Template for the review of the draft regional environmental management plan for the Area of the northern Mid-Atlantic Ridge with a focus on polymetallic sulphide deposits

Please use the review template below when providing comments. Line and page numbers have been provided in the draft REMP. Please use these as a reference as illustrated in the table below.

TEMPLATE FOR COMMENTS

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General Comments

When preparing the general comments, stakeholders are invited to consider the following:

1) The structure and layout of the draft REMP.
2) The level of detail of the draft REMP, while avoiding being too prescriptive.
3) The goals and objectives in the draft REMP in providing for long-term, effective protection of the marine environment in the Area of the northern Mid-Atlantic Ridge.
4) The management measures and their ability to achieve the goals and objectives in the draft REMP.

Specific Comments

Page	Line	Comment
8	144	'sulphide-rich' instead of just 'sulphide' – it is extremely unlikely to be a rock outcrop composed exclusively of sulphides. Even when named 'massive sulphide deposit' it encompasses other, non-sulphide, accessory minerals. The correct form is 'sulphide-rich'
	145	idem
	171	idem
	173	It is not the sediments that are 'hydrothermally active'. There may be hydrothermal activity within/on/under the sediments. There may be sediments of hydrothermal origin, hydrothermal sediments. I suggest correction to: 'including pelagic sediment and hydrothermal sediment from hydrothermally active and inactive areas'
	179	'twenty two sites of PMS deposits' the term **deposit** is incorrectly used here. PMS deposit, the word deposit, implies suitable for extraction at profit for that moment in time. It as an economic weight in it that requires detailed assessment using well-defined regulations and codes. That is not the case for the 22 sites. It is not known at this point. Unfortunately, we have been seeing this nomenclature being abused by biologists, sometimes in major publications and reports, when trying to describe geology concepts. It is scientifically wrong and should be avoided, particularly with the implications it brings. An hydrothermal site or vent or area does not necessarily make a PMS deposit. A PMS deposit is or was, at some point an hydrothermally active area.

9	201	Used in abstract: 'PMS deposits' is ok but it is necessary to understand that when using the term deposits it automatically EXCLUDES occurrences, that is, hydrothermal systems that do not form a PMS deposit in the geological sense.

Draft regional environmental management plan for the Area of the northern Mid-Atlantic Ridge (MAR) with a focus on polymetallic sulphide deposits

Introduction and background

1. In accordance with the United Nations Convention on the Law of the Sea (the "Convention") and the 1994 Agreement relating to the implementation of Part XI of the Convention, the International Seabed Authority is the organization through which, the States parties to the Convention administer the mineral resources of the International Seabed Area (the "Area") and control and organize current exploration and future mining activities for the benefit of humankind as a whole. At the core of ISA's mandate lies its duty to take all necessary measures to ensure effective protection of the marine environment from harmful effects which may arise from activities in the Area. Article 145 of the Convention requires ISA to adopt appropriate rules, regulations and procedures for, *inter alia*, the prevention, reduction and control of pollution and other hazards to the marine environment, the protection and conservation of the natural resources of the Area, and the prevention of damage to the flora and fauna of the marine environment.

2. To this end, Article 165 of the Convention assigns the Legal and Technical Commission (LTC) of ISA the responsibility to make recommendations to the Council on the protection of the marine environment, with respect to relevant rules, regulations and procedures, as well as a monitoring programme on the risks and effects on the marine environment resulting from activities in the Area. In addition, the LTC is also responsible for keeping under review the rules, regulations and procedures on activities in the Area.

3. Three sets of exploration regulations have been adopted by ISA on prospecting and exploration for polymetallic nodules (PMN), polymetallic sulphides (PMS), and cobalt-rich ferromanganese crusts (CMC)[1], which are supplemented by a series of recommendations issued by the LTC[2]. Draft Regulations on Exploitation of Mineral Resources in the Area are presently

1 See ISBA/19/C/17, ISBA/16/A/12 Rev. 1 and ISBA/18/A/11
[2] See https://www.isa.org.jm/mining-code/recommendations

under consideration by the Council, which will be supplemented by a set of standards and guidelines to support the implementation of such regulations.[3]

4. In pursuance of the mandate under Article 145 of the Convention, the Council, during its seventeenth session in 2012, approved, in its decision ISBA/18/C/22, an Environmental Management Plan for the Clarion-Clipperton Zone (CCZ), on the basis of the recommendation of the LTC. Among other elements, the environmental management plan established objectives and priority actions at various levels, as well as a mechanism for review. In line with these provisions, the LTC reviewed progress in the implementation of the environmental management plan in 2016 and 2021, and identified further actions to advance the goals and objectives of the plan[4]. On the basis of the recommendation of the LTC, the Council in 2021 adopted a decision relating to the review of the Environmental Management Plan for the CCZ, as contained in ISBA/26/C/58.

5. Building on the experience of the Environmental Management Plan for the CCZ and ISA workshops held for other regions, the development of regional environmental management plans (REMPs) became an essential element of the strategic plan of the Authority for the period 2019–2023 adopted by the Assembly in 2018 (ISBA/24/A/10) and, subsequently, a central part of the high-level action plan adopted by the Assembly in 2019 (ISBA/25/A/15, annex II). Strategic Direction 3.2 of the strategic plan calls for efforts to "*develop, implement and keep under review regional environmental assessments and management plans for all mineral provinces in the Area where exploration or exploitation is taking place to ensure sufficient protection of the marine environment as required by, inter alia, Article 145 and Part XII of the Convention*". Likewise, in 2020, the Assembly adopted the Action Plan of the Authority in support of the United Nations Decade of Ocean Science for Sustainable Development (ISBA/26/A/4), which identifies a number of expected outputs that highlight the role of scientific approaches to developing REMPs.

6. At its twenty-fourth session, in March 2018, the Council took note of a strategy proposed by the Secretary-General for the development of REMPs for key provinces where exploration activities under contracts are carried out. The Council agreed with the priority areas that had been identified, including the Mid-Atlantic Ridge (MAR). The Council, at its twenty-fifth session in 2019, took note of a report of the Secretary-General on the implementation of the strategy (ISBA/25/C/13), including a programme of work to develop those plans through a series of expert workshops.

7. To support the organization of these workshops, the ISA secretariat prepared a guidance document to facilitate the development of REMPs. As requested by the Council in its Decision ISBA/26/C/10, this guidance document is being further developed by the LTC with a view to recommending to the Council a standardized approach for the development of regional environmental management plans, including a template with indicative elements. The guidance document recalled that both contractors and sponsoring States "*undertake […] to comply with […] the decisions of relevant organs of the Authority*"[5] and referred, in this regard, to the decisions concerning REMPs.

8. As part of the implementation of this strategy, ISA organized two expert workshops in Szczecin, Poland in 2018 and Evora, Portugal in 2019, as well as a virtual expert workshop in 2020, in support of the development of a REMP by the LTC for the Area of the northern MAR.

9. The development and implementation of REMPs have become an integral part of the work of ISA on the protection of the marine environment and have the potential to contribute to the effective conservation and management of marine biodiversity in areas beyond national jurisdiction. REMPs also have the potential to contribute to the achievement of Sustainable Development Goal 14 (Life below water) of the 2030 Agenda for Sustainable Development, namely to "*conserve and sustainably use the oceans, seas and marine resources for sustainable development* ".

[3] See https://www.isa.org.jm/mining-code/standards-and-guidelines
[4] See ISBA/26/C/43
[5] 3 Annex IV, Section 13.2 (b) in each set of the Authority's regulations on prospecting and exploration.

10. This REMP contains references to measures applicable to the exploitation phase for which the Draft Regulations on Exploitation of Mineral Resources in the Area are still under negotiation, therefore, these measures will need to be aligned once the draft regulations become adopted.

Guiding principles

11. The development and implementation of REMPs in the Area are guided by the following overarching principles:

a) **Common heritage of mankind**. The Area and its resources are the common heritage of humankind. All rights to the resources of the Area are vested in humankind as a whole on whose behalf the Authority shall act;

b) **Precautionary approach**. Principle 15 of the Rio Declaration on Environment and Development specifies that where there are threats of serious or irreversible damage to the environment, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation;

c) **Transparency**. The Authority shall enable public participation in environmental decision-making procedures in line with strategic direction 9 of the Strategic Plan of ISA for the period 2019-2023[6] ;

d) The application of an **ecosystem approach**; and

e) Incorporate the **best available scientific evidence** into decision-making processes.

Overarching goals

12. REMPs in the Area are developed to achieve the following overarching goals:

a) Sustainably manage the Area across the region;

b) Ensure the protection and preservation of the marine environment;

c) Maintain regional biodiversity and ecosystem structure, function and processes across the region;

d) Enable the conservation of representative habitats and vulnerable marine ecosystems;

e) Ensure environmental sustainability and functionality during and after exploitation activities;

f) Ensure that activities are undertaken in an environmentally responsible manner in the Area;

g) Promote access to, and sharing of, data and information relating to the protection and preservation of the marine environment in the Area, including oceanographic and environmental baseline studies;

h) Facilitate cooperative research to better understand the marine environment to inform the implementation of this plan, including through the participation of developing countries and multilateral exchange of views on environmental management issues; and

i) Encourage cooperation between contractors, sponsoring States and other stakeholders in the region.

Purpose of the REMP

13. The purpose of this REMP is to set in place conservation and management measures and tools across the region in the Area of the northern MAR to ensure the effective protection of the marine environment from harmful effects that may arise from activities in the Area, in accordance with Article 145 of the Convention and the strategic plan of the Authority. To this end, this REMP

[6] See ISBA/24/A/10.

establishes the principles, goals and objectives and identifies area-based and other management measures, as well as an implementation strategy.

Geographic scope of the REMP

14. The MAR is an elevated area of seafloor that runs roughly north-south through the middle of the Atlantic Ocean. This REMP applies to the Area of the northern MAR. The geographical area covered under this plan extends 100km on each side of the ridge axis to ensure complete coverage of the ridge system, including its axis and shoulders. The geographical limits of the area covered under this REMP are represented in Figure 1.

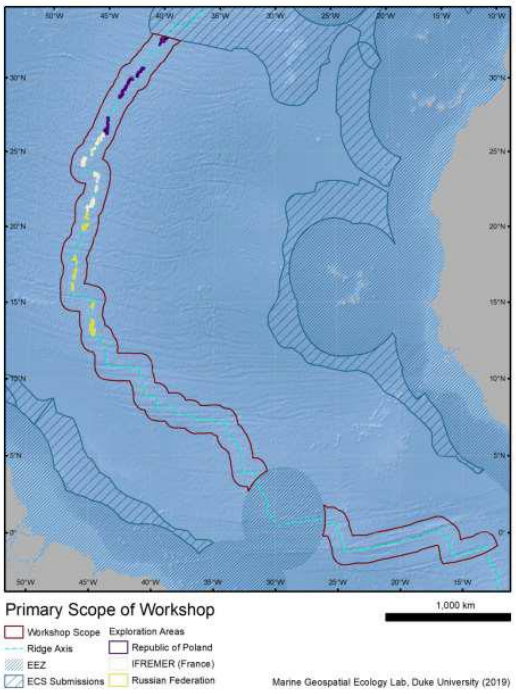

Figure 1. Geographic scope of the REMP for the Area of the northern MAR.

Environmental and geological setting and the exploration areas for PMS deposits

15. Comprehensive sets of scientific data and information on the geology, oceanography and biological communities of the MAR have been compiled and synthesized in the Data Report and Regional Environmental Assessment[7], as inputs to the preparation of this REMP. Drawing on these scientific compilations, the environmental characteristics of the MAR are summarized in this section.

