Instituto Milenio de Oceanografía

FECHA: 13-11-2024

DECLARO LO SIGUIENTE:

- a) Que el oferente no tiene entre sus socios a una o más personas que sean funcionarios directivos del Servicio Nacional del Patrimonio Cultural, ni personas unidas a ellos por los vínculos de parentesco descritos en la letra b) del artículo 54 de la ley N°18.575, Orgánica Constitucional de Bases Generales de la Administración del Estado.
- b) Que el oferente no es una sociedad de personas de las que formen parte los funcionarios directivos y personas mencionadas en el punto anterior, ni es una sociedad comandita por acciones o anónima cerrada en que aquéllos o éstas sean accionistas, ni una sociedad abierta en que aquéllos o éstas sean dueños de acciones que representen el 10% o más del capital.
- c) Que el oferente no sea de aquellas personas naturales o jurídicas que, dentro de los dos años anteriores al momento de la presentación de la oferta, hayan sido condenados por prácticas antisindicales o infracción a los derechos fundamentales del trabajador, o por delitos concursales establecidos en el Código Penal.
- d) Que el oferente no se encuentra afecto a la prohibición del artículo 10 de la Ley N°20.393, esto es, no haber sido condenada, temporal o perpetuamente, a celebrar contratos con los organismos del Estado, en virtud de haberse establecido su responsabilidad penal en delitos de lavado de activos, financiamiento de terrorismo y delitos de cohecho.
- e) Oferentes que hayan sido condenados por el Tribunal de Defensa de la Libre Competencia en conformidad con lo dispuesto en el artículo 26, letra d), del decreto ley N°211, de 1973, esto es, por participar en hechos, cometer actos o concurrir a convenciones que impiden, restringen o entorpecen la libre competencia o que tienden a producir dichos efectos, conforme con lo previsto en el artículo 3, letra a), del mismo cuerpo normativo.



Servicio Nacional
del Patrimonio
Cultural

Ministerio de las
Culturas, las Artes
y el Patrimonio

Todo lo anterior, conforme al Título III de la Ley 18.575, Orgánica Constitucional de las Bases de la Administración del Estado.

Atilio Morgado Malebrán

Nombre representante legal

A. Morgado
Firma representante legal



Certificado de Habilidad Registro de Proveedores

Se certifica que el proveedor indicado a continuación posee el siguiente estado de habilidad para ser contratado por el Estado de Chile, de acuerdo a la fecha y hora de la consulta especificada.

Proveedor	RUT/ID	Estado
Instituto Milenio de Oceanografía	65.090.637-3	✓ HÁBIL

Observaciones:

- ✓ HÁBIL
Cumple con los requisitos para contratar con el Estado de acuerdo a las siete causales estipuladas en el Reglamento de la Ley 19.886.
- ✗ INHÁBIL
No cumple con uno o más de los requisitos para contratar con el Estado.
- ? EN REVISIÓN
Proveedor se encuentra en proceso de validación con fuentes oficiales para Ingreso al sistema. Su estado de habilidad aparecerá a contar del día hábil siguiente.
- SIN INFORMACIÓN
Proveedor no tiene contrato vigente con el Registro de Proveedores o es una persona jurídica constituida fuera de Chile. En consecuencia, en virtud de los principios de libre concurrencia y de igualdad ante las bases, debe considerarse que los proveedores extranjeros cumplen con la habilidad en el Registro de Proveedores, cuando aquélla haya sido exigida como requisito para contratar, a la luz del artículo 16 de la ley N° 19.886.

Se emite el presente certificado conforme a lo especificado en la Ley de Compras Públicas y su respectivo Reglamento en el Artículo 92 del Reglamento de la Ley de Compras Públicas N° 19.886 para uso exclusivo de los Organismos Compradores del Estado de Chile.

Fecha: 24 de octubre de 2024

Señorita

Andrea Müller

Encargada del área de exhibiciones
Subdirección Nacional de Museos

Coordinadora IMO: Bárbara Léniz

COTIZACIÓN IMO N° 24

Ítem N°	Descripción del Servicio	Cantidad	Valor Unitario	Valor Subtotal Exento
1	Taller y exposición Tema: Desafíos tecnológicos de la exploración submarina / Condiciones de la presión hidrostática	2	1.000.000	2.000.000
2	Lugar: Chañaral / Caldera, Región de Atacama			
3	Inmersión de vasos de plumavit para su exposición a la presión hidrostática			
4				
5				
6				
7				
<i>LA PRESENTE COTIZACIÓN TIENE UNA VALIDEZ DE 30 DÍAS</i>			TOTAL CON IVA	\$ 2.000.000

Gracias por solicitar nuestro servicio. Por favor sírvase devolver la presente Cotización firmada en señal de aceptación, completando los siguientes datos y enviando copia al E-mail: olga.perez@imo-chile.cl

Firma del Solicitante _____

Nombre del Solicitante	
Email del Solicitante	
Glosa a incluir en la Facturación	



Servicio Nacional
del Patrimonio
Cultural

Ministerio de las
Culturas, las Artes
y el Patrimonio

DECLARACION JURADA SIMPLE PACTO DE INTEGRIDAD

NOMBRE TRATO DIRECTO: “Exploración del Océano profundo” para el Museo Regional de Atacama

NOMBRE COMPLETO PROPONENTE: Corporación Instituto Milenio de Oceanografía

FECHA: 13-11-2024

DECLARO LO SIGUIENTE:

Declaro bajo juramento que la persona Jurídica o Natural que represento no ha sido condenada por responsabilidad penal, según lo dispuesto en el artículo 10° de la Ley N° 20.393 y que ni ésta ni quien suscribe se encuentran en la situación prevista en el artículo 26° letra d) del Decreto Ley N° 211, que fija normas para la defensa de la Libre Competencia. El inciso primero del artículo 4° de la ley N° 19.886 prescribe que podrán contratar con la Administración las personas naturales o jurídicas, chilenas o extranjeras, que acrediten su situación financiera e idoneidad técnica conforme lo disponga el reglamento, cumpliendo con los demás requisitos que este señale y con los que exige el derecho común. letra b) del artículo 54 de la ley N° 18.575, ley Orgánica Constitucional de Bases Generales de la Administración del Estado.

1.- Declaro bajo juramento que, por el sólo hecho de participar en esta licitación, acepto expresamente el siguiente “Pacto de Integridad”, sin perjuicio de las que se señalen en el resto de las Bases de Licitación o Trato Directo y demás documentos integrantes, obligándose a:

2.- Cumplo con la Normativa Vigente adhiero a los altos estándares éticos conozco mis derechos y obligaciones como proveedor del Estado y los respeto.

No Incurro en práctica corruptas o delictivas como el cohecho adulteración de documentos, infracción a la propiedad intelectual o industrial, violación a los derechos de los trabajadores y el cumplimiento del medio ambiente y sus normas

3.- Reconocer y declarar que la oferta presentada en este proceso licitatorio es una propuesta seria, con información fidedigna y en términos técnicos y económicos ajustados a la realidad, que aseguren la posibilidad de cumplir con la misma en las condiciones y oportunidad ofertadas.

Revisar y verificar toda la información y documentación, que deba presentar para efectos del presente proceso licitatorio o de compra, tomando todas las medidas que sean necesarias para asegurar la veracidad, integridad, legalidad, consistencia, precisión y vigencia de la misma.

4.- Suministrar toda la información y documentación que sea considerada necesaria y exigida de acuerdo con las presentes Bases de Licitación. No ofrecer, ni conceder, ni intentar ofrecer o conceder, sobornos, regalos, premios, dádivas o pagos, cualquiera fuese su tipo, naturaleza y/o monto, a ningún funcionario público en relación con su oferta, con el proceso de licitación pública, ni con la ejecución del contratos que eventualmente se derive de la misma, ni tampoco a ofrecerlas o concederlas a terceras personas que pudiesen influir directa o indirectamente en el



Servicio Nacional
del Patrimonio
Cultural

Ministerio de las
Culturas, las Artes
y el Patrimonio

proceso licitatorio, en su toma de decisiones o en la posterior adjudicación y ejecución del contrato que de ello se derive.

5.- No intentar, ni efectuar acuerdos o realizar negociaciones, actos o conductas que tengan por objeto influir o afectar de cualquier forma la libre competencia, cualquiera fuese la conducta o acto específico, y especialmente, aquellos acuerdos, negociaciones, actos o conductas de tipo o naturaleza colusiva, en cualquier de sus tipos o formas. Aceptar y asumir las consecuencias y sanciones previstas en estas Bases de Licitación, así como en la legislación y normativa que sean aplicables a la misma.

6.- Ajustar su actuar y cumplir con los principios de legalidad, ética, moral, buenas costumbres y transparencia en el presente proceso licitatorio y durante la relación contractual, y cumplir con las leyes generales o especiales, y con las normas generales o particulares que rigen su actuar, incluyéndose las relativas al respeto de los derechos fundamentales de los trabajadores.

Evitar dar lugar o contribuir a efectos adversos en los derechos humanos mediante sus actividades, productos o servicios, y subsanar esos efectos cuando se produzcan, adopto las medidas necesarias para evitar conductas discriminatorias en toda mi cadena de servicio, de acuerdo a los Principios Rectores de Derechos Humanos.

7.- Tomar todas las medidas que fuesen necesarias para que las obligaciones anteriormente señaladas sean asumidas y cabalmente cumplidas por sus empleados, dependientes, asesores o agentes, y, en general, todas las personas con que éste o éstos se relacionen, directa o indirectamente, en virtud o como efecto de la presente licitación, incluidos sus subcontratistas, haciéndose plenamente responsable de las consecuencias de su infracción, sin perjuicio de las responsabilidades individuales que también procediesen y/o fuesen determinadas por los organismos correspondientes. Aceptar la inclusión de este Pacto de Integridad en el contrato que se suscriba en caso de adjudicarse la licitación.

Si NO

Declaro que los Empleados y Directivos de la empresa conocen íntegramente nuestro el Pacto de Integridad

Si NO

Declaro que la empresa cuenta con mecanismos para Controlar el cumplimiento del Pacto de Integridad Interno.

