



## Environmental Science Work:

References to peer reviewed publications and presentations arising from datasets and samples collected on the UK Seabed Resources-sponsored Abyssline AB01 (2013) and AB02 (2015) environmental survey cruises in the Pacific Ocean Clarion-Clipperton Zone. Both cruises took place under Exploration Contracts awarded to UK Seabed Resources by the International Seabed Authority.

### 2021 Publications Arising from UK1 AB01 (2013) and AB02 (2015) Environmental Datasets

Mohrbeck, I., Horton, T., Jazdzewska, A.M. et al. DNA barcoding and cryptic diversity of deep-sea scavenging amphipods in the Clarion-Clipperton Zone (Eastern Equatorial Pacific). *Mar. Biodivers.* 51, 26 (2021). <https://doi.org/10.1007/s12526-021-01170-3>

### 2020 Publications Arising from UK1 AB01 (2013), and AB02 (2015) and Ocean Minerals Company (OMCO) Environmental Datasets

McQuaid K.A., Attrill M.J., Clark M.R., Cobley A., Glover A.G., Smith C.R. and Howell K.L. (2020) Using Habitat Classification to Assess Representativity of a Protected Area Network in a Large, Data-Poor Area Targeted for Deep-Sea Mining. *Front. Mar. Sci.* 7:558860. doi: 10.3389/fmars.2020.558860

McQuaid K.A., (2020) Ecological Studies of an Abyssal Nodule Province to Inform the Management of Deep-sea Mining. PhD Thesis, University of Plymouth, <https://pearl.plymouth.ac.uk/handle/10026.1/16676>

Hestetun, J. T., Bye-Ingebrigtsen, E., Nilsson, R. H., Glover, A. G., Johansen, P. O., & Dahlgren, T. G. (2020). Significant taxon sampling gaps in DNA databases limit the operational use of marine macrofauna metabarcoding. *Marine Biodiversity*, 50(5), 1-9. doi:10.1007/s12526-020-01093-5, <https://doi.org/10.1007/s12526-020-01093-5>

Clark, M., Smith C.R., et al, Deep CCZ Biodiversity Synthesis Workshop, Friday Harbor Lab, Washington, USA, 1-4 October 2019, International Seabed Authority, [isa.org.jm/workshop/deep-ccz-biodiversity-synthesis-workshop](http://isa.org.jm/workshop/deep-ccz-biodiversity-synthesis-workshop)

### 2019 Publications Arising from UK1 AB01 (2013) and AB02 (2015) Environmental Datasets

Glover, AG., Wiklund, H., Neal, L., Rabone, M., Drennan, R., Dahlgren, T.G.; (2019). Benthic Biological Studies in the Clarion-Clipperton Zone: Megafaunal and Macrofaunal Biodiversity and Genetics. Environmental Baseline Studies for UK Seabed Resources Interim Progress and Data Report – Period 1st January 2019 to 31st December 2019.

Rabone M., Harden-Davies H, Collins JE, Zajderman S, Appeltans W, Droegge G, Brandt A, Pardo-Lopez L, Dahlgren T.G., Glover A.G., Horton T. (2019) Access to Marine Genetic Resources (MGR): Raising Awareness of Best-Practice Through a New Agreement for Biodiversity Beyond National Jurisdiction. *Frontiers in Marine Science.* 6:520. doi:10.3389/fmars.2019.00520.



### 2019 Publications Arising from UK1 AB01 (2013) and AB02 (2015) Environmental Datasets *(continued)*

Guggolz T, Meißner K, Schwentner M, Dahlgren TG, Wiklund H, Bonifacio P, Brandt A (2020) High diversity and pan-oceanic distribution of deep-sea polychaetes: *Prionospio* and *Aurospio* (Annelida: Spionidae) in the Atlantic and Pacific Ocean. *Organism, Diversity and Evolution* 109:138–19. <https://doi.org/10.1007/s13127-020-00430-7>

Kristensen, R. M., Gooday, A. J., & Goineau, A. (2019). Loricifera inhabiting spherical agglutinated structures in the abyssal eastern equatorial Pacific nodule fields. *Marine Biodiversity*, 49(5), 2455-2466. <https://doi.org/10.1007/s12526-019-00962-y>