16. The MAR covers not only the rocky ridge, but also rift valleys, fracture zones, seamounts, submarine volcanoes, hydrothermal vents, sedimented slopes, sedimented plains and pelagic oceanic complexes. The ridge itself has an active spreading centre, with a pronounced central rift

[7] https://www.isa.org.jm/event/workshop-regional-environmental-plan-area-northern-mid-atlantic-ridge#BckDocs

valley, whilst the flanks of the MAR are made up of mainly (> 95 %) gentle slopes and discontinuous flat plains, which are largely sedimented. The flat plains are generally aligned parallel to the axis of the ridge. Steep (gradients >5 % and mainly hard substrate) slopes comprise only about 5 % of the MAR area although in the context of a largely sedimented Atlantic Ocean basin, the MAR provides a large proportion of hard substrata habitat.

17. The MAR is a slow spreading ridge system. The ridge axis is broken into numerous segments by fracture zones which can offset the ridge by hundreds of metres to hundreds of kilometres. The active volcanism associated with spreading centres along the MAR has created a series of hydrothermal vent sites. The hydrothermal activity at these sites and resulting precipitation of sulphide minerals has formed hard substrate sulphide-rich habitat, and in some places, metal-rich sediments. In some locations, sulphides-rich habitat remains hydrothermally active, whilst in other locations, hydrothermal activity has ceased rendering the vents hydrothermally inactive.

18. The large-scale circulation of the North Atlantic consists of largely wind-driven, surface-intensified gyre circulations interacting with a significant density-driven meridional overturning component in which warm surface waters are drawn to high latitudes where they are transformed and returned as dense, deep waters. It is the open connection to the Nordic Seas and the Arctic that permits this strong overturning circulation, mediated by the relatively shallow ridge between Greenland and Scotland which must be traversed by newly formed deep waters.

19. The complex hydrographic setting around the MAR in general and the presence of the ridge itself leads to enhanced vertical mixing and turbulence that results in areas of increased ocean productivity. The presence of the northern MAR disrupts the ocean circulation creating regions of high biomass that may arise from topographic influences on water circulation, bathymetrically induced fronts, and upwelling nutrient-rich deep water. As a result of these factors, the MAR concentrates biomass over its flanks and summits creating mid ocean regions of high productivity. [8]

20. The combined surface and mid-water environment (surface to 50m above seafloor) is a vast environment spanning thousands of meters' water depth and host diverse fauna. The pelagic environment exhibits large gradients in light, heat, and availability of surface-derived food, all of which are in general negatively correlated with depth. However, compared with the adjacent abyssal and pelagic environments, the presence of the MAR has the effect of greatly concentrating biomass.

21. The benthic environment of the northern MAR is a complex patchwork of habitats spanning thousands of metres depth range and encompassing varied seabed geomorphological types. [9] The MAR exhibits a high heterogeneity of habitats. The diverse range of benthic habitats can be broadly grouped into four types: (i) hydrothermal hard substrata habitat (subdivided into hydrothermally active and inactive sulphide-rich habitat); (ii) exposed rock outcrops non-sulphide hard substrate (such as basalt); (iii) soft sediment (including pelagic sediment and hydrothermal sediment from hydrothermally active and inactive areas and (iv) the water column 50m above the seafloor (benthopelagic). These deep-sea benthic habitats are dynamically connected over a range of spatial scales through dispersal processes and interactions with the pelagic ecosystem. Distinguishing between active and inactive sulphide habitat can be challenging, but is essential, because active and inactive habitats support very different biological communities, with potentially different resilience and recovery potential.

22. In the northern MAR, distribution of the known twenty two sites of PMS deposits is heterogeneous and distances between sites vary considerably (from 10 to more than 100 km). It

Commented [FM|SU1]: Sediments are not 'hydrothermally active', incorrect choice of words

Commented [FM|SU2]: These are not deposits as per economic geology definition. They may be in the future with more knowledge but not now.

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[8] Priede et al., 2013 Does Presence of a Mid-Ocean Ridge Enhance Biomass and Biodiversity? PLOS one 8(5): e61550

[9] Harris PT, Macmillan-Lawler M, Rupp J & Baker EK (2014) Geomorphology of the oceans. Marine Geology, 352: 4 – 24.

was estimated all known sites represent 20-30% of predicted number of undiscovered sites.[10] Further advancement in the resource evaluation of the sulphide areas may result in discovery of more vent sites.

23. The environmental setting of the MAR influences the development of this REMP in a number of ways. The complex geomorphology and high heterogeneity of habitats make it challenging to identify a representative network of sites or areas that can capture the full range of biodiversity and environmental gradients across the region. Distinct habitats and communities, such as active hydrothermal vent systems, occur at a much finer spatial scale, compared to abyssal plain and other deep-sea environments. Several active vent systems are present within existing contract areas for exploration. As such, the goals, objectives and management measures developed under this REMP were developed to reflect these regional characteristics.

24. As of July 2021, three contracts have been granted by ISA for exploration of polymetallic sulphides in the Area of the northern MAR. Exploration contracts last for up to 15 years. One of the obligations of these three contractors is to relinquish parts of their exploration area. At the end of the relinquishment process, their exploration areas shall not exceed 2,500 km^2. All relinquished areas revert to the international seabed Area.

25. It should be noted that PMS deposits differ from PMN and CMC deposits. This applies to the more complex geological and geomorphological setting, the presence of specific physicochemical conditions and biocenoses associated with hydrothermal vents, as well as to the limited surface extent of PMS deposits on the ocean floor. The surface area of known PMS deposits is measured at a scale of a few hundreds of meters. In comparison, the surface area is dozens of times larger for CMC deposits, and hundreds and thousands of times larger for PMN deposits. [11] The large difference in the surface extent of different mineral deposits likely result in different scales of the potential environmental impacts from exploitation activities in different mineral provinces, and should be taken into consideration in regional environmental planning and management.

Commented [FM|SU4]: Here is ok to use deposit because the term is used in abstract.

Commented [FM|SU5R4]: Anyhow, it should be used carefully. PMS deposits ARE NOT PMS sites / areas / fields. Deposits are in sites/areas/fields but not all sites/areas/fields are deposits!

Region-specific goals and objectives

I. Region-specific goals

26. This REMP aims to achieve the following environmental goals at the regional scale for the northern MAR:

a) Prevent habitat loss to maintain ecosystem viability;

b) Ensure connectivity is maintained amongst populations;

c) Maintain representativity of habitats at the regional scale;

d) Maintain migratory corridors;

e) Maintain feeding and breeding grounds;

f) Maintain ecosystem function (both benthic and pelagic); and

g) Ensure exploitation does not exceed cumulative impacts thresholds.

II. Operational objectives

A. Operational objectives for the area covered under this REMP

[10] Beaulieu et al., 2015. Where are the undiscovered hydrothermal vents on oceanic spreading ridges? Deep Sea Research PtII, 121, DOI:10.1016/j.dsr2.2015.05.001

[11] Petersen S. et al (2016) News from the seabed – geological characteristics and resource potential of deep-sea mineral resources. Marine Policy 70: 175-187.

27. The following operational objectives apply to the geographical scope of this REMP (see Figure 1):

a) Determine the types and distribution of habitats (including through modeling) to assess representativity at the regional scale;

b) Determine patterns of connectivity between populations of species important for maintaining ecosystem function and processes;

c) Identify and designate, where appropriate, Areas and Sites in Need of Protection and establish processes for the identification and designation of such sites;

d) Monitor and assess impacts from activities in the Area;

e) Develop scientific methodologies for understanding and assessing cumulative environmental impacts in the Area, through collaboration with other competent regional and international organizations and scientific communities, where feasible;

f) Identify and map corridors of migratory species such as marine mammals and turtles;

g) Identify feeding and breeding grounds for key species such as marine mammals and large nekton;

h) Compile, analyze and synthesize data and information, in collaboration with different contractors and the scientific community regarding the benthic and pelagic ecosystems as well as an food web and energy pathways, and thereby enhancing the understanding of ecosystem structure and functioning at a regional level;

i) Assess the distribution of habitats and model potential responses to impact from climate change and human activities that would require assessment or reassessment of any future area-based management tools(ABMTs) to be established under this REMP;

j) Establish a process for periodically updating environmental baseline data for the region;

k) Update regional environmental assessments, as outlined in the Strategic Plan of the International Seabed Authority for the period 2019–2023[12], when appropriate as new scientific data and information are made available; and

l) Promote the development of mining technologies that can help effectively address the potential environmental risks to the MAR systems, that may be posed by exploitation of polymetallic sulphides.

B. Operational objectives for contract areas

28. The following operational objectives are related to contract areas as well as the regional scale:

a) Avoid harmful environmental impacts on active vent sites with significant megafauna communities, including loss of vent communities in areas around a potential mine site.

b) Ensure that sustainability is not compromised due to harmful environmental impacts on vulnerable/sensitive habitats and communities, including coral gardens and sponge aggregations in the contract area and surrounding areas;

c) Minimize harmful environmental impacts on important species for the maintenance of ecosystem functioning and integrity; and

d) Manage harmful environmental impacts to ecologically important sediment systems.

Management measures

[12] See ISBA/24/A/10

I. Overall consideration

29. This REMP recognizes that contractors have security of tenure over contract areas, and any management measures prescribed in the context of this plan will need to take this into account. It will be particularly important to ensure that the implementation of spatial management measures does not interfere with the implementation of environmental baseline studies and monitoring programmes by contractors. Other exploration activities, including large-scale sampling, testing of mining components and test mining require a prior Environmental Impact Assessment (EIA) to be conducted, in accordance with the recommendations of the LTC.[13] Management measures contained in this REMP should complement the implementation of those activities relating to environmental baseline studies and monitoring.

30. Contractors are encouraged to conduct environmental surveys outside their contract areas, in cooperation with the scientific community and in particular those from developing countries.

31. This REMP does not include ABMTs identified through the application of network criteria such as representativity and connectivity, based on a regional analysis. It is noted that additional expert discussion led by the LTC will be needed in the future on the application of the network criteria.

32. It is noted that thresholds are needed for describing the occurrence of vulnerable ecosystem features in the application of the criteria for ABMTs, and for evaluating and controlling the impacts of mining activities. As such thresholds would be useful for consistent implementation of both area-based and non-spatial management measures. These thresholds may need to be adaptive, and likely change as new data and information are collected on the impacts of mining activities and new knowledge of habitat and species responses becomes available. Periodic updates on appropriate parameters and thresholds will be also needed.

II. Area-based management measures

A. Areas in Need of Protection (AINPs)

33. Areas in need of protection (AINPs) are large-scale areas of ecological importance due to their uniqueness and/or biodiversity. They are described using, in the context of ISA, the scientific criteria outlined in Annex 4.

34. AINPs aim to protect regional-scale ecosystem features, which are important in terms of basin-scale water mass exchange, biogeographical zonation and transitions, connectivity and ecosystem function. Because of their large areal extent and up to abyssal depths, they cover multiple biogeographical provinces, habitats and ecological gradients.

35. This REMP identifies three AINPs (Kane Fracture Zone, Vema Fracture Zone, and Romanche Fracture Zone System), as listed in Annex 1.