Si NO



Atilio Morgado Malebrán- Representante legal

FIRMA



Servicio Nacional
del Patrimonio
Cultural

Ministerio de las
Culturas, las Artes
y el Patrimonio

INFORME TÉCNICO POR LA ADQUISICIÓN DE TALLER “EXPLORACIÓN DEL OCEANO PROFUNDO” PARA EL MUSEO REGIONAL DE ATACAMA

1.- El Museo Regional de Atacama, dependiente del Servicio Nacional del Patrimonio Cultural, reúne colecciones de ciencias naturales, arqueología, paleontología, de historia regional y una importante colección bibliográfica e iconográfica, entre otras. En la actualidad se encuentra en etapa de ejecución de la museografía para la nueva exhibición permanente, la que incorpora temas de interés regional, como son la historia, diversidad, medioambiente, comunidades locales, pueblos originarios, entre otros.

2.- El Instituto Milenio de Oceanografía (IMO), RUT N° 65.090.637-3, el año 2018 llevó a cabo una exitosa expedición a la Fosa de Atacama alcanzando un importante hito científico: la inmersión del vehículo submarino Lander Audacia, realizando observaciones y toma de muestras a más de 8 mil metros en el océano profundo. En esta expedición, además, se identificó una nueva especie para la Región de Atacama, bautizada “*Eurythenes atacamensis*”, la que estará representada en la nueva exhibición permanente. En el año 2022, el instituto IMO realizó la expedición llamada Atacama Hadal donde, a bordo del sumergible “Limiting Factor”, se logró el primer viaje tripulado a la Fosa de Atacama.

3.- En el contexto de la investigación y elaboración del guion de la sala 5 dedicada a la Biodiversidad Marina, la Unidad Técnica se reunió con el instituto IMO, quien dio cuenta del taller “*Exploración del Océano profundo*” realizado el año 2016, en donde trabajaron distintas condiciones medioambientales del mar y del océano profundo, como la alta presión. Para enseñarlo de manera práctica, cada niño y niña pintó y personalizó su propio vaso de plumavit para que, durante la siguiente expedición, estos fueran sumergidos y expuestos al efecto de la presión hidrostática. De esta manera, los vasos se comprimieron, volviendo a la superficie de un tamaño considerablemente menor al que tenían de manera natural, manteniendo su forma y, por supuesto, los dibujos y diseños realizados por los niños y niñas previamente. Este es un claro y evidente ejemplo visual del impacto de la presión sobre los materiales y de las dificultades y desafíos tecnológicos que los científicos deben enfrentar para estudiar el océano profundo.

4.- El IMO es actualmente la única institución con acceso a la fosa de Atacama y lidera un proyecto FONDEQUIP que permitió instalar en la Fosa de Atacama un Sistema Integrado de Observación del Océano Profundo para la Investigación en Geociencias (IDOOS), el que estará vigente hasta el año 2027. Este sistema implica la instalación de varios sensores en la Fosa de Atacama, ubicados a distintas profundidades, entre los 4000 y 8000 metros, abarcando el suelo oceánico, pero también la columna de agua. Asimismo, el IMO cuenta con la aprobación del convenio folio EQY200033 correspondiente al Concurso de Equipamiento Científico y Tecnológico Mayor de la Subdirección Centros e Investigación Asociativa, mediante la Resolución N° N°12278/2020, con fecha 30-11-2020, el que estará vigente hasta el año 2027, y que se adjunta a la documentación.

5.- A requerimiento de la Subdirección Nacional de museos se solicitó un presupuesto al oferente Instituto Milenio de Oceanografía (IMO), RUT N° 65.090.637-3, por la realización del taller “*Exploración del Océano profundo*” en la localidad de Caleta de Chañaral y Huasco, que incluya la actividad de pintado de vasos para que estos sean sumergidos en la próxima expedición a la Fosa de Atacama, programada para enero del 2025, que permitan acercar los conocimientos asociado a la biodiversidad marina y que generen un producto que pueda ser parte de la exposición permanente, como son los vasos de plumavit expuestos a la presión hidrostática. La suma del presente servicio es por \$2.000.000.- (dos millones de pesos) IVA incluido.



**Servicio Nacional
del Patrimonio
Cultural**

Ministerio de las
Culturas, las Artes
y el Patrimonio

6.- Se estima necesario, conveniente e indispensable para los intereses del SERPAT, contratar con el oferente Instituto Milenio de Oceanografía (IMO), RUT N° 65.090.637-3, por la realización del taller “*Exploración del Océano profundo*” en la localidad de Caleta de Chañaral y Huasco para el Museo Regional de Atacama, por la suma de \$2.000.000.- (dos millones de pesos) IVA incluido, ya que fortalece los objetivos de la nueva exhibición permanente del museo, promoviendo la integración experiencias, elementos, colecciones y relatos que incorporan la participación de niños y niñas en el guion y los distintos modos de aprender, y además por tratarse del único proveedor.

7. El SERPAT procederá a efectuar el pago en dos (2) estados de pagos, que se realizará de la siguiente manera:

Estado de Pago	Porcentaje	Avance
1er Estado de Pago	50% del monto total	Entrega plan de trabajo y detalles de talleres a realizar
2do Estado de Pago	50% del monto total	Realización de talleres.

Andrea Muller Benoit
Encargada Área de Exhibición
Subdirección Nacional de Museos



**Servicio Nacional
del Patrimonio
Cultural**

Ministerio de las
Culturas, las Artes
y el Patrimonio

MEMORANDUM N° 239

DE: SUBDIRECTOR NACIONAL DE MUSEOS

A : SR. JEFE ABASTECIMIENTO SERPAT

SANTIAGO/ 19 de noviembre de 2024

1.- Adjunto envío a Ud., para los fines pertinentes, propuesta de resolución exenta que aprueba la contratación por Trato Directo con el oferente Instituto Milenio de Oceanografía (IMO), RUT N° 65.090.637-3, por la realización del taller “*Exploración del Océano profundo*” en la localidad de Caleta de Chañaral y Huasco para el Museo Regional de Atacama, por la suma de \$2.000.000.- (dos millones) Exentos de IVA.

2.- Se anexa documentación de respaldo.

Junto con agradecer a Ud. la pronta tramitación, lo saluda atentamente,

ALAN TRAMPE TORREJÓN
SUBDIRECTOR NACIONAL DE MUSEOS
SERVICIO NACIONAL DEL PATRIMONIO CULTURAL

Dts

PROPOSAL - FIRST CALL Scientific and Technological Major Equipment FONDEQUIP – 2020

PROPOSAL TITLE	Integrated Deep-Ocean Observing System for geoscience research (IDOOS)
---------------------------	--

Instructions:

1. Describe each of the requested items in this formulary considering the **evaluation criteria** of the Contest Guidelines.
2. Respect the format and maximum length of each section.
3. It is not allowed to alter the established format regarding sentences, margins, spacing and font size.
4. According to the Contest Guidelines, in this call a bonus of 0,2 points will be granted to the equipment proposals related with the following areas:
 - a. Study of the Climate change in oceans, coasts and high latitudes (including Antarctica)
 - b. Outer space science.
 - c. COVID-19.

Therefore, you must answer the following question before starting:

Does your equipment proposal relates to climate change, outer space science, high latitude science (including Antarctica) or CODIV-19?	YES
---	------------

5. If your answer is positive, you must develop the idea in the question 1.1 of the proposal.

1. Scientific and technical justification of the proposal.

1.1 Clarity, coherence and pertinence of the requested equipment with the research activities and/or experimental development of the research area(s) that the institutions wish to support.

Justify the participation of the institutions conforming this application, both Principal and Associates, and including the detail of tasks distribution and the synergies that could be achieved. Explain the link between the requested equipment and the research and / or experimental development activities that are developed in these institutions. Justify the reasons for choosing the requested equipment, clearly explaining your preference compared to other similar equipment, according to its characteristics, in relation to the proposed research (s).

(Maximum length 3 pages, including this one. You must use Verdana letter 09 and line spacing 1.0).

Understanding the role of the deep ocean in the Earth system is imperative for our society. The deep-sea is a highly connected environment, where the Earth's geo-, bio- and hydrosphere interact. The deepest parts of oceans are located in tectonic trenches, which are formed by plate subduction along convergent margins. This process bends the seafloor and the outermost crust forming a steep depression that is occupied by the deepest layer of the ocean – known as the hadal zone. Trenches are one of the most dynamic environments, where unstable and complex interactions between geological and marine processes constantly affect the seafloor stability and habitat of ecosystems. Despite their importance, ocean trenches remain one of the most elusive and least explored habitats on Earth due to their remoteness and the costly technological challenges required to explore them. Therefore, we currently lack the data necessary to study the marine and geological processes at trenches, in particular those related to great earthquakes and ecology of ecosystems.

The deepest part of the ocean is characterized by extremely high pressures and low temperatures although some marine organisms have been able to adapt to these environmental conditions. Deep trenches support one of the largest ecosystem reservoirs of biodiversity on the planet. Vertical export of organic matter, dead bodies of animals, the inputs of terrestrial organic matter from the adjacent continent, in situ chemosynthetic production, and the lateral transport of organic material from continental slopes seem to provide potential sources of organic matter supporting life in this hadal environment. Today, however, oceans are under attack by climate change and overfishing, causing alterations in ocean chemistry and ecosystems. Atmospheric release of anthropogenic carbon dioxide (CO₂) has given rise to a marked increase in ocean acidity which apparently may impact water as deep as 4.000 m depth. Recent studies have demonstrated that the slowing down of the thermohaline circulation due to ocean warming could reduce the pH in the deep oceans (Chen-Tung et al. 2017). The deep ocean absorbs large amounts of heat and carbon dioxide and is therefore a critical buffer for climate change. This exposes the vulnerable marine ecosystems to the combined effects of warming, acidification, deoxygenation, and alteration of nutrients and food flows from different depths.

