

Clim. Past Discuss., referee comment RC2  
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## Comment on cp-2021-162

Anonymous Referee #2

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Referee comment on "A 300 000-year record of cold-water coral mound build-up at the East Melilla Coral Province (SE Alboran Sea, western Mediterranean)" by Robin Fentimen et al., *Clim. Past Discuss.*, <https://doi.org/10.5194/cp-2021-162-RC2>, 2022

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### Referee Report

#### General comments

The work by Fentimen and co-authors is dealing with the already well characterized Brittlestar Ridge I, within the East Melilla Coral Province. The authors analysed one sediment core, collected from the later mound to improve the information on this mound's development during the Middle and Late Pleistocene in relation to palaeo-environmental variations. The authors based their discussion and conclusions on a combined chronostratigraphy of  $^{14}\text{C}$ , U-Th ages,  $\text{d}^{18}\text{O}$  results and the environmental interpretations extracted from the relative abundances of foraminifera, macrofauna and chemical proxies of terrigenous input.

This work presents novel and remarkable results in the area, providing the first evidence of coral growth in the Alboran Sea during the last two glacial periods, but especially during the MIS 4-2. These results contrast with the current knowledge of coral mound development in the Alboran Sea and in the Brittlestar Ridge 1 itself, where mound formation was mainly confined to temperate interstadials and interglacial periods. Although, the current paper shows coral growth both during glacial and interglacial periods, the authors suggest that coral mound formation in the Brittlestar Ridge 1 is linked to increased sediment inputs, enhanced organic matter flux and high food availability at the seafloor during interglacial periods.

Although the results acquired and methods followed comply with good scientific standards, I believe that there is considerable room for improvement in the introduction and discussion sections, as the authors disregard a part of the studies on coral mounds and CWC assemblages carried out in the Mediterranean Sea. While the paper focuses on a Mediterranean coral mound, the authors give much more detailed information on the

environmental variables and processes controlling coral mound formation in the North Atlantic. For instance, there are no comments on the current state and species dominance of CWC assemblages in the Mediterranean Sea. In a similar way, although there is relevant information on coral mound development in the Alboran sea going back >300 kyr, the authors do not comment on it. Although one of these studies is an unpublished PhD thesis (by Thomas Krengel), I believe the authors should still comment on the conclusions acquired there, especially because the thesis is built around MeBo cores collected in the Brittlestar Ridge 1 itself. In addition, the studies from the Cabliers Coral Mound Province, showing the only currently thriving coral reefs in the Alboran Sea and their development since the Middle Pleistocene are also ignored. The authors should add all this information and provide numbers on aggradation rates and oldest dated corals in the Mediterranean Sea to set a good ground for a more relevant discussion of their results.

With regards to the discussion I recommend moving the first part of the results where the authors discuss the chronostratigraphy of the core and set it as the first section of the discussion. I suggest to also add here or just before chapter 5.3 all the information from section 5.1.3 together with a more in-depth discussion of the paper's results, in terms of coral growth periods and mound aggradation rates with those previously published for other coral mounds of the Mediterranean Sea (e.g. Fink et al., 2013; Stalder et al., 2015, 2018; Wang et al., 2019; Krengel, 2019; Corbera et al., 2021, 2022). And then continue the discussion as it is, with environmental setting during interglacials and glacials and the final section comparing with North Atlantic coral mounds. Regarding the later chapter, I recommend to shorten this section avoiding too many details on the specific environmental controls for the Atlantic coral mound provinces as they are located in very contrasting environmental settings.

Nonetheless, as this study provides a significant contribution to the current knowledge on coral mound formation in the Mediterranean Sea, I recommend to publish this manuscript subject to moderate revisions of the introduction and discussion chapters as commented above, and after addressing the specific comments below, which will hopefully help to improve the quality of the manuscript.

## **Specific comments**

### ABSTRACT

Line 22: Please change "300 ky" for "300 kyr", and revise throughout the text. The abbreviation "kyr" should be used when the authors refer to a period of time and "ka BP" when they refer to a specific moment in the past.

Line 26: Coral mounds in the Gulf of Cadiz develop during glacial periods, while Norwegian and Irish mounds develop during interglacials, both of them being in the Northeast Atlantic. On another note, I believe it would be more relevant to the work presented here to compare the results acquired with those already published for other mounds in the Mediterranean Sea. Especially, because this is the first time that such amount of coral ages have been obtained in an Alboran Sea coral mound for the last glacial period (MIS 2-4).