36. In these three AINPs, the following management measures will be applied:

a) They will be protected from direct or indirect impacts from exploitation of mineral resources in the Area;

b) Each of them will be protected as an integrated system;

c) For the management of AINPs, the LTC should develop a zoning scheme, where applicable. For example: (i) a core zone of full protection, (ii) a buffer zone of sufficient size to provide protection from indirect effects, (iii) and possibly other zones where activities compatible to the management purpose of AINPs can be allowed, when scientific information on the spatial scale of transportation of fine particles from mining plumes becomes available;

d) ISA secretariat should promote and facilitate collaborative monitoring[14] and scientific

[13] ISBA/25/LTC/6/Rev.1 and Corr.1

[14] Monitoring referred to in this paragraph describes the collection and analysis of environmental data for understanding the marine environment at a large scale and beyond the geographical boundaries of contract areas,

research efforts in the AINPs, within the context of ISA's mandate on marine scientific research, in particular the ISA Action Plan in support of the UN Decade of Ocean Science for Sustainable Development. ISA secretariat should also look for opportunities for capacity-building of nationals from developing States within these monitoring and research programmes.

B. Sites in need of protection (SINPs)

37. SINPs are fine-scale sites, where vulnerable marine ecosystems have been identified. They are described on an individual basis, using, the scientific criteria provided in Annex 4. Identification of such sites is intended with a view to managing activities that would have serious harmful effects on vulnerable marine ecosystems.

38. This REMP identifies 11 active vent ecosystems whose existence has been confirmed by direct observation as SINPs.[15] These 11 SINPs are located within the existing contract areas for exploration, as listed in Annex 2.

39. The management of SINPs should aim to maintain ecosystem functions and associated features from the direct and indirect impacts of exploitation of mineral resources.

40. Fully respecting the rights and obligations of contractors in the existing contracts for exploration, the following management measures will be applied for the 11 SINPs:

a) The SINPs will be protected from direct and indirect impacts of exploitation of mineral resources. Contractors operating in the vicinity of a SINP will be required to provide sufficient information and data that there would be no direct or indirect impacts on the SINP, including negative impacts on any subsurface fluid flow to active vent features, before any proposed exploitation activities can be approved;

b) Contractors will delineate as guided by the LTC, the specific boundaries of these SINPs located within their respective contract areas, to a sufficient resolution and precision to allow for management measures as outlined in paragraph 40 to be applied to protect intact habitats, species and ecosystem function of each site.

c) A SINP may include within its boundary: (i) a core zone of full protection, (ii) a buffer zone of sufficient size to provide protection from external effects, (iii) and possibly other zones where activities compatible to the management purpose of SINPs can be allowed. Buffer zones may be asymmetrical in extent reflecting local oceanographic and site geography;

d) Contractors may prepare a clear description, through detailed mapping (including physical and biological features), of the different zones (core and buffer) in terms of their areal extent, based on the generic guidance developed by the LTC on the zoning scheme, including identification of a set of different zones and the corresponding set of allowed and/or prohibited activities.

41. Information on newly discovered vulnerable or sensitive ecosystems will be compiled and used for the future process of identifying SINPs as follows:

a) Contractors report the discovery of new vulnerable or sensitive ecosystems, through their exploration activities, with supporting information including spatial configuration of such ecosystem occurrences, and submit to ISA as part of their annual reporting process;

b) In addition to contractors' exploration activities, new vulnerable or sensitive ecosystems can also be discovered by scientific communities, which can be communicated to the ISA secretariat for review by the LTC;

c) The LTC can consider if further discussion or appropriate actions would be needed, based on the information received; and

therefore does not form part of the obligation relating to monitoring the likely effects of Contractors' programmes of activities.

[15] See the 11 site descriptions in the Appendix 1-2 of Evora workshop report, pp. 95-115,https://www.isa.org.jm/files/files/documents/Evora%20Workshop_3.pdf

d) Newly discovered vulnerable or sensitive ecosystems should be described and assessed against the criteria for SINPs, before any recommendations can be made regarding their conservation status or management measures.

C. Site/Areas in Need of Precaution (S/A Precaution)

42. Sites/Areas in need of increased precaution (S/A-Precaution) are either fine-scale sites or large-scale areas that have been predicted to have features that may give the site/area conservation value. The predictions could be based on various methods, including the detection of natural hydrothermal plumes (e.g., inferred hydrothermal vents) or habitat modelling (e.g., cold-water octocorals). When scientific information from further research and direct observation becomes available, ISA, through its relevant process (e.g., LTC supported by expert workshops), can assess if the sites/areas can be described as sites/areas in need of protection and inform future review of the REMP.

43. This REMP identifies twelve inferred active hydrothermal vent systems as Sites in Need of Precaution, based on detection of hydrothermal plumes in the water column but not linked to active vent sites, and areas of potential cold-water octocoral habitat, drawn from habitat suitability models as Areas in Need of Precaution, as listed in Annex 3.

44. During the exploration phase, if S/A Precaution are described and meet relevant criteria, supported by scientific information, they can be considered as SINPs or AINPs. If inferred or predicted areas are found not to meet the criteria for SINPs or AINPs, their S/A Precaution status may be removed.

45. In the case of inferred active vents, contractors are encouraged to apply increased survey efforts to validate the existence of active vents. It is noted that habitat suitability models can be useful for showing areas where new sites are potentially more likely to be discovered. However, suitable habitat areas predicted by models must be validated through surveys, and encounters and quantitative measurements (e.g. abundance, diversity, biomass) of indicator species need to be reported.

46. Contractors planning to undertake exploitation activities in the S/A Precaution should apply a precautionary approach until their status are assessed.

III. Other management measures

47. Other management measures have been identified to complement area-based management measures, and to encourage sound environmental management of exploration and exploitation activities in a way that is consistent with the goals and objectives of this REMP.

A. At the scale of the area covered under this REMP

48. The following non-spatial management measures will be applied at the regional scale (see Figure 1 for the geographical scope of this REMP):

a) Apply a range of mitigation measures, as appropriate, to all major impacts from exploitation activities;

b) Monitoring for potential cumulative impacts in the Area to prevent serious harm;

c) Develop multiple thresholds, which can enable timely detection of where impacts are approaching serious harm. Determining the thresholds for what would be considered "serious harm" can draw on existing frameworks and strategies and benefit from engaging with appropriate experts. The following thresholds together with their indicators and methodology for measuring these thresholds will be developed:

- acceptable levels of potentially toxic contaminants and particulates impacting on biota in the SINPs and AINPs listed in Annex I and II;
- acceptable levels of potentially toxic contaminants in returned water;
- acceptable levels of particulate content of returned water;

- acceptable levels of noise from vessel and any noise emitted in the water column and benthic environment;
- acceptable deviation from baseline information on habitats before an action is taken; and
- acceptable levels of light pollution in the pelagic and benthic environment.

B. At the scale of contract areas

49. This REMP will apply the following non-spatial management measures at the scale of contract areas:

a) On active vent sites with significant megafauna communities, contractors should ensure active mining plume management as well as monitoring of hydrothermal flows to avoid interruption or disruption to hydrothermal flows upon which vent communities rely;

b) On vulnerable habitats including coral gardens, sponge aggregations, contractors will monitor any of such habitats likely to be impacted by their activities, including the habitats that lie in the vicinity outside their contract areas;

c) On key vulnerable/sensitive species, contractors will monitor significant communities of fauna within contract areas and in surrounding areas likely to be impacted by mining activities.

d) To manage harmful environmental impacts to key sediment systems, contractors will need to identify key sediment communities both within and in the areas surrounding a contract area and actively manage the return-water plumes and the impact of the removal of any sediment overlying the mineral resources (over burden) and its deposition to avoid serious harm to the marine environment.

e) To control exploitation activity to remain within impact thresholds, contractors should apply the established thresholds and where relevant identify relevant environmental thresholds, e.g. for impact of particulates in plumes;

f) To ensure no increase in ambient particulate flux in the pelagic environment, contractors should control the generation of plumes arising from extraction and redeposition of waste material from surface processes such that they remain at or below ambient levels. The release of returned water plume (particles, contaminants, and altered water chemistry) should be returned as close to the sea floor as practical, noting that release in midwater can disrupt larval dispersal and gene flow at all ocean depths leading to loss of connectivity or ecosystem function[16];

g) Apply thresholds for the impacts of mining plume (particles and toxic contaminants) on SINPs;

h) Prevent the impact of overburden removal and placement on hydrothermal vent faunas and fauna of other SINPs;

i) Apply an adaptive management approach in undertaking activities in their contract area;

j) Control generation of underwater sound from surface vessel, from riser pipe pumps, particularly in the Sound Fixing and Ranging (SOFAR) channel and at the seabed to avoid interference with pelagic fauna communications, particularly marine mammals;

k) Control light on the seabed and from vessels that can attract birds and disrupt their behavior;

l) Apply thresholds for noise at seabed and in riser pipe pumps and for light pollution at seabed and on the surface, recognizing that such thresholds may need to be periodically reviewed as more information becomes available on environmental baselines and biological responses to pressures;

[16] These points were only considered to be relevant at the regional scale if multiple sites within an area undergo exploitation activities at the same time.

m) Avoid the introduction of invasive species from vessels that can lead to loss of ecosystem function and biodiversity**;**

n) Monitor direct and indirect impacts of mining, including impacts on subsurface hydrological flow changes, impacts of overburden removal and on key habitats outside contract areas, and potential long-term impacts on biological communities, in order to minimize such impacts;

o) Undertake seabed surveys and habitat mapping of the area predicted to be impacted by the mining plume;

p) Apply temporal suspension of mining operations during significant biological events (e.g., major spawning aggregations); and

q) Develop thresholds for categorization of significant faunal communities.

Implementation strategy

50. In the context of implementing this REMP, the following priorities for future monitoring[17] and research are identified:

I. *Monitoring at the regional scale and research to enhance a comprehensive understanding of regional environmental baseline, and spatial and temporal variations*

a) Bathymetry, geophysics and regional scale mapping: Efforts may start from collating data and information from different sources, including the ISA DeepData database, to develop regional-scale knowledge of bathymetry and geophysics, in order to provide a regional baseline and to guide future sampling efforts.

b) Physical and chemical oceanography: Oceanographic models can be developed at the regional scale through collaboration. Contractors are encouraged to enhance sampling efforts and collaborate with each other and with scientific communities to establish regional patterns of ocean chemistry, currents and other oceanographic parameters.

c) Regional patterns of biodiversity: A practical first step may be to focus on basic matrices, such as species abundance and composition of different taxa and the diversity, richness, evenness of assemblages.

d) Population connectivity: Initial monitoring and research efforts may focus on validating existing connectivity models. A standardized approach can be established using suitable indicator species for regional analyses of connectivity to provide regional baselines against which changes can be monitored.

e) Migratory connectivity of marine mammals, sea turtles, or other large animals in the surface and midwater environments: Monitoring and research may focus on mapping regional baselines, key habitats that serve as feeding and breeding grounds, as well as potential impacts from underwater noise or plumes during exploitation activities on the suitability of migration corridors.

f) Trophic connectivity/relationships: Monitoring and research may focus on measurements at different trophic levels, such as surface primary productivity, the location of the deep-scattering layer and diel vertical migrations in the mid-water column, and abundance of top predators.

g) Ecosystem function: Research efforts may focus on structural properties critical for ecosystem function. Studies on community structure may be an essential first step in understanding ecosystem function, which can be followed by experimental studies on "tipping points" beyond which further loss on structural properties may impact on ecosystem function.

[17] Monitoring referred to in paragraphes 50-54 may describe the collection and analysis of environmental data for understanding the marine environment at a large scale and beyond the geographical scope of contract areas, therefore may not form part of the obligation relating to monitoring the likely effects of Contractors' programmes of activities.