Subduction zone earthquakes are fundamentally controlled by the mechanical coupling between the down-going subducting plate and the overriding plate (Moreno et al., 2010), a process that occurs predominantly beneath the seafloor between the trench and the coastline. Hence, most of the accumulated strain between earthquakes and the majority of fault slip during earthquakes occur underwater, meaning that measuring seafloor deformation is key to characterize seismogenic processes. Knowledge of the downdip depth limit of unstable (i.e., seismic) slip is very important because this transition controls the landward extent of destructive ground shaking; in turn, knowledge of the updip limit is important for tsunami generation as shallow slip commonly results in larger seafloor deformation. In recent years, geodetic ocean bottom techniques have been developed and optimized to achieve measurement accuracy comparable to that obtained on land (Yokota et al., 2016). However, technical challenges and the associated high costs have greatly limited the application of geodesy to proof-of-concept studies along most subduction zones. Society now depends on timely information on climate, seismogenesis, ecosystems, biodiversity, and natural disasters. Deep-ocean data across a range of disciplines can bridge the gaps in understanding the impacts of climate change, safeguard integrity and resilience of deep-sea ecosystems, and improve earthquake and tsunami hazards. Observing the deep ocean can benefit from integrating (or co-measuring) variables that are rarely measured together, but whose joint observations can help achieve an effective understanding of complex earth and ocean processes and their inter-linkages. Recent achievements in deep ocean oceanography and geodesy suggest

that this field will advance rapidly over the next decade, allowing for further discoveries. As part of these advancements, we wish to deploy the first **Integrated Deep-Ocean Observing System (IDOOS)** at the Atacama Trench and continental slope by linking cutting-edge monitoring technology for data acquisition within a novel transdisciplinary framework. The overarching goal of **IDOOS** is to detect and quantify a wide range of poorly understood deep-ocean processes ranging from the characterization of the structure and temporal variability of physical, geochemical, and biological conditions, up to detecting seafloor deformation associated with the build-up of strain leading to a great earthquake, over several years. Moreover, the implementation of biogeochemical sensors (O_2 , pH/p CO_2) will improve our understanding about how climate change, and specifically global warming and ocean acidification, can impact the hadal habitat of this unique reservoir of biodiversity for the Earth. Our observing system will have two principal elements (Fig. 1a) which will be integrated in three research lines (described in section 1.2):

- A deep ocean moored system composed of a line anchored to the bottom of the sea with a set of oceanographic sensors located at different depths that allow the recording of different physical and biogeochemical parameters, such as water movement, temperature, salinity, pressure, dissolved oxygen, and CO_2 , as well as different substances that sediment through the water column. This moored system will be implemented in collaboration with the new Danish Center for Hadal Research based at the University of Southern Denmark, who will install extra components at the platform (see letter of support in the Annexes).
- A set of three sea-floor pressure and tilting sensors with the new capacity of removing instrumental drift and measuring vertical displacements related to interseismic locking, seismic deformation and slow slip or transient events. These sensors will be integrated with a dense network of ocean bottom seismometers, which will be installed by GEOMAR, and a dense network of onshore instruments installed by the ANILLO PRECURSOR project (Fig. 1).

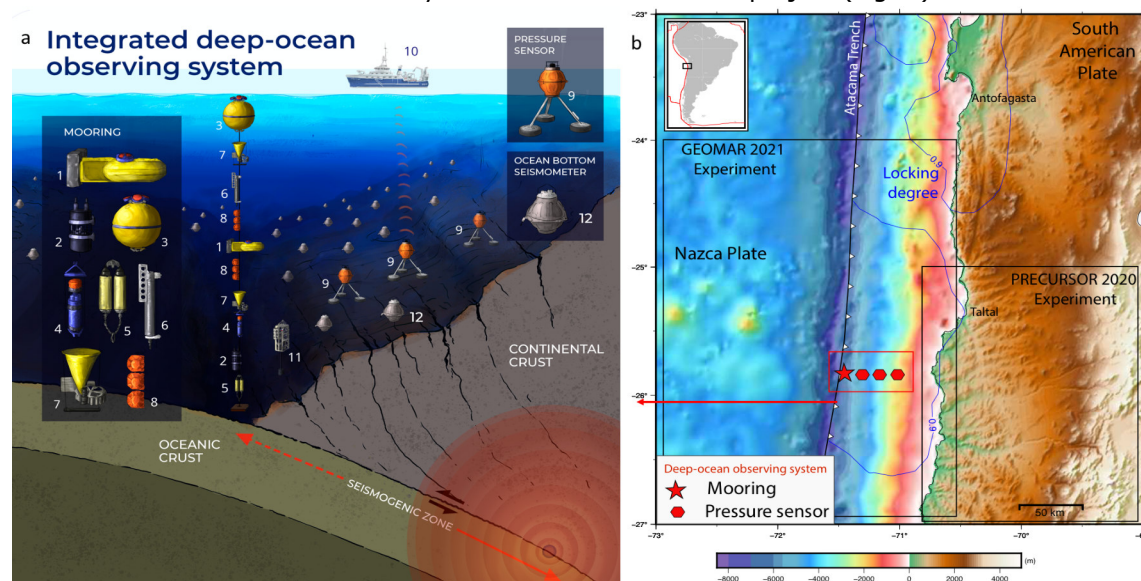


Figure 1. Schematic representation of the deep-ocean observing platform (IDOOS) and its tectonic context. a) Layout of our platform, which consists of a mooring and a set of pressure sensors. Details of each instrument are given in section 1.3. b) Rectangle and red symbols show the location of our platform. Locations of GEOMAR and Anillo Precursor project experiments are shown.

Hadal habitats are directly influenced by tectonic and sedimentary mass-flux processes. The relationships between mass flux (fluids and sediments from earthquake processes) and the evolution of deep ecosystems is an emerging field in which our proposal is framed. The integration of oceanographic sensors will provide in-situ data on the water column, salinity, and currents, which are needed to eliminate oceanographic signals from pressure sensors and consequently achieve greater accuracy in detecting vertical movement of the seafloor. Moreover, the concurrent tectonic/seismic and oceanographic data will allow the testing of alternative hypotheses for the origin of the material and energy flux sustaining hadal ecosystems. This observing system will be the first in Chile and the South Pacific region, and -unlike other anchored systems- it is designed to integrate multiparametric observations at hadal depths (below 6.000 m).

The observation platform will be installed across a deep section of the Atacama Trench (Fig 1b). Great earthquakes in this area last occurred in 1819 (Mw~8.0) and 1922 (Mw~8.4); therefore this zone is considered to be a mature seismic gap, at risk of breaking in a great earthquake in the near future. Analyses of GPS data indicate that this area is highly locked, and periodically affected by slow earthquakes. However, the resolution of land-based GPS does not allow for determining the updip limit of the locked zone that is fundamental for estimating slip deficit and the magnitude of an imminent forthcoming earthquake. New methods to remove instrumental drift from seafloor pressure sensors and oceanographic in-situ data enable the detection of seafloor land-level changes with amplitudes less than 1 cm/yr at 7000 m depth (Wilcock et al., 2018). Current plate locking models predict ~2 cm/yr of seafloor subsidence at the deployment locations, rates of deformation that are fast enough to ensure high signal-to-noise ratios within the project's timeframe. Hence, **IDOOS** pressure data will provide robust estimates of seafloor subsidence or uplift and valuable insight into the up-dip extent of plate locking and slow earthquake deformation.

This technological challenge can only be carried out by an interdisciplinary group of experts and institutions (Chilean and international) with scientific and technical experience. The Instituto Milenio de Oceanografía (IMO) conducts pioneering research in oceanography by applying new technologies and platforms for observational work in the deep ocean. In the past, researchers now at IMO have deployed and maintained deep moorings for current observations (Shaffer et al. 1995). During the Atacamex 2018 expedition, IMO made the first observations from the absolute deepest depths, 8.081 m in the Atacama Trench, a milestone for marine science in Chile. This demonstrates that IMO has the technological expertise required to achieve this new challenge. Marine Sciences are one of the most developed areas of research and education at the University of Concepción, hosting three centers of excellence in areas related to Oceanography. Geophysics is an emerging field at the University of Concepción (UDEC). This year has seen the beginning of the ANID-ANILLO PRECURSOR project, which aims to study precursory earthquake deformation by installing a dense network of 20 continuous GPS stations and a temporary network of 60 seismometers (Fig. 1). This provides a unique opportunity to integrate ocean-floor observations from our platform with a dense land-based geodetic-seismological network. The Millennium Nucleus CYCLO, led by the Austral University (UACH), studies the deformation processes associated with the seismic cycle along subduction zone and is therefore also highly relevant to this project. The University of Antofagasta (UA) is a partner institution of IMO, carrying out research in different disciplines of marine sciences, and particularly in the biology of the deep ocean. It will also provide the logistic base for the project. The Pontifical Catholic University of Valparaiso (PUCV) is a regional centre for marine geophysics and oceanography in Chile. All universities associated with this project have under- and postgraduate programs in earth sciences that will benefit from the data and synergy of the **IDOOS** project.

IDOOS will have the support of two international research centers: GEOMAR Helmholtz Centre for Ocean Research in Kiel, Germany; and the Centre for Hadal Research of the University of Southern Denmark. GEOMAR will deploy a dense network of 50 ocean bottom seismometers in October 2021 for a refraction seismic study, which will allow us to have a detailed record of the offshore seismicity with which to compare our sea-floor deformation measurements (Fig. 1). Our platform will be installed during the same cruise as the deployment of GEOMAR instruments. Investigators from the new Centre for Hadal Research of the University of Southern Denmark have a vast experience in deep-ocean in-situ observations. Their support will be essential for the implementation of the oceanographic mooring and joint research cruises to the Atacama Trench. Finally, our project is High-Risk, High-Reward Research pursuing highly innovative and technological research with the potential for broad impact, and therefore is expected to have a high societal impact, especially for countries such as Chile.

References:

- Chen-Tung et al. (2017). *Deep oceans may acidify faster than anticipated due to global warming*. *Nature Climate Change* 7: 890-895.
- Moreno, M et al. (2010). *2010 Maule earthquake slip correlates with pre-seismic locking of Andean subduction zone*. *Nature*, 467(7312), pp.198-202.
- Shaffer et al. (1995). *Currents in the deep ocean off Chile (30°S)*. *Deep-Sea Research I* 42: 425-436.
- Yokota et al. (2016). *Seafloor geodetic constraints on interplate coupling of the Nankai Trough megathrust zone*. *Nature* 534: 374-377.
- Wilcock, W.S. et al (2018). *New Approaches to In Situ Calibration for Seafloor Geodetic Measurements*. In 2018 OCEANS-MTS/IEEE Kobe Techno-Oceans (OTO) (pp. 1-8). IEEE.

