Clim. Past Discuss.,
https://doi.org/10.5194/cp-2020-82-SC2, 2020

Climate of the Past Discussions
Open Access
EGU

Interactive comment on "The influence of Atlantic climate variability on the long-term development of Mediterranean cold-water coral mounds (Alboran Sea, Melilla Mound Field)" *by* Robin Fentimen et al.

Andres Rüggeberg

andres.rueggeberg@unifr.ch

Received and published: 6 September 2020

This is a reply of the authors to the Short Comment of Silvia Spezzaferri from 05.09.2020:

First of all we would like to acknowledge all referees that they took their time and effort to critically review our manuscript. We appreciate all the comments and suggestions and integrated all in our best way possible!

In the following, we dispute (indicated by "Reply") the scientific comments from Dr.

Printer-friendly version

Discussion paper

Spezzaferri's (indicated by "SC").

SC: In general, the interpretation is forced, giving CWC foraminifera a "clear, fixed and not questionable" significance, which may not be the case, especially for these ecosystems that are not completely well understood. These organisms can easily adapt and change their ecological preferences according to geographical location, oceanographic parameters, e.g., water depth, substratum, salinity, temperature, etc: : :: : :.(e.g., the same species can live in relatively shallower or deeper water according to the type of substratum, the same applies for all other parameters, e.g., salinity, nutrient and oxygen availability). In the manuscript all the discussion is based on given and fixed foraminifera ecological preference taken from the literature and in different geographical setting, instead of starting from establish proxies (e.g. TOC) and then interpret foraminiferal data.

Reply: It should be stated that foraminifera species and assemblages are a very powerful proxy to study past environmental settings. Lots of studies have been proven this approach. . ...please add references. The ecological preference of certain species and assemblages is used to interpret past environmental settings and compared to other ecological or environmental parameters based on different sedimentological, macrofaunal and geochemical proxies. In this manuscript, several proxies are combined and compared to the studied foraminiferal assemblages to draw the final conclusions. This classical multiproxy approach has been used to get solid interpretations. It should be mentioned that often lots of weight is only put on one or the other proxy, while this study is integrating both, foraminiferal proxy and geochemical datasets. To highlight the critical note of the authors towards using foraminifera having a fixed ecological preference being bound to certain settings, just one example: Earlier publications (Margreth et al., 2009, 2011; Stalder et al., 2014; Spezzaferri et al., 2013) use single species (i.e. Discanomalina coronata) as bioindicator for cold-water coral reefs, although other studies showed that this species occurs in high-energy environments (Schönfeld, 2002) or is not or very low abundant in other CWC reef sediments (e.g., Smeulders et al., 2014).

In this manuscript we discuss that D. coronata not directly associates to periods where CWC reefs thrive and question their ecological preference.

SC: Every situation must be evaluated case by case and anyhow a complete dataset including fractions smaller than 125 m should be presented. Explainig everything with displacement is not a real reason. The same applies to the counting of the plankton, is more a problem of time consuming than scientific. To demonstrate that it is a scientific reason, data sghould be presented first and tehn excluded. The >125 m can be useful when making taxonomic work e.g., taxonomic atlases and guides with plates (e.g., Milker and Schmiedl, 2012) but not for ecological purposes, in this case the 40 m frection counts should be presented and eventually afterward not included in the discussion.

Reply: The fraction > 125 μm has been often used in settings characterized by high currents (e.g., Lutze and Coulbourn, 1984). Also the study of Stalder et al. (2015) based on sediment cores from nearby CWC mounds of the Melilla Carbonate Mound Field presents data and interpretation only based on foraminiferal identification and interpretation of fractions >125 μm, this for the same reasons we mention in our manuscript ("[Stalder et al., 2015] decided to focus on specimens larger than 125 μm to exclude smaller forms, which are often displaced by redeposition (Lutze and Coulbourn, 1984), and to make the data comparable to other benthic foraminiferal studies in adjacent areas (Caralp, 1988; Vergnaud-Grazzini et al., 1989; Schönfeld, 2002; Milker and Schmiedl, 2012“). To integrate planktonic data is of course very important for future studies.

SC: It is not clear how he density of benthic foraminifera has been calculated. The method used should be better explained and should be specified the reason for the choice. The method used in the manuscript does not correspond to any of the generally used in micropaleontology. . .

