

Response to Dr. Madeleine Vickers:

20: “:mainly due to their (possible) utility for palaeoenvironmental (especially palaeoclimatic) reconstructions:::” I think the word “possible” should be added as this is still debated among the palaeoclimate community.

- done

70: discussion on transformation from ikaite to water and vaterite, calcite, aragonite: : :.could cite Tang et al. 2009 (J. Applied Crystallography) who also show ikaite transforming to vaterite before the calcite.

- we cited this article, as well as additional (previously omitted) paper providing evidence of ikaite transformation to amorphous calcium carbonate

75: “Purgstaller et al. (2017) showed that the formation of anhydrous calcium carbonates is controlled mainly by the prevailing physicochemical conditions, such as the Mg/Ca ratio of the aqueous medium and water availability.” - Stockmann et al., 2018 (Applied Geochemistry) also show this, and should probably be cited here.

- done

90 – 95: “The size of natural modern ikaite clusters: : :.” Are all of these from personal observation or are there published studies you used to determine this? (in which case, cite them).

- proper references were added

100 – 105: Petrography and Cathodoluminescence: You cite studies that have used these techniques: we have just published CL, SEM element maps, and thin section work on the Danish Fur Formation glendonites (Vickers et al., 2020, Nature Communications) that you might want to include here.

- done

120: “Besides multiple carbonate generations, some detrital material is typically also found in glendonites” - They also tend to have a high OM content - enough that can be measured for stable isotopes by dissolving the carbonate (we did this with subsamples of the Danish Eocene glendonites, see Vickers et al., 2020 for the data).

- we cited Vickers et al., 2020 here

165: “Interestingly, most glendonite occurrences have been reported from the northern Hemisphere, which is challenging to explain.” - Could it be partially due to there being fewer high latitude southern hemisphere outcrop studies? Could it be that since many of the Mesozoic and early Cenozoic S. hemisphere studies are based on cores, they may not have sampled rare glendonites in the successions?

- glendonites are so remarkable and easily distinguished from other types of concretions common in sedimentary rocks, that as follow from the both authors’ experience and analysis of publications, we rather suggesting that rarity of the Southern Hemisphere occurrences are reflect the real situation, which will be analyzed in detail elsewhere. Although the described database could be partially biased towards the datapoints located in Russia due to availability of diverse data sources, including reports and explanatory notes, online search in different languages indicates rarity of glendonites in the Southern Hemisphere except the Australian and Tasmanian occurrences.

180: “It should be noted that the giant glendonites from Denmark are mainly embedded in post- PETM rocks, but clumped isotope data from the glendonites are indicative of near-freezing temperatures” – we also present new clumped and stable isotope data for the Danish Eocene mega-glendonites in Vickers et al. (2020).

- added

180-185: “only a single occurrence has been reported from the Barremian.” – Who reported this?

- we found this specimen from the Barents sea shelf in core storage, it will be studied soon. Age of this core was determined by means of dinocysts (Shurekova and Gogin, 2018 – reference added to the database)

225: However, experiments carried out during the last few years have revealed at least short-term ikaite stability at much higher temperatures, up to 30-35°C – also Stockmann et al. (2018) could/should be cited here.

- added

Figures: Overall very nice figures. Figure 4, however, the dots showing glendonite/ikaite locations are very small. I think you should make the dots bigger as it's hard to distinguish some of them at this scale (particularly the purple ones)

- figure was corrected by changing of grey to light-grey background of landmasses; point sizes were enlarged nearly in two times

Response to anonymous reviewer:

MS structure and the organization of sections is confusing. I suggest an improved structure like that 1. Introduction, 2. Background of ikaite and glendonite (2.1 Mineralogy and petrology, 2.2 Morphology, 2.2 Isotopic signatures), 3. Method of data compilation (3.1 Data mining, 3.2 Database content), 4. Results and discussion of data compilation (4.1 Temporal and spatial distributions of glendonite, 4.2 Glendonites as palaeoenvironmental indicators), 5 Conclusions.

- proposed structure of the paper is very close to its current one, with minor corrections only. We accepted reviewer's suggestions

Note: the cathodoluminescence properties should be included in the section about mineralogy and petrology.

- corrected

The language of the MS needs to be further sharpened.

Line 84: cementation and diagenesis occur in sediments related to porewater not seawater.

- corrected

Line 110: Mg and Fe-depleted.

- corrected

Line 112: cement in different morphology.

- corrected

Line 160: Supplementary material.

- corrected

Line 171: in contrast to other geological periods.

- we have revised text following reviewer's suggestions

Line 181: The occurrence of glendonite over geological time is patchy possibly due to challenges in preservation. Some periods in addition to Cretaceous lack glendonite record. I think it does not mean anything based on the lack of glendonite. It is OK to describe limited existence of glendonite in greenhouse-prevailed periods like Cretaceous.

- taking into account glendonite occurrences from the diverse terrigenous rocks (and also dissolved holes after glendonites) we rather suggest that lacking of glendonites from some stratigraphic intervals is corresponding to their real absence or rarity, but not to preservation bias

In section 5.1. Temporal distribution of glendonite seems not simple. I suggest the periods can be reorganized into three categories including frequent occurrence, occasional occurrence, and absence.

- we prefer to consider glendonite distribution in stratigraphic order, as in this case abrupt appearance or disappearance of these pseudomorphs in the geological records became clearer

Line 223: experiments results in the last few years suggest:

- corrected

Line 225-235: I think the discussion should be extended regarding to the paradox between glendonite occurrence and non-low-T settings from both nature and labs. I suggest the discussion can be basically according to temporal and spatial distributions of glendonite summarized in this study. The importance of different environmental factors in glendonite/ikaite formation can be evaluated related to specific scenario and background of glendonite existence

- according to journal rules we provided description of database and brief geological summary rather than long paper with discussion of all features of ikaite/glendonite origin and transformations.