Identifying functional trait profiles can also be a useful approach for understanding ecosystem function. Information on trait profiles will need to be augmented by information on trophic flows, functional diversity, and redundancy of traits at the major trophic levels. Models of ecosystem function and identification of proxies or indicator species should be undertaken for monitoring ecosystem function.

h) Resilience and recovery: Monitoring and research may focus on the abundance or health of indicator species and community trait profiles, in particular biological traits linked to sensitivity. Small-scale disturbances or experiments can also inform models and predictions of resilience and recovery.

II. *Monitoring and research to support area-based management*

a) Habitat mapping and modelling: Habitats will first need to be comprehensively defined and mapped within the region to establish environmental baselines and assess habitat quality, quantity and regional distribution. Habitat models may be developed for the identification of representative habitats.

b) Buffers and depth zonation: Experimental studies and research may be conducted to address important data gaps for designing buffer zones, such as data on hydrodynamic patterns and geophysical characteristic of vents fields, which are necessary for understanding the footprint around which to design buffer zones.

c) Better knowledge of AINPs and S/A-Precaution: As such areas may be located outside contract areas and cover large geographical space, contractors are encouraged to collaborate with scientific organizations to conduct joint surveys. Where possible, the ISA secretariat may facilitate collaboration with other organisations and multinational research projects in developing multidisciplinary programmes for monitoring and research.

III. *Monitoring and research to support non-spatial management*

a) Risk analyses at the regional scale: This can be achieved through the development and application of frameworks and methodologies, such as cumulative impact analyses and scenario planning, to identify and assess risks to ecosystems, habitats, communities and species and to establish key thresholds which trigger management actions.

b) Physical and chemical characterization of natural hydrothermal plumes, as well as plumes from exploitation activities. Changes in hydrothermal fluid which may be associated with exploitation activities should also be monitored. Monitoring may focus on the composition of natural and mining-induced plumes and ecotoxicology, plume dispersal models, and the identification of tipping-points to inform monitoring efforts and associated management actions. A combination of different methodologies (field experiments and models) may be used to understand the behaviour of plumes and inform the development of relevant thresholds. Contractors will be encouraged to develop technological solutions for plume reduction.

c) Underwater noise: Hydrophones can be used for passive acoustic monitoring of background noises. The activities and behavior of fishes and marine mammals should also be monitored to understand the impacts of noises, and to inform the development of relevant thresholds.

d) Development of other thresholds: Thresholds should be identified through a phased approach, in collaboration with contractors, scientific communities and other relevant international bodies.

51. In implementing the above-noted priorities, dedicated expert workshops will be organized/facilitated by the ISA secretariat to identify priority knowledge gaps and to develop a structured approach towards monitoring, including the use of key indicators and parameters and associated thresholds for monitoring at a range of spatial and temporal scales. Consideration

should be given to identifying variables that fulfil the criteria of specificity, sensitivity, and responsiveness for relevant monitoring priorities.

52. A collaborative approach will be essential for monitoring and research at the regional scale. To this end, the ISA secretariat should facilitate collaboration among contractors, sponsoring States, scientific institutions and programmes, international and regional bodies, and other organizations in the implementation of the priorities. Such collaboration will be directed towards, *inter alia*: developing mechanisms for reviewing environmental data in DeepData and intercalibration studies to ensure coherence within DeepData, and to bring together historic academic data as well as contemporaneous data. As part of this collaboration, models and methodologies need to be developed or adapted from existing efforts to ensure compatibility between datasets, particularly historical datasets. Intercalibration of sensors may also help ensuring consistency in sensor methodology and comparability of sensor data. ISA secretariat will also facilitate taxonomic standardization and associated intercalibration studies through the organization of taxonomic workshops and other means, aimed at the development of standarized taxonomy identification systems using traditional, image-based and molecular methods.

53. In implementing the monitoring and research priorities in relation to area-based and non-spatial management, the ISA secretariat will facilitate collaboration with relevant international and regional organizations, contractors, scientific institutions and the industries. It is recognized that the implementation of this REMP can draw on existing practices and lessons of other competent international and regional organizations, where relevant and appropriate. Collaboration with other competent international and regional organizations will aim to bring together existing knowledge and resources to inform the design and monitoring of SINPs, AINPs and S/A Precaution, as well as the development of relevant thresholds. The implementation of this REMP would also benefit from sharing best practices and creating synergies at the regional scale with the relevant competent international and regional organizations within the context of respective competences and mandates.

54. The implementation of the different monitoring and research programmes should also create opportunities for capacity development of developing country member States, including through the collaboration with relevant international and regional bodies/organizations/initiatives.

55. Technology will play an important role in future environmental management and monitoring. ISA secretariat will facilitate a forum on technology development, to link engineers, contractors and scientists, to better understand how technology is evolving, the impacts of new technologies, and how technology advancements can improve our ability to monitor the environment (e.g., through development of AUV and sensor technologies).

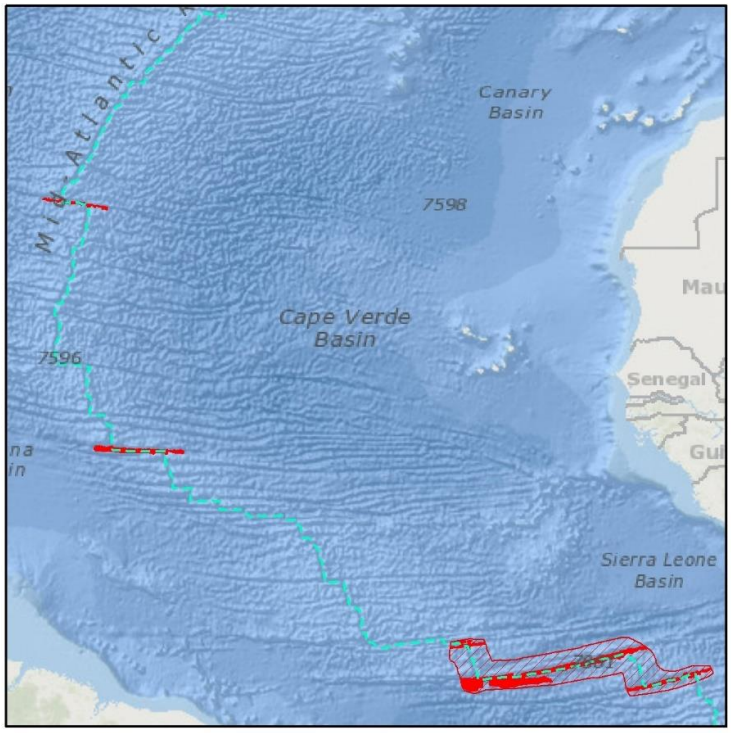
56. In order to effectively facilitate the implementation of this REMP, the ISA secretariat will develop an information-sharing mechanism to compile relevant scientific and technical information in support of its implementation, where appropriate in connection with the ISA DeepData database, in collaboration with contractors and other relevant stakeholders.

Review of the progress in the implementation of the REMP

57. The progress of the implementation of this REMP is to be reviewed by the LTC at least every five years, as required, focusing on the key elements of the plan, including the environmental setting, the management measures, and the implementation strategy. The review will be undertaken to determine their suitability or need for amendment, on the basis of the best available data and information and in alignment with the rules, regulations, and procedures of ISA.

58. The LTC will report the results of the review to the Council, and where appropriate, provide recommendations to the Council on amendments to be considered for strengthening the scientific basis and improving the implementation of the plan.

Annex I. List of Areas in Need of Protection (AINPs), with coordinates



588 **1. Turning points for Kane Fracture Zone**

Points	Longitude	Latitude	Points	Longitude	Latitude
1	-46.9892065	23.9425133	**39**	-45.1541388	23.6795076
2	-46.9458730	23.9236403	**40**	-45.0156542	23.6638032
3	-46.8666369	23.9593322	**41**	-44.9721101	23.6909290
4	-46.8233970	23.9389840	**42**	-44.9369214	23.6617369
5	-46.7938254	23.9250680	**43**	-44.8917116	23.6724444
6	-46.7367184	23.8943729	**44**	-44.8438238	23.6683564
7	-46.6596238	23.8950868	**45**	-44.7941537	23.6641163
8	-46.5466267	23.8639910	**46**	-44.7555812	23.6696408
9	-46.5275673	23.8700657	**47**	-44.7315466	23.6730831
10	-46.4621286	23.8909227	**48**	-44.6780087	23.6366773
11	-46.4507959	23.9186683	**49**	-44.6302088	23.6148615
12	-46.4448775	23.9331582	**50**	-44.5371719	23.6153374
13	-46.3890791	23.9407724	**51**	-44.4795617	23.6252559
14	-46.3425606	23.9682552	**52**	-44.4517220	23.6081238
15	-46.2955663	23.9634963	**53**	-44.4221229	23.6083881
16	-46.2705820	23.9450555	**54**	-44.3717721	23.6088376
17	-46.2384592	23.9236403	**55**	-44.3503569	23.5895640
18	-46.2220409	23.8929453	**56**	-44.2632686	23.5867086
19	-46.1950341	23.8415489	**57**	-44.2104446	23.5824256
20	-46.1539884	23.8671281	**58**	-44.1140764	23.5688627
21	-46.1165119	23.8213235	**59**	-44.0148529	23.5517306
22	-46.0778729	23.8080737	**60**	-43.9423067	23.5213487
23	-46.0379896	23.8094262	**61**	-43.9295214	23.5211506
24	-45.9707699	23.8379797	**62**	-43.9319845	23.4730260
25	-45.9322226	23.8094262	**63**	-43.9367934	23.4385125
26	-45.8274073	23.8046673	**64**	-43.9434964	23.4107037
27	-45.7827924	23.8445232	**65**	-43.9848717	23.3996830
28	-45.7631619	23.8088313	**66**	-44.0177083	23.4467963
29	-45.6959421	23.8171594	**67**	-44.0498310	23.4225258
30	-45.6626297	23.7814675	**68**	-44.0748153	23.4039660
31	-45.5981463	23.8094262	**69**	-44.0869506	23.4703530
32	-45.5400874	23.7755189	**70**	-44.1383469	23.5174663
33	-45.4865496	23.7927700	**71**	-44.1619036	23.5096141
34	-45.4503817	23.7580298	**72**	-44.1419161	23.4325196
35	-45.3768564	23.7901526	**73**	-44.2083031	23.4496517
36	-45.3083279	23.7944356	**74**	-44.2604133	23.5381676
37	-45.2212396	23.7546986	**75**	-44.3382217	23.5395953
38	-45.1398621	23.7544606	**76**	-44.4180254	23.5577506

