Dear Takashi,

Thank you very much for investing your time and effort in reviewing our paper. We will address your major points and afterwards the minor suggestions in an itemized list:

Item 1: Na/Ca spikes

> **The reason for Na/Ca spike cannot be explained by the increase of Na concentration in seawater. Foraminiferal Na/Ca is also an indicator of salinity. If we try to explain the large Na/Ca variation as in Fig. 7 by seawater Na/Ca variation, we have to suppose an event in which salinity increases by two digits scale. However, from the desert in the hinterland, even if minerals are input and somewhat dissolved, it is hard to consider an impact on the salinity at the scale of digit change. Also, from the analysis of T. clarkei in Fig. 9b, c, Na shows positive correlation with Mg, Al, Ti, Mn, Fe. This may suggest that T. clarkei has the property to incorporate sinking particles containing Na, such as Albite/Na-feldspar and Plagioclase, on/into the shell during calcification. I guess the possibility of particle trap on the shell. This is possibly indicating a new role of foraminifera as "fossils that trapped sinking particles" in addition to being environmental proxies. From Fig. 7(b), there is a possibility that the same phenomenon is happening in G. ruber. If this is because the study area has an arid region in the background and seasonally sinking particles become extremely abundant in seawater, this does not affect the soundness of proxies using planktonic foraminifera from other regions. Also, if we can monitor some elements like Ti, Na or Si to check whether the proxy is working normally, the soundness of the environmental proxy in the study area is also kept, while the role as a catcher of sinking particles itself will emerge.**
>
> **From the perspective of calcification mechanisms, the calcifying fluid is to some extent isolated from ambient seawater, making the direct incorporation of external particles unlikely. However, it is possible that particles adhering to the shell surface become enclosed when a new chamber is formed over them. Although unpublished, in my own experience this reviewer has observed cases where diatom frustules were incorporated into the interior of the shell. In other words, the incorporation of foreign material into the shell interior can indeed occur. While such occurrences have generally been rare enough to go unnoticed, this study might find by the possibility that in certain seasons in this particular region, such incorporation might happen more frequently.**
>
> **To verify whether the Na/Ca spikes originate from calcite itself or from the incorporation of external mineral particles, it is necessary to conduct some form of direct check. For example, confirming the amount and seasonal changes of sinking particles in the study area, and performing SEM observations or XRD analysis of the shells, would allow you to determine whether mineral-like foreign materials are present inside the calcite. Alternatively, by examining the depth-resolved elemental profiles obtained from the authors' LA-ICP-MS analyses, it should be possible to determine whether the influence of external particles extends throughout the entire calcite structure or is confined to specific locations.**

Establishing this point is essential for assessing the reliability of Na/Ca as a proxy in this environment, and solving it would also strengthen the discussion of Fig. 12.

Reply 1: Thank you very much for the thorough and comprehensive points regarding the Na/Ca 'spikes' in the three species from the hyper-saline Gulf of Aqaba.
Considering the new role of foraminifera as "fossils that trapped sinking particles" in addition to being environmental proxies: we have reexamined the relationships of Na/Ca with Al/Ca, Ti/Ca, Mn/Ca and Fe/Ca in the three species in a 'Spearman correlation' matrix and we see a weak correlation in G. ruber albus and a strong correlation in T. clarkei 'big' (slightly weaker in T. clarkei 'encrusted') as well as a strong correlation to the environmental variable MLD in T. clarkei 'big'. Potentially, this may suggest that during water column mixing some foreign particles are incorporated into T. clarkei shells (suspended particles?). The close proximity of station A in the GOA to the nearby hyper-arid desert land may be an important aspect leading to this phenomenon and we will check for data of amount and seasonal changes of sinking particles in the study area as you suggested but is beyond the scope of this manuscript (we will include it in our future paper on T. clarkei: Levy et al., in prep). In the meantime, we show here SEM images of three samples (i.e., three individuals) in which we have not observed any particles enclosed in their shells. We attach here several SEM images of T. clarkei which will be published in a future paper (Levy et al., in prep) (Figure 1 below):

