



National Oceanography Centre  
European Way  
Southampton  
SO14 3ZH  
UK

FPS Economy, SMEs, Self-employed and Energy  
To the attention of Patrik Schotte  
Koning Albert II-laan 16  
1000 Brussel  
Belgium

29 August 2018

Dear Sir / Madam,

We were pleased to hear that, as part of Global Sea Mineral Resources' (GSR) efforts to explore the feasibility of deep sea mining of polymetallic nodules, GSR have decided to publish their environmental impact statement (submitted on 30 March 2018 to the International Seabed Authority) in the interests of stakeholder transparency. We also welcome the formal consultation period and opportunity to comment on the documentation. We have evaluated the document, which is generally well presented, informative and appropriate, and would like to provide some technical comments (provided below this letter).

We have direct experience of working in the Clarion-Clipperton Zone at a number of claim and APEI areas, as well as experience of conducting scientific assessments in deep-water areas worldwide. We also have experience of impact assessment and monitoring, which is of direct relevance to this project. We value the work of GSR in carrying out these collector tests and their rigorous evaluation through partnership with the European scientific community through the JPI-Oceans project. We feel that small-scale testing is an important step to understanding the temporal and spatial scales of disturbance caused by mining.

We hope these comments can be used to improve this environmental impact statement. We feel that it is particularly important to get these first environmental statements and their associated monitoring and management plans right as they will inevitably act as a benchmark for future environmental assessment associated with mining.

