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Interactive comment on "Responses of an abyssal meiobenthic community to short-term burial with crushed nodule particles in the South-East Pacific" *by* Lisa Mevenkamp et al.

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We are very thankful for the thorough and constructive comments and remarks on our manuscript made by Dr. Sharma. The issues raised by the reviewer were taken into consideration and in the following paragraphs, we present our reply to each of them:

General remarks:

Reviewers comment: 1. Describe in 'Introduction' as to what is the likely source of the crushed nodules during a mining operation and what is the expected concentration and size of the nodule particles that are will be introduced on the seafloor based on

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which this experiment is planned. Also mention what is the size and concentration of the crushed nodules used in the experiment.

Authors reply: The most likely source of the spreading of nodule particles will be the collecting device. Nodule particles may be abraded and brought into suspension by the water jet used during the collection or, depending on the design of the collector, during separation of nodules and sediment inside the collector. This will result in the distribution of nodule particles, which are smaller than the mesh used for the separation. These particles would then spread as part of the sediment plume and would settle depending on their sedimentation rate. Particle sizes used during this experiment are shown in Supplementary figure S2 (former S3) and the material and method section has been expanded (see specific comment #7)

Changes to the manuscript: Page 2, Line 13: We expanded the sentence to “Therefore, breakage and abrasion of nodule particles is likely to occur during a mining operation with heavy gear, for example during separation of nodules and sediment as part of the collection process or by the force of the water jet used for the collection of nodules.”

Reviewers comment: 2. The study makes certain comparisons with the results of previous benthic impact experiments (BIEs) that were not at all similar either in spatial terms or time scales or volume and nature of re-sedimentation. This study is based on effects of concentrated crushed nodules on meiobenthos over eleven days in a restricted area, whereas the BIEs were studies of impacts of distribution of resuspended sediments (and not crushed nodules) over large areas and longer periods of time (1 year or more). So, it is not correct to compare the results of these two.

Authors reply: We agree with the reviewer in the sense that a direct comparison I indeed not very relevant to compare our results with the JET experiment and we therefore would opt to remove that paragraph from the discussion. Nevertheless, migratory responses by meiofauna have been observed in several studies regardless of the nature of the substrate used. Therefore, we would argue that, to a certain extent, it is

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valid to use studies using different material to interpret our findings, while considering also the differences in approach.

Changes to the manuscript: The comparison with the JET experiment on Page 14, Line 17-28 was removed.

Reviewers comment: 3. It is interesting to see that many of the results of this experiment have shown positive response of meiofauna as well as other groups (upward migration into the re-sedimented layer, no additional accumulation of copper, and no extreme changes in community structure) that should be highlighted. When the understanding of likely impacts of deep-sea mining is limited and mostly negative impacts are being projected by the environmental groups based on little or no data, it is important to bring out positive impacts as well so as to have a balanced approach towards sustainable mining. Also researchers need to appreciate that it is not necessary that all responses to any manmade activity will always be negative, but could be positive as well as shown in this study and this is an important contribution from the marine biologists to this subject.

Authors reply: We understand the concern raised by the reviewer, however, we do not believe that the changes in vertical distribution should be described as positive. Indeed some responses, such as copper accumulation were absent/neutral but the upward migration of the meiofauna from upper layers and changes in feeding type composition should be interpreted with care as long-term effects are unknown and may not necessarily be positive. It is not our intention to highlight negative effects of deep-sea mining but to interpret our findings based on the available information. We rephrased some sentences in the manuscript that may be interpreted in a stronger way than intended.

Changes to the manuscript: Page 1 Line 28-29 “The results indicate that short-term substrate burial requires special attention with regard to ecological consequences of mineral extraction in the deep-sea.” Was changed to “Our results indicate that short-

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term impacts from burial with crushed nodule particles on meiobenthic communities are limited but that long-term studies are needed, especially with regard to vertical structure, community composition and mortality."

Page 11, Line 30-31 the sentence "We found that this behavioural response was stronger in polychaetes, copepods and their nauplii compared to nematodes, which could result in a shift in meiobenthos community composition." was removed.