1.2 Viability and sustainability of the equipment over time.

Explicitly indicate current projects or research, valid at least until the end of 2022, that will be linked to, or benefit from, the requested equipment and that can assume the costs associated with its operation. You must present an economic plan that makes the operation viable in the medium term. **(Maximum length 3 pages, including this one. You must use Verdana letter 09 and line spacing 1.0). If necessary, insert rows in the chart.**

Valid Project code	Financing source	Project ending date	Principal investigatgor and University (to which he/she belongs)	Use that will be given to the equipment (simple description)
IC 120019	Instituto Milenio de Oceanografía	December 2023	Osvaldo Ulloa, IMO, Universidad de Concepción	To study circulation, biogeochemistry, and ecology at hadal depths
ACT192169	PIA-ANID (ANILLO)	December 2022	Marcos Moreno, Universidad de Concepción, IMO	Linking land-based and sea-floor geodetic and seismological data
1191360	Fondecyt Regular, ANID	March 2022	Osvaldo Ulloa, IMO, Universidad de Concepción	Assess the origin and magnitude of the particulate matter flux sustaining hadal microbial communities
1181479	Fondecyt Regular, ANID	March 2022	Marcos Moreno, Universidad de Concepción, IMO.	Upper plate deformation and seismic hazard
1190276	Fondecyt Regular, ANID	March 2022	Oscar Pizarro, (Co-Investigador) Universidad de Concepción, IMO	Use of observations for ocean models
1191343	Fondecyt Regular, ANID	March 2022	Pamela Hidalgo, Universidad de Concepción, IMO	Use of physical data and biogeochemicals for marine environment
SO285 PISAGUA	German Federal Ministry for Science and Technology / BMBF	2023	Dietrich Lange, GEOMAR	Pre-site survey
SO286 COMBO	German Federal Ministry for Science and Technology / BMBF	2023	Heidrun Kopp, GEOMAR & University of Kiel, Germany	Equipment installation and recovery
HADAL	The Danish National Research Foundation	2029	Ronnie N Glud, University of Southern Denmark	Biogeochemistry and microbial ecology of the hadal ecosystem

Briefly explain how the use and access to individualized Projects will be implemented and indicate, specifically, the importance of the equipment for each of them:

Projects that are linked and will benefit from our multi-parametric platform's observations include the main scientific initiatives funded by ANID, such as a Millennium Institute and a PIA project, and Regular FONDECYT projects. In addition, three major international projects led by experts in deep ocean instrumentation (two Germans, one Danish) will collaborate directly with **IDOOS**. All these projects, Chilean and international, promote science and technology-based research in oceanography, marine environment, geodesy, and geophysics, fostering interdisciplinary research and offering viability and many opportunities for the scientific use of the data. Hence, **we expect IDOOS project to result in an international academic environment to train young scientists (under- and postgraduate students) at the highest level, exposing them to different backgrounds, technical approaches, and collaborative research.**

The economic plan showing the viability of the proposal and the contributions of each institute are described in Section 2.2. Below we describe the interconnection of each project with **IDOSS** and the main lines of research.

Instituto Milenio de Oceanografía IC 120019 (IMO) is a centre of excellence that was born in 2013 with the aim of studying oceanographic processes of the open sea, as well as the exploration of the deep and ultra-deep ocean, which includes pelagic ecosystems associated with seamounts, oceanic islands and the Atacama trench. Since 2016, IMO has been a legal private non-for-profit corporation for research and education, hosted by the Universidad de Concepción and Pontificia Universidad Católica de Chile (<https://en.imo-chile.cl/>). The IMO has vast experience operating equipment to the depths required in this new experiment. IMO has an annual operational budget of ~1.3 M\$, which provides the basis for supporting the maintenance and sustainability of **IDOSS**.

PIA-ANID ACT192169 assembles a multidisciplinary group of researchers, integrating geodesy, seismology, and numerical modeling, to advance our knowledge of the physical causes of transient and precursory earthquake processes (www.precursor.cl). This year a dense geodetic and seismological network will be installed in the continental zone near our platform (Fig. 1) as part of a joint experiment with the GFZ Potsdam, Germany, and the University of Grenoble, France. The combined analysis of seafloor and land deformations with seismicity will allow an unprecedented resolution to capture transient motions and evaluate their potential role as a precursory activity.

FONDECYT 1191360 is providing the first phylogenetic and metabolic characterization of the suspended hadal pelagic microbial community. The proposed observing system will allow -for the first time- to assess the magnitude, time variability, and source of the organic matter flux into the ultra-deep ocean evaluate alternative hypotheses for the mechanisms providing the energy and material flows sustaining the rich hadal microbial communities.

FONDECYT 1181479 aims to study the relationship between subduction earthquakes and upper plate faults. The information, unknown up to now, of seafloor motions near the trench, will allow the investigation of the influence of crustal faults and their relation to deep seismicity.

FONDECYT 1190276 aims to investigate the Oxygen Minimum Zone (OMZ) dynamics of the South Eastern Pacific (SEP) focusing on El Niño Southern Oscillation forcing, an external forcing to the SEP OMZ so far disregarded in the interpretation of global model projections. Time series from **IDOSS** will allow us to collect data to identify and analyze dominant scales of variability and model validation.

FONDECYT 1191343 aims to identify and characterize the physical and chemical conditions controlling the habitat of pelagic organisms associated with sub-surface and deep waters. New data from **IDOSS** off northern Chile will be a unique opportunity to investigate where hypoxic conditions prevail and how such conditions can affect organisms' dynamics and ecology.

SO285 PISAGUA RV SONNE cruise SO285 is scheduled from Aug. 30 to Oct. 10, 2021 and will study the TalTal offshore domain. The position of the mega thrust in this region is not well constrained due to the sparse data coverage. During the cruise, seismic refraction data will be acquired to map the depth location of the plate interface. In order to detect secondary structural features (e.g. splay faults, fracture zones), an extensive high-resolution mapping program will be conducted. This data set will serve to identify suitable deployment sites for the seafloor pressure stations. Neotectonic information from the seafloor bathymetry data will yield important constraints on surface processes which may be correlated with the deformation rates detected by the pressure sensors to separate signals resulting from local tectonic processes from signals due to seismic loading.

SO286 COMBO RV SONNE cruise SO286 will sail from Antofagasta to Valparaíso between Oct. 14-Nov. 10, 2021. Ship time will be used to install the new infrastructure of **IDOSS** on the previously mapped seafloor locations. These maps will be instrumental in characterizing tectonically active fault scarps at the seafloor and will help to interpret the results of the seafloor pressure survey and allow inferences regarding the active tectonics of a much larger area.

Danish Center for Hadal Research (HADAL) It is a new Center of Excellence -based at the University of Southern Denmark- with the aim of exploring the deepest part of the ocean in the next 10 years. HADAL's objectives are: 1) Investigate how material is transported to and deposited at the greatest depths of the global ocean. 2) Explain how organic matter and nutrients are

processed in the hadal zone. 3) Explore the composition and function of the microbial life in the hadal zone. Thus, **IDOSS** is essential for a joint work in the Atacama Trench, particularly in relation with the biogeochemistry and microbial ecology of the hadal ecosystem.

Additionally, the **Millennium CYCLO Project** (www.cyclosismico.cl) is currently under evaluation for an extension until 2024. CYCLO studies the physical processes that control earthquake magnitude using geophysical imaging, paleoseismology, and numerical modeling, and integrates observables into earthquake hazard models. It bridges across spatiotemporal scales and integrates physics- and hazard-oriented modeling. The knowledge acquired by CYCLO is fundamental in defining the location of our platform and developing interdisciplinary operational seismic hazards by integrating the new observables into a suit of probabilistic models.

We expect **IDOSS** project to act as a catalyst for collaboration initiatives with government institutions, and national and international research centers, connecting scientific outcomes to stakeholders and policymakers. Our platform will serve to connect the main institutions related to study, receive information, and make decisions of the processes related to earthquakes (e.g., Ministry of Science, Servicio Hidrográfico y Oceanográfico de la Armada de Chile: SHOA, Oficina Nacional de Emergencia del Ministerio del Interior y Seguridad Pública: ONEMI, Centro Sismológico Nacional: CSN). SHOA and CSN both confirmed their interest in using our platform's data and are willing to discuss future collaborations. The main lines of research that will benefit through a multi and interdisciplinary use of the platform data are:

Line 1: Oceanography (Osvaldo Ulloa, Rubén Escribano, Oscar Pizarro, Pamela Hidalgo, Marcelo Oliva, Montserrat Aldunate, Carolina González, Nadin Ramirez, and Ronnie Glud)

- Physical oceanography (recording temperature, conductivity/salinity, pressure/depth, dissolved oxygen and currents).
- Chemical/Geochemical Oceanography (collection of discrete samples in sediment traps and measurements of physical and biogeochemical parameters).
- Biological Oceanography (microorganisms and other life in extreme deep environments).
- Biodiversity, functioning and conservation of deep-sea ecosystems.
-

Line 2: Climate and Global Change research (Cristian Vargas, Rubén Escribano, and Mauricio Urbina)

- Climatic control and feed-backs in the deep-sea environment.
- Links between the changing conditions at the atmosphere-ocean surface interface and the deep-sea environment (record and analysis on the penetration depth of anthropogenic CO₂).

Line 3: Geophysics and geohazards (Marcos Moreno, Daniel Melnick, Juan Díaz, Ignacia Calisto, Heidrun Koop, and Dietrich Lange)

- Measuring and monitoring deformation from the trench to the coastline.
- Modeling geohazards and their consequences (earthquakes, tsunamis).
- Linking sources and sinks in deep-sea landscapes: sediment stability, transport and fluxes.

Researchers of different disciplines and non-members of the proposal's institutions have confirmed their keen interest in using the platform's data in their research and providing their scientific support. This includes:

Seismology: Sergio Barrientos (Director of CSN), Sergio Ruiz and Jaime Campos (University of Chile, and director of Programa Riesgo Sísmico:PRS);

Tsunami modeling: Sebastian Riquelme (CSN), Patricio Catalán (Universidad Técnica Federico Santa María), Juan Gonzalez (Universidad Católica de la Santísima Concepción), and SHOA;

Technology development: Giancarlo Troni (Pontificia Universidad Católica de Chile);

Marine natural resources: Lucia Villar (Centro de Investigación y Formación San Ignacio de Huinay);

Marine geophysics: Eduardo Contreras-Reyes (University of Chile).

As such, **IDOSS** will not only directly support research of our core group of accomplished Associate Researchers and collaborators, but we expect more scientists and institutions will become part of this effort, consolidating Chile as a world leader in oceanographic and seismological studies.

1.3 Justification of the need for the requested equipment in relation to the already existing equipment in the applicant and associated institutions and / or in other entities, at a national or international level.