Yours faithfully,

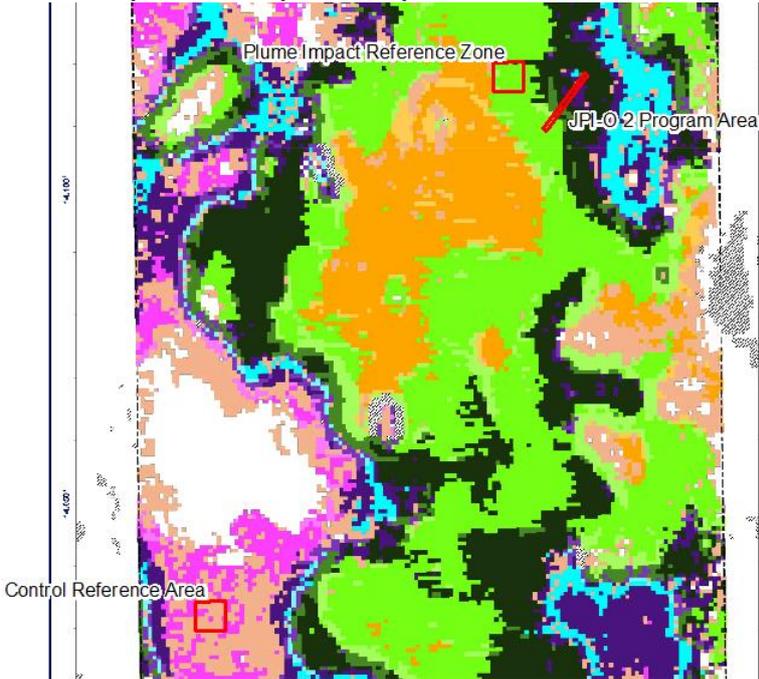
Dr Daniel Jones

## GSR Environmental Impact Statement Comments

Points in bold are particularly important points

Section	Page	Para	Comment
Summary	3	1	The statement “no serious harm will be caused to the marine environment at any depth within the water column.” Is unqualified, does not seem to be backed up by any evidence and indeed is potentially contradicted later on in the same paragraph “4) potential release of possibly toxic sediments and/or substances into the lower water column”. No quantification of ‘serious harm’ is provided.
Summary	3	2	The cut-off concentration values used (10 mg/L, 1 mg/L and 0.1 mg/L) appear reasonable (i.e. not artificially high to reduce the reported spatial footprint). Trawling induced gravity flows created sediment concentrations of up to 236 mg/L (baseline levels < 10 mg/L) in Mediterranean Canyons (Puig et al., 2012). Shallow water experimental studies typically use similar levels (e.g. Humanes et al. 2017). Likewise, 1 and 0.1 mm deposition seem appropriate levels for assessing impact.
Summary	3	2	The executive summary appears to refer to the least or average impacting scenarios (The text is “For the intended disturbance experiment, the sediment deposition from the plume is expected to reach approximately 500-750 m (cut-off value of 1 mm deposition) and roughly 5 km (cut-off value of 0.1 mm deposition) from the source.”). The exact values are not given for all the scenarios (page 143) and are difficult to read from the maps in appendix 12.4.1.1. The executive summary should probably refer to the worst-case scenario. See later note about the worst case scenario not being very bad.
Introduction	19-20		The description of the projects appears straightforward and transparent
Introduction	21	1	Emphasises the conceptual difference between this EIA and an EIA of a full-scale, long-term industrial mining activity.
Introduction	22	2	I generally agree that the “The scale of the environmental impact disturbance is limited and controlled”.
Introduction	22	2	The EIS claims to have followed the key relevant guidelines
Project description	25	2	The IRZ planned for this test will need to be different from that used by the mining activity. It doesn’t clarify that this will be the case in the EIS.
Project description	25	2	It is encouraging that the contractor has a reference zone for both the direct disturbance of the mine vehicle, but also specifically monitors at the plume site. It would be preferable to monitor multiple plume sites to establish more of the gradient of disturbance of the plume as well as providing some resilience in the sample design to environmental heterogeneity or differences between the modelled and actual results.
Project description	25	2	The name “Control reference zone” is used instead of “Preservation Reference Zone”, as used in the mining code. This may cause confusion.

Project description	25	2	<p><b>My concern is that there is only one control site. If these is deemed inappropriate for whatever reason (e.g. unusual environmental characteristics, model results that are different from actual impacts etc.) then this site will not be an effective control. As it is such a small area (500 x 500m) I would say that there is a reasonable likelihood that it is not representative of the relatively small impacted site; NOTE in the EMMP there is a line that says “one or more” sites will be monitored. This does not seem to carry through into the sampling design figures.</b></p> <p><b>In addition, the text says that the control reference zone has “geophysical, biological and chemical features comparable to the affected area” but only the geomorphology is demonstrated until much later in the report.</b></p> <p><b>I would argue that the geomorphology is quite different, with the Program area being on a shallow downward slope leading off a local high (4502 +- 16 m depth, p172) and the control reference area being near the bottom of a local depression (likely a Graben) (4551 +- 4 m depth, p172). These differences have the potential to be significant, particularly in terms of local sediment / food deposition, and may help explain some of the differences observed later in the report.</b></p> <p><b>It is recommended that (1) the stipulated control site be revisited to ensure geophysical, biological and chemical similarity, and (2) at least one other control site be established.</b></p>
Project description	25		<p>Page 25 says the Patania II tracks are expected to penetrate 5 cm into the sediments and that the “depth of influence” of the water jets will be investigated for the first time. It appears that no plans to measure this are articulated in the EMMP. It may be difficult to measure accurately.</p>
Project description	26	map	<p><b>The AUV photo track design is interesting. It needs further elaboration as to the monitoring value of such a track. It appears as though it will provide some information on the scale of disturbance, although there may not be sufficient coverage or replication for robust conclusions.</b></p> <p><b>It is recommended that the EIS includes more detail on the monitoring design and how it will be analysed – this would allow some sort of statistical power analysis to be carried out</b></p>
Project description	26 and 33-34	Maps	<p>Not helpful that the maps have a different coordinate system (UTM zone 10 in first map then lat/long in the second maps) and none of the proposed sampling locations are marked on the later maps.</p> <p>In addition, sampling area marked on later maps but called B4S03 in map on page 26. These are the same areas (confirmed by georeferencing both maps in GIS).</p>
Project description	26	Map	<p>It is not clear what the “Technical test area” (100 x 100m area) referred to on the map is for. We believe the mining collector test</p>

