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Interactive comment on “Paleo-ice flow directions of the Northern Antarctic Peninsula ice sheet based upon a new synthesis of seabed imagery” by C. Lavoie et al.

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Review of Lavoie et al – Paleo-ice flow directions of the Northern Antarctic Peninsula ice sheet based upon a new synthesis of seabed imagery

General comments

This paper uses a new synthesis of swath bathymetric data from several nations to produce what is in effect a map of submarine geomorphology for both sides of the northern Antarctic Peninsula (AP). The data are a very substantial compilation - covering several years work by a range of vessels - and it is welcome to see the key groups collaborating. The authors have interpreted the map for information on former flow di-

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reconstructions of the AP ice sheet and provided a regional interpretation of the location of major ice streams, their tributaries and intervening areas. Former flow data are difficult to obtain by other means and provide important constraints for ice sheet models as well as having a number of implications for past ice sheet volume and behaviour. For this reason, the paper is a significant contribution and I recommend publication after some revisions. Most of my comments relate to presentation of the reasoning behind the description and interpretation of inter-stream areas.

Specific comments

Ice Domes

The reasoning behind and evidence for the inter-stream areas being domes is not well-presented. This is a critical part of the paper but it is split into several parts of the paper (e.g. 5333, line 19-20; but also a whole section (Sec 4.3) much later on 5337; and seems to be a mix of results and assumptions). Although the key elements of the logical argument may all be there and the interpretation of former ice domes in these areas may be one reasonable explanation for some of the observations the inference needs to be explained more clearly, and other explanations discussed (e.g. explain why there was not sheet flow between the streams). For example on 5337 – line 13 it says they (ice domes) ‘must’ have been centred without fully explaining why. Why were these areas not composed of other thicker (higher) parts of slow-moving ice without them being domes ?

It is notable that there are not major domes in other reconstructions, whether they are field-based (Davies et al 2012; O’Cofaigh et al, 2014) or models (Golledge, 2014, Antarctic Science – I accept that this is a new paper but the resultant ice sheet is similar to other models) so it is particularly important to explain why this reconstruction does now include domes.

5338 – 10: Alexander Island is not an ice rise or ice dome in the same way as the domes grounded on continental shelf you are discussing.

Place names

There are several place names that are not on maps, or incorrect orientations given (some examples: Dyer plateau (5332, 11): I think this is mostly S of your study area so not sure why its mentioned;, Hugo Island Trough (5332, 20); Biscoe Trough (5333-5); Graham Land coast (5332, 24 and 26) is a huge area stretching several degrees of latitude so usage here seems inconsistent with mention of individual bays); 5330 – 1: I think this is SE not SSW.

Age of features

It would be helpful to see a discussion of the potential for, or real, over-print of the LGM flow features by younger (deglacial) flow patterns. How do you know the patterns are all GM relicts ?

Links to regional geology

There is a discussion of geological control for one of the ice streams discussed but less so for the whole study area. It would be interesting to discuss what controls the gross location of the major ice streams – are they along major geological faults or across geological boundaries ?

Technical corrections

5324 – 18-25 – this is a result of this work rather than background (unless it can be independently referenced)

24 – believed by whom ?

5325 – 1 – but AP ice sheet glacier change is at least partly driven by oceanographic change