Justify why it is essential to purchase the new equipment. Refer to the existence of similar equipment in the Institutions or other entities (at a national or international level). Explain why the Institutions consider that they require this equipment, also what standards, requirements and / or capacities limit them today and what is the evolution, progress and / or improvement that this equipment would represent. **(Maximum length 2 pages, including this one. You must use Verdana letter 09 and line spacing 1.0). If necessary, insert rows in the chart.**

Similar equipment name	Equipment location	OECD ¹ discipline
GeoSEA (Geodetic Earthquake Observatory on the SEAFloor), GEOMAR	Seafloor at 21°S, off Iquique, Chile	Earth and related Environmental sciences, geophysics
Autonomous Ocean Lander "Audacia"	Instituto Milenio de Oceanografía	Earth and related Environmental sciences, oceanography

In recent years, the need for multi-parametric observatories to address a wide range of topics, including from physics, biology, and ecology of the deep ocean to seismology, disasters, and natural resources, has been recognized worldwide. These initiatives are being implemented with great success in Europe, Japan, Canada, and the United States. In Chile, this development is not yet implemented, *so we wish* to take up this challenge and make Chile a leader in this field. **IDOOS** is specially designed to operate in the deep and ultra-deep sea, i.e., at a depth of more than 6.000 m, continuously for relatively long periods of time. **IDOOS** will observe a wide range of poorly understood deep-oceans processes by integrating as seamlessly as possible different sensors to collect deep-ocean data. As a whole, **IDOOS** will establish the foundation for discoveries and major advances in geoscience science in Chile. With **IDOSS**, we will have the opportunity to look at the seismogenic zone at its entire depth, by combining seafloor deformation monitoring, ocean bottom seismicity, and a dense geodetic and seismological network inland. This has the potential to lead to transformative discoveries of plate boundary tectonic processes and addresses a novel element of marine geophysical research. Modern seafloor deformation monitoring is likely to reveal a range of dynamic deformation processes in tectonic, and non-tectonic, systems that are as yet unknown. As is the case for precursor signals that precede large earthquakes, the effect of ocean floor deformation on the generation of tsunamis both tectonically and from underwater landslides. Our platform's success can be used as a proof of concept for the future development of an early warning system, either by extending the capabilities of this system or implementing submarine cables.

Pressure measurements are a precious and unique tool for integral ocean-current monitoring and observations of relative sea-level changes. However, the drift of pressure sensors limits their usefulness for long-term monitoring. We will install new pressure sensors that use offset self-correction to regularly recalibrate the absolute pressure, eliminating the sensor drift (Paroscientific, Redmond, Washington, USA). The resulting drift-free pressure record can be used to achieve sea floor vertical motion better than 0.4 cm/yr. These geodetic sensors also include high-precision tiltmeters, useful for estimating the direction of deformation of the seafloor. This equipment can also be used as transponders for GPS-a type observations, which can measure the absolute position. This will allow a broader development and use of our geodetic sensors in the future. GeoSEA project installed three subarrays of acoustic seafloor transponders in 2015 offshore Iquique, with the deepest deployment at a depth of 5.000 m. These measurements were used to estimate distances between transponders to give insights on the deformation of the seafloor. This method provided relative deformation of each baseline (usually shorter than 1km), while the *absolute transponder positions or motions were not determined*. Our pressure sensors with the new drift correction technology are a step forward for the precise estimation of vertical seafloor movements, information needed to understand earthquake-related deformation. The GeoSEA experiment demonstrates the high capacity and leadership of GEOMAR in marine geodesy. The only oceanographic equipment designed to measure in deep waters in Chile is IMO's Lander Audacia. This is an entirely different concept; it operates as an autonomous vehicle in free fall,

¹ Check the list in the section MANUALES DE USUARIO Y OTROS of the I Concurso FONDEQUIP Mayor in <https://www.anid.cl/concursos/>

designed only for short period measurements (hours or at most some days). The propagation of climate perturbation signals from the shallow ocean into the deep ocean is of particular interest as a function of direct disturbance (e.g., freshwater forcing) versus indirect radiative forcing (e.g., CO₂, dust, aerosols). To date pH and pCO₂ are only monitored using autonomous systems in the surface ocean or subsurface layers (upper 1000 m depth). Consequently, significant gaps still exist in terms of the data availability for accurately establishing our environmental baseline for the future constraints of climate change impacts on relevant scales for deep-sea. At present, most continuous observations on the ocean floor have been associated with a few benthic observatories on continental shelves, seamounts, and canyon systems. This would be the first opportunity to measure CO₂ concentrations at hadal depths in Chile, which would make it possible to determine the propagation of climate perturbation signals from the shallow ocean into the deep ocean.

IDOOS will integrate different sensors (Fig. 2) in a new type of infrastructure, capable of providing long-term, high-resolution observations based on emerging technologies to record complex earth and ocean processes and the inter-linkages among them. This approach will allow the study of multiple interrelated properties, variables, and processes, which cannot be obtained by individual observations. For instance, the passage of mesoscale eddies or planetary waves influences sea-level variations, affecting the seafloor's pressure observations. Thus, measurements of the physical properties of the water column (temperature, salinity, and sea level) are needed to improve seafloor pressure gauges' precision. Additionally, new studies show that geological and earthquake processes have an essential influence on flows of organic matter and sediments towards trenches. Therefore the coupling of sensors such as sediment traps, dissolved oxygen temperature, and salinity sensors operating in conjunction with geophysical sensors are fundamental to understanding these processes. **IDOOS** sensors are (Fig. 2):

- 2 acoustic current meters plus 2 oxygen sensors (ACMO, N°4);
- 3 conductivity, temperature and depth sensors, plus 3 oxygen sensors (CTDO, N°6);
- 1 conductivity, temperature and depth sensors (CTD, N°6);
- 2 partial pressure of CO₂ sensors (pCO₂, N°2);
- 2 sediment traps (N°7);
- 3 ocean-bottom pressure sensors (FETCH AZA, N°9);
- Other accessories needed for the assembly of the mooring (e.g., Floating Spheres N°3).

IDOOS instrumentation will be complemented by:

- 50 ocean-bottom seismometers (from the COMBO GEOMAR project, N°12);
- 2 acoustic doppler current profilers (ADCP, N°1, N°3, provided by the UDEC);
- 1 sediment trap, 1 CTD, 1 acoustic release (provided by the Danish Hadal Project).

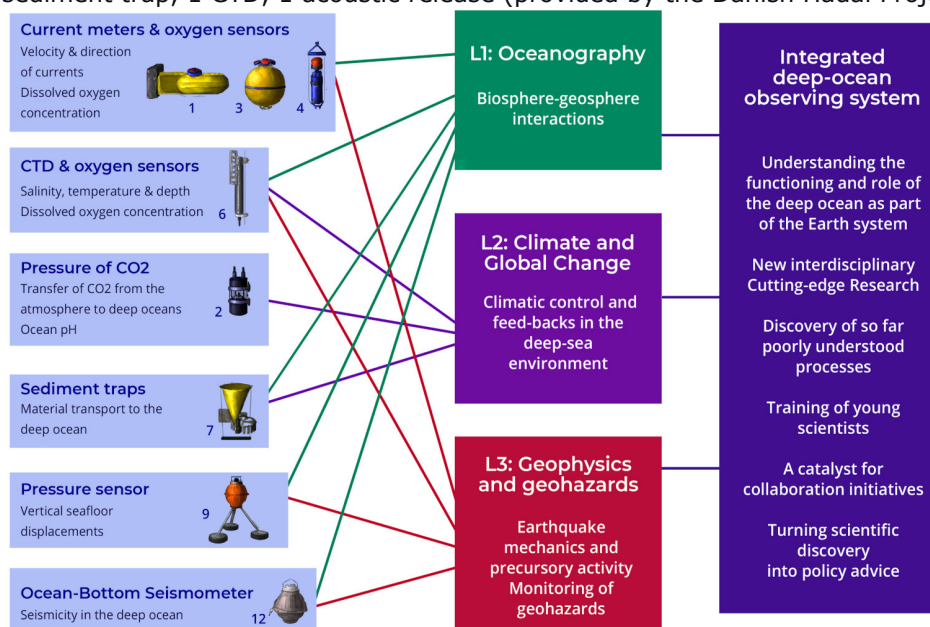


Figure 2. Characterization IDOOS sensors showing: Information that can be derived from each sensor; Interrelations and contributions to research lines and goals of the system. The numbers of each sensor refer to its position in Fig.1a and are described above.

1. Strategic Contribution from the Institutions.

2.1. Use and access plan of the requested equipment.

Describe the Plan for use and access of the requested equipment to support cooperative research and, both intra and inter-institutional / or with foreign researchers.

It is required to specify the measures that will be taken for the dissemination of the equipment. Also to describe the model of use and the details related to the time that must be disposed for the access and use of other researchers, external to the application, such as the distribution of the 30 annual business days (at least), supplies, reagents, personnel. If, due to the nature of the equipment, its access will not be available, it must be justified at this point.

(Maximum length 2 pages, including this one. You must use Verdana letter 09 and line spacing 1.0).

Within IMO and UdeC, the exploration and study of the deep ocean is one of the core research themes and several researchers and students converge their work towards many aspects of the deep-sea realm. IMO approaches and efforts to tackle this theme have been transdisciplinary, ranging from physical, chemical and biological oceanographers, engineers and geophysicists, who have jointly focused and devoted time and efforts aiming at understanding the environmental conditions and the dynamics of hadal systems, particularly the Atacama trench. An observatory system will even strengthen and expand this joint work, but will also serve to expand collaboration with researchers from IDOOS associated and collaborating institution through an uncountable number of new research lines and initiatives linked to the disciplines of oceanography, geophysics, geology, and seismicity.

Given the nature of our observing system, projects and data users do not require exclusive use of the platform. The data will be recovered once a year. After the raw data set is validated and certified, it will be deposited in public databases (e.g., DENDHOC and PANAGEA), with a restriction of a maximum of 1 year before it become fully available. The project researchers will analyze the data, and the results will be used in oceanographic and geophysical models. Time series analysis will be performed by implementing algorithms for signal detection. These codes are being developed in the Precursor Anillo and CYLCO projects, which will allow an easy implementation and adaptation to time series of other sensors. Numerical modeling of the data will be carried out by the principal researchers as part of current projects. The results and data analysis will be presented through scientific publications and thesis development by undergraduate and graduate students.