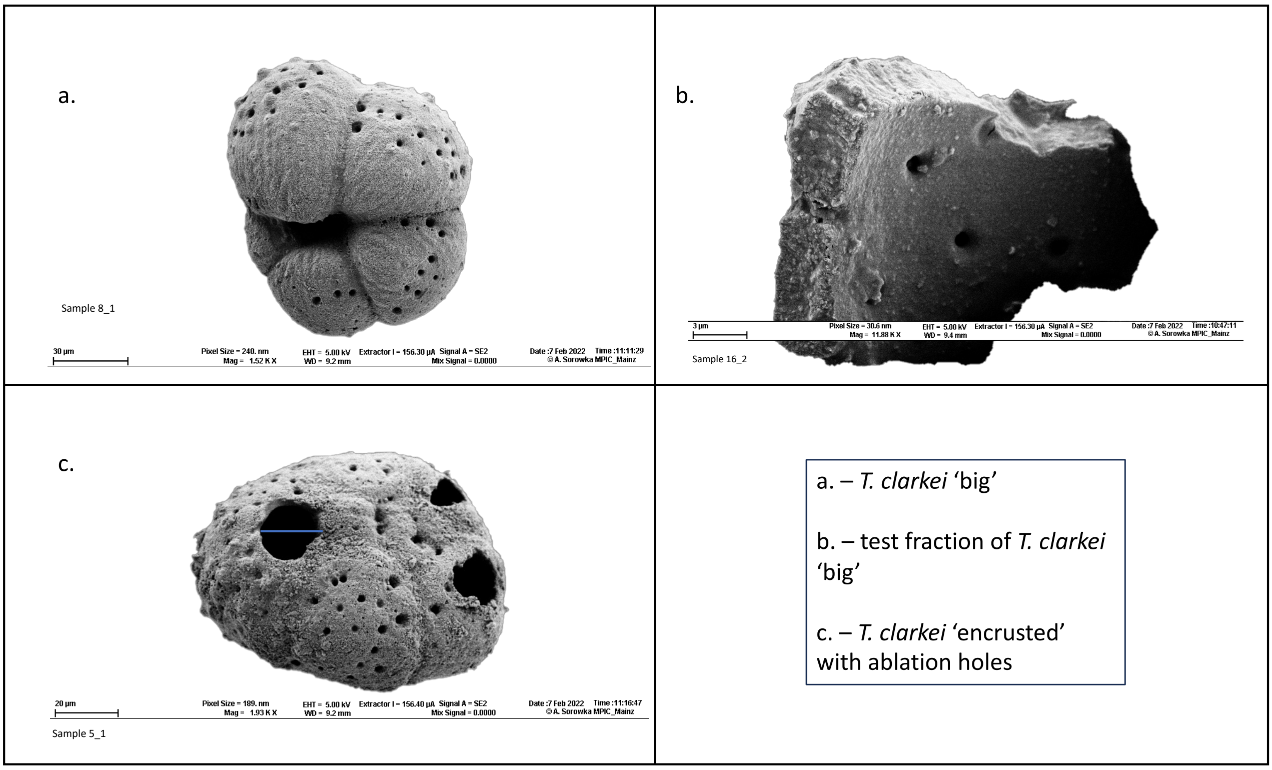

Figure 1: SEM images of T. clarkei 'big' and T. clarkei 'encrusted'.

Regarding checking the Na ablation profiles: we calculated the average element-to-calcium ratio from the spot derived LA-ICP-MS count data from just after the start of the ablation peak until where we believe the end of calcite is based on Mg/Ca ablation profile. This time average should amount to the portion of the ablation signal that represents the stable internal material of the shell, rather than the noisy beginnings or ends of the ablation event *(see the Figure 2 below for Na23 count signal and raw Na/Ca of G. ruber at 220m depth April 2015 as an example).*