Wiklund, H., Neal, L., Drennan, R., Rabone, M., Dahlgren, T.G.; (2019). Abyssal fauna of polymetallic nodule exploration areas, eastern Clarion-Clipperton Zone, central Pacific Ocean: Annelida: Capitellidae, Opheliidae, Scalibregmatidae, and Travisiiidae. *ZooKeys* 883: 1–82. <https://doi.org/10.3897/zookeys.883.36193>

### 2018 Publications Arising from UK1 AB01 (2013) and AB02 (2015) Environmental Datasets

Gooday, A.J., Sykes, D., Góral, T., Zubkov, M.V., and Glover, A.G.; (2018). Micro-CT 3D imaging reveals the internal structure of three abyssal xenophyophore species (Protista, Foraminifera) from the eastern equatorial Pacific Ocean. *Nature - Scientific reports*, 8(1), p.12103. <https://doi.org/10.1038/s41598-018-30186-2>

Gooday, A.J., Holzmann, M., Goineau, A., Kamenskaya, O., Melni, V.F., Pearce, R.B., Weber, A. A.-T. and Pawlowski, J.; (2018). Xenophyophores (Rhizaria, Foraminifera) from the Eastern Clarion-Clipperton Zone (equatorial Pacific): The Genus *Psamina*. *Protist*, Vol. 169, 926–957, <https://doi.org/10.1016/j.protis.2019.09.003>

Lindh, M.V., Maillot, B., Smith, C.R., and Church, M.J.; (2018). Habitat filtering of bacterioplankton communities above polymetallic nodule fields and sediments in the Clarion-Clipperton zone of the Pacific Ocean. *Environmental Microbiology Reports* 10: 113-122, <https://doi.org/10.1111/1758-2229.12627>

Sweetman, A.K., Smith, C.R., Shulse, C.N., Maillot, B., Lindh, M.V., Church, M.J., Meyer, K.S., van Oevelen, D., Stratmann, T., and Gooday, A.J.; (2018). Key role of bacteria in the short-term cycling of carbon at the abyssal seafloor in a low particulate organic carbon flux region of the eastern Pacific Ocean. *Limnology and Oceanography*, 9999, 1-20, <https://doi.org/10.1002/lno.11069>

Glover, A.G., Dahlgren T.G., Wiklund H., Smith C.R.; (2018). The biodiversity of animals living on polymetallic nodules in the eastern Clarion-Clipperton Zone. 15th Deep Sea Biology Symposium, Monterey California, USA.

Glover, A.G., Wiklund, H., Chen, C. and Dahlgren, T.G., 2018. Point of View: Managing a sustainable deep-sea ‘blue economy’ requires knowledge of what actually lives there. *eLife*, 7, p.e41319.

Leitner, A.B., Durden, J.M., Smith, C.R., and Drazen, J.C.; (2018), Topographic Effects on Bait-Attending Fauna: Examining the Effect of Abyssal Hills Using Baited Cameras. Oral presentation. 15th Deep Sea Biology Symposium, Monterey California, USA.



### 2018 Publications Arising from UK1 AB01 (2013) and AB02 (2015) Environmental Datasets (*continued*)

Smith, C.R., Sweetman, A.K., Nunnally, C.C., Lewis, M., Young, E., Vernet, M., and Ziegler, A.F.; (2018). Very high macrofaunal diversity in an area targeted for nodule mining in the eastern CCZ. Oral presentation. 15th Deep Sea Biology Symposium, Monterey California, USA.

Taboada, S., Riesgo, A., Wiklund, H., Paterson, G.L., Koutsouveli, V., Santodomingo, N., Dale, A.C., Smith, C.R., Jones, D.O., Dahlgren, T.G. and Glover, A.G., 2018. Implications of population connectivity studies for the design of marine protected areas in the deep sea: An example of a demosponge from the Clarion-Clipperton Zone. *Molecular ecology*.

Amon, D.J., Simon-Lledo, E., Boessenecker, R., Jones, D.O.B., Chim, C.K., Wong, H.P.S., Tan, K.S., Ziegler, A.F., Glover, A.G., Smith, C.R.; (2018). Cetacean and shark fossils are abundant in the eastern Clarion Clipperton Zone, Oral presentation. 15th Deep Sea Biology Symposium, Monterey California, USA.