Specific comments

Reviewers comment: 1. Page 1, line 23 - Abstract - change '....in covered and undisturbed sediments.' To '....in covered and uncovered sediments.' (because there is no other disturbance on the seafloor but covering of sediments by crushed nodules).

Authors reply: adjusted as suggested

Reviewers comment: 2. Page 2, line 6 – Introduction – change 'extraction in' to 'exploitation from' – as 'extraction' means 'removal of metals from ore', whereas 'exploitation' means 'removal of ore from its original source".

Authors reply: adjusted as suggested

Reviewers comment: 3. Page 2, line 14 – change 'such as' to 'due to'- as these are causes not impacts.

Authors reply: adjusted as suggested

Reviewers comment: 4. Page 4, line 8 – Correct 'Fig S1" to 'Fig 1',

Authors reply: throughout the manuscript, the label of supplementary figures was adjusted to "Supplementary Fig. S..." to avoid confusion with the figures inside the manuscript.

Reviewers comment: 5. Page 4, line 8 – change 'substrate distribution device' to 'crushed nodule distribution device' – see below for explanation.

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Authors reply: see next reply

Reviewers comment: 6. Page 4, line 8 – According to Cambridge dictionary, the word 'substrate' means something lying below or base or bed and cannot be used for crushed nodules being deposited artificially from top. So change 'crushed nodule substrate' to ' crushed nodule particles' and 'substrate' to 'nodule particles' in the entire manuscript..

Authors reply: We would like to keep the phrasing "substrate" ins the manuscript. The added material is intended to be used as a new substrate by the fauna after deposition, similar to sediment, and relates to the Cambridge dictionary definition "a substance or surface that an organism grows and lives on and is supported by". This wording is particularly useful when referring to different material without the need to specify each material separately (e.g. nodule particles, inert tailings, sediment).

Reviewers comment: 7. Page 4, line 10-11 – Add mean size of crushed nodules '...substrate of ### micron / mm size that was filled inside the tubes of the device.'

Authors reply: Mean sizes of the nodule substrate were not measured and would not be very informative due to the large range of the particle sizes. The Material and Method section was expanded with information about acquisition of the nodule particles including size range: Page 4 Line 15 "To obtain the crushed nodule particles, several nodules from the experimental site were collected 2 days prior to the experiment. Upon retrieval, epifauna, if present, was removed from the nodules and nodules were thoroughly washed with fresh water to remove all sediment and fauna. Subsequently, nodules were put inside plastic bags and manually crushed with a hammer. The resulting nodule particles varied in size between 3 μm and 1 cm (Supplementary Figure S2)."

Reviewers comment: 8. Fig. 1 caption – change 'Impressions' to 'Images' or 'Photographs'

Authors reply: “Impressions” changed to “Images”

Reviewers comment: 9. Page 7, line 14 – Please mention the ‘values for sediment characteristics, metal values, and meiofauna composition’ before the experiment and compare the values after the experiment to evaluate the impact of burial of seafloor sediment by crushed nodule particles.

Authors reply: We did not conduct a sampling of the sediment before the experiment. Results are based on a Control-Treatment comparison. However, also in the Control, stainless steel rings were used to achieve the same conditions (e.g. limiting lateral movement, water flow) in both treatments.

Reviewers comment: 10. Page 7, line 25 - change ‘burial treatment’ to ‘ burial treatment sediment sample’.

Authors reply: adjusted as suggested

Reviewers comment: 11. Page 9, line 3 – add units ‘cm’ after ‘0-1’ and ‘1-2’.

Authors reply: units were added

Reviewers comment: 12. Page 10, line 7 – change ‘Table S1’ to ‘Table 1’

Authors reply: “Table S1” was changed to “Supplementary Table S1”

Reviewers comment: 13. Page 10, line 10 – change ‘control’ to ‘control samples’ and ‘burial treatment’ to ‘burial treatment samples’.

Authors reply: In our view, this change does not significantly add to the understanding of the sentence and this distinction would need to be applied also to all other sentences.