			will be carried out in the “Mining Impact 2 Program area” 80 x 1200 m.
Project description	34	Maps	<p><b>Although all classified as “Dense / Intermediate” nodule coverage on Figure 5, p 33), the PIRZ, RA and test site are all in differently classified nodule sub-groups in Figure 6 (p 34) arguably affecting the comparability between the sites and undermining the monitoring plan. It appears as though the control site has 12-19 nodules m<sup>-2</sup> and the test site has 19.9-23.8 nodules m<sup>-2</sup>. The plume impact reference zone also appears to have higher nodule levels (22.9-23.8 nodules m<sup>-2</sup>), which may reduce the potential impacted impact on nodule fauna.</b></p>  <p>Figure: Our GIS analysis of maps in EIS with monitoring and test zones superimposed on the map on page 34.</p>
Project description	27-32	All	Simple model approach seems sound.
Project description	35-36	All	<p>Geochemical section appears sound but outside expertise of reviewers.</p> <p>Not clear what “Total TR” is in table at end of p 35. The abbreviations section says it stands for transport, which appears to be referring to something else.</p>
Project description	44	1	Lots of parts of the nodule collector are named, but not labelled on the diagram. This would greatly facilitate understanding of the process
Project description	44	2	The hopper on Patania II is only big enough to store 3mT of nodules. Given the approximately 20 kg m <sup>2</sup> nodule densities, some rough calculations suggest it should fill up after covering around 150m <sup>2</sup> or a track length of about 32 m. Even with a much reduced collection efficiency the hopper could be filled many times over even on the relatively short tracks. The Project scale section (p 48) also suggests that it will be filled after 50 – 150m. It is not clear what will happen to the remaining nodules in each

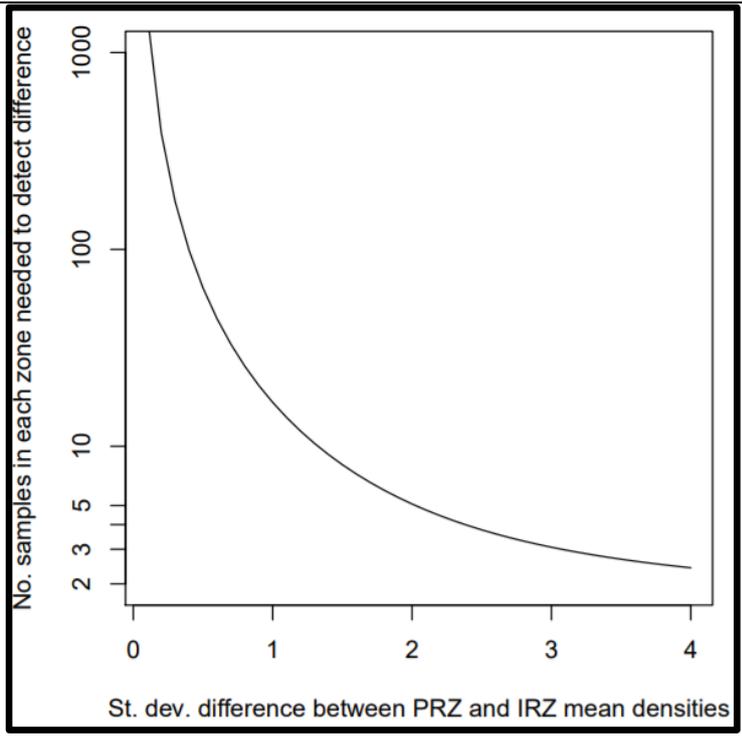
			track once the hopper is filled but before the hopper is dumped at the ends of the tracks (in Figure 15 indicated as being 340 m long). This should be detailed.
Project description	44-51	All	Detailed description of operations is useful.
Description of the existing environment	52	3	It would be useful to see a map of the cruise tracks for the 3 GSR and 1 JPI-O past expedition. References to the cruise reports would be beneficial (and made public if not already) so more metadata can be found.
Description of the existing environment	53		Throughout the physico-chemical environment section there is reference to winter and summer. Given its tropical location (and potential southern hemisphere readership) month references may be better.
	54		Reference is made to “research is described in GSR's annual reports to the ISA”. These are not public documents. It is recommended that they are either made public, or pertinent sections are made public, or the EIS includes an annex describing the results.
Description of the existing environment	56	Fig 19	It would be useful if some of the contours were labelled.
Description of the existing environment	64	1	Do currents get strong enough to “prevent deposition of sediments”? Evidence is that this was not the case on the abyssal seafloor. This interpretation is reinforced by the discussion on p 111-112, which concludes that “Current speeds of maximally 20 cm/s could lie around or above anticipated thresholds for natural resuspension of deep-sea muds according to McCave and Hall (2006) – but there is no evidence for it.”
Description of the existing environment	69	1	Should refer to and discuss research included here (appears to be referred to but not referenced): Aleynik, D., Inall, M.E., Dale, A., Vink, A., 2017. Impact of remotely generated eddies on plume dispersion at abyssal mining sites in the Pacific. Scientific Reports 7, 16959.
Description of the existing environment	75	3	Why was HYCOM expt_19.1 used? This run limited the temporal domain of the results (expt 19.1 is August 1, 1995 to December 31, 2012). Today it is possible to access HYCOM expt_91.2 with all the same parameters, which covers the same period as the data (Apr-18-2016 to Present). There may be a reason for this, but it should be documented.
Description of the existing environment	81		It is not clear what the model time series is. I can't find mention of the start and end times. It is a shame that the model run does not coincide with any of the data (it says this is because no global HYCOM hindcast data were available for the May-June 2017 period, but see comment above). It is further not clear why the periods shown for the model data (March, April and May 2009) in Figure 37, 38 and 39 were chosen. They seem a strange choice as they are for different months and 8 years previously?