Points	Longitude	Latitude	Points	Longitude	Latitude
77	-44.4515113	23.5653687	**116**	-46.4853283	23.8028827
78	-44.5609392	23.5774287	**117**	-46.4965297	23.7987988
79	-44.5752160	23.5167525	**118**	-46.5424354	23.7820624
80	-44.6116217	23.4989065	**119**	-46.5965681	23.8463078
81	-44.6380338	23.5296016	**120**	-46.6893944	23.8723192
82	-44.6473137	23.5917055	**121**	-46.7417425	23.8616116
83	-44.6775601	23.5891633	**122**	-46.8246724	23.8867088
84	-44.7236944	23.6224006	**123**	-46.8321620	23.8889754
85	-44.7289892	23.6230057	**124**	-46.9151779	23.8365520
86	-44.8236317	23.6338220	**125**	-46.9487283	23.8622502
87	-44.8236435	23.6337152	**126**	-46.9642221	23.9008727
88	-44.8275578	23.5981301	**127**	-47.0118113	23.8901651
89	-44.8532560	23.5317431	**128**	-47.0486657	23.8629641
90	-44.9032544	23.5553326	**129**	-47.0927130	23.8758883
91	-44.9450140	23.5428405	**130**	-47.1200768	23.9115803
92	-44.9835613	23.5542619	**131**	-47.1581482	23.9222878
93	-45.0064933	23.6071720	**132**	-47.2349775	23.9107912
94	-45.0725506	23.6308039	**133**	-47.3155177	23.9140652
95	-45.1962553	23.6315615	**134**	-47.3147026	23.9485370
96	-45.2551470	23.6440537	**135**	-47.3120485	23.9968561
97	-45.3092797	23.6375101	**136**	-47.3060230	23.9943337
98	-45.3390230	23.6623755	**137**	-47.2371190	23.9914550
99	-45.4125483	23.6852183	**138**	-47.2021409	24.0057317
100	-45.4990417	23.7267399	**139**	-47.1464615	23.9900273
101	-45.5817280	23.7255502	**140**	-47.1165076	23.9401338
102	-45.6186369	23.7069466	**141**	-47.0729362	23.9350617
103	-45.6780962	23.6934275	**142**	-47.0251090	24.0071594
104	-45.7542389	23.7326886	**143**	-46.9892065	23.9425133
105	-45.8196741	23.6934275			
106	-45.8986722	23.7480361			
107	-45.9648485	23.7366899			
108	-46.0357292	23.7037781			
109	-46.1587746	23.7497769			
110	-46.2265892	23.7521564			
111	-46.2836963	23.7652434			
112	-46.2967833	23.8223505			
113	-46.3645980	23.8401964			
114	-46.4332999	23.8417231			
115	-46.4716737	23.8425759			

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590 **2. Turning Points for Vema Fracture Zone**
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Points	Longitude	Latitude	Points	Longitude	Latitude	Points	Longitude	Latitude
1	-44.4142454	11.0104244	**38**	-43.5538044	10.9504854	**75**	-42.8276209	10.9095353
2	-44.4028240	10.9847262	**39**	-43.5462181	10.9704495	**76**	-42.8123923	10.9019210
3	-44.3923544	10.9942441	**40**	-43.5090985	10.9609316	**79**	-42.7229246	10.8771746
4	-44.3809330	11.0237494	**41**	-43.4526236	10.9406359	**80**	-42.6629621	10.8790782
5	-44.3723669	11.0589654	**42**	-43.4481843	10.9390406	**81**	-42.6401193	10.8847889
6	-44.3419098	11.0627726	**43**	-43.4053540	10.9304745	**82**	-42.5934819	10.8866924
7	-44.3295366	11.0399297	**44**	-43.4018732	10.9356957	**83**	-42.5655454	10.8702592
8	-44.3181152	11.0189905	**45**	-43.3844147	10.9618834	**84**	-42.5611212	10.8676568
9	-44.3066938	10.9894852	**46**	-43.3596683	10.9628352	**85**	-42.5535951	10.8710777
10	-44.2933688	10.9752084	**47**	-43.3349219	10.9333299	**86**	-42.5401820	10.8771746
11	-44.2667189	11.0028101	**48**	-43.3246115	10.9281746	**87**	-42.5333948	10.8724613
12	-44.2410207	11.0266047	**49**	-43.3063684	10.9190531	**88**	-42.5059177	10.8533800
13	-44.2238886	11.0227976	**50**	-43.2711524	10.9142942	**89**	-42.4735571	10.8571871
14	-44.1962868	11.0142316	**51**	-43.2615039	10.9215305	**90**	-42.4554731	10.8695603
15	-44.1658297	10.9923405	**52**	-43.2521167	10.9285710	**91**	-42.4345339	10.8705121
16	-44.1652042	10.9922333	**53**	-43.2264185	10.9618834	**92**	-42.4002697	10.8495728
17	-44.1325173	10.9866298	**54**	-43.1988168	10.9590281	**93**	-42.3707643	10.8762228
18	-44.1030119	10.9980512	**55**	-43.1626490	10.9276192	**94**	-42.3636235	10.8840437
19	-44.0763620	10.9809191	**56**	-43.1217222	10.9609316	**95**	-42.3507769	10.8981139
20	-44.0440013	10.9523656	**57**	-43.0874580	10.9495102	**96**	-42.3306837	10.8834115
21	-44.0116406	10.9380888	**58**	-43.0769884	10.9352334	**97**	-42.3117537	10.8695603
22	-43.9792800	10.9476066	**59**	-43.0665187	10.9181013	**98**	-42.2958136	10.8824152
23	-43.9459675	10.9951959	**60**	-43.0531938	10.9266674	**99**	-42.2822484	10.8933549
24	-43.9202693	11.0009066	**61**	-43.0370134	10.9371370	**100**	-42.2717788	10.8962103
25	-43.8905824	10.9962498	**62**	-43.0122670	10.9409442	**101**	-42.2548169	10.8812439
26	-43.8717283	10.9932923	**63**	-42.9979903	10.9257156	**102**	-42.2394181	10.8676568
27	-43.8308016	11.0037619	**64**	-42.9780028	10.9085835	**103**	-42.2191173	10.8802239
28	-43.8172856	10.9959642	**65**	-42.9646778	10.9181013	**104**	-42.1994431	10.8924031
29	-43.8060552	10.9894852	**66**	-42.9570635	10.9095353	**105**	-42.1737450	10.8819335
30	-43.7917784	10.9656905	**67**	-42.9503795	10.8886475	**106**	-42.1657278	10.8786985
31	-43.7784535	10.9352334	**68**	-42.9494493	10.8857407	**107**	-42.1194933	10.8600425
32	-43.7584660	10.9323781	**69**	-42.9432564	10.8878947	**108**	-42.0595308	10.8609943
33	-43.7384785	11.0332672	**70**	-42.9275582	10.8933549	**109**	-42.0388271	10.8750728
34	-43.6775643	11.0332672	**71**	-42.8856797	10.8943067	**110**	-42.0357362	10.8771746
35	-43.6375894	10.9790155	**72**	-42.8698745	10.8835304	**111**	-41.9967131	10.8828853
36	-43.6042769	10.9295227	**73**	-42.8647404	10.8800300	**112**	-41.9837514	10.8739742
37	-43.5643020	10.9228602	**74**	-42.8609388	10.8830517	**113**	-41.9662560	10.8619460

Points	Longitude	Latitude	Points	Longitude	Latitude	Points	Longitude	Latitude
114	-41.9386542	10.8628978	**156**	-40.7831387	10.8056239	**196**	-39.9518089	10.7332254
115	-41.8863061	10.8619460	**157**	-40.7781093	10.8047857	**197**	-39.9524469	10.7145231
118	-41.8301508	10.8724157	**158**	-40.7755553	10.8043600	**198**	-39.9536609	10.6789395
119	-41.8101633	10.8847889	**159**	-40.7441648	10.7991283	**199**	-39.9694123	10.6849141
120	-41.7521045	10.8800300	**160**	-40.7003827	10.7867551	**200**	-40.0055801	10.6782517
121	-41.7362711	10.8698149	**161**	-40.6952066	10.7990142	**201**	-40.0236640	10.6677820
122	-41.7225992	10.8609943	**162**	-40.6822988	10.8295854	**202**	-40.0417479	10.6487463
123	-41.6930938	10.8657532	**163**	-40.6575524	10.8276818	**203**	-40.0617354	10.6601678
124	-41.6464564	10.8676568	**164**	-40.6404203	10.7848515	**204**	-40.0807711	10.6782517
125	-41.6105851	10.8676568	**165**	-40.6251917	10.7962729	**205**	-40.1407335	10.6830106
126	-41.5969636	10.8676568	**166**	-40.5536493	10.7874293	**206**	-40.1959370	10.6772999
127	-41.5788797	10.8743192	**167**	-40.5350895	10.8088444	**207**	-40.2330566	10.6953838
128	-41.5512780	10.8686085	**168**	-40.5262062	10.7810444	**208**	-40.2597065	10.6696856
129	-41.5074375	10.8657983	**169**	-40.5062187	10.7753337	**209**	-40.2835011	10.6763481
130	-41.4770388	10.8638496	**170**	-40.4871830	10.8067426	**210**	-40.2968261	10.6906249
131	-41.3989925	10.8581389	**171**	-40.4808378	10.8495332	**211**	-40.3272832	10.6972873
132	-41.3770859	10.8634496	**172**	-40.4424491	10.8552836	**212**	-40.3567885	10.7039498
133	-41.3675836	10.8657532	**173**	-40.4195786	10.8319721	**213**	-40.3558368	10.6772999
134	-41.3637683	10.8632096	**174**	-40.4115955	10.8238350	**214**	-40.3653546	10.6677820
135	-41.3333193	10.8429104	**175**	-40.3872456	10.7905622	**215**	-40.3881974	10.6772999
136	-41.2705016	10.8419586	**176**	-40.3216518	10.8131274	**216**	-40.4015224	10.6858659
137	-41.2352855	10.8457657	**177**	-40.3109443	10.7760078	**217**	-40.4111157	10.6906626
138	-41.1895999	10.8248265	**178**	-40.2795354	10.7860016	**218**	-40.4148474	10.6925284
139	-41.1790902	10.8227702	**179**	-40.2488403	10.8138413	**219**	-40.4500634	10.7001427
140	-41.1458178	10.8162604	**180**	-40.2387673	10.7848515	**220**	-40.4786169	10.6820588
141	-41.0953732	10.8086461	**181**	-40.2149727	10.7829479	**221**	-40.4881348	10.6915766
142	-41.0439769	10.8143568	**182**	-40.1810257	10.8516747	**222**	-40.4995562	10.7077570
143	-40.9859180	10.8143568	**183**	-40.1597692	10.8200675	**223**	-40.5109776	10.7220337
144	-40.9583251	10.8160291	**184**	-40.1635763	10.7877069	**224**	-40.5614222	10.7325034
145	-40.9231003	10.8181640	**185**	-40.1664317	10.7458283	**225**	-40.6366132	10.7382141
146	-40.8858614	10.8066376	**186**	-40.1426371	10.7391659	**226**	-40.6834141	10.7434874
147	-40.8831253	10.8057908	**187**	-40.1093246	10.7629605	**227**	-40.7041898	10.7458283
148	-40.8660124	10.8046240	**188**	-40.1003620	10.8745175	**228**	-40.7365505	10.7591533
149	-40.8412468	10.8029354	**189**	-40.0796606	10.8002783	**229**	-40.7604207	10.7639274
150	-40.8330699	10.8380479	**190**	-40.0589593	10.8488194	**230**	-40.7928747	10.7704182
151	-40.8250665	10.8724157	**191**	-40.0398443	10.7620087	**231**	-40.7936576	10.7705747
152	-40.8136451	10.8809817	**192**	-40.0360372	10.8153086	**232**	-40.8536200	10.7772372
153	-40.8060308	10.8448139	**193**	-39.9836891	10.7867551	**233**	-40.9459431	10.7772372
154	-40.7992088	10.8206269	**194**	-39.9531498	10.7658139	**234**	-41.0239894	10.7800926
155	-40.7955612	10.8076943	**195**	-39.9525870	10.7521359	**235**	-41.0572328	10.7793620