Reviewers comment: 14. Page 10, line 15 – change ‘Figure S4’ to ‘Figure 4’.

Authors reply: “Figure S4” was changed to “Supplemenary Figure S4” Reviewers comment: 15. Page 13, line 14-15 – After ‘Changes in oxygen could be one of the factor’ it would help to give either layer-wise oxygen values before and after the experiment or at

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least give general values for oxygen content in sediment layers from other publications (eg. Rzeznik-Orignac et al, 2004) to support the hypothesis.

Authors reply: Unfortunately, as mentioned on Page 13 Line 18 we were not able to measure oxygen concentrations in our sample. We hypothesized oxygen availability as explanation for the observed behavior as it has been proposed to play a role in meiofauna extraction techniques. Furthermore, oxygen penetration depth was reduced in the experiments of Mevenkamp et al 2017 leading the authors to hypothesize this oxygen reduction as an explanation for the upward migration of nematodes and increased mortality.

Changes to the manuscript: "by using natural gradients of oxygen availability" was inserted at Page 13, Line 17

Page 13 Line 17 "Moreover, in a short-term laboratory experiment, Mevenkamp et al. (2017) observed significantly reduced oxygen concentration in the underlying soft sediment after the addition of 0.5 and 3 cm sediment and an upward migration and increased mortality of nematodes." was added

Reviewers comment: 16. Page 15, line 9-10 – 'Interestingly, all dominant nematode genera responded with upward migration.....' is a positive response further supported by section heading 4.3 'Increased copper concentrations in added substrate are not reflected in nematode body copper content' - these need to be highlighted as mentioned in #3 of general comments.

Authors reply: See reply on general comment #3.

Reviewers comment: 17. Page 15, line 18-19 – 'The results of our experiment did not indicate that these nematodes were more successful to inhabit added substrate' contradicts the above statements, unless it refers specifically to monhysterids. So please specify or remove this sentence.

Authors reply: Indeed, this sentence refers to the monhysterids. "these nematodes"

replace with “monhysterids”

Reviewers comment: 18. Page 15, line 30-34 – Effects of resedimentation of sediment over large open area and that of crushed nodules over small enclosed area cannot be compared as the material deposited and the process and concentrations are entirely different. The discussion needs to be modified.

Authors reply: We changed the last sentence to acknowledge the difference in the disturbance between both studies and to not mislead the reader. Nevertheless, we believe that the persisting change in nematode communities observed by the cited study should be mentioned here to underline the caution needed in the interpretation of disturbances in the deep-sea as even small changes may be long-lasting and a no-impact-conclusion should not be drawn too fast.

Changes to the manuscript: Page 15 Line 33 sentence adjusted to “Although the disturbance studied by Miljutin et al. (2011) strongly differs from our experiment, it indicates that changes in nematode community composition in polymetallic nodules areas may be long lasting and are potentially irreversible and, therefore, underlining the importance of long-term experiments.”

Reviewers comment: 19. As the experiment of depositing crushed nodules has shown positive response of nematodes by upward migration and maintaining similar community structure, the sentence on page 16 (line 1-2) ‘....Changes in nematode composition.... may be long lasting and positively irreversible.....’ need to be revised.

Authors reply: Community structure on a higher taxonomic level was indeed similar in both treatments, but at lower taxonomic level, changes in nematode feeding types were observed. Therefore, we do believe that this sentence is still valid in order to alert the reader on the potential long-term risks. Furthermore, samples exhibited a very high diversity and high evenness with many rare (<5%) taxa, also evidenced by the low similarity among replicates, which may increase the risk of losing rare taxa after strong sediment disturbances. Nevertheless, in response to the comment #18, the sentence

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was rephrased (see above).

Reviewers comment: 20. Page 16 – Conclusions – needs to be revised according to the above discussion

Authors reply: This comment relates to our reply to general comment #3. We have done small adjustments to the text; however, also taking into account the remarks of reviewer 2, we would like to keep the overall conclusion as it is.

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