Description of the existing environment	87	1	The methods of the oceanographic sampling are generally fairly poorly described. This would be OK if there was a reference where the detailed information could be obtained, but there does not appear to be. For example, which sensor model and make was used for the various measurements. The FTU measurements may be near the detection limit of the instrument, although this is not possible to ascertain.
Description of the existing environment	90	2	Munsell colour codes are used with no reference to the Munsell system or “normal” descriptions of the colour (e.g. “yellowish brown”). This may complicate interpretation.
Description of the existing environment	99		Should include grain size distributions for the sediments.
Description of the existing environment	112	2	The paragraph on light is weak and not very convincing.
Description of the existing environment	113	1	Another reference to data that are not possible for the public to obtain (the GSR annual reports to the ISA).
Description of the existing environment	115	6	The sentence “During GSRNOD14A, GSRNOD15A, GSRNOD17, and also during the JPI Oceans campaigns in the GSR contract area, for birds mainly boobies (masked, brown and red-footed) were identified.” does not make sense. Did they mean 4 birds, if so is that species or individuals?
Description of the existing environment	115	6	It is not clear if these are sightings of fish and whales that were made during transit on the GSR cruises or more general information on the area from the literature. I think this section needs to be bolstered by more literature information. For example, no mention is made of the threatened beaked whales that inhabit the area.
Description of the existing environment	116	1	<b>The midwater section appears inadequate. There are no data at all on any zooplankton. Even generalities for the area would be useful (there may be no specific information). Suprabenthic pelagic fauna are likely to be impacted by the tests, as such more information is required on what might be present.</b>
Description of the existing environment	118 and 119		The lack of temporal differences in meiofauna and macrofauna may be related to the small samples and limited number of replicates. This is not possible to judge from the information contained within the EIS (and should be).
Description of the existing environment	118		<b>The methods of the biological part is generally lacking. The EIS is somewhere between the results and discussion section of a scientific paper. This EIS needs to be supported by detailed methods (or links to publically-available full text studies that contain them) and the report would be stronger with more background data, even if they are for the region as a whole, to try and interpret the significance of the results.</b>