Lines 28: Saying that coral mound build-up in the Southeast Alboran Sea presents aggradation rates  $< 10 \text{ cm kyr}^{-1}$  is not accurate. What about the high aggradation rates of the brittlestar ridges and Cabliers mounds during the Early Holocene? The Dragon mound and Cabliers also display ARs higher than  $10 \text{ cm/kyr}$  in the MIS 5. See Thomas Kregel PhD Thesis (2019; available online), Wang et al. (2019) and Corbera et al. (2021). In fact, the authors comment on such aggradation rates (75 to  $420 \text{ cm/kyr}$ ) in line 83.

## INTRODUCTION

Line 38: Please change "common on Earth" by "widespread in the world ocean"

Lines 44-46: Please add that such oceanographic features also accumulate particulate organic matter due to their sharp density gradient.

Line 50: Please add the reference by Hebbeln et al., 2016, dealing with the baffling capacity of coral frameworks and the role of the hemipelagic sediments in stabilising the coral frameworks.

Line 53: The study focuses in the Alboran Sea, where there are already many examples of aggradation rates equal or even higher than those of the porcupine Seabight. Hence, I believe it would be more appropriate to use one of those mound aggradation rates as an example.

Line 54-56: Please change the structure of the sentence for an easier lecture. For instance: "As such, and in spite of mound formation being generally discontinuous, coral mounds..."

Lines 60-75: Too much detail on the controls of CWC mound development for each

"province" of the Atlantic. Instead, I would state the main development periods and give and overall explanation on the environmental controls at the end of the paragraph and explain better the environmental variables driving mound development in the Mediterranean Sea.

Lines 72-75: Gulf of Cadiz coral mounds only develop during glacials. Check Wienberg et al. (2010). It displays one coral age in the MIS5 but this cannot be attributed to mound formation.

Line 78: Please change "concentrated in the East Alboran Sea" for "concentrated in the Alboran Sea" as Lo Iacono et al. (2014) is not really East Alboran. Nonetheless, there are also many documented mounds in the Corsica channel (Remia and Taviani 2005; Angeletti et al., 2020), south of Pantelleria (strait of sicily; Martorelli et al., 2011) and on the Tunisian Plateau (Camafort et al., 2020; Corbera et al., 2022), that should not be disregarded.

Lines 77-88: Although the manuscript focuses on Mediterranean CWC mounds, the introduction gives more detailed information on the environmental controls for the Atlantic coral mounds than the Mediterranean Sea ones. Here it focusses only on information from the Melilla Mound Field and just during the MIS1. I recommend to add the results from Thomas Krengel PhD thesis and Corbera et al. (2021, 2022), which expands the information to other areas of the Alboran and Mediterranean Sea, and to the Late and Middle Pleistocene. It should also be stated somewhere in this paragraph that most of the Mediterranean coral mounds are in a stagnation stage, except for the North Cabliers Coral Mounds (Corbera et al., 2019) and the Corsica Mounds (Angeletti et al., 2020).

Line 91: This is not entirely true. Although the data has not been published in a peer reviewed journal there is information on long-term mound development and environmental forcing from the Brittlestar Ridge 1 and Dragon Mound (both from the EMCP) that goes back > 300 kyr.

Line 93: Considering that this paper shows for the first time the presence of coral proliferation in the Alboran Sea during the last glacial period (MIS 2-4), I believe that instead of comparing the development of BR1 with Atlantic mounds, the paper would benefit and become stronger from comparing its results with the development of other Mediterranean Coral Mounds. Especially, with results acquired from gravity cores previously collected from the BR1 itself, where no glacial ages have been reported before.

Do the authors have any hypotheses on why this part of the mound presents limited coral growth during the last glacial, whereas less than 2 km to the south west and around the same depth (i.e. ~330 m) no coral growth has been observed during this period?

## STUDY AREA

Lines 98-100: Please move these two sentences to the start of the paragraph.

Line 105: Please change to "The ridges are 3 to 20 km in length and vary in height from 50 to 150 m..."

Lines 106-108: Please change sentence to "These mounds are characterized by dead coral framework with some living corals at their summits..."

Line 136-138: Please modify to "It is important to note that, as it moves towards the west, the LIW receives contributions from other water masses and hence, its characteristics gradually change as it gets closer to the Strait of Gibraltar (Millot, 2013)".

Line 139: What is this water mass? Which are the differences in physicochemical conditions with the LIW? There is barely more than one paper where someone mentions this water mass. Also Ercilla et al. (2016) is not a physical oceanography paper, but an study dealing with contourites.

Line 144: Please find another REF, as this is not a physical oceanography paper.

## MATERIAL AND METHODS

Line 189: Please modify to "*MaterialStatistics*"

Lines 200-201: Please change to "background sediment (i.e. aluminum)"

Lines 208-211: Please modify to "Since the Saharan region, which is the dominant source

of aeolian dust in the Mediterranean Sea, is essentially composed of silicates with high quartz content (REFS) and considering silica is rare in the Alboran Sea sediments (REF), the Si/Al ratio has been used to track variations in terrestrial inputs"

Line 215: Please modify to "Rb/Al ratios provide robust and valuable records of terrestrial input".