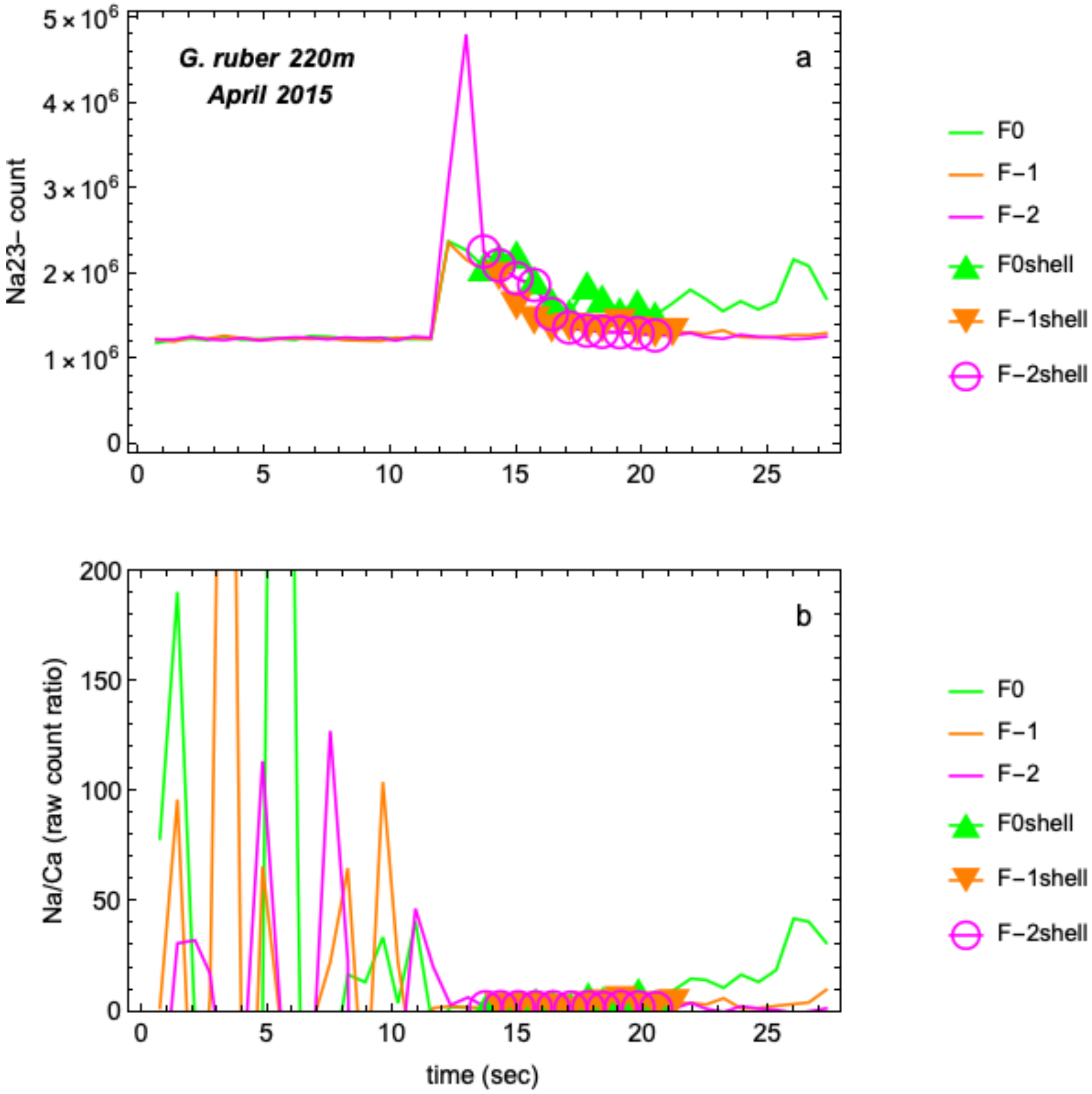

Figure 2: A timeseries plot of (a) Na23 counts and (b) respective Na/Ca for F0, F-1, and F-2 in G. ruber taken from 220 m sediment trap in April 2015. Plot markers show the data used for calculating Na/Ca averages.

In some cases, we found that both the element signals and the middle of the ablation peak were very noisy and elevated relative to the other chambers (see Figure 3: F0 in G. ruber at 120m depth April 2015 as an example). In these cases, we could not accurately ascertain the El/Ca ratios and the values are not reported in the supplementary table S4). Thanks to your point raised we rechecked the Na/Ca ablation profiles of some of the unusually high Na/Ca 'spike' measurements and found elevated Na/Ca intensities towards the end of the ablation event in a measurement which calculated to Na/Ca= 64.1mmol/mol - the highest Na/Ca value in the G. ruber dataset (see Figure 3 here: F-2 in G. ruber at 120m depth April 2015). It is important to note that for this measurement (F-2 in G. ruber at 120m depth April 2015), the other El/Ca ratios did not show unusually high values (Mg/Ca, B/Ca, Sr/Ca, Al/Ca, Ti/Ca, *Mn/Ca, Fe/Ca, we did not measure Si/Ca) which suggests that the ablation still measured the chamber wall. However, an additional 'foreign' particle would indeed be a possibility, especially considering the unusual F0 measurement in the same specimen.*