Description of the existing environment	120	1	<p>The EIS says that the density of megafauna is higher than other studies in the area, but does not mention the studies or their densities. Another example of poor reporting in this document.</p> <p>I believe (although do not know and cannot find out from this report) that the megafaunal density in the GSR data are likely to be underestimated (or at least only larger organisms could be enumerated) because of the altitude of the AUV photographs. Therefore, it is an interesting result if the densities are still higher than in other areas nearby.</p>
Description of the existing environment	120	1	<p>There is no indication of either megafaunal or macrofaunal diversity in the GSR area. I expect this is because of limited taxonomic resolution. However, it would be useful to say how many unique forms were distinguished and why no diversity metrics were reported.</p>
Description of the existing environment	122	2	<p>The section on vertical distribution of meiofauna within the sediments seems out of place in a section on nodule-associated fauna. To avoid confusion, a new subsection should be created.</p>
Description of the existing environment	128	2	<p>The connectivity section is poorly reported. It is lacking a lot of detail, which is a shame as it is an interesting and relevant result.</p>
Assessment of impacts and proposed mitigation	132	2	<p>Not clear why there is more detail on JET and the other studies aren't mentioned. I expect it is because more plume information is available, but the EIS doesn't say.</p>
Assessment of impacts and proposed mitigation	132	5	<p>Some interesting results from SO-242/2 but not enough information. In general, a direct comparison with the estimates for the test referred to in the EIS would be beneficial to improve decision making (i.e. is this test going to make a plume much bigger than the experimental assessments).</p>
Assessment of impacts and proposed mitigation	137	3	<p><b>The simulation period is only 21 days, which includes a 15-day period after the Patania II trial. I would be interested to see if the results get appreciably worse (in terms of extent of amount of sediment deposited after this time. One way of presenting this would be to demonstrate the amount of material still in suspension at the end of the experiment. It is likely that these will be very slow sinking fine particulates that may travel long distances.</b></p>
Assessment of impacts and proposed mitigation	137	3	<p><b>I also think that the fate of the plume should be tracked until all suspended sediment is thought to have been deposited. This may take some time, but it would be a useful result for decision makers.</b></p>
Assessment of impacts and proposed mitigation	139		<p>It would have been good to include a worst case scenario that is as extreme as possible (e.g. with continuous sediment release) within the technical constraints. There are a lot of assumptions that could be pushed to the limits to get a feel for how bad it could be, which is the question many people will be asking.</p>

			I also think that the worst scenario (i.e. 2) results should be presented in the figures rather than the “average” scenario.
Assessment of impacts and proposed mitigation	146		There is no information on the potential toxicity of metals etc. released from the nodules being collected. There should be reference to the later section on this 5.2.4.5
Assessment of impacts and proposed mitigation	146	3	The EIS is not very convincing on the potential toxicity of the hydraulic oil or other chemicals/substances used. This is particularly important as chemical behaviour and toxicity may be appreciably different in the deep sea.
Assessment of impacts and proposed mitigation	146		The accidents section is not very extreme. What happens if Patania 2 is lost. The ship sinks, etc. Reference should be made to section 6, which has more detail on some of the potential scenarios.
Assessment of impacts and proposed mitigation	149	2	I don’t think the impact of the collector needs to be downplayed here. It is a small impact. The last sentence should be removed or altered to make sure it is not misconstrued.
Assessment of impacts and proposed mitigation			The document has several topics discussed across multiple sections. Better referencing of the other relevant sections should be made throughout. Rather careful reading of the (large) document is required to gather all the information on each aspect.
EMMP	171	5+	I think the EMMP should be future looking and talk about the planned monitoring scheme. At the moment it is filled with detailed comparison between the test and control sites, which is useful, but should have been in the environmental description section. This would make the EMMP much clearer.
EMMP	171-177		<p><b>Comparability between impacted and control zones.</b></p> <p><b>I am not convinced by the evidence that the control and impact sites are comparable (they may be, but not well demonstrated). It has already been pointed out that there is geomorphological variation between sites.</b></p> <p><b>There are quite a few differences (non-overlapping confidence intervals) in many of the parameters physical parameters between the control and impacted site, particularly in the most biologically active surface layers (only sand content appears to overlap between sites).</b></p> <p><b>Figure 103 shows some departure in some of the control sites and this is backed up by the PERMANOVA testing. This is dismissed in the report</b></p> <p><b>Part of the problem is that only three cores have been taken. These probably only contain a few tens of macrofaunal individuals.</b></p>

