

Reply to comments (from Prof. Darby) on “Circum-Arctic Sediment PROvenance Database (CASPROD): A database of mineralogy and geochemistry for the Circum-Arctic surface sediments” by Yao et al.

The database by Yao et al. misses an important component of provenance studies. This is the relative accuracy of source determinations. Users would greatly benefit from knowing how accurate each provenance method is. This does not mean how precise each method is!

Reply:

We sincerely thank Prof. Darby for the further comments. We agree with the reviewer's statement: in a complex, multi-source sedimentary basin like the Arctic Ocean, the overlap of geological signatures can often render the source-determination accuracy of certain individual proxies low. To address the reviewer's concerns and better position our study, we have added a description on the accuracy and limitations of individual proxies in Section 3.2 (*Circum-Arctic provenance implications*) of the revised manuscript.

“While individual proxy may have limitations in discriminating sediment provenance, integrating multiple indicators provides more reliable constraints on source contributions. In a complex, multi-source sedimentary system like the Arctic Ocean, individual tracers might suffer from signature overlap across geologically diverse circum-Arctic source areas, which can lower the accuracy of provenance discrimination. For example, Sr-Nd isotopes overlap between the Laptev Sea and Canadian Arctic Archipelago, and between the Kara and Chukchi seas. Detrital zircon U-Pb ages are biased toward felsic sources, and fail to trace mafic provinces like the Siberian Traps. For mineral assemblages, smectite enrichments blur distinctions between the Kara Sea and Canadian Arctic Archipelago, while illite signals dominate most eastern Arctic shelves. Similarly, hydrodynamic fractionation and lithological overlaps complicate detrital mineral interpretations, as pyroxene and garnet remain abundant across the Kara, Laptev, and Barents seas.

To overcome the ambiguity introduced by these overlapping signatures, CASPROD establishes a multi-proxy, cross-validation framework. By synthesizing geochemical, geochronological, and mineralogical datasets, this integrated framework provides multiple constraints on endmembers and substantially improve the accuracy of provenance identification. Furthermore, to achieve higher accuracy when interpreting highly complex mixed signals, particularly regarding ice-rafted debris, we encourage database users to couple CASPROD with other approaches, such as the Fe-oxide grain chemical fingerprinting method introduced by Darby et al. (2015).”