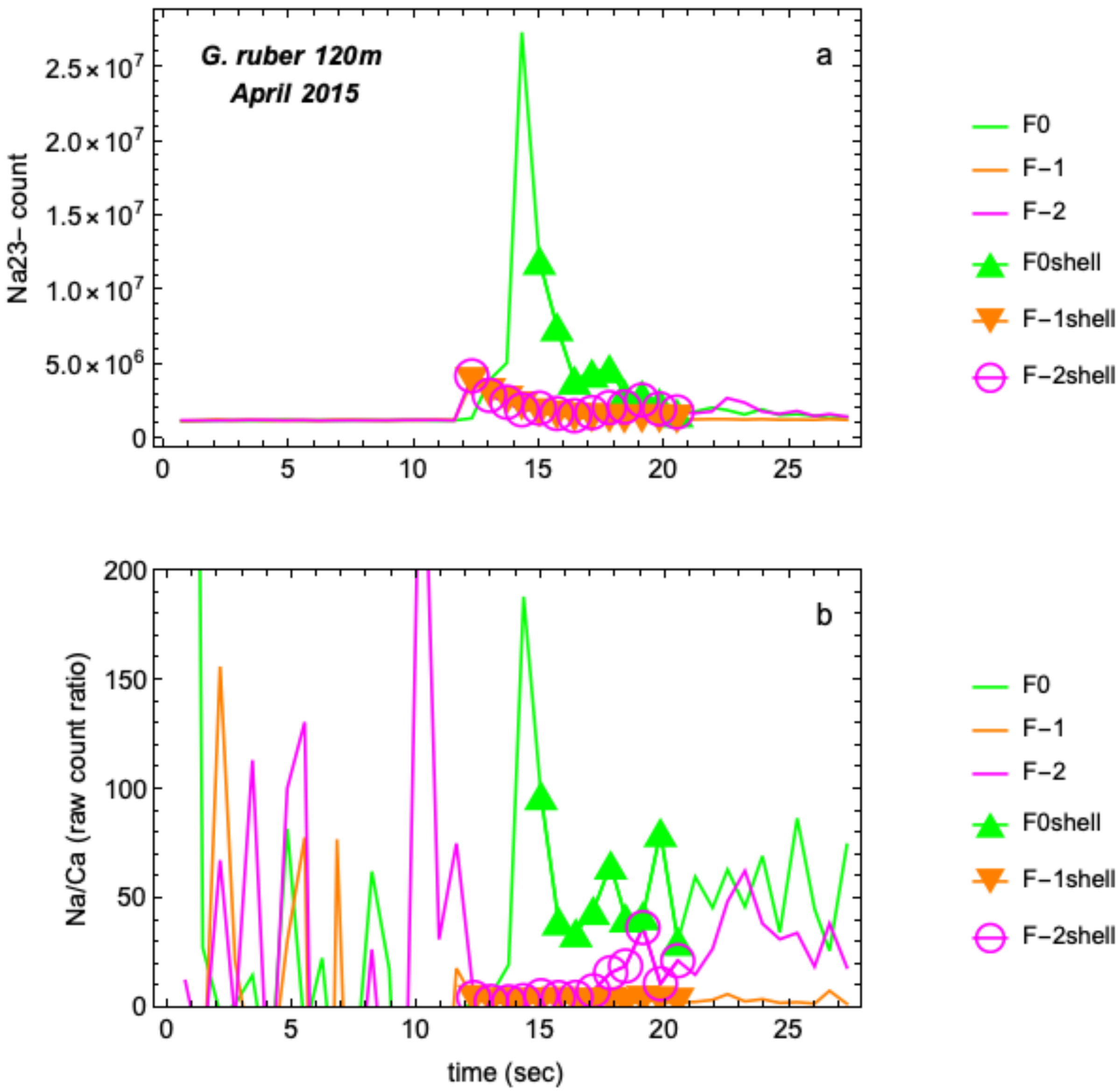

Figure 3: A timeseries plot of (a) Na23 counts and (b) respective Na/Ca for F0, F-1, and F-2 in G. ruber taken from 120 m sediment trap in April 2015. Plot markers show the data used for calculating Na/Ca averages.

