The following reply represents a point-by-point response to the comments and observations of reviewer #1. We would like to sincerely thank the reviewer for their time and effort in commenting on and critically evaluating our manuscript. The supplied comments have been constructive in our efforts to improve the text of this manuscript. Our comments are indented and formatted in blue, while the original review comments are formatted in black and retain their original formatting.

Auer and colleagues present new methods for non-destructive study of clasts in marine drill cores, motivated by the need to study ice-rafted debris without excessive sampling of the limited amount of material. This work builds on many years of trying to determine the best approaches to do this and explores new methods focused on CT scanning and uXRF. It is a super interesting approach and I enjoyed reading about it—although I was not super convinced it would be the best approach for IRD quantification in these specific cores. That said, the science is sound, it is an interesting method, and promotes the use of legacy cores. I think it will be of interest to the wider community as they evaluate the best approaches for IRD quantification. I think it could be published with limited revision.

As a commentary—not a criticism of this work—in my own research, I have become more and more convinced that there is no better way to quantify IRD than breaking out the sieves and actually looking at what is there. For the record, this is coming from someone who initially really pushed for automated approaches. In my recent experience, we've found that other particles (like iron sulfides) can confuse many different detection algorithms and are responsible for the differences between x-ray/CT counts and physical sieved wt% data. In the author's work, metal flakes pose a similar problem. However, the datasets we've been developing from sieved samples have ended up quite different from x-ray derived methods in some intervals (supervised and unsupervised), with the sieved data seeming to make a lot more sense when compared to other proxy data. I was left wondering after Section 4.3 if the authors actually thought that these approaches were useful or if they would still require significant work looking at sieved fractions in order to ground truth their interpretations.

We thank the author for this assessment. Indeed, we agree that ultimately the most effective way to define IRD will always be through the washing of material and manual picking of IRD grains. However, this resolution, which is usually recovered by IODP expeditions, is neither feasible nor would it allow for the preservation of precious and often irreplaceable material, such as IODP legacy cores. It is thus imperative to explore alternative methodologies and evaluate their feasibility – and most crucially, report on the findings in a transparent and FAIR manner, irrespective of success.

We also agree that the statements found in Section 4.3 may benefit from clarification. We will therefore revise this section, also in accordance with the comments of reviewer #2, to clarify these points further.

As a final note, I wonder if the authors might comment a bit more about the metal flakes and if this is an issue that is likely limited to early DSDP rotary cored un-lithified sediments and to what extent the issue might persist in the more common legacy APC cored sediments. From my experience, I had thought that for APC cores, these flakes are generally limited to the near the core liner and generally in greater quantities near the top of the cores—and thus a bit easier to work around. I know that there has been a bit of documentation about this from the paleomagnetic community, with one of the primary reasons for the development of the 'u'-channel method to sample the more pristine centers of the cores to get away from

the metal flakes that were sometimes found near the core liner and messed up the half-core pass-through measurements (see the first u-channel study: Mead et al., 1986; https://doi.org/10.1029/PA001i003p00273). There is also documentation on rust contamination from Carl Richter's 2007 "Handbook for Shipboard Paleomagnetists." As the author's conclusions do not mention this complication, despite being a major caveat, I wonder if they think that their approach here might be better suited for legacy APC cores than legacy rotary cores (for soft mud), like reported here?

> We sincerely thank the reviewer for this insight. We fully agree that APC coring will likely be much less affected by such contamination issues, although exceptional cases may always exist. One such example is also ODP Site 707, which has suffered from severe drill pipe contamination during APC drilling, resulting in a strikingly cyclic magnetic susceptibility signal with an exact one-per-core (or ~ 9.5 m) periodicity.
>
> We also agree that these aspects should be discussed in more depth and therefore intend to add a relevant paragraph to our discussion at the end of section 4.2, stating:
>
> „*Although severe pipe flake contamination as found in this study is likely primarily associated with older DSDP material, similar iron contamination was also documented in newer ODP cores. For example, ODP Site 707 (located in the western equatorial Indian Ocean) exhibited pervasive contamination from pipe material. However, the use of the advanced piston corer (APC) limited severe contamination to sections 1 and 2 of each core. The Shipboard Scientific Party (1988) of Leg 115 notes a fine and relatively uniform distribution of the material severely affecting magnetic susceptibility and paleomagnetic analyses at Site 707. It is consequently not implausible that other ODP and possibly even newer IODP cores may pose similar challenges for non-destructive methods, such as µXRF and CT scanning, as shown here. As this has posed a common problem for paleomagnetists over the history of IODP methods, techniques like u-channeling have been developed to alleviate such contamination (Mead et al., 1986). We speculate that, at least for the higher-resolution µCT analyses, u-channeling may also serve as a viable alternative for newer APC-drilled OPD and IODP materials.*
>
> *In contrast, older DSDP material would not benefit from such an approach. The low sample surface area, however, would invalidate any benefit from large-area µXRF scanning methods, as were applied here. In this context, our findings highlight the importance of thoroughly assessing sediment quality before analysis. Any such assessments should include reviewing shipboard reports, relevant publications, visual core descriptions, and conducting spot sampling to ensure reliable interpretations from non-destructive imaging and elemental analysis methods.*"

Minor comments:

Line 84: You do such a good job reviewing the literature, I am surprised you don't list some examples of CT scans being used to quantify IRD at the end of this sentence, including many studies that have previously developed automated detection routines from CT data.

> Thank you for these suggestions. Indeed, our review was primarily focused on the application of medical CT imaging on legacy IODP core material. We acknowledge

that this narrow focus may have resulted in an unintentionally skewed view on the application of CT-scanning data (especially in the field of micro CT imaging) that has been published based on other (generally shorter and fresher) core material. We will include a relevant extension to the introduction, in accordance with the suggestions of reviewer #2 (please refer to the response to reviewer #2 for details on the changes we intend to implement).

Line 181-182: Figure call out to Fig. 2, but it doesn't seem to align with the statement which seems to be suggesting that you are going to show a picture of the 19 grains and 1 fish tooth. Please clarify this statement. Or is it meant to call out to Figure 8?

Thank you. We will remedy this error and change the text to reference the correct table (not figure) 2, which we intended to call out here.

Figure 4 caption: Should cycle by circle?

Indeed, ‚circle' is correct. We apologize for the confusion and will correct the caption accordingly

Figure 7: spelling? Shon -> shown

Thank you for catching this typo. We intend to fix it in our revised version

Line 304-307: This would be true IF the object filled an entire voxel. Based on the resolution of the CT scanner, it is unlikely that the flake would be large enough and the voxels would be an integration of the high density steel and matrix sediment (thus, more likely in the range of a lithic clast). Unless the flakes were sufficiently thick?

Thank you for bringing this up. We fully agree and apologize for not being clear enough in our initial version of the manuscript regarding this critical methodological detail. We intend to clarify this in more detail in the revised version, as it has led to some confusion in revision #2 (please also see our response to their comment, which includes our intended revision, thank you).