IDOOS will provide closely linked, multi-parametric measurements, allowing collaborative use of the equipment, and encouraging multidisciplinary. Our platform's data will be of interest to many user groups, ranging from different earth science disciplines to government organizations. We envisage a broad range of use of our data and results in areas relevant to natural disaster monitoring and resilience, biodiversity and ecosystem sustainability, ocean system science, and climate change research. To ensure the dissemination and easy use of our data, we plan to integrate these both in national and international free access platforms, which are specialized in publishing scientific data. We also plan to integrate with other international initiatives and observatories such as IPOC (www.ipoc-network.org/welcome-to-ipoc), SZ4D (www.sz4d.org), and other large deep-Ocean Observatories and collaborative networks, to increase the visibility of **IDOOS** and build new collaborations.

We will communicate our results to both professionals and the general public via a range of strategies targeted at academic and non-academic audiences alike. Knowledge transfer and dissemination activities will consist of: (1) Public communication of our academic results through a website unique to the project, social networking, press releases of fieldwork activities and publications, attendance of scientific conferences, and organization of workshops for academic exchange; (2) Publicly accessible digital repositories for our data and analyses.

At the national level, many opportunities for collaboration will be opened throughout the country, both with associated partners-institutions of the project and also with other public, academic and private institutions being attracted by this visionary and novel project, which will be viewed as a key Chilean achievement. The Pontificia Universidad Católica de Valparaíso will provide the online platform GEOOS (www.geoos.org, in Spanish GEOPortal Observacional) to distribute and visualize the data. This new platform is the continuation of the Caletas and POMEQ platforms, which have

been successfully operating since 2014. GEOOS is a reliable system, tested for more than five years, that can be easily adapted to receive the data sets acquired by our project. Currently, GEOOS displays all 43 SHOA tidal and 26 SERVIMET meteorological stations owned by the Chilean Navy (Armada de Chile). Additionally, we will integrate our data and results in the new open database that is being planned by ANID and the Chilean Ministry of Science. Every time we make new data acquisitions, we will inform the scientific community and government agencies such as ONEMI, SHOA, and CSN.

At the international level, this project will provide high-quality and extremely valuable data on physical, chemical and geophysical data from deep water, and deep-sea floor from the Atacama region. We expect data will be open source for the scientific community and public at large. On an annual basis, our previously processed (after quality control), databases will be submitted to PANGAEA server, which is a public domain server hosted in Germany for Earth and Environmental Sciences (www.pangaea.de), and widely known and used by the global community. After finishing the first phase of the project (5 years) Data Descriptors will be submitted to the journal Scientific Data (Nature-Springer, www.nature.com/sdata).

IMO and its researchers are all strongly connected with international projects, programs and collaborative networks with which we contribute with information and databases from the southeast Pacific. For instance, IMO is a full member of POGO (Partnership for Observation of the Global Ocean) (www.ocean-partners.org), and to our knowledge our project will be the first observatory of hadal systems and the visibility and contribution of our project will be of global impact. We are also involved in several networks and programs of regional and global scope. Some of them are: The ocean KAN of Future Earth (futureearth.org/networks/knowledge-action-networks/ocean), IMBeR (Integrated Marine Biosphere Research: www.imber.info), Working Groups of SCOR (Scientific Committee on Oceanic Research: scor-int.org), CLIVAR (Climate Variability: www.clivar.org), and several other specific networks with international partners. **IDOOS** will strengthen collaborative research and certainly open overwhelming opportunities for new joint initiative with international partners. In more specific terms, it is expected that international projects and partners will be much interested in physical and chemical data for testing and validation of climate models, as well as biogeochemical models, similar expectations are for geophysical modelers, seismicity models and development of geohazard and early warning tools. Information about pH and pCO₂ in deep environments is extremely useful, not only for determining the concentration baseline of carbon dioxide in this hadal environment, but also for understanding how the Ocean Acidification process can occur in such an extreme environments as promoted by the input of anthropogenic CO₂ and the synergistic effect of global warming. We will make fully available the **IDOOS** CO₂ data, contributing to national and international networks focused on the study of the deep ocean biogeochemistry. In fact, Global networks, such as the Ocean Acidification Observing Network (GOA-ON) and International Ocean Carbon Coordination Program (IOCCP), have clearly manifested interest in this kind of deep-moored observing systems. Moreover, GOA-ON, which is a collaborative international network aiming to the detection and understanding of the drivers of ocean acidification in ocean environments, will be very interested in utilizing these data to optimize modelling studies. IOCCP is a collaborative international program aiming to develop an international ocean carbon observation network and to establish international agreements on observation methods, standards, data management, and data sharing for ocean carbon research. Finally, the recently founded Latin-American Ocean Acidification Network (LAOCA) has also manifested to us their interest for the valuable contribution that we can provide with information about the carbonate chemistry conditions in deep environments of the Pacific Ocean. All these programs will certainly become engaged to the project and its implications.

Finally, we will support, guide, and nurture young researchers within a collaborative interdisciplinary national-international research framework. Students will be integrated and financed by ongoing projects. They will be trained in application of modern techniques to process and manage **IDOOS** data sets. Our project will provide these promising young researchers with the skills and knowledge needed to emerge as independent scientists, and to become a new generation of geo-scientists in Chile. Moreover, and, most importantly, the students will be nurtured in an environment where all of these diverse techniques will be discussed and integrated into collaborative work. Thus, fostering interdisciplinary research and exposing young researchers to specialists from different disciplines.

2.2 Consistency and justification between the resources requested from FONDEQUIP and those provided by the Principal and Associated Institutions.

Detail how the Institution (s) will implement the installation and start-up plan, and how it will ensure the operation and maintenance of the requested equipment, during the term of the project and after its completion, specifying the resources to be used and their origin (FONDEQUIP and / or Principal and Associated Institutions).

It must be specified how the Pecuniary Contribution of the institution (s) will be materialized to carry out the hiring of the technician and / or specialized professional, in charge of the operation of the equipment (except in cases where, due to the nature of the equipment, a person in charge is not required), and the training of personnel related to the use of the equipment. In addition, refer to the consistency of the **Non-Pecuniary Contributions**, considering a valuation within the term of the project and according to the date of purchase and installation of the equipment (according to what is indicated in number 2.5 of the Contest Guidelines). Consider the need for additional equipment or laboratories for the proper performance of the applied equipment and the existence or access to these. Regarding the valorization of human resources, only the specialized technical and / or professional personnel in charge of the manipulation, use and / or maintenance of the equipment (with a current contract in the institution) can be considered. In relation to the technical and / or administrative personnel in charge of purchasing the equipment and the associated researchers who participate in this process or directly in the execution of the project. **It is not possible to include a valuation of the remuneration of the potential users** of the equipment once it has been put into operation.

In relation to the adaptation of infrastructure and / or habilitation of spaces, **the renovation of offices or the purchase of furniture** that are not **directly related** to the operation of the equipment to be acquired **will not be considered**.

(Maximum length 3 pages, including this one. You must use Verdana letter 09 and line spacing 1.0)

A major investment in deep-ocean research is needed to improve our knowledge of this poorly understood environment. IMO and the associated institutions are committed to this initiative's success, so they will make a significant investment, both pecuniary and non-pecuniary contributions, which will cover from the preparation phases, assembly, start-up, and maintenance (7 years), to supporting students and outreach. The IMO and GEOMAR have the advantage of having vast experience in these scientific and technological challenges. Hence, the system will be sustainable, multi-disciplinary, multi-thematic, efficient, and fit-for-purpose, and will enhance new partnerships among governments, science, civil society and the private sector. We describe the different steps that will be implemented to ensure the start up, installation, operation, and maintenance of the **IDOOS**. We also specify the contributions and described each item with the same numbering as in the Budget file for an easy comparison (summary in Table 1):

B.- TRANSPORT AND INSTALLATION.

B.1. Transport, Transfer Insurance, Customs Clearance, and VAT on Equipment. In this sub-item, we request \$7.000.000 from FONDEQUIP to cover the cost of shipping the equipment and its corresponding insurance within Chile. The cost for international transfers and insurance, customs clearance, and VAT on equipment in Chile are included in both suppliers' quotations, so these costs are already incorporated in the Subitem A.1, which considers the cost of the equipment.

B.2.- Habilitation of spaces for equipment: In our proposal, we need a physical space for the reception, checking, testing, and assembly of the platform. The preparation and assembly of the equipment, as well as the base for operations and maintenance of the platform will be located in a facility that the Universidad Antofagasta makes available to the project. The space offered by the Universidad de Antofagasta will be conditioned for these purposes, which will include, among others, the installation of fences and four to five meter-high ceiling, a system for lifting heavy equipment (e.g. winch), and desks for assembly and general work. For this purpose, an amount of \$30.000.000 will be covered by the associated institutions as pecuniary contributions. The institutions will contribute \$10.000.000 in non-pecuniary support comprising laboratories and equipment for testing and preparing the operation of the platform. No funding is requested for this item from FONDEQUIP.

B.3.-Installation and start-up:

The installation and start-up of the platform will be prepared and executed at the University of Antofagasta, in the second half of 2021. All the equipment will be transferred from the land base to the German oceanographic vessel R/V Sonne. The German oceanographic vessel R/V FS Sonne is

scheduled to deploy an array of 50 Ocean Bottom Seismometers in the same geographical region within the framework of the COMBO project (see support letter). During this cruise, the FETCH AZA (pressure sensors) nodes and the oceanographic mooring will be installed. This phase's operating costs include contracts for transportation, harvesting machinery, cargo handling, port access, materials, and implements. These will be covered by a \$14.370.000 pecuniary contribution from the associated institutions and \$10.000.000 requested to FONDEQUIP. In addition, we will count with a non-pecuniary contribution of \$10.000.000 from associated institutions, mainly related to complementary equipment for the start-up of the observation platform.

B.4. Maintenance, Warranties and Equipment Insurance.

Maintenance

Starting with the installation and start-up phase of the equipment, there will be a contract with the supplier for a maintenance service, which will be valid for the first two years of operation, with a value of \$24.990.000 (requested to FONDEQUIP).