McQuaid, K., Attrill, M., Glover, A., Jones, D.O.B., Simon-Lledo, E., and Howell, K.; (2018). A habitat classification to support spatial planning associated with deep-sea mining, Oral presentation. 15th Deep Sea Biology Symposium, Monterey California, USA.

### 2017 Publications Arising from UK1 AB01 (2013) and AB02 (2015) Environmental Datasets

Amon, D.J., Ziegler, A.F., Drazen, J.C., Grischenko, A.V., Leitner, A.B., Lindsay, D.J., Voight, J.R., Wicksten, M.K., Young, C.M., and Smith, C.R.; (2017). Megafauna of the UKSRL exploration contract area and eastern Clarion-Clipperton Zone in the Pacific Ocean: Annelida, Arthropoda, Bryozoa, Chordata, Ctenophora, Mollusca, *Biodiversity Data Journal*. <https://doi.org/10.3897/BDJ.5.e14598>

Amon D.J., Ziegler A.F., Kremenetskaia A, Mah C., Mooi R., O'Hara T., Pawson D., Roux M., and Smith C.R., (2017) Megafauna of the UKSRL exploration contract area and eastern Clarion-Clipperton Zone in the Pacific Ocean: Echinodermata. *Biodiversity Data Journal* 5: e11794. <https://doi.org/10.3897/BDJ.5.e11794>

Goineau, A., and Gooday, A.J.; (2017). Novel benthic foraminifera are abundant and diverse in an area of the abyssal equatorial Pacific licenced for polymetallic nodule exploration. *Scientific Reports*, <http://www.nature.com/articles/srep45288>

Gooday, A.J., Holzmann, M., Caille, C., Goineau, A., Kamenskaya, O., Weber, A. A.-T., and Pawlowski, J.; (2017). Giant protists (xenophyophores, Foraminifera) are exceptionally diverse in parts of the abyssal eastern Pacific licenced for polymetallic nodule exploration, *Biological Conservation*, Volume 207, Pages 106-116. <http://dx.doi.org/10.1016/j.biocon.2017.01.006>

Gooday, A.J., Holzmann, M., Caille, C., Goineau, A., Jones, D.O.B., Kamenskaya, O., Weber, A. A.-T., and Pawlowski, J.; (2017). New species of the xenophyophore genus *Aschemonella* (Rhizaria: Foraminifera) from areas of the abyssal eastern Pacific licenced for polymetallic nodule exploration, *Zoological Journal of the Linnean Society*, XX, 1–21, <https://doi.org/10.1093/zoolinnean/zlx052>