<u>**Item 2:**</u> **Final chamber (F0) composition**

Regarding the idea that F0 (final chamber) element composition does not reflect the environment, I think there are both opinions, but to deny it here needs a little more basis. For example, Sadekov et al. (2009: https://doi.org/10.1029/2008PA001664) concluded that Mg/Ca of the final chamber has the highest correlation with temperature, and Hupp and Fehrenbacher (2024: https://doi.org/10.61551/gsjfr.54.4.355) also did not point out problems in analyzing the final chamber. There are other similar studies. Especially Mg/Ca has

many cases that respond rather straightforward to temperature changes, so I would be more convinced if you point out that calcification temperature (depth) is different from the assumption.

<u>Reply 2:</u> *Yes, we agree that F0 does reflect the environmental conditions but records El/Ca slightly differently than the other chambers. In the revised manuscript we clarified this and add the mentioned references (Sadekov et al., 2009; and Hupp and Fehrenbacher, 2024), respectively (section 4.3 in the revised manuscript (lines 638-651).*

<u>Item 3:</u> Small number of individuals

I appreciate again the accumulation of efforts that you analyze three categories of foraminifera at each depth every month, which is very ambitious. However, the small number of individuals in each population is obvious. ICV is discussed, but I do not find quantitative treatment of inter-individual variability or pooled mean value. As the basis to say that discussion is possible with few individuals, could you add, in addition to pooled mean value, statistical indices showing the magnitude of variation among individuals (for example: standard deviation, coefficient of variation) or excuses from previous studies which state that comparing by pooled mean value for inter-individual variation is no problem?

<u>Reply 3:</u>
In the revised manuscript we now report standard deviations (SD) in each specimen (individual foram) as a measure of Inter-chamber variability in the results section 3.1 for the reported El/Ca discussed respectively (and include a supplementary table S4). We included statistical analyses of the SD in the new 'Spearman correlation matrix' which reveals environmental parameters, such as MLD, correlative to ICV in some species (i.e. T. clarkei 'big') (supplementary figure S12 and, also in Figure 1 in the reply to reviewer 1). The pooled means and SD for each chamber in all specimens taken at each given time interval as a function of time is shown, as well as the total pooled mean (lower timeseries panels in the revised figures 3-7) (see also in Figure 2 in the reply to reviewer 1). We additionally include biplot's summarizing Redundancy analysis (RDA) per species and El/Ca to examine the relationship between depth El/Ca and environmental parameters. Furthermore, we have appended the 'Spearman correlation' matrix with environmental parameters (MLD, T, S, pH; Figure 9 in the revised manuscript).

<u>Item 4:</u> Minor points

a) **Fig. 2 appears quite late in the text. You forget to refer to Fig. 2 somewhere in the first half.**
b) **In the text final chamber is written as F0, but in Fig. 1 it is F-0. Please unify.**
c) **In Fig. 4 etc., please indicate MLD also in the legend.**
d) **Comparing the environmental figure in Fig. 1 with Fig. 3–8, the horizontal axis is shifted. Please fix, and please also write what the horizontal axis represents.**
e) **In Fig. 9, elements are slightly misaligned with the columns. For example, U is completely showing the result of the previous element for both vertical and horizontal axes.**

<u>Reply 4:</u> *Thank you for the following comments.*

a) *We now refer to figure 2 much earlier in the introduction –line 116 in the revised manuscript.*
b) *F-0 in Figure 1 is now changed to F0.*
c) *Figures 4-8 moved and now titled 3-7. They all have a top panel per species of the MLD for better visualization. The MLD is now also present in the legend.*
d) *Regarding the environmental parameters in Figure 1 we have added a title to the x-axis but have opt to leave the horizontal axis longer than in figures 3-7 as we find the 'wide' perspective is more suitable.*
e) *Figure 9 has now changed – elements are now aligned with the columns; more parameters are available (environmental parameters) and we have changed the axis to be from -1 to 1 (previously it wrongly displayed as 0 – 1 which altered the color gradients).*

Sincerely,

Noy Levy on behalf of all co-authors