Points	Longitude	Latitude	Points	Longitude	Latitude	Points	Longitude	Latitude
236	-41.1106018	10.7781890	**275**	-41.5208209	10.6021089	**314**	-44.2362618	10.7791408
237	-41.1629499	10.7743819	**276**	-41.5360494	10.6144821	**315**	-44.3124045	10.7791408
238	-41.2124427	10.7639123	**277**	-41.5455673	10.6401803	**316**	-44.3790294	10.7753337
239	-41.2160798	10.7540402	**278**	-41.5542483	10.6496330	**317**	-44.4104383	10.7962729
240	-41.2191052	10.7458283	**279**	-41.5883976	10.6868177	**318**	-44.4627865	10.8000801
241	-41.1905517	10.7420212	**280**	-41.6226618	10.6658785	**319**	-44.5551095	10.8057908
242	-41.1420107	10.7325034	**281**	-41.6445528	10.6734927	**320**	-44.6070384	10.8074659
243	-41.0687233	10.7334552	**282**	-41.6826242	10.6772999	**321**	-44.6108045	10.8332848
244	-40.9659306	10.7363105	**283**	-41.7264063	10.6896731	**322**	-44.6114455	10.8376793
245	-40.8954985	10.7401176	**284**	-41.8073080	10.7125159	**323**	-44.6165497	10.8795345
246	-40.8909974	10.7413680	**285**	-41.8882096	10.7106123	**324**	-44.6193874	10.9177036
247	-40.8612343	10.7496355	**286**	-41.9710149	10.6944320	**325**	-44.6196756	10.9215791
248	-40.8288736	10.7515391	**287**	-42.0243148	10.6896731	**326**	-44.6223126	10.9735988
249	-40.7974647	10.7277444	**288**	-42.0899879	10.7077570	**327**	-44.6230222	10.9821396
250	-40.7993683	10.6887213	**289**	-42.1870699	10.6982391	**328**	-44.6017470	10.9723530
251	-40.8079343	10.6630231	**290**	-42.2736823	10.7001427	**329**	-44.5798559	10.9856780
252	-40.8212593	10.6220964	**291**	-42.4269196	10.6991909	**330**	-44.5674827	11.0266047
253	-40.8450539	10.5954464	**292**	-42.5858676	10.6972873	**331**	-44.5522542	11.0618208
254	-40.8736075	10.5963982	**293**	-42.7533817	10.6963356	**332**	-44.5322667	11.0570618
255	-40.8935949	10.6201928	**294**	-42.9294618	10.6963356	**333**	-44.5179899	11.0294601
256	-40.9097753	10.6639749	**295**	-42.9875206	10.6953838	**334**	-44.5008578	10.9970994
257	-40.9421359	10.6925284	**296**	-43.0874580	10.7010945	**335**	-44.4827739	10.9799673
258	-40.9982912	10.7049016	**297**	-43.2083346	10.7077570	**336**	-44.4665936	11.0142316
259	-41.0211341	10.6830106	**298**	-43.2978023	10.7144195	**337**	-44.4513650	11.0561101
260	-41.0373144	10.6953838	**299**	-43.3882219	10.7248891	**338**	-44.4370883	11.0694350
261	-41.0630126	10.7134677	**300**	-43.4672200	10.7372623	**339**	-44.4151972	11.0513511
262	-41.1153607	10.7115641	**301**	-43.5519288	10.7458283	**340**	-44.4142454	11.0104244
263	-41.1448660	10.7134677	**302**	-43.6309269	10.7477319			
264	-41.1724678	10.7010945	**303**	-43.7222982	10.7677194			
265	-41.2476587	10.6991909	**304**	-43.7519900	10.7651847			
266	-41.2904890	10.7068052	**305**	-43.8003445	10.7610569			
267	-41.3190426	10.7020463	**306**	-43.8581073	10.7833919			
268	-41.3809086	10.6830106	**307**	-43.8717283	10.7886586			
269	-41.4008960	10.6972873	**308**	-43.9221729	10.7762855			
270	-41.4399192	10.6953838	**309**	-43.9440640	10.7562980			
271	-41.4732316	10.6725410	**310**	-44.0078335	10.7553462			
272	-41.5036887	10.6496981	**311**	-44.1030119	10.7553462			
273	-41.5038510	10.6487249	**312**	-44.1374665	10.7615729			
274	-41.5103512	10.6097232	**313**	-44.1820101	10.7696230			

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3. Turning points for Romanche Fracture Zone System

Points	Longitude	Latitude	Points	Longitude	Latitude	Points	Longitude	Latitude
1	-15.7433035	0.5282108	**40**	-16.9507502	-0.0013369	**80**	-18.0729040	-0.2540356
2	-15.6772096	0.4858205	**41**	-17.0064296	-0.0198967	**81**	-18.1014575	-0.2540356
3	-15.6700018	0.4802524	**42**	-17.0649643	-0.0170413	**82**	-18.1266972	-0.2447368
4	-15.6786903	0.4812178	**43**	-17.1149330	0.0043738	**83**	-18.1285834	-0.2440419
5	-15.7043885	0.4683687	**44**	-17.1290158	0.0150768	**84**	-18.1324125	-0.2469520
6	-15.7124237	0.4598314	**45**	-17.1506249	0.0314997	**85**	-18.1642753	-0.2711677
7	-15.7272313	0.4440982	**46**	-17.1469461	0.0100402	**86**	-18.2085333	-0.2911552
8	-15.7586402	0.4226831	**47**	-17.1420588	-0.0184690	**87**	-18.2485082	-0.2940106
9	-15.8414455	0.4112617	**48**	-17.0957417	-0.0506896	**88**	-18.2597151	-0.2919991
10	-15.8871311	0.4126894	**49**	-17.0885713	-0.0556777	**89**	-18.3041876	-0.2840168
11	-15.9071186	0.3984126	**50**	-17.0763857	-0.0641546	**90**	-18.3798545	-0.3011489
12	-15.9656533	0.3841358	**51**	-17.0992285	-0.0884251	**91**	-18.4341062	-0.3225641
13	-15.9999176	0.3941296	**52**	-17.1491972	-0.0941358	**92**	-18.4969239	-0.3339855
14	-16.0180902	0.4064610	**53**	-17.1929826	-0.0780044	**93**	-18.5383266	-0.3439792
15	-16.0398925	0.4212554	**54**	-17.2034489	-0.0741484	**94**	-18.6016202	-0.3568283
16	-16.0969996	0.4255384	**55**	-17.2166281	-0.0632612	**95**	-18.6302924	-0.3482267
17	-16.1441129	0.4112617	**56**	-17.2362855	-0.0470225	**96**	-18.6396916	-0.3454069
18	-16.1856866	0.3710291	**57**	-17.2648390	-0.0284627	**97**	-18.7234486	-0.3872854
19	-16.1883709	0.3684314	**58**	-17.2768751	-0.0264567	**98**	-18.7976878	-0.3948997
20	-16.2589652	0.3194708	**59**	-17.2991033	-0.0227520	**99**	-18.8890591	-0.4139354
21	-16.2768868	0.3070413	**60**	-17.3547827	-0.0398841	**100**	-18.9575876	-0.4348747
22	-16.3611197	0.2870538	**61**	-17.3593644	-0.0446651	**101**	-19.0527660	-0.4462961
23	-16.4582018	0.2385128	**62**	-17.3658566	-0.0514395	**102**	-19.1403302	-0.4596210
24	-16.5581391	0.2028209	**63**	-17.3876192	-0.0741484	**103**	-19.1701634	-0.4799076
25	-16.5981141	0.2013932	**64**	-17.4490093	-0.0755760	**104**	-19.1879194	-0.4919817
26	-16.6090872	0.2076113	**65**	-17.4540338	-0.0761722	**105**	-19.2242026	-0.4850706
27	-16.6409444	0.2256637	**66**	-17.5332422	-0.0855698	**106**	-19.2278944	-0.4843674
28	-16.6709256	0.2413682	**67**	-17.5575127	-0.0941358	**107**	-19.3078443	-0.4843674
29	-16.7116082	0.2421078	**68**	-17.6003430	-0.0955635	**108**	-19.3858906	-0.4881746
30	-16.7494478	0.2427958	**69**	-17.6902867	-0.1169787	**109**	-19.4410941	-0.4805603
31	-16.7893816	0.2102183	**70**	-17.7364469	-0.1162897	**110**	-19.4962976	-0.4843674
32	-16.8036995	0.1985379	**71**	-17.7859410	-0.1155510	**111**	-19.4962976	-0.5110670
33	-16.8408191	0.1671290	**72**	-17.8330543	-0.1326831	**112**	-19.4962976	-0.5300531
34	-16.8685433	0.1364343	**73**	-17.8353147	-0.1350691	**113**	-19.5857653	-0.5605102
35	-16.8807940	0.1228710	**74**	-17.8587525	-0.1598090	**114**	-19.6561973	-0.5795459
36	-16.9101039	0.0876991	**75**	-17.8674357	-0.1639897	**115**	-19.7380508	-0.5833530
37	-16.9164859	0.0800407	**76**	-17.8972998	-0.1783688	**116**	-19.8002061	-0.5882279
38	-16.9293350	0.0400658	**77**	-17.9615452	-0.2083500	**117**	-19.8351328	-0.5909673
39	-16.9311298	0.0365959	**78**	-18.0200800	-0.2226267	**118**	-19.9112756	-0.6252315