Line 224: Sometimes written as "grain-size" and others as "grain size". Please revise and keep consistency throughout the manuscript.

Line 279: Please modify to *L. lobatula*, as this species has already been mentioned in the manuscript (line 261)

## RESULTS

Lines 309-316: These are not really results and thus, I recommend to move this paragraph to the discussion section. Maybe just at the start of the discussion, before talking about the environmental setting

Line 323: What test is this package doing? A linear regression of the data points? Please specify and in any case the authors the authors should also show the p-value of the test.

Line 340: By correlation coefficient are you referring to  $R^2$ ? If so please display it in a consistent way throughout the manuscript and add the p-value.

Line 345: Add p-values please.

Line 363: Please modify "surrounded by" for "embedded in"

Line 368: Please change "of essentially terrestrial.." to "essentially of terrestrial..."

Lines 387-388: Please change to "G. bulloides goes from -2.2 ‰ at 12 cm to -0.5 ‰ at 292 cm, whereas that of the benthic *L. lobatula* goes from 0.9 ‰ at 872 cm to 1.8 ‰ at 362 (Fig. 5)."

Line 414: If you specify the core depth for the MIS 3, please do the same for the MIS 6.

Line 419: Please change to "(Figs 3, 8)".

Line 419-421: Please modify to "Although the dominant coral species in the core is the scleractinian *D. pertusum*, in the upper 20 cm this species is replaced by *M. oculata* (Figs. 3, 8)"

Line 422: Please specify approx/average coral contents for glacial and interglacial periods.

Line 426: Please explain with a bit more detail the changes in aggradation rates from MIS 6 to MIS 1.

Lines 438-441: Please change to "*G. vitreus*, *T. retusa* and *B. pectunculoides*" as they have already been fully mentioned at the beginning of this paragraph.

Lines 460-461: Please change to *D. coronata* and *L. lobatula*.

Line 470: Please write full genus for "*B. aculeata*" as it is the first time this species is mentioned

Line 475: Please modify to "*U. mediterranea*" it has already been mentioned before.

## DISCUSSION

Line 486: I recommend to add the discussion on the chronostratigraphy construction as a

general discussion at the beginning of this section.

Lines 493-496, 500-502, 505-508: The authors talk about organic matter flux in all these sentences. Such repetition is a bit confusing for the reader and it makes it difficult to follow the authors argumentation. Please merge these statements in a couple of sentences prior to lines 497-499.

Line 513: Please change "Overall" to "Indeed, the.."

Line 516: Please modify to "towards the end of such periods"

Lines 537-539: This is a bit contradictory as both this mound (i.e. BRI), the dragon mound (also EMCP), West Melilla and southern Cabliers show aggradation rates > 20 cm/kyr during interglacial periods. Please check Krengel PhD Thesis, Wang et al. (2019), Corbera et al. (2021). In fact, there are papers of CWC reefs thriving under hypoxia off Angola and Namibia. Check Tamborrino et al. (2019) and Hebbeln et al. (2020).

The present paper also shows higher coral content during the MIS 5, indicative of a more prolific coral growth/mound formation period (as observed in Fig. 3 and mentioned by the authors in lines 568-570). However, the lack of enough coral ages (n=3) does not allow to properly constrain the actual aggradation rate during this interglacial (encompassing > 1m of core).

Line 541: CWCs are not pelagic ecosystems. This should be changed to epibenthic.

Line 567: Please change title to "Variability of cold-water coral mound formation in the Alboran Sea"

Lines 573-577: Here the authors compare the youngest age of different cores from the EMCP and the WMCP. Please discuss with more detail how the aggradation rates observed in this core compare to those of the EMCP during the MIS1 (Fink et al., 2013; Stalder et al., 2015, 2018 and other refs) and previous MIS (Krengel PhD thesis results). Also compare with detail with other nearby provinces such as the WMCP (Want et al., 2019) and the Cabliers coral mounds (Corbera et al., 2021), which has information on coral mound development going back to > 300 ka BP.

Line 580: These are not papers assessing the resilience of *D. pertusum* or *M. oculata* to env. conditions... Add examples of experimental studies and maybe also the review by

Wienberg and Titshack (2015), where they show the distribution of these two species along the Atlantic with respect to env. variables.

Lines 582-583: Also consistent with most of the currently living CWC assemblages in the MED, which are mainly dominated by *M. oculata* (Orejas et al., 2009; Gori et al., 2013; Taviani et al., 2017; Angeletti et al., 2020). You have many examples, including living reefs in the Eastern Alboran Sea (Cabliers; Corbera et al., 2019). Please add all this information.