Two specialized professionals will be hired by IMO, who will participate from the reception attesting of the equipment to the installation and start-up, together with the provider's maintenance team. They will then carry out the maintenance of the platform autonomously over the next 5 years (since the 3rd year of the project). The institution's pecuniary contribution to executing this plan is \$101.430.000 throughout the project, while the non-pecuniary contribution is \$22.000.000 in the form of equipment and complementary assistance. Thus, the professional team of the main institution, with the support of the associated institutions, will periodically attend to carry out the maintenance and verification of the correct functioning of the observation platform equipment. The regular schedule of maintenance will be once a year, but some other maintenance could be done to solve some contingency.

For the maintenance tasks, we need 3 to 4 days of operations in the ocean each time, requiring ship time. For this item, we have a pecuniary contribution from IMO of \$72.000.000. A second visit of SONNE is planned to recover the equipment of the COMBO project, allowing its use for one maintenance within the timeframe of the project. Thus, with these contributions we can finance the maintenance until the 7th year of the project. Additionally, we will request the use of the Chilean oceanographic vessel Cabo de Hornos and vessels of the Chilean Navy to mitigate these costs.

The operations for the maintenance will be carried out each year and will consist of:

A) Oceanographic Mooring

- 1.- Measurements of an independent oceanographic profile with Rosette/CTD system to contrast and compare with the data recorded by the equipment installed in the mooring, and sampling for laboratory analysis (e.g., salinity, dissolved oxygen, pCO₂).
- 2.- Release of mooring equipment using an acoustic deck unit.
- 3.- Recovery of mooring system.
- 4.- Cleaning of equipment
- 5.- Checking the condition of each sensor.
- 6.- Downloading data.
- 7.- Battery replacement.
- 8.- Equipment configuration
- 9.- Change of hardware, ropes, chains, etc.
- 10.- Installation and deployment of the mooring system.

B) Geodetic sensors

The communication with the pressure sensors will be done using a Dunker provided by the partner institution GEOMAR. This will be mounted on a vessel and will allow: downloading of data; verification of correct operation; and eventual reconfiguration.

Guarantees: An amount of \$13.1 million is requested from FONDEQUIP to obtain the necessary guarantee policy to secure the funds provided by ANID.

Insurance: IMO will cover the "in-land" insurance by a pecuniary contribution of \$10.000.000. Once the entire platform is deployed in the ocean, it cannot be covered by any insurance. For this reason, apart from international and national transport insurance, operational insurances at the deep sea cannot be included in the platform's operation period.

Finally, in the 7th year, the system will be recovered, including the oceanographic mooring and the geodetic sensors. The equipment will be taken to the laboratory, where measurements will be performed in a controlled environment to verify the drift of the measurements in order to make any adjustment or correction to the recorded data if necessary. After seven years, these instruments can be reinstalled in the same or another place in Chile. Also, the geodetic sensors can be expanded to become either continuous monitoring equipment (using buoys) or used as GPS-A.

C. OPERATION.

C.1. Training: At the beginning of the project and parallel to the acquisition of the equipment, two specialized professionals will be hired with pecuniary contributions from IMO. The training will take place in Chile and Europe. IMO has a professional staff with vast experience in the preparation and deployment of deep oceanographic anchors at ca. 4.000 m, making it possible to hire expert personnel to carry out the deployments of this new observation system. In the first step, the two professionals and the Principal Investigator will be trained at the University of Concepcion facilities in the maintenance and operation of the oceanographic mooring equipment, for two weeks. A non-pecuniary contribution of \$6.000.000, from University of Concepción considers access to laboratories, facilities, and the hours of the personnel that will do the training. Later these professionals will be trained in the use and maintenance of geophysical-geodetic equipment. This will be held at GEOMAR in Kiel (Germany) and Sonardyne, in Yateley (United Kingdom). The funding of the training in Europe of the professional team will be covered by pecuniary contributions from IMO, including flight tickets, accommodation, and travel expenses, with a total of \$10.000.000. This will allow the acquisition of the know-how necessary to properly operate and maintain each of these sensors, and to supervise the appropriate handling during operations. They will also learn the processing techniques and methods for evaluating the information provided by these sensors.

C.2. Other operating expenses.

This sub-item is the second most expensive of the project and considers the expenses necessary to guarantee the platform's operation in the whole period of the project. It considers the expenses required for ship time, transportation, lodging, per diems, equipment, materials and supplies, spare parts, personal protection elements, etc., to support the maintenance, supervision, operation, and data collection during the seven years of operation of the platform. This includes land-based operations and ship access to perform the recovery, inspection, and annual maintenance of the necessary components. Financing for this phase will come from pecuniary contributions of \$299.880.000 (IMO) and non-pecuniary contributions of \$83,240.000 that account for the use of facilities, complementary equipment, personal insurance, and professional hours to support these operations for the duration of the project.

Contributions from foreign institutions. GEOMAR and HADAL will contribute with equipment, use of ship times, and qualified personnel. The Budget file and cost of the project do not include the contributions of foreign institutions.

C.3 Administrative Costs: Considers a non-pecuniary contribution of \$10.000.000 from IMO for the costs of the partially dedicated administrative human resources, for a period of six months estimated to last for the complete management of the purchase of the equipment.

Item	FONDEQUIP	Pecuniary	Non Pecuniary	Y1	Y2	Y3	Y4	Y5	Y6	Y7
Equipment	673.601.200	0	0	X						
Training	0	10.000.000	6.000.000	X						
Shipping and handling	64.600.000	0	0	X						
Taxes	140.258.245	0	0	X						
Domestic Transportation & insurance	7.000.000	10.000.000								
Habilitation of spaces for equipment	0	30.000.000	10.000.000	X						
Starting up	10.000.000	14.370.000	10.000.000	X						
Maintenance Contract Supplier	24.990.000			X	X					
Guarantees	13.010.000			X						
Institutional Maintenance		101.430.000	22.000.000	X	X	X	X	X	X	X
Operation and personnel		227.880.000	83.240.000	X	X	X	X	X	X	X
Administration (Purchase process)			10.000.000	X						
Ship time		72.000.000			X	X	X	X	X	X

Table 1. Details of the costs and plan of activities over the years of the project.

2. Expected results of the Proposal.

Describe the expected results with the use of the requested equipment in each of the sub-criteria described in the chart, taking into account the **indicators** committed in this application.

(Maximum length for this chart is 5 pages, including this one. You must use Verdana letter 09 and line spacing 1.0). If necessary, insert rows in the chart.

3.1 New knowledge that will be generated with the use of the requested equipment.	
Current situation	Situation considering the equipment
<p>The Atacama Trench, located off the coasts of Chile and Peru, is not only one of the deepest (8.081 m) and longest (~6.000 km long) ocean trenches, but is also one of the most seismic areas in the world. At present, there is not an observing platform capable of collecting data below 1000m depth. Thus, there is a lack of knowledge about the processes that occur in the deep ocean near the trench in Chile. This knowledge is urgently needed for a variety of reasons, ranging from how deep sea ecosystems respond to climate change to better understand geohazards.</p>	<p>The installation of the first multiparametric platform for deep ocean processes in Chile will allow to detect deep-ocean processes ranging from characterizing the structure and the temporal variability of physical, geochemical, and biological conditions, up to detecting seafloor motion related to earthquake deformation.</p> <p>The open data policy of IDOOS observations will contribute to globally integrated databases granting broad access and use of the data.</p>
<p>Until now, deep ocean observation has been conducted through loosely aligned arrangements of national or international efforts. These have been project-based experimental design to monitor data for process-oriented research in specific fields, without a proper integration of data from diverse disciplines. This research requires an interdisciplinary approach</p>	<p>An integrated, multi-disciplinary and comprehensive international ocean observing system led by Chilean institutions for the Atacama Trench.</p> <p>Our project will strengthen the existing research cooperation between Chilean institutions not only on the topic of ocean processes, but also on more specific areas of the geodesy, seismology, oceanography, geography, geology, and biology to further cement the Atacama Trench zone as one of the premier natural laboratories for studying ocean-coastal dynamic hazards.</p>
<p>The upper limit of the coupled (seismogenic) zone is still a question that has not been resolved, does it reach the trench?</p> <p>Seafloor geodesy has been deployed only at a few subduction zones, leading to breakthrough results on the current accumulation of strain that could potentially lead to a forthcoming earthquake. Presently, there is a complete lack of knowledge on seafloor deformation rates along the Chile margin.</p>	<p>One of the first measurements of vertical movement in subduction zones near the trench in the interseismic period of a seismic gap.</p> <p>Maps of the location and rates of strain accumulation associated with interseismic plate locking across the Chile margin. Through modeling, insight on the physical processes responsible for strain accumulation.</p> <p>First estimate of the upper limit of the coupled zone in the plate contact in Chile using ocean floor deformation data together with a dense onland-GPS network and OBS. Thus, providing feedback to better understand the causes of earthquakes and tsunamis.</p>
<p>Nationwide tsunami detection system based on onshore tide gauges and DART buoys and an onshore geodetic system.</p>	<p>Feasibility of developing a real time tsunami early warning system based on seafloor geodesy. This system may be coupled with the onshore geodetic system currently developed by CSN. Hence, the outcome of this project will lead to a new generation of observation strategies and knowledge that will further future assessment of earthquake-tsunami hazard.</p>

