

Answer to reviewer comment 1

Review of Du et al. A database of radiogenic Sr-Nd isotopes at the “three poles”

General comments

Du et al. present a dataset regarding the Sr and Nd isotope of various surface sediments to trace the source-to-sink process of dust in the three poles of the Earth. Such a data compilation is timely because there are emerging Sr-Nd isotopic data in past years. I list some concerns for improving this paper.

Reply: We appreciate that the reviewer finds our work interesting and acknowledge the suggestions for improvement. We have regrouped some of the questions and added much more data to improve the text flow.

First, a major pitfall of this paper is that many previous studies regarding Sr-Nd isotopes of surface sediment are absent in this study. I am only familiar with those studies on Asian dust sources, and the suggestion can be found in specific comments below. The authors should check other regions, e.g., the Arctic and Antarctic.

Reply: Thanks, we added the surface sediment data from the Third Pole, and Sr-Nd data from the Arctic and Antarctica were also collected in revised dataset (See in the dataset).

Second, the present compilation of Asian dust sources only covers the Tibetan Plateau and Jungar Basin. The data in other regions of central and East Asia should not be omitted in this study because those data in North China and Mongolia could provide dust to the North Pacific and even Greenland (dust in the Arctic).

Reply: Thanks, in original version, we just considered the high altitude regions. We added Sr-Nd data based on the area of Third Pole. And Sr-Nd data from the Pan-Third Pole were also added in revised manuscript.

Third, because the Sr-Nd isotopic fingerprint in Asian dust sources was studied extensively, the paper should not only focus on the bulk sediment Sr-Nd isotopic but also leave a position for the different grain sizes (e.g., for Nd and Sr isotopes) and different mineral phases (for Sr isotopes), those distinct grain size and phases will correspond to different dust dynamics.

Reply: Thanks for your suggestions, we add Sr-Nd data, which referred the different

grain sizes and mineral phases Sr-Nd data in revised manuscript (See in dataset).

Specific comments

First, lots of data regarding the surface sediment in the Asian dust source region are missing. Only the dust samples, mostly from snow/ice, are insufficient to track the regional dust transport. Because a substantial amount of those dust from snow/ice is not in situ and probably long-distance transported, the regional distribution of the Nd isotope dataset mostly from those snow/ice dust cannot reflect the dust transport dynamic. In this regard, the box plot in Figure 3 divided by regional distribution can be biased, especially for those sand/soil samples.

Reply: We thank the reviewer for bringing this point forward. We agreed that the most of dust samples are from snow/ice, however, in some sub-regions, in our previous studies (Du et al., 2019a; Don et al., 2014) and the others (Wei et al., 2017; Dong et al., 2018), the local dust from the glaciers were also measured. Therefore, we added these data and redid this figure in the revised manuscript.

Yang et al. 2021 GCA (<https://doi.org/10.1016/j.gca.2020.12.026>) compiled a new Nd isotope distribution of surface sediment (desert, fluvial, moraine, loess, and soil samples) over east and central Asia from many previous studies and new data. Most of many previous studies are missing in the present manuscript, e.g., Blayney et al., 2019; Chang et al., 2000; Clift et al., 2017; Garzzone et al., 2005; He et al., 2019; Li et al., 2009; Liu et al., 1994; Nakano et al., 2004; Rao et al., 2015; Wu et al., 2010; Zhao et al., 2014, 2015. In Yang et al. 2021. The authors can find those missing studies with detailed citation information and data in Yang et al.'s Table S1.

Reply: We thank the reviewer for bringing this important reference to our attention. We defined that the Third Pole covers the area of 40° to 23° N and 106° to 61° E (Li et al., 2020, <https://doi.org/10.1175/BAMS-D-19-0280.2>). Therefore, we mainly focused on Sr-Nd data from the snow or ice and referred the potential dust sources in last version. As you suggestions, we added and integrated some Sr-Nd data by Yang et al., (2021) into the entire Third Pole.

Second, many of those missing studies of Nd isotopes also reported Sr isotopes, which should be compiled in this study. Other studies for the Sr isotope of surface sediments

should also be cited. e.g., Jacobson, 2004 (<https://doi.org/10.1029/2004GC000750>)

Reply: Agreed. We have realized this problem and added Sr data as your suggestion.

Third, there are many Sr isotopic data regarding different phases of sediments (e.g., water-soluble salts, acetic acid leachate, acid-residue, etc., Honda et al., 2004 (doi:10.1046/j.1365-3091.2003.00618.x); Yokoo et al., 2004 (doi:10.1016/j.chemgeo.2003.11.004); Nakano et al., 2005 (doi:10.1016/j.atmosenv.2005.05.050) and many other studies. If available, different phases of Sr isotopic data could also be compared.

Reply: It was not clear. Thanks for your these important references. Because the style of this Journal focuses on the dataset, therefore, we presented Sr-Nd isotopic data with different phases of sediments in dataset (See in the dataset).

Fourth, we know that there are many different units in the Himalayas with particular Sr-Nd isotopes (for example, see Jonell et al. 2018 <https://doi.org/10.1016/j.chemgeo.2018.03.036>). Those Sr-Nd isotopes of surface sediment should also be cited. If the authors think that the much variable Sr-Nd isotopes of source rock are not related to the present snow/ice dust samples, the authors should state the limit of the current compilation and explain the reason why the Himalaya dust yields a limited range of Sr-Nd isotopes within a region consisting of such variable source rocks. Nanga Parbat, the Lesser Himalaya, and the Indian craton yield the least radiogenic ϵ Nd values ranging from -26 to -23 (Ahmad et al., 2000; Clift et al., 2002; Robinson et al., 2001). The Greater Himalaya (ϵ Nd = -17 to -12) and Karakoram (ϵ Nd = -12 to -8) have intermediate values that are distinct enough for source discrimination (Ahmad et al., 2000; Crawford and Searle, 1992; Deniel et al., 1987; Inger and Harris, 1993; Parrish and Hodges, 1996; Schärer et al., 1990).

Reply: Thanks for your valuable reference. The Sr-Nd isotopes of source rock are not related to the present snow/ice dust samples, however, as you mentioned that the Himalayas is very important and complicated, in this study, the age of Sr-Nd data was limited to the Quaternary period. And the variable Sr-Nd isotopes of source rock may refer the geology in the three poles, Therefore, Sr-Nd data was not compiled from the rocks of three poles. And we did not further discuss this part in text.

Technical corrections

Line 76-70, there is another paper regarding Sr isotope as an eolian tracer Yang et al., 2017 (<http://dx.doi.org/10.1016/j.epsl.2017.02.009>).

Reply: Thanks, Done.

Sr-Nd correlation plot like figure 8 for the Antarctic could also be illustrated for those data in Asian dust sources and the Arctic.

Reply: We have fixed this.