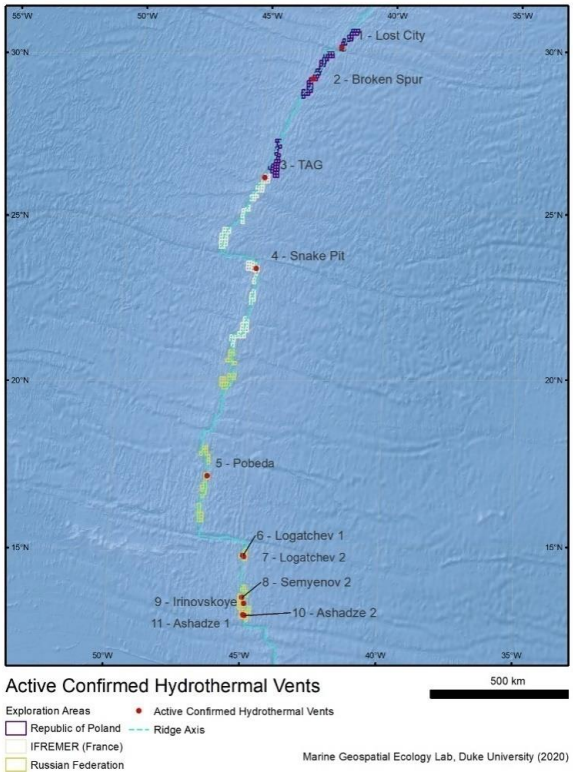
Points	Longitude	Latitude	Points	Longitude	Latitude	Points	Longitude	Latitude
119	-19.9204613	-0.6300946	**159**	-21.6035482	-1.1011237	**199**	-23.4703826	-1.5226280
120	-19.9759969	-0.6594958	**160**	-21.3846378	-1.1030273	**200**	-23.5642241	-1.5084875
121	-20.0457409	-0.6841113	**161**	-21.3579879	-1.0725702	**201**	-23.6708240	-1.5046803
122	-20.0730789	-0.6937600	**162**	-21.3027844	-1.0364024	**202**	-23.6941213	-1.4933158
123	-20.1036332	-0.6937600	**163**	-21.1999916	-1.0383060	**203**	-23.7488703	-1.4666089
124	-20.1587395	-0.6937600	**164**	-21.1124275	-0.9964275	**204**	-23.8668915	-1.4799339
125	-20.1663538	-0.7032779	**165**	-21.0534168	-1.0344988	**205**	-23.9297093	-1.4532840
126	-20.1685128	-0.7045733	**166**	-20.9734670	-1.0820880	**206**	-23.9449379	-1.3980805
127	-20.1949073	-0.7204100	**167**	-20.8364100	-1.1030273	**207**	-23.9335164	-1.3048056
128	-20.2297826	-0.7147849	**168**	-20.7336173	-1.1315808	**208**	-23.9339910	-1.3034935
129	-20.2539179	-0.7108921	**169**	-20.7227829	-1.1577639	**209**	-23.9592449	-1.2336739
130	-20.3080600	-0.7126109	**170**	-20.7170582	-1.1715987	**210**	-23.9658771	-1.2153379
131	-20.3738428	-0.7146993	**171**	-20.7107745	-1.1867843	**211**	-24.1676554	-1.1963022
132	-20.4880569	-0.7070850	**172**	-20.6669924	-1.3009985	**212**	-24.3028088	-1.2305664
133	-20.6346317	-0.7375421	**173**	-20.7431351	-1.3124199	**213**	-24.3096208	-1.2714387
134	-20.7526530	-0.7851313	**174**	-20.7696558	-1.3029903	**214**	-24.3142302	-1.2990949
135	-20.8992278	-0.8003599	**175**	-20.8287957	-1.2819628	**215**	-24.3151822	-1.3447925
136	-21.0819704	-0.8422384	**176**	-20.9277813	-1.2724449	**216**	-24.3180373	-1.4818375
137	-21.1695345	-0.8498527	**177**	-21.0305740	-1.2876735	**217**	-24.3069251	-1.5498997
138	-21.2875558	-0.8707919	**178**	-21.1847631	-1.3029020	**218**	-24.3028088	-1.5751124
139	-21.3960592	-0.8898276	**179**	-21.3123022	-1.3485877	**219**	-24.4378293	-1.5779253
140	-21.5540554	-0.9050561	**180**	-21.4227092	-1.3790448	**220**	-24.4855514	-1.5789195
141	-21.6367311	-0.9173044	**181**	-21.5559590	-1.4037912	**221**	-24.5179121	-1.5732088
142	-21.6568482	-0.9202847	**182**	-21.6701731	-1.4075983	**222**	-24.5481324	-1.6015403
143	-21.7310873	-0.9355133	**183**	-21.8243622	-1.4114055	**223**	-24.5483692	-1.6017623
144	-21.7765224	-0.9374887	**184**	-21.9538049	-1.4095019	**224**	-24.5523194	-1.6274390
145	-21.8186515	-0.9393204	**185**	-21.9754926	-1.4120702	**225**	-24.5674049	-1.7254943
146	-21.9347692	-0.9545489	**186**	-22.0984761	-1.4266340	**226**	-24.7292082	-1.7864085
147	-22.0356584	-0.9964275	**187**	-22.1993653	-1.4304411	**227**	-24.9804793	-1.7521443
148	-22.1079940	-1.0249810	**188**	-22.2218533	-1.4343917	**228**	-25.1460898	-1.6664837
149	-22.1147699	-1.0511168	**189**	-22.3402294	-1.4551875	**229**	-25.2279432	-1.6322194
150	-22.1213189	-1.0763773	**190**	-22.4544435	-1.4666089	**230**	-25.3310983	-1.6235196
151	-22.1135256	-1.1257355	**191**	-22.5103432	-1.4886539	**231**	-25.3364423	-1.6131804
152	-22.1098975	-1.1487130	**192**	-22.5895969	-1.5199089	**232**	-25.3653032	-1.5573415
153	-22.0394655	-1.1601344	**193**	-22.7533038	-1.5389446	**233**	-25.3952779	-1.4844442
154	-21.9519013	-1.1296773	**194**	-22.9360464	-1.5408481	**234**	-25.4188246	-1.4091952
155	-21.8453015	-1.0763773	**195**	-22.9931535	-1.5713052	**235**	-25.4357646	-1.3321670
156	-21.7786766	-1.1182559	**196**	-23.0902355	-1.5427517	**236**	-25.4450205	-1.2642300
157	-21.7101481	-1.1087380	**197**	-23.2710745	-1.5713052	**237**	-25.4580336	-1.1315198
158	-21.6359089	-1.1296773	**198**	-23.4252636	-1.5294267	**238**	-25.4587202	-1.1245182

Points	Longitude	Latitude	Points	Longitude	Latitude	Points	Longitude	Latitude
239	-25.4587543	-1.1243620	**274**	-24.4850755	-1.0881557	**314**	-22.6081567	-1.0082058
240	-25.4125894	-1.1178989	**275**	-24.4403416	-1.0929146	**315**	-22.5424835	-1.0024951
241	-25.3555352	-1.1335428	**276**	-24.3832346	-1.0881557	**316**	-22.4339801	-0.9653755
242	-25.3388261	-1.1381244	**277**	-24.2775865	-1.0586504	**317**	-22.3026339	-0.9187381
243	-25.3341129	-1.1339656	**278**	-24.2071545	-1.0434218	**318**	-22.2713908	-0.8944977
239	-25.4587543	-1.1243620	**279**	-24.1519510	-1.0367593	**319**	-22.2474304	-0.8759078
240	-25.4125894	-1.1178989	**280**	-24.0938921	-1.0329522	**320**	-22.1646251	-0.8406917
241	-25.3555352	-1.1335428	**281**	-24.0491583	-1.0377111	**321**	-22.1573532	-0.8378569
242	-25.3388261	-1.1381244	**282**	-24.0053762	-1.0481807	**322**	-22.1084699	-0.8188007
243	-25.3341129	-1.1339656	**283**	-23.9615941	-1.0386629	**323**	-22.0675875	-0.8113222
244	-25.3186007	-1.1202784	**284**	-23.9206674	-1.0272415	**324**	-22.0304235	-0.8045239
245	-25.2507861	-1.1143297	**285**	-23.8702228	-1.0281933	**325**	-21.9533290	-0.7902472
246	-25.1948687	-1.1274168	**286**	-23.8359585	-1.0158201	**326**	-21.8809934	-0.7750186
247	-25.1460898	-1.1143297	**287**	-23.7607676	-1.0348557	**327**	-21.8029471	-0.7635972
248	-25.0794649	-1.1000530	**288**	-23.7207926	-1.0281933	**328**	-21.7883437	-0.7648400
249	-25.0101540	-1.0953539	**289**	-23.6836730	-1.0167718	**329**	-21.7582132	-0.7674043
250	-25.0092708	-1.0952941	**290**	-23.6532159	-1.0053504	**330**	-21.6858776	-0.7531276
251	-24.9664405	-1.1143297	**291**	-23.5999160	-1.0072540	**331**	-21.5983134	-0.7359954
252	-24.9190292	-1.1421581	**292**	-23.5190143	-0.9967844	**332**	-21.4926653	-0.7264776
253	-24.9117129	-1.1464525	**293**	-23.4561966	-0.9882183	**333**	-21.4650636	-0.7102973
254	-24.8546058	-1.1476422	**294**	-23.3971859	-0.9853630	**334**	-21.3993905	-0.7160080
255	-24.8396682	-1.1417843	**295**	-23.2982004	-0.9644237	**335**	-21.3698852	-0.7083937
256	-24.7939295	-1.1238476	**296**	-23.2020701	-0.9606166	**336**	-21.3061156	-0.7026830
257	-24.8077304	-1.0938664	**297**	-23.1897098	-0.9534476	**337**	-21.2480568	-0.6893580
258	-24.7858394	-1.0710236	**298**	-23.1775592	-0.9464002	**338**	-21.2099854	-0.6769848
259	-24.7477680	-1.0700718	**299**	-23.1544809	-0.9330148	**339**	-21.1871426	-0.6655634
260	-24.7420988	-1.0668322	**300**	-23.1240238	-0.9101720	**340**	-21.1585890	-0.6646116
261	-24.7211180	-1.0548432	**301**	-23.0926149	-0.9187381	**341**	-21.1071927	-0.6674670
262	-24.6954199	-1.0348557	**302**	-22.9888704	-0.9092202	**342**	-21.0710249	-0.6569973
263	-24.6729291	-1.0357208	**303**	-22.8708492	-0.9006541	**343**	-21.0358088	-0.6436724
264	-24.6706735	-1.0358075	**304**	-22.8181635	-0.8757276	**344**	-21.0015446	-0.6408170
265	-24.6468789	-1.0529397	**305**	-22.7823332	-0.8587756	**345**	-20.9358715	-0.6293956
266	-24.6173735	-1.0358075	**306**	-22.6966726	-0.8616310	**346**	-20.8873305	-0.6246367
267	-24.6107111	-1.0120129	**307**	-22.6955167	-0.8694913	**347**	-20.7988145	-0.6046492
268	-24.5469415	-1.0043986	**308**	-22.6871548	-0.9263523	**348**	-20.7750469	-0.5983435
269	-24.5536040	-1.0272415	**309**	-22.7021356	-0.9422695	**349**	-20.7055396	-0.5799028
270	-24.5650254	-1.0529397	**310**	-22.7023833	-0.9425327	**350**	-20.6198791	-0.5570600
271	-24.5650254	-1.0824450	**311**	-22.7157083	-0.9691826	**351**	-20.5532541	-0.5427832
272	-24.5479608	-1.0885707	**312**	-22.7071053	-0.9808827	**352**	-20.4599793	-0.5180368
273	-24.5279058	-1.0957699	**313**	-22.6919137	-1.0015433	**353**	-20.3914508	-0.5047118

Points	Longitude	Latitude	Points	Longitude	Latitude	Points	Longitude	Latitude
354	-20.2743813	-0.4675922	**394**	-18.8400422	-0.2087069	**434**	-17.5932047	0.1386944
355	-20.2020457	-0.4457012	**395**	-18.7991155	-0.1963337	**435**	-17.5721965	0.1557635
356	-20.1525529	-0.4409423	**396**	-18.7534298	-0.1753944	**436**	-17.5627476	0.1634408
357	-20.1259029	-0.4457012	**397**	-18.7010817	-0.1573105	**437**	-17.5061609	0.1667694
358	-20.0983012	-0.4504601	**398**	-18.6553960	-0.1458891	**438**	-17.4980262	0.1672480
359	-20.0535673	-0.4333280	**399**	-18.6192282	-0.1401784	**439**	-17.4953944	0.1685639
360	-20.0354834	-0.4171477	**400**	-18.5754462	-0.1297088	**440**	-17.4561477	0.1881872
361	-20.0069299	-0.4000156	**401**	-18.5335676	-0.1068660	**441**	-17.4256906	0.2015122
362	-19.9726657	-0.3981120	**402**	-18.5173547	-0.0960573	**442**	-17.3781014	0.2034158
363	-19.9431603	-0.3847870	**403**	-18.5123042	-0.0926903	**443**	-17.3228979	0.2224514
364	-19.9088961	-0.3733656	**404**	-18.5107248	-0.0916374	**444**	-17.2791158	0.2319693
365	-19.8632105	-0.3686067	**405**	-18.4859784	-0.0821196	**445**	-17.2315266	0.2262586
366	-19.8394158	-0.3628960	**406**	-18.4777502	-0.0829424	**446**	-17.1820338	0.2319693
367	-19.8118141	-0.3524263	**407**	-18.4760312	-0.0831143	**447**	-17.1420588	0.2510050
368	-19.7718391	-0.3533781	**408**	-18.4479070	-0.0859267	**448**	-17.1268303	0.2776549
369	-19.7204428	-0.3391013	**409**	-18.3803304	-0.0821196	**449**	-17.1363481	0.2985942
370	-19.7111859	-0.3319015	**410**	-18.3508250	-0.0668910	**450**	-17.1150060	0.3185136
371	-19.7033107	-0.3257764	**411**	-18.2861037	-0.0450000	**451**	-17.1077946	0.3252442
372	-19.6673113	-0.3164862	**412**	-18.2204306	-0.0221571	**452**	-17.0583018	0.3309549
373	-19.6443000	-0.3105478	**413**	-18.2134256	-0.0171536	**453**	-17.0183269	0.3461834
374	-19.6301963	-0.3090632	**414**	-18.1871181	0.0016375	**454**	-16.9440877	0.3595084
375	-19.6081322	-0.3067407	**415**	-18.1528539	0.0206732	**455**	-16.8888842	0.3766405
376	-19.5424591	-0.3010300	**416**	-18.1490477	0.0259066	**456**	-16.8482317	0.3717129
377	-19.4863038	-0.2991264	**417**	-18.1376253	0.0416124	**457**	-16.8260664	0.3690262
378	-19.4862398	-0.2991308	**418**	-18.1109754	0.0454195	**458**	-16.7918022	0.3576048
379	-19.4311003	-0.3029335	**419**	-18.0976504	0.0625517	**459**	-16.7594415	0.3595084
380	-19.4377628	-0.3324389	**420**	-18.0929302	0.0845790	**460**	-16.7386597	0.4026706
381	-19.4481116	-0.3464097	**421**	-18.0919397	0.0892016	**461**	-16.7346951	0.4109048
382	-19.4567985	-0.3581370	**422**	-18.0514486	0.0940606	**462**	-16.7175630	0.4299404
383	-19.4263414	-0.3609924	**423**	-18.0443505	0.0949123	**463**	-16.6547452	0.4508797
384	-19.4120646	-0.3467156	**424**	-18.0500612	0.0720695	**464**	-16.5557597	0.4527833
385	-19.3302112	-0.3324389	**425**	-18.0024719	0.0758767	**465**	-16.5404827	0.4520889
386	-19.2455024	-0.3200657	**426**	-17.9605934	0.0949123	**466**	-16.5138811	0.4508797
387	-19.1864917	-0.3000782	**427**	-17.8406686	0.1215623	**467**	-16.5073013	0.4410100
388	-19.1132043	-0.2905603	**428**	-17.7721401	0.1329837	**468**	-16.5043544	0.4365895
389	-19.0770923	-0.2796773	**429**	-17.7484158	0.1263936	**469**	-16.4986526	0.4280369
390	-19.0437241	-0.2696211	**430**	-17.7378759	0.1234659	**470**	-16.4713381	0.4305976
391	-19.0104116	-0.2524890	**431**	-17.6535564	0.1422035	**471**	-16.4377384	0.4337476
392	-18.9152332	-0.2334533	**432**	-17.6350832	0.1463087	**472**	-16.3939563	0.4375547
393	-18.8570272	-0.2142969	**433**	-17.6321382	0.1457732	**473**	-16.3444635	0.4375547