			<p>Interpretations are made more complicated by an incorrect y-axis on Figure 105 (it is copied from figure 104, but I believe it refers to macrofauna).</p> <p>It would be expected from what we know about ecology that the meiofaunal results should be more robust than the macrofaunal results just because more individuals would be encountered.</p> <p>Even then the analysis is only performed at a higher taxon level, presumably either because time-consuming species- (or genus-level analysis was not done or it was omitted because it showed differences between the sites.</p> <p>It is unfortunate that densities are lower at the planned control site. This will permit more negative change to happen before a statistically significant difference is found. Careful selection of the statistical approach will be required to ensure that these differences are considered.</p> <p>It is recommended that more data are obtained in the control and impacted site immediately prior to the investigation both to reduce potential temporal differences and to increase the replication.</p>
EMMP	178	2	How will megafaunal ecophysiology be assessed?
EMMP			I would like to see more detail on how the experiments conducted as part of JPI-O2 will be integrated with the modelling results to better predict the thresholds or extent of impact. At the moment it is not clear to me that the experiments will enable this to be carried out.
EMMP	190	2	<p>I think the monitoring sample plan should be estimated and simulated using existing data. This would allow statistical power analysis to be used to determine the magnitude of effects that can be detected. It would also clarify how the data will be analysed from the experimental design. My guess is that the power analysis will show that only large changes could be detected. This whole process would greatly inform the quick decision making that will have to happen on the ship during the JPI-O 2 cruises. The section where this is notionally done (7.2.3.2 Environmental monitoring program) starts off relatively well (for the plume modelling) but becomes rapidly vague.</p> <p>Specifically regarding p190 paragraph 2: This multi-scale analysis would be good. However, it is not easy to do in a way that is scientifically acceptable in the deep-sea. More detail on the specific approach would be useful to be able to judge its efficacy.</p>
EMMP			It appears that five samples will be taken for each parameter in the control site (RA), impacted site (IRZ) and Plume impacted site (PIRZ). The numbers are tentative (p 169). Assuming that the data will be analysed by some sort of ANOVA design (the EIS doesn't say) then statistical theory allows us to predict the effect size (measured as number of standard deviations the mean of the impacted site is away from the mean of the control site). The graph below shows this relationship:



**For 5 samples it means that over 2 standard deviation differences in the parameter of interest are needed to detect an effect (at 95% confidence level, which is normal for these tests). This is an enormous difference. According to Cohen 1988 (Statistical Power Analysis for the Behavioral Sciences) differences of > 0.5 are large. We strongly recommend that the EMMP attempts similar calculations and commits to a sampling plan that can be theoretically tested prior to implementation to ensure that it is sufficient to detect the sort of effects of interest.**

EMMP	192	1	The EIS presents 4 scenarios on pp 141-142, with a predicted maximum extent of the 1mm deposition zone of 1-2.5 km (though p 3 says 500-750m) and a predicted maximum of 2-6km for the 0.1mm deposition zone across the scenarios. Throughout the EIA, there are assertions that the model will be validated through data collection. I would think you would want to validate this by having sampling arrays within, at the edge of, and outside of the predicted impact areas to verify your predictions. However, page 192 seems to suggest that the plume sampling will be happening is a 2-5km <sup>2</sup> array. This doesn't seem sufficient to test the assumptions above. At minimum, the EIS should provide more information on the sampling protocol planned and how it will be designed to test the model assumptions, including testing at various points both inside and outside the predicted impact zones. Also, there's a comment on p. 148 that suggests the worst-case scenario for plume suspension in the water column is 25m: is this going to be tested/validated as well?
EMMP	195		It is good that this EIS includes detailed provisions for data and sample management.
EMMP			<b>What is the plan for continued monitoring? At present the EMMP presents the plan for immediate post cruise monitoring</b>

			<p>and some further short term assessment. I don't see a plan for longer-term monitoring. It is recommended that a longer-term plan for monitoring should be developed.</p>
--	--	--	---