## 2017 Publications Arising from UK1 AB01 (2013) and AB02 (2015) Environmental Datasets *(continued)*

- Gooday, A.J., Holzmann, M., Goineau, A., Pearce, R.B., Voltski, I., Simon-Lledó, E. Weber, A. A.-T., and Pawlowski, J.; (2017). Five new species and two new genera of xenophyophores (Foraminifera: Rhizaria) from part of the abyssal equatorial Pacific licensed for polymetallic nodule exploration. *Zoological Journal of the Linnean Society*. <https://doi.org/10.1093/zoolinnean/zlx093>
- Kaiser, S., Smith, C.R., and Martínez Arbizu P.; (2017). Editorial: Biodiversity of the Clarion Clipperton Fracture Zone, Senkenberg, DOI 10.1007/s12526-017-0733-0.
- Kersten, O., Smith C.R., and Vetter, E.W.; (2017). Abyssal near-bottom dispersal stages of benthic invertebrates in the Clarion-Clipperton polymetallic nodule province. *Deep Sea Research 1, Oceanographic Research Papers*, Volume 127, September 2017, Pages 31-40. <https://doi.org/10.1016/j.dsr.2017.07.001>
- Leitner, A.B., Neuheimer, A.B., Donlon, E., Smith, C.R., and Drazen, J.C; (2017). Environmental and bathymetric influences on abyssal bait-attending communities of the Clarion Clipperton Zone, *Deep-Sea Research Part I, Volume 125*, July 2017, p. 65-80. <https://doi.org/10.1016/j.dsr.2017.04.017>
- Lim, S.-C., Wiklund, H., Glover, A. G., Dahlgren, T. G., & Tan, K.-S. (2017). A new genus and species of abyssal sponge commonly encrusting polymetallic nodules in the Clarion-Clipperton Zone, East Pacific Ocean. *Systematics and Biodiversity*, 15(6), 507-519. <http://dx.doi.org/10.1080/14772000.2017.1358218>
- Lindh, M.V.; Maillot, B.M.; Shulse, C.N.; Gooday, A.J.; Amon, D.J.; Smith, C.R.; and Church, M.J.; (2017). From the surface to the deep-sea: bacterial distributions across polymetallic nodule fields in the Clarion-Clipperton zone of the Pacific Ocean. *Frontiers in Microbiology*, 8. 01696.10.3389/fmicb.2017.01696. <http://doi.org/10.3389/fmicb.2017.01696>
- Shulse, C.N., Maillot, B., Smith, C.R., and Church, M.J. 2017. Polymetallic nodules, sediments, and deep waters in the equatorial North Pacific exhibit highly diverse and distinct bacterial, archaeal, and microeukaryotic communities. *Microbiology Open*, 6: e428, doi:10.1002/mbo3.428
- Taboada, S., Kenny, N.J., Riesgo, A., Wiklund, H., Paterson, G.L., Dahlgren, T.G., Glover, A.G.; (2017). Mitochondrial genome and polymorphic microsatellite markers from the abyssal sponge *Plenaster craigi* Lim & Wiklund: tools for understanding the impact of deep-sea mining. <http://dx.doi.org/10.1080/14772000.2017.1358218>
- Wiklund, H., Taylor, J.D., Dahlgren, T.G., Todt, C., Ikebe, C., Rabone, M., and Glover, A.G.; (2017). Abyssal fauna of the UK-1 polymetallic nodule exploration area, Clarion-Clipperton Zone, central Pacific Ocean: Mollusca. *ZooKeys* 707: 1-46 (10 Oct 2017). <https://doi.org/10.3897/zookeys.707.13042>

## 2016 Publications Arising from UK1 AB01 (2013) and AB02 (2015) Environmental Datasets

- Amon, D.J., Ziegler, A.F., Dahlgren, T.G., Glover, A.G., Goineau, A., Gooday, A.J., Wiklund, H., and Smith, C.R.; (2016). Insights into the abundance and diversity of abyssal megafauna in a polymetallic-nodule region in the eastern Clarion-Clipperton Zone. *Scientific Reports* 6: 30492. doi: 10.1038/srep30492 <http://www.nature.com/articles/srep30492>

## 2016 Publications Arising from UK1 AB01 (2013) and AB02 (2015) Environmental Datasets *(continued)*

Amon, D.J., Hilario, A., Martínez Arbizu P., and Smith, C.R.; (2016). Observations of organic falls in the abyssal Clarion-Clipperton Zone, tropical eastern Pacific Ocean. *Marine Biodiversity*. doi: 10.1007/s12526-016-0572-44. <http://rd.springer.com/article/10.1007/s12526-016-0572-4>

Dahlgren, T.G., Wiklund, H., Rabone, M., Amon, D.J., Ikebe, C., Watling, L. Smith, C.R., and Glover, A.G.; (2016). Abyssal fauna of the UK-1 polymetallic nodule exploration claim, Clarion-Clipperton Zone, central Pacific Ocean: Cnidaria, *Biodiversity Data Journal* 4: e9277 (30 June 2016) doi: 10.3897/BDJ.4.e9277 <http://bdj.pensoft.net/articles.php?id=9277>

Glover, A.G., Wiklund, H., Dahlgren, T.G., Rabone M., Amon, D.J., Smith C.R., and O'Hara, T.; (2016). Abyssal fauna of the UK-1 polymetallic nodule exploration claim, Clarion-Clipperton Zone, central Pacific Ocean: Echinodermata, *Biodiversity Data Journal* 4: e7251, doi: 10.3897/BDJ.4.e7251 <http://bdj.pensoft.net/articles.php?id=7251>

Glover, A. G., Dahlgren, T. G., Wiklund, H., Mohrbeck, I., & Smith, C. R. (2016). An End-to-End DNA Taxonomy Methodology for Benthic Biodiversity Survey in the Clarion-Clipperton Zone, Central Pacific Abyss. *Journal of Marine Science and Engineering*, 4(1), 2. doi: 10.3390/jmse4010002 <http://www.mdpi.com/2077-1312/4/1/2/html>