Reply: Indeed, there are different ways to present total benthic foraminifera densi-

ties with respect to sample weight or accumulations rates (including time). As mentioned above, calculating foraminiferal densities on sample weight is biased in CWC settings due to the large abundance of macrofauna. Often, direct comparison to other foraminiferal studies is not possible. Therefore, the number of individuals per gram of fraction was chosen. However, to avoid confusion we will present the relative abundance (in %) of the benthic foraminifera to be comparable to the study of Stalder et al. (2015) and others.

SC: I would like also to comment on Figure 10, which looks very fancy but presents a few problems. First of all it is upside down (even if the cardinal points are marked), we conventionally (and geographically) see the African margin at South and European Margin at North. Not the vice versa. This confuses the reader.

Reply: This is a discussion of an artistic point of view. We prefer to present the Alboran Sea in this way looking towards the SW to better visualize the patterns occurring at the Melilla Carbonate Mound Field. The authors have made different versions of this figure and this orientation illustrates much better the interpretation. Sometimes a different perspective might change the view on traditional conventions. Of course, the authors make sure that N and S are clearly indicated on the respective figure.

SC: As commented above (WHERE?) during glacials the thermocline and pycnocline should be very shallow favoring water and nutrient mixing. In Figure 10 glacials are on the contrary described as stratified, the explanation for this is based only on comparison with modern times, it is generally confused and/or based on assumptions and circular reasoning. No clear evidence is presented. On the contrary interglacial are represented as are the typical models for high latitudes/glacial times e.g., with strong mixing of water mass and nutrients. I First of all in the Mediterranean this cannot be possible, even in the past, also considering the temperate latitude and seasonality. Additionally, if during interglacials fluvial input increased, then the fresh water plume arriving into the sea must have produced a clear separation of water masses (fluids with different densities) and not mixing. The closest large river is only at 50 km (Mouloya)

Printer-friendly version

Discussion paper

, if the fluvial input was so massive to trigger coral growth, then also the fresh water plume must have been significant enough to produce stratification not mixing. Other alternative processes must be discussed?

Reply: The authors have difficulties to understand the reasoning outlined above. To clarify the outcome, we clearly conclude the following in the manuscript: 1) Cold-water corals develop mainly during interglacial periods. Their growth is promoted by the combination of increased fluvial input and enhanced influence of Alboran Gyres. Increased fluvial organic matter inputs are driven by the increased impact of warm and moist Atlantic air masses with intensified Western and Eastern Alboran Gyres that lead to more important turnover between surface and intermediate water masses. This phenomenon is promoted by enhanced Modified Atlantic Water inflow at the Strait of Gibraltar. . . . These results demonstrate the paramount importance of enhanced fluvial input as a trigger for cold-water growth in the Southeastern Alboran Sea. This is illustrated in Figure 10. Interglacial. 2) Glacial periods are unfavourable for cold-water corals; in contrast the bryozoan Buskea dichotoma is more suited to glacial environmental conditions. The retreat of corals during glacial periods is triggered by arid continental conditions that lead to reduced fluvial input and nutrient supply. Moreover, reduced inflow of Modified Atlantic Water at the Strait of Gibraltar results in a lower contribution of surface waters to intermediate waters. In contrast, the contribution of Western Mediterranean Deep Water to intermediate water masses increased. Weaker Alboran Gyres and increased contribution of well-ventilated deep waters at intermediate depths resulted in increased stratification. Lower input of organic matter, but less degraded, further characterizes glacial environmental conditions. Aeolian dust was the main fertilizing influence and may have enabled corals to survive throughout glacial periods. This is illustrated in Figure 10. Glacial.

SC: If responsible for stratification in glacials are the stronger ShW then it must be demonstrated that they are indeed stronger (what ever “stronger” means: denser? colder?) and remarkably colder than at the surface to justify such a stratification acting

a physical barrier between the sea floor and the surface. And this is not possible with the present data. At least an intermediate water species should have been analyzed for oxygen isotopes and not only at the BRI site but also in the Atlantic waters, e.g., Cadiz to have the ShW signature, as these are the waters that are supposed to influence the Alboran Sea (e.g, as in the title). Only Atlantic or Mediterranean waters are marked in the figures. If there were rivers they have to be documented as they are not only today but also how they were in the past 400.000 years, according to geological information.