Emerging field in the detection of transient deformation signals and interpretation as seismic precursory activity using only onshore geodesy. Therefore, lacking the resolution to detect signals near the trench.	Rapid technological growth in the field by integrating on- and offshore time-series allowing for a better localization of the source of transient deformation signals and their interpretation as potential precursory activity in the wake of a great earthquake.
Presently, there is no oceanographic information continuously collected at hadal depths in the Atacama Trench that allows the study of the transport of organic matter into the ultra-deep ocean.	The proposed observing system will allow -for the first time off Chile- to assess the magnitude, time variability, and source of the organic matter flux into the ultra-deep ocean (via sediment traps) and evaluate alternative hypotheses (e.g., surface versus lateral, exogenous versus allochthonous, surface-productivity versus tectonically driven inputs) for the mechanisms providing the energy and material flows sustaining the rich hadal microbial communities.
Only punctual oceanographic observations below in hadal regions of the eastern South Pacific. There are no time series of currents and water properties (temperature, conductivity, dissolved oxygen) of water bodies below 4000 m.	First records (time series) to study temporal variability of movements and the properties of deep, bottom and hadal waters (below 4000 m and up to ~ 8000 m).
In general, not only for the Chilean region, in general pCO_2 has been restricted to the upper 1.000 m depth, with scarce reports of observations down to 4.000 m depth.	The present proposal considers the first established deep-sea oceanographic mooring for the observation of the natural variability of pCO_2 in the deep ocean. We lack completely on mid-term (years) observations about variability at such depths, and therefore, this is a major contribution to knowledge about the functioning of the carbon cycle at hadal depths.
There is no scientific research and publications by Chilean researchers on circulation, water mass properties and ultra-deep ecosystems.	Chilean research projects and publications on circulation and mixing in the ultra-deep marine environment and the ecosystems of the Atacama trench.
The deep seafloor is also important because it contains a wealth of marine resources, and supports the largest part of the Earth's biosphere. Its biodiversity Chile is unknown and therefore not included in conservation plans.	Long term deep-sea observations will allow monitoring of deep-sea ecosystem health and its relation to global climate change. These variables will help to support the implementation of effective management strategies in Chile.
Little or no knowledge of physically linked processes that occur near the trench. Deep-sea processes are highly connected, but their relations are poorly known.	The integration of various sensors to detect multi-parameters will improve detection (enhanced resolution) and understanding of physically related phenomena occurring in the deep ocean. This allows corrections of pressure sensors for currents, eddies, and salinity to achieve robust data of vertical ocean floor movements. Study the links between ocean dynamics, particle fluxes, seabed conditions, seascape, and tectonic deformation.
The Chilean Ministry of Science is promoting the development of observatories and oceanographic data acquisition in Chile, mainly on climate change related topics. However, to better understand these processes it is necessary to integrate the wide range of factors that control the dynamics of deep ocean processes.	IDOOS will generate the opportunity of connecting scientific outcomes to stakeholders and policymakers. We expect members of our group to help shape policy in Chile, influencing areas such as seismic hazard and oceanography, biodiversity, and climate research strategies in governmental institutions.

3.2 Generation of derived research lines.	
Current situation	Situation considering the equipment
There is almost no research on deep ocean physical oceanography and biogeochemistry of hadal environments (>6000 m) in Chile.	Two new lines of oceanographic research will be initiated in the country: Physical Oceanography and Biogeochemistry of hadal environments.
Most of the national and international scientific community working on carbon biogeochemistry has been focused on processes occurring in the upper 1.000 m depth, with scarce opportunities for investigating processes occurring down to 4.000 or 5.000 depth.	This new ocean-observing system platform opens a new research line on the biogeochemistry of deep and hadal environments; and moreover, the potential for including deep-sea observation into main international ocean observing programs (e.g. GOOS; Global Ocean Observing System).
Most of carbon chemistry science has been restricted to the upper surface ocean, including the main scientist's community studying carbon chemistry in the open ocean.	We open a new door not only for knowledge, but to the generation of a new cohort of scientists interested in studying the carbon cycle, and how ocean acidification in surface waters could have consequences in the deep ocean as well.
Currently, there is no seafloor geodetic monitoring in Chile focused on absolute vertical motions. We lack aimed at estimating observables relevant for seismic hazards such as slip deficit and updip, seaward extent of the seismogenic locking zone.	Seafloor monitoring system across the Chile margin for direct assessment of the geometry of the interplate seismogenic zone. With the new results, it will be possible to open the line of research in marine geodesy in Chile.
Recently it has been detected that the deformation detected by geodetic data offers the possibility of identifying stationary signals that are related to hydrological loads. In addition, there is more and more evidence relating atmospheric loading to the occurrence of surface seismicity. However, this is an emerging topic that needs further development.	The integration of data from our platform with seismic data recorded on land and on the seafloor will allow us to test hypotheses that relate changes in hydrological load to the occurrence of microseismicity. This is an issue that may not be possible to detect, but we think that its research is worthwhile. New research on the role of global climate change in geohazard dynamics.
The relationships between mass flux (fluids and sediments from earthquake processes) and the evolution of deep ecosystems is not well understood. So far there are no studies in Chile, due to the lack of data at hadal depths.	Integration across disciplines to investigate factors such as seismic activity, bathymetry, slope failure, affect the sedimentary mass-flux processes and sustainability of hadal ecosystems. This will allow the development of a new line of research involving geological, geophysical, biological and oceanographic processes.
The deep-sea environment modulates both global climate and ocean circulation.	IDOSS will be of global relevance providing new data for fundamental, forefront research on the exchanges between the sub- seafloor, seafloor, and water column and predict how they might modulate climate change or vary due to it. This would lead to new possibilities for high-impact research in Chile.

3.3 Support for the education and training of undergraduate and graduate students, both nationally and internationally (mention the benefited programs).	
Current situation	Situation considering the equipment
There is a limited interaction between undergraduate and graduate students in Chile with international institutions.	Our project and the data generated by the platform will promote the exchange and co-supervision of students related to the analysis and interpretation of observations. This will result in an international academic environment to train young scientists at the highest level, exposing them to different backgrounds, technical approaches, and collaborative research.
There is not a bridge in Chile between the scientific community and decision making.	Our platform will provide data of national interest, contributing to new opportunities for collaboration in science and technology between policy makers and scientists. This will result in the transferring of new knowledge to end-users in government and industry.
There is limited dissemination of scientific knowledge to the community in Chile.	<p>We propose to communicate our results to both professionals and the general public via a range of strategies targeted at academic and non-academic audiences alike. Knowledge transfer and dissemination activities will consist in general of: (1) Public communication of our scientific results through a website unique to the project, social networking, press releases of fieldwork activities and publications, attendance of scientific conferences, and organization of workshops for academic exchange; (2) Publicly accessible digital repositories for our data and analysis results; (3) Outreach events for high schools, the private sector, and national/local emergency agencies in charge of natural disaster administration in Chile.</p> <p>For the educational and outreach programme, we will develop school activities for primary students (from first to eighth grade) in collaboration with the Antofagasta Par Explora (Government) and the University of Antofagasta. The main objective will be to inspire the new generations about the need for knowing and protecting the ocean.</p> <p>IDOOD poses a tremendous technological challenge for Chile. That is why we want to develop an itinerant workshop where we transmit and introduce the different observational techniques of IDOOS to school students in regional cities. We will show how we explore the greatest depths of the ocean to decipher not only marine processes but also those that occur on and under the seafloor. Additionally, we will produce a documentary about the research for the general public and decision makers to be broadcasted by regional and national television channels.</p>

Given the open data policy of **IDOSS**, we will contribute with observations that will be useful for developing undergraduate and graduate theses on different topics, which were not possible previously due to lack of data.

There are various needs in the programs that study geosciences in Chile. So far:

MSc and PhD students from marine science and/or environmental science graduate programs have been for decades focused on the study of the first, one, or two-thousand-meter depth of the oceans, including their respective training activities.

There are no deep-circulation graduate theses in Chile and no graduate program in Earth System Science in Chile.

There are no graduate or undergraduate theses in Chile on the physical oceanography of hadal environments.

There is no marine geodesy research in Chile.

Few graduate students are conducting interdisciplinary work on oceanographic and seismological issues.

Few international students come to do internships in graduate programs in Chile.

Limited technological expertise in deep ocean exploration in undergraduate and graduate courses in Chile.

IDOOS will increase the range of data available, allowing a more comprehensive insight into interrelated processes in the deep ocean. This will make it possible to develop undergraduate, master, and Ph.D. theses on entirely new subjects in Chile. These young researchers will benefit from our international research network (e.g., through research stays and joint supervisions) and the framework of collaborations between all participant institutions in this proposal.

Information from this deep-ocean observation system opens the possibilities for including both outreach and training activities for undergraduate and postgraduate students from Chilean universities focused on understanding the Earth system. New data from **IDOSS** will help constraining Earth's geo-, bio- and hydrosphere interactions, boosting collaboration between disciplines. This will allow the co-supervision of students with experts in different subjects both in Chile and abroad.

Undergraduate Programs

Marine Sciences (UDEC, PUCV, UA).

Geophysics (UDEC).

Geology (UDEC; UACH).

The proposed equipment will allow the students to be exposed early to state-of-the-art oceanographic geodesic seismological equipment and handle multiparametric data. The equipment will directly contribute to the courses on instrumentation, data analysis, and fieldwork at the associated universities.

In this way, students can be prepared on an international level to enter postgraduate programs in Chile or abroad. The participation of GEOMAR and the University of Southern Denmark will provide opportunities for exchanges and internships.

Postgraduate Programs

Master in Geophysics (UDEC)

Master in Oceanography (UDEC, PUCV)

Master in Ecology of Aquatic System (UA)

PhD in Geology (UDEC), PhD in Oceanography (UDEC), Ph.D. in Applied Sciences, mention in Aquatic Sciences (UA).

The proposed equipment is expected to increase the number of master and Ph.D. students doing work based on the new themes described above.

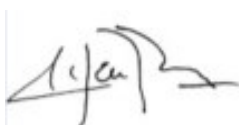
A new Ph.D. program in Earth System Science is being developed at UACH (to hopefully start in 2021), which will allow the integration of the different geosciences relevant to this proposal and the direct use of the data from IDOOS. It is also expected to increase the number of students applying to these programs from other Chilean or foreign universities and external institutions participating in this project, enriching the programs with varied views and knowledge.

The significant number of research projects led by the investigators of this proposal ensures that there will be funding opportunities for undergraduate, Master and PhD theses during the execution of this project.

CERTIFICADO DE EMISIÓN DE RESOLUCIÓN

Por medio del presente, la Agencia Nacional de Investigación y Desarrollo - ANID, certifica que se ha aprobado su convenio folio **EQY200033** correspondiente al concurso **I Concurso de Equipamiento Científico y Tecnológico Mayor** de la Subdirección **Centros e Investigación Asociativa**, mediante la Resolución N° **N°12278/2020**, con fecha **30-11-2020** .

Se emite certificado el día 15 de diciembre de 2021



Aisen Etcheverry Escudero
Directora Nacional
AGENCIA NACIONAL DE INVESTIGACIÓN Y DESARROLLO

Código de verificación: 4d9e40ea-4282-4f23-83c6-9236e6778994

Folio: CEL00033581

Este certificado cuenta con Firma Electrónica Avanzada, su autenticidad podrá ser verificada en

<https://servicios.anid.cl/web/certificados-en-linea/#/portal-validacion/ingreso/CEL00033581/4d9e40ea-4282-4f23-83c6-9236e6778994>

Este certificado se encuentra vigente por 365 días a partir de su fecha de emisión

