Response to Jeremy Ely (reviewer #2)

Evan J. Gowan[1], Lu Niu[1], Gregor Knorr[1], and Gerrit Lohmann[1]

[1]Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Bremerhaven, Germany

Correspondence: Evan J. Gowan (evan.gowan@awi.de)

1 Introduction

We would like to thank Dr. Ely for his comments. We have responded to the comments below. The comments from the reviewer is in italics, while our response is in normal font.

2 General comments

General comments: This paper presents useful datasets regarding the geology and sedimentology of North America, Greenland, Iceland and parts of Russia. The datasets are extensive and useful for the community. The demonstration of use in ice sheet models is interesting and also useful for the reader to consider how future experiments with this and similar datasets might be conducted. However, the aim of these simulations for this paper should be noted in the text (i.e. to demonstrate utility of the dataset, not to draw scientific conclusions about the Laurentide which I presume is the focus of a later paper). The authors should be applauded for citing all the original literature that goes into this dataset in Tables 1 and 2. It may also be useful to distribute a similar bibliography with the dataset. This is therefore a very worthwhile contribution to the literature and I hope that my comments below can help improve the manuscript.

As mentioned in the response to reviewer #1, the intention of our simulations was just as mentioned here - to demonstrate the utility of the datasets. We have updated the section to make this more clear (see response to reviewer #1 for details). Adding the bibliography to the datasets is a good idea, we have added it to the dataset.

3 Specific comments

The title - only North America is mentioned, yet the data includes Greenland and Iceland. I think these places need incorporating in the title somehow. As far as I can tell from figures (could not check the actual data as pangea is password protected) the whole of North America is not covered by the data either.

We apologize for the inaccessibility of the datasets - Pangaea added a password for some reason. Once this was pointed out, we had the password removed.

This compilation started off as being purely focused on North America, the additions of Greenland and Iceland to the dataset came very late in the process. We will change the title to the following:

Geology datasets in North America, Greenland and surrounding areas for use with ice sheet models

2. In section 2.3 discussing sediment properties, the text says "Glacial sediments tend to be very poorly sorted, so these values should be assessed as being an average composition" (pg. 5 lines 12-13). Confusingly, the rest of the section seems to discuss grain-size properties only of the fine-grained material (matrix) that enclose pebbles and boulders (clast), and exclude the pebbles+boulders themselves. (Grain-size values in Table 3 are sub-millimeter). Do the clay and silt classes (pg. 5, lines 18-19) have significant fractions of pebbles+boulders, which is only mentioned for sand (line 21)? If so, what are the ranges of that fraction for each class? Do pebbles+boulders significantly influence the bulk(?) physical properties in Table 3? Both clast and matrix play crucial roles in sediment deformation in Evans et al.'s comprehensive review (referenced here: Earth-Sci. Rev., 2006), especially their sections 5.1 to 5.4 on the "till-matrix framework".

We acknowledge that this section is confusing as written. We went back to some of the original papers discussing the composition of till to try and clarify the meaning of the descriptions. We have rewritten the first paragraph of section 2.3 to be as follows.

The map of generalized grain size of glacial sediments is shown on Figure 2. A glacial sediment, diamiction or till (the later has a definitive glacial origin) is an unsorted material with grain size ranging from clay to boulder. Glacial sediments generally have a bimodal grain size distribution, with peaks in the course (pebble to boulder) and fine (clay to sand) fractions (Dreimanis and Vagners, 1971). The relative amount of course to fine is dependent on the distance from the source of the course material, so on glacial geology maps and datasets, glacial sediments are described in terms of the fine fraction only. To simplify the classification, we only have three main classification types, based on the dominant grain size of fine fraction. This classification scheme is based on the Surficial Materials in the Conterminous United States map (Soller and Reheis, 2004), and we attempted to unify this scheme with maps and data in Canada. The grain size of the sediments tends to have geographical dependence. As an example, in the map by Soller and Reheis (2004), clay rich glacial sediment exists in areas around the Great Lakes, where source material was derived from lake sediments, and sandy glacial in mountainous regions where there are extensive rock outcrops. The relative fraction of the sediment that is coarser than sand is not possible to quantify, since most of the data sources only give qualitative descriptions of the coarse fraction.

Uncertainty. In creating the dataset the authors necessarily and reasonably had to make some interpretations and interpolations between sources of data. However, there doesn't seem to be any record of where gaps have had to be filled or boreholes *consulted. A map of data coverage (boreholes, geology map location etc), or another map showing some sort of confidence level in the data would be very useful for those using the data in model experiments and for focusing future work.*

This is a really good suggestion. It took some time go back to the original shapefiles to create this, but we now include this in the final version of the dataset, and added this figure to the main document:

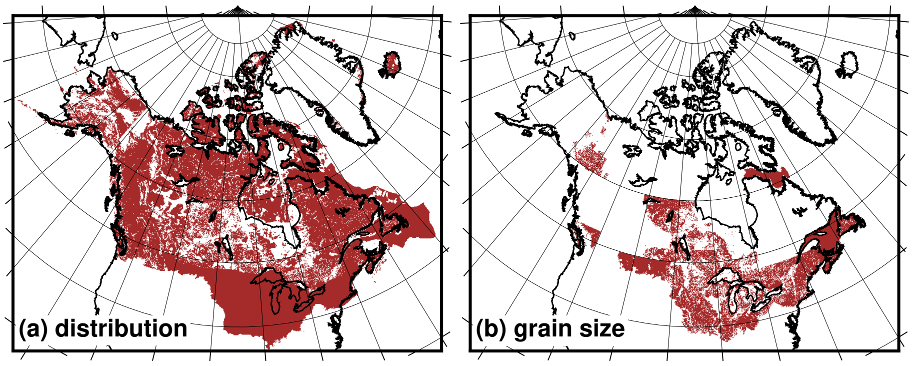

Figure 1. Data coverage (brown areas) derived directly from surficial geology maps. (a) sediment distribution (b) sediment grain size

Some notes on the data format that the data is provided in would be useful. As mentioned above, I could not check as not yet accessible through the repository.

We added these details to the last paragraph of section 2.1:

> The final dataset is presented as shapefiles that are compatible with GIS programs, as well as 5 km resolution NetCDF files.

4 Minor comments

Abstract, page 1, line 5. Please state the scale or resolution of the dataset.

We added the scale here. (1:5 000 000 scale)

P1, L 17 - I find the use of the word substrate odd here, it is more about whether sediments were present beneath the ice sheet or not. To me, these sediments (or bedrock) would then be the substrate, i.e. the bit in contact with the bed of the ice is the substrate.

We reworded the sentence as follows:

> Temperate ice sheets, such as the Laurentide and Eurasian ice sheets behaved differently depending on whether or not there was thick, continuous unconsolidated sediments underneath the ice (Clark and Walder, 1994).

P1, L 19 - Consider adding the more recent reference of Storrar et al., 2014 on eskers across the Laurentide.

We have added the reference.

P2, L 9 - Unclear subject matter. Presence or absence of what?

Added " of available unconsolidated sediment " to this sentence.

P2, L 15-17 - This section needs better linking to scope of the paper. These are all important factors, but some better crafting of the paragraph is required to state why we need to know about these things. In particular, here the subject jumps from the Laurentide to Svalbard without any linking.

This was added here to state that the conditions that probably existed on the Laurentide ice sheet is also applicable to modern glaciers. But perhaps such details are elaborated better in the subsequent paragraphs. We have removed these sentences.

P3, L 6-9 - These sentences are better incorporated into the following section.

We moved the paragraph to the next section.

P3, L 13 - use of word "extended" is technically correct, but I wonder if better for reader if you use occurred between or similar, given the use of the word "extent" later to refer to where the ice got to.

We changed "extended" to a proper chronological descriptor word "happened".

P3, L 32 - requires rewording. Perhaps "information" rather than "glacial"

Thank you for pointing out the wording mistake. We changed it to read "glacial geological units".

Section 2.1. - A statement on the intended use and resolution of the data would be useful for those intending to use the dataset and to prevent misuse. I imagine the datasets will be useful for those doing ice sheet-scale experiments. However, the resolution may limit utility for those interested in a single outlet glacier/ice stream for example.

This is a good idea, we have added the following sentences:

> We want to emphasize that these datasets are low resolution, generalized representations of geological properties. The intended use is for relatively low resolution ice sheet simulations (*i.e.* 5 km or great), and are not likely to be appropriate for resolving higher resolution features.

P5, L 30 - No notes on clay

We do not use a clay unit when inferring properties from geological maps. We have added the following sentence to emphasize this:

> Since the distribution of clay rich till appears to correlate strongly with the location of lakes, it is not included.

P6, Section 2.5. This section would be useful for including the notes/map of "uncertainty" stated above.

As mentioned earlier, we now include a figure for data coverage, and included the shapefiles in the dataset.

P7, L 23. I think it worth restating here for the audience that your aim is not to draw specific conclusions about the form of the Laurentide in this paper. The following sections (3.2.1 to 3.2.3) do mention specifics of the modelled ice sheet. However, I think that these are safe as they fall short of evaluating whether there is an improvement or not, by just stating that there is a change induced by the data.

We addressed this by revising section 3.1, as elaborated in the comments to Reviewer #1.

Additional references: Storrar, R.D., Stokes, C.R. and Evans, D.J., 2014. Morphometry and pattern of a large sample (> 20,000) of Canadian eskers and implications for subglacial drainage beneath ice sheets. Quaternary Science Reviews, 105, pp.1-25.

References

Clark, P. U. and Walder, J. S.: Subglacial drainage, eskers, and deforming beds beneath the Laurentide and Eurasian ice sheets, Geological Society of America Bulletin, 106, 304–314, https://doi.org/10.1130/0016-7606(1994)106<0304:SDEADB>2.3.CO;2, 1994.

Dreimanis, A. and Vagners, U. J.: Bimodal distribution of rock and mineral fragments in basal tills, in: Till, a symposium, edited by Goldthwait, R. P., pp. 237–250, Ohio State University Press, Columbus, Ohio, 1971.

Soller, D. R. and Reheis, M. C.: Surficial Materials in the Conterminous United States, U.S. Geological Survey Open File Report OFR-03-275, U.S. Geological Survey, https://pubs.er.usgs.gov/publication/ofr2003275, scale 1:5,000,000, 2004.