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Interactive comment on "Benthic foraminifera as tracers of brine production in Storfjorden "sea ice factory"" *by* Eleonora Fossile et al.

Anonymous Referee #1

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The manuscript entitled 'Benthic foraminifera as tracers of brine production in Storfjorden "sea ice factory" by Eleanor Fossile and others definitely fits within the mission on Biogeosciences.

The hypothesis tested with the data presented is that the ratio of agglutinated to calcareous benthic foraminifera in Storfjorden, Svalbard archipelago, is largely controlled by brine formation and therefore can be used as a proxy for brine rejection processes and brine overflows in the paleo record. Previous research in the area has established that brine formation and overflow out of Storfjorden happen today and it has been inferred to have occurred in the past. The authors need to show that brine formation causes carbonate dissolution in modern samples and to rule out other processes such as high TOC causing low pH in the porewaters or show how other processes combine

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with the brine formation and overflow to cause dissolution.

I can see that it is important to have a proxy for the brine formation in this area and that it relates to the coastal polynya and the sea-ice factory, but please state clearly why it would be important for paleo studies to know if there were brines forming or not in the past. Why is your study significant? What does brine formation tell us about the sea ice conditions or climate/environment in the larger Arctic?

You use a carefully developed dataset of living (biologically stained) foraminifera and environmental parameters such as various food types, hydrographic parameters and grain size from modern seabed samples to explore the ecology of the modern fauna. I find the paper to be carefully and clearly written in general. The development of the biozones and their association with various qualities of food source and hydrography is well done. However, I am not 100% convinced about the role of brine as the main driver of dissolution, but I think you could hone your arguments. I have some questions with that in mind. 1. Is there any chance of dissolution of calcareous faunas during your laboratory methods? Ethanol has a pH of 7.3. Did your samples sit in unbuffered water? You do not mention anything about buffering. 2. Are there dead (unstained) calcareous forams in your samples? It seems like an important missing bit of information. Are there large variations in calcareous forams in the fossil record? Is that how people have inferred that there were brines in the past? 3. The living fauna at the time of sample collection may not represent only this year or only one season, or it may exclude forams that bloomed earlier in the year. Give some insight into what the living fauna represents in terms of time. It does seem strange that living forams are badly dissolved! Are they really living at the time of collection or are they recently dead and already dissolving? 4. How do you determine what degree or type of staining points to a 'living' foram at the time of collection. 5. I suggest you add the word 'living' as a modifier of calcareous, agglutinated etc more often because you are only presenting living assemblages and that really needs to be made clear. For example 4.5.1 Abundances and diversity of living forams. 6. Can you provide a concise summary of why brine is

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corrosive to $CaCO_3$, along with explanation about how other factors (high CO_2, cold Arctic water and high TOC for example) interplay or potentially play their own role in the dissolution?

Questions about the environmental setting:

Storfjorden is called a fjord and you mention often about glacial meltwater and its influence on the headwaters of the fjord. But glaciers are not shown on your maps and I don't think they are described in your paper. That description is needed because you call on glacial meltwater and sediment delivery as an important part of the environmental gradient. On line 421 and 425 you use the term continental glacier, but I think you mean plateau ice cap or mountain glaciers? And Storfjorden really looks like a sound as it forms a connection between the Barents and Greenland seas via Heleysundet and Freemansundet. What role do these connections play in the fjord hydrography? How important is the ESC waters that come into the head of the fjord for the formation of brines? Can the differences you see in MC3s be related to its proximity to Freemansundet? Your map figure is so small that I could not easily read the labels.

On Figure 1b, add the Atlantic Water..you can use a special arrow or something. Also add the Arctic water. Can you add the polynya to Figure 1a?

On page 4 you discuss the organic matter composition of the sediments and the potential of a terrestrial component. What is the bedrock geology of this area? Can some refractory carbon be from bedrock erosion and deposition in the fjord?

Line 125. How does Storfjorden introduce brine to the Arctic Ocean when it drains to the Greenland Sea?

Line 545. Explain what it is about brines that make them corrosive to carbonate. You have said they have high CO_2 content, which is also what the Arctic Surface waters have that enter the fjord. I think you are getting at several factors that converge to make acidic pore waters in the fjord basins one of which is brines. Clarify and organize this

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argument.

In your conclusions you also mash together the brine and other factors that can cause dissolution together (Lines 595 to 597) but the takeaway is that the dissolution is because of the brine formation. Can you clarify this and maybe state that brines are associated with some other conditions that converge to cause dissolution?

Minor comments: 45 in the meantime 105 clarify this sentence. If there is a persistent polynya then why is there extended winter sea ice cover as well? 138 (10 cm diameter) 150 microelectrode 162 'replicate analyses' Not replicated? I find this sentence unclear. How do you know which sample is most representative? 166 Pb dating was... 184 30 μg C μg phytopigment -1. Is this the correct way to state this? It is awkward 247 describe the silt % in various samples and its range in percent. Say that 20μm is medium silt and 10 μm is fine silt. 249 and declines to 6.8% at MC7 258 not lower that (n)...have to say 'less than or equal to'... 297 Elphidium clavatum is considered to be a separate species now. See Darling et al., 2016 in Marine Micropaleo v. 129, p 1-23. P. 10 suggest you add the word living to modify foraminifera in this section. You need not do this every time, but use this modifier in the top of each section and especially in the heading so that it is clear that your total assemblage is limited to living fauna. 354 change 'distinguishes also to separate' to distinguishes 477 italicize E. 478 Melonis has been associated with degraded OM (Caralp, 1989) 479 G. auriculate is often associated with buried OM 533 I don't know if it is true that the most obvious explanation for the severe dissolution is the brine. You really need to build this argument. This lack of building an argument about the affect of brine and the other factors associated with Arctic water and TOC weakens the paper. 540 change et to and

Figures:

The stacked histograms showing species at sites are really hard to read. A major problem is that the key is so small that a person cannot see the pattern. I like the idea, but it may be better to make histograms of species in each site and stack them

one above the other. Or choose fewer species. For example you could use only the species found to be statistically significant.

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