Lines 608-610: Please modify to "Higher bryozoan content during glacials at BRI is in tune with previous observations made at the Great Australian Bight, where bryozoan proliferation during glacial periods has been able to promote the formation of mounds (James et al., 2000; Holbourn et al., 2002)." Are they looking at the same species? If not, I would not compare the env. conditions but just the fact that bryozoans can form mounds.

Lines 610-611: Please remove "Conversely, higher temperatures and downwelling during interglacials halted bryozoan extension at the Great Australian Bight (James et al., 2000; Holbourn et al., 2002)."

Line 615: Please modify to "bryozoans, due to the high concentration"

Line 618: Please change to "*G. vitreus*"

Lines 633-637: Please check and rephrase this sentence, it is hard to follow.

Lines 680-682: Please modify for "The last glacial shows a strong variability in macrofaunal and benthic foraminiferal assemblages, whereas maximum coral content is reached during the MIS 3 (Fig. 3)".

Lines 682-683: I think using Rb/Al as an explanatory variable here is an overinterpretation of the data as this proxy barely changes along the core.

Lines 683-685: Didn't the authors say river run-off was considerably reduced during glacials (Lines 622-628)? Please revise and clarify. In addition, the aggradation rates of 10 cm/kyr cannot be considered as fast mound formation rates, when there are many records of aggradation rates >100 cm/kyr in the Alboran Sea (Please check the literature).

Line 693: What is the reason to compare the data acquired here with North Atlantic coral mounds and not the Mediterranean Sea? As I have already commented in this revision, this paper would benefit from a better comparison with Mediterranean mounds, as the environmental variables and climatic events affecting their development will be more similar (if not the same) and relevant for discussion.

Lines 697-698: The results obtained here show sporadic coral growth during interglacial and glacial periods with the first ages ever acquired in the Alboran Sea during the last glacial. This is very interesting, but the aggradation rates showed are not high enough to be attributed to mound formation (check Frank et al., 2009 where the authors set a threshold of 15 cm/kyr to consider that there is coral driven mound formation).

Lines 729-733: Again, what about the information in Krenzel's PhD thesis. He obtained ARs up to 83 cm/kyr during interglacial periods and no growth during glacials. I also see a lack of discussion in the potential effect of sapropel events on alboran sea coral mound development as discussed by Krenzel's PhD and Corbera et al (2021).

Line 735: This is not true. As already commented above, there are records of significant coral mound formation during interglacials in this mound. Limited mound formation of the BR1 is just observed in this core/region of the BR1. Please discuss this in more detail.

Lines 739-742: Exactly! In the sector of the BR1 from where this core was collected, the corals grew under stressful conditions. However, there are parts of the discussion where this message is not clear. Please revise and modify accordingly.

Line 723-749: What about the Gulf of Cadiz coral mounds?

## CONCLUSIONS

Line 754: This is not entirely accurate. Please replace "Cold-water coral mound build-up takes place during both interglacial and glacial periods" for something in the lines of "Although previous results indicated that CWC growth and mound formation in the Alboran Sea occurred just during interglacials, this study shows that CWCs did not disappear from the BR1 during the last glacial periods."

Line 757: Please modify for "conditions in this sector of the Brittlestar Ridge I".

Line 763: Please add "and surface productivity" after terrestrial input

## REFERENCES

Line 1093: The link provided here does not work, please revise and try to provide a working link.

## FIGURES

Figure 1: Please add the locations of the West Melilla Coral Mound Province and the Cabliers Coral Mound Province in panel B. I also believe that in panel C the authors should add the location of other gravity and/or MeBo cores acquired from the Brittlestar ridge 1. Check previous literature and Thomas Krengel PhD thesis. The red box just comprises the BRI and not the entire EMCP, please revise and modify.

Figure 4: Please add p-values to all  $R^2$  in the figure caption. In line 334 change "high" to "higher"

Figure 7: Add p-values please.

Figure 10: Still not convinced about the existence of the Shelf Water as an independent water mass different of the LIW.

## Technical corrections

Line 130: Please change "East to West" to lower case.

Line 131: Please add a coma after Sicily.

Lines 161-163: Please remove space in between sentence.

Line 247: Please change from "(percentages)" to "(%)".

Line 350: Add a coma after "ages"

Line 373: Please remove the "is" after SS.

Line 374: Please modify "MIS 6 were SS..." for "MIS 6, when SS..."

Figure 2: Please change the label "Oxygen ( $\mu\text{mol.kg}^{-1}$ )" to "Oxygen ( $\mu\text{mol kg}^{-1}$ )". Please modify this also in the figure caption.

Figure 3: Please revise and modify the oldest  $^{14}\text{C}$  age (i.e. 30.1 ka BP), as in table 1 it says 30.9 ka BP.