Reply: It is clearly described in the discussion (chapters 5.1 and 5.2) what the processes are with respect to water mass dynamics during glacial and interglacial periods. The increased stratification during cold periods is discussed in detail in chapter 5.2.2 where we integrate grain size data, carbon isotope data and benthic foraminiferal ecology. As the benthic foraminifera analyzed for oxygen isotopes at BRI represents the situation at intermediate water depths, only a transect from the deeper basin across the slope to the shelf would be the most suitable approach to characterize different water mass signature. However, such a transect of cores was not available (yet). Furthermore, we cannot follow the reference to the Gulf of Cadiz with respect to the ShW, as the ShW is a local phenomenon <300 m described for the Eastern Alboran Sea offshore Morocco as a mixture of MAW and WMDW (see Ercilla et al., 2016) - this (strictly not a) water mass does not occur in the Gulf of Cadiz. Rivers are indicated in figure 10, however, where exactly the rivers were draining into the Mediterranean Sea during glacials is less certain but possibly similar to today.

SC: Last but not least and for respect to the funding agency the first author Robin Fentimen should also acknowledge the Swiss National Science Foundation Project Ref. 200020_153125 “Faunal assemblages from active, declining and buried cold-water coral ecosystems” that payed his salary for 3 years over the 4 years of his PhD, and that has co-funded with the amount of 54.000 Euro the cruise Eurofleets GATEWAY, MD194 during which the cores investigated in this research were retrieved.

Reply: We thank you for this comment. Of course, we will acknowledge this project

properly.

References in this Reply:

Caralp MH (1988) Late glacial to recent deep-sea benthic foraminifera from the Northeastern Atlantic (Cadiz Gulf) and Western Mediterranean (Alboran Sea): paleaooceanographic results. Marine Micropaleaotology 13: 265–289.

Ercilla, G., Juan, C., Hernández-Molina, J., Bruno, M., Estrada, F., Alonso, B., Casas, D., Farran, M., Llave, E., García, Vázquez, J.T., D'Acremont, E., Gorini, C., Palomino, D., Valencia, J., El Moumni, B., and Ammar, A. (2016) Significance of bottom currents in deep-sea morphodynamics: An example from the Alboran Sea, Mar Geol, 378, 157-170.

Lutze GF, Coulbourn WT (1984) Recent benthic foraminifera from the continental margin of northwest Africa: Community structure and distribution. Marine Micropaleontology 8: 361–401.

Margreth, S., Rüggeberg, A., and Spezzaferri, S. (2009) Benthic foraminifera as bioindicator for cold-water coral reef ecosystems along the Irish margin, Deep-Sea Res Pt I, 56, 2216-2234.

Margreth, S., Gennari, G., Rüggeberg, A., Comas, M.C., Pinheiro, L.M., Spezzaferri, S. (2011) Growth and demise of cold-water coral ecosystems on mud volcanoes in the West Alboran Sea: The message from planktonic and benthic foraminifera. Marine Geology 282: 26–39.

Milker Y, Schmiedl G (2012) A taxonomic guide to modern benthic shelf foraminifera of the western Mediterranean Sea. Palaeontologia Electronica 15(2): 1–134.

Schönfeld, J. (2002) Recent benthic foraminiferal assemblages in deep high-energy environments from the Gulf of Cadiz (Spain). Mar. Micropaleontol. 44: 141–162.

Schönfeld J (2002) A new benthic foraminiferal proxy for near-bottom current velocities

in the Gulf of Cadiz, northeastern Atlantic Ocean. Deep-Sea Research Part I 49: 1853–1875.

Smeulders, G.G.B., Koho, K.A., De Stigter, H.C., Mienis, F., de Haas, H., van Weering, T.C.E. (2014) Cold-water coral habitats of Rockall and Porcupine Bank, NE Atlantic Ocean: Sedimentary facies and benthic foraminiferal assemblages: Deep-Sea Research II 99: 270–285.

Spezzaferri, S., Rüggeberg, A., Stalder, C., Margreth, S. (2013) Benthic foraminifer assemblages from Norwegian cold-water coral reffs. Journal of Foraminiferal Research 43(1): 21–39.

Stalder, C., Vertino, A., Rosso, A., Ruggeberg, A., Pirkenseer, C., Spangenberg, J.E., Spezzaferri, S., Camozzi, O., Rappo, S., and Hajdas, I. (2015) Microfossils, a Key to Unravel Cold-Water Carbonate Mound Evolution through Time: Evidence from the Eastern Alboran Sea, PLoS One, 10, e0140223.

Vergnaud-Grazzini C, Caralp M, Faugères J-C, Gonthier E, Grousset F, Pujol C, et al. (1989) Mediterranean outflow through the Strait of Gibraltar since 18 000 years B.P. Oceanologica Acta 12: 305–324.

Interactive comment on Clim. Past Discuss., https://doi.org/10.5194/cp-2020-82, 2020.