Points	Longitude	Latitude	Points	Longitude	Latitude	Points	Longitude	Latitude
474	-16.3254278	0.4432654						
475	-16.2492851	0.4489761						
476	-16.2416708	0.4832404						
477	-16.1902744	0.4889511						
478	-16.1614530	0.5004797						
479	-16.1522031	0.5041796						
480	-16.1122281	0.5327332						
481	-16.0341818	0.5289260						
482	-16.0040498	0.5289260						
483	-15.9523283	0.5289260						
484	-15.9104498	0.5251189						
485	-15.8704749	0.5289260						
486	-15.8381142	0.5441546						
487	-15.7829107	0.5460581						
488	-15.7804302	0.5485387						
489	-15.7433035	0.5282108						
477	-16.1902744	0.4889511						
478	-16.1614530	0.5004797						
479	-16.1522031	0.5041796						
480	-16.1122281	0.5327332						
481	-16.0341818	0.5289260						
482	-16.0040498	0.5289260						
483	-15.9523283	0.5289260						
484	-15.9104498	0.5251189						
485	-15.8704749	0.5289260						
486	-15.8381142	0.5441546						
487	-15.7829107	0.5460581						
488	-15.7804302	0.5485387						
489	-15.7433035	0.5282108						

601 **Annex II. List of Sites in Need of Protection (SINPs), with coordinates**



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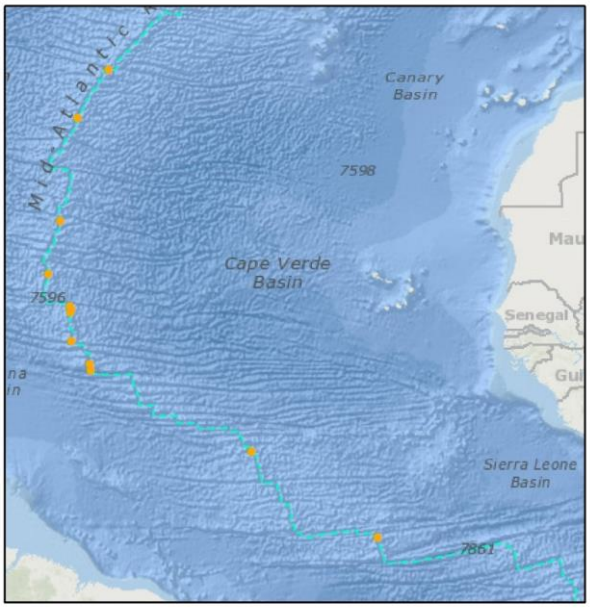
SINP	Longitude	Latitude
Lost City	-42.1183000	30.1250000
Broken Spur	-43.1717000	29.1700000
TAG	-44.8267000	26.1367000
Snake Pit	-44.9500000	23.3683000
Pobeda	-46.4166670	17.1333330
Logatchev 1	-44.9785000	14.7520000
Logatchev 2	-44.9380000	14.7200000
Semyenov 2	-44.9630000	13.5137000
Irinovskoe	-44.8833330	13.3333330
Ashadze 2	-44.9067000	12.9917000
Ashadze 1	-44.8633000	12.9733000

603

Annex III. List of Site/Areas in Need of Precaution (S/A Precaution)

It should be noted that the GIS coordinates for the Sites in Need of Precaution are GIS coordinates for the inferred active vents, and the GIS coordinates for the Areas in Need of Precaution are derived from models of habitat suitability for cold-water octocorals (Yesson 2012)[18]. The GIS coordinates included in this Annex will need to be validated through future surveys of such sites and areas.



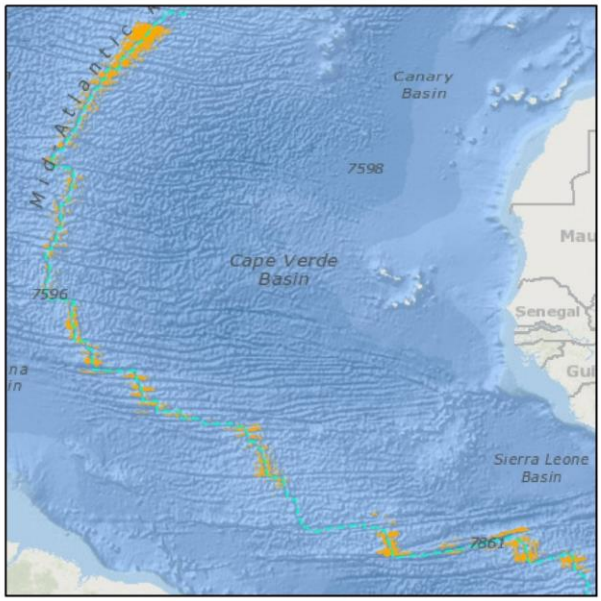
Sites in Need of Precaution (Inferred Active Vents)

Sites in Need of Precaution	Longitude	Latitude
MAR, 30°N	-42.5000000	30.0333000
MAR, 27°N	-44.5000000	27.0000000
Puy des Folles	-45.6417000	20.5083000
MAR, 17°09'N	-46.4200000	17.1500000
MAR, south of 15°20'N fracture zone	-45.0000000	15.0833000
MAR, 14 54'N	-44.9000000	14.9200000
Logatchev 3	-44.9667000	14.7083000
Neptune's Beard	-44.9000000	12.9100000
MAR, 11°26'N	-43.7035000	11.4482000

[18] Yesson, C, Taylor, M.L, Tittensor, D. P. Davies, A.J., Guinotte, J., Baco, A., Black, J., Hall-Spencer, J. M. and Rogers, A.D. (2012) Global habitat suitability of cold-water octocorals." Journal of Biogeography 39 (7): 1278–1292. https://doi.org/10.1111/j.1365-2699.2011.02681.x.

MAR, 11°N	-43.6483000	11.0380000
Markov Deep	-33.1800000	5.9100000
MAR, segment south of St. Paul system	-25.0000000	0.5000000

610



Areas in Need of Precaution
(Octocoral Habitat Suitability; Ridge Area)

611

612 Due to the large number of GIS coordinates for the Areas in Need of Precaution, the coordinates can be accessed
613 through the supplementary material available on ISA website https://isa.org.jm/files/2022-04/GIS-coordinates-
614 areas-in-need-of-precaution-nMAR.xlsx

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Annex IV. Scientific criteria applied for the identification and description of ABMTs in the northern Mid-Atlantic Ridge based on criteria developed by other competent international organisations

The criteria below are adopted from the criteria developed by other component international organizations, for details please refer to the report of the Evora workshop[19].

Scientific criteria for the identification and description of sites in need of protection (SINPs)

- **Uniqueness or rarity**: An area or ecosystem that is unique or that contains rare species whose loss could not be compensated for by similar areas or ecosystems. These include (i) habitats that contain endemic species; (ii) habitats of rare, threatened, or endangered species that occur only in discrete areas; (iii) nurseries or discrete feeding, breeding, or spawning areas.
- **Functional significance of the habitat**: Discrete areas or habitats that are necessary for (i) the survival, function, spawning/reproduction, or recovery of species; (ii) particular life history stages (e.g. nursery grounds or rearing areas); (iii) or of rare, threatened, or endangered marine species.
- **Fragility**: An ecosystem that is highly susceptible to degradation by anthropogenic activities.
- **Life-history traits of component species that make recovery difficult**: Ecosystems that are characterized by populations or assemblages of species with one or more of the following characteristics: (i) slow growth rates; (ii) late age of maturity; (iii) low or unpredictable recruitment; (iv) long-lived.
- **Structural complexity**: An ecosystem that is characterized by complex physical structures created by significant concentrations of biotic and abiotic features. In these ecosystems, ecological processes are usually highly dependent on these structured systems. Further, such ecosystems often have high diversity, which is dependent on the structuring organisms.
- **Information relating to any other relevant scientific criteria**: such as potential use as a scientific reference site

Scientific criteria for the identification and description of areas in need of protection (AINPs)

- **Uniqueness or rarity**: Area contains either (i) unique ("the only one of its kind"), rare (occurs only in few locations) or endemic species, populations or communities, and/or (ii) unique, rare or distinct, habitats or ecosystems; and/or (iii) unique or unusual geomorphological or oceanographic features.
- **Special importance for connectivity**: Areas that are required for a population to survive and thrive.
- **Importance for threatened, endangered or declining species and/or habitats**: Area containing habitat for the survival and recovery of endangered, threatened, declining species or area with significant assemblages of such species.
- **Vulnerability, fragility, sensitivity, or slow recovery**: Areas that contain a relatively high proportion of sensitive habitats, biotopes or species that are functionally fragile (highly susceptible to degradation or depletion by human activity or by natural events) or with slow recovery.
- **Biological productivity**: Area containing species, populations or communities with comparatively higher natural biological productivity.
- **Biological diversity**: Area contains comparatively higher diversity of ecosystems, habitats, communities, or species, or has higher genetic diversity.
- **Naturalness**: Area with a comparatively higher degree of naturalness as a result of the lack of or low level of human-induced disturbance or degradation.

[19] https://www.isa.org.jm/files/files/documents/Evora%20Workshop_3.pdf