Glover, A.G., Dahlgren, T.G., Taboada, S., Paterson, G.L., Wiklund, H., Waeschenbach, A., Cobley, A., Martínez Arbizu, P., Kaiser, S., Schnurr, S., Khodami, S., Raschka, U., Kersken, D., Stuckas, H., Menot, L., Bonifacio, P., Vanreusel, A., Macheriotou, L., Cunha, M., Hilário, A., Rodrigues, C., Colaço, A., Ribeiro, P., Błażewicz, M., Gooday, A.G., Jones, D. O.B., Billett, D. S.M., Goineau, A., Amon, D.J., Smith, C.R., Patel, T., McQuaid, K., Spickermann, R., and Brager, S. ; (2016). The London Workshop on the Biogeography and Connectivity of the Clarion-Clipperton Zone. *Research Ideas and Outcomes* 2: e10528 (16 Sep 2016) doi: 10.3897/rio.2.e10528 <http://rio.pensoft.net/articles.php?id=10528>

Goineau, A.; (2016). "Monothalomophobia" or the tragedy of the monothalamous benthic foraminifera: can we ignore them? TMS Foraminifera and Nanofossil Spring Meeting, 19-24 June 2016, Angers, France

Goineau A., and Gooday A. J.; (2016). High abundance and diversity of novel benthic foraminifera in the abyssal equatorial Pacific (Clarion-Clipperton Zone). *MeioScool*, Brest, France, June 2016.

Gooday, A.J., and Goineau, A.; (2016). Recent research on benthic foraminifera (Protista) in the abyssal equatorial Pacific (Clarion-Clipperton Zone). Talk given at Challenger Society - UK Deep-Sea Ecosystems Special Interest Group, University of Liverpool, 9th September 2016.

Markhaseva, E.L., Mohrbeck, I., and Renz, J.; (2016). Notes on the biogeography of benthopelagic aetideid calanoids with the description of *Pseudeuchaeta vulgaris* (Copepoda: Calanoida), a new aetideid species from the deep Pacific Ocean, *Marine Biodiversity* (Special issue: Biodiversity of the CCZ) <http://rd.springer.com/article/10.1007/s12526-016-0527-9>

Mohrbeck, I., Neira, C., and Martínez Arbizu P.; (2016). Abyssal Meiofauna Communities in the UK-1 Exploration Area in the Clarion-Clipperton Zone (Northeast Pacific), *International Meiofauna Conference (ISIMCO 03. -08.07.2016)*, Heraclion, Greece.





## 2016 Publications Arising from UK1 AB01 (2013) and AB02 (2015) Environmental Datasets *(continued)*

Shulze, C., Maillot B., Smith C.R., and Church M.J.; (2016). Polymetallic nodules, sediments, and deep waters in the equatorial North Pacific exhibit highly diverse and distinct bacterial, archaeal, and microeukaryotic communities. *Microbiology Open*, DOI: 10.1002/mbo3.428.

Zinssmeister, C., Wilke, T., Hoppenrath, M., and von Ossietzky, C.; (2016). Species diversity of dinophysoid dinoflagellates of the Clarion Clipperton Fracture Zone. *Marine Biodiversity*. <http://rd.springer.com/article/10.1007/s12526-016-0607-x>.

## 2015 Publications Arising from UK1 AB01 (2013) Environmental Dataset

Amon, D.J., Smith, C.R., Ziegler, A.F.; (2015). Megafaunal community structure and biodiversity in the UK-1 claim area of the Clarion-Clipperton Zone. Oral presentation. 14th Deep-sea Biology Symposium, Aveiro, Portugal, September 2015

Cairns, S.; (2015). New abyssal Primnoidae (Anthozoa: Octocorallia) from the Clarion-Clipperton Fracture Zone, equatorial northeastern Pacific. *Marine Biodiversity*, 1-10, doi: 10.1007/s12526-015-0340-x. <http://rd.springer.com/article/10.1007/s12526-015-0340-x> (Includes species descriptions of cnidarians collected by the ABYSSLINE project.)

Dahlgren T.G., Wiklund H., and Glover A.G.; (2015). Biogeography and connectivity of the Clarion-Clipperton Zone abyssal fauna: insights from recent cruises to the UK-1 claim area, Oral presentation. 14th Deep-sea Biology Symposium, Aveiro, Portugal, September 2015

Glover A.G., Dahlgren T.G. and Wiklund H.; (2015). Environmental stewardship of the central Pacific Clarion-Clipperton Zone Mining frontier requires a vastly improved knowledge of species taxonomy and natural history, Oral presentation. 14th Deep-sea Biology Symposium, Aveiro, Portugal, September 2015.

Goineau A., Gooday A. J.; (2015). Radiolarian tests as microhabitats for novel benthic foraminifera: Observations from the abyssal eastern equatorial Pacific (Clarion-Clipperton Fracture Zone). *Deep-Sea Research I* 103, 73–85. <http://www.sciencedirect.com/science/article/pii/S0967063715000850>

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Gooday A. J., Goineau A., Voltski I.; (2015). Abyssal foraminifera attached to polymetallic nodules from the eastern Clarion Clipperton Fracture Zone: a preliminary description and comparison with North Atlantic dropstone assemblages. *Marine Biodiversity*, doi: 10.1007/s12526-014-0301-9. <http://rd.springer.com/article/10.1007/s12526-014-0301-9>

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## 2015 Publications Arising from UK1 AB01 (2013) Environmental Dataset *(continued)*

Kersten, O.; (2015). Abyssal Near-Bottom Zooplankton in the Eastern Tropical North Pacific. Master's Thesis, Hawai'i Pacific University.

Kersten, O., Smith C.R., Vetter, E.W.; (2015). Abyssal benthopelagic zooplankton in the Clarion Clipperton Zone. Poster presentation. 14th Deep-Sea Biology Symposium, Aveiro, Portugal.

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Mohrbeck, I., Neira, C., Singh, R., and Martínez Arbizu, P.; (2015). UKSR Environmental Baseline Programme: Meiofaunal Community Structure and Diversity in the UK1 License Area. Workshop of the International Seabed Authority (14.-17.12.2015), Ghent, Belgium

Mohrbeck I., Janssen A., Brenke N., Kaiser S., Menzel L., and Martínez Arbizu P.; (2015). Molecular genetics of Crustacea as a tool to investigate the post-mining recovery potential of deep-sea ecosystems. MIDAS meeting (16-20.11.2015), Sintra, Portugal.

Mohrbeck I., Janssen A., Kaiser S., Brenke N., Borges V.A., Albers L., Raschka U., and Martínez Arbizu P.; (2015). Isopod distribution patterns in polymetallic nodule fields: German vs. UK license area. Presentation at the 14th Deep Sea Biology Symposium (31.08.-04.09.2015), Aveiro, Portugal.

Sweetman, A.K, Smith, C.R, Maillot, B., Schulse, C., Church, M.J., Gooday, A.J., and Moodley, L.; (2015). Bacteria, not macrofauna, are key players in the short-term degradation of phytodetritus in oligotrophic abyssal sediments. Oral presentation. 14th Deep-sea Biology Symposium, Aveiro, Portugal, September 2015.

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Smith C.R., Amon D.J., Drazen J., Church M., Vetter E., Glover A.G., Dahlgren T.G., Gooday, A.J., Martínez Arbizu P., Sweetman A., and Ziegler A.; (2015). Nodule Mining and Ocean Stewardship in the CCZ: An overview of the ABYSSLINE project with results on macrofaunal diversity and community structure. Oral presentation. 14th Deep-sea Biology Symposium, Aveiro, Portugal, September 2015.

Wiklund H., Dahlgren T.G., and Glover A.G.; (2015). Phylogenetics of the Clarion-Clipperton Zone abyssal fauna: species concepts, diversity and origins. 14th Deep-sea Biology Symposium, Aveiro, Portugal, September 2015.

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## 2014 Publications Arising from UK1 AB01 (2013) Environmental Dataset

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Glover, A.:(2014). Environmental Futures in the Deep-Sea Mining Frontier, 16th Biennial Challenger Society Marine Conference, September 2014.

Goineau, A. and Gooday, A.:(2014). Evaluation of benthic foraminiferal assemblage characteristic in the abyssal eastern equatorial Pacific, an area of likely future polymetallic nodule mining. World Conference on Marine Biodiversity, 12-16 October 2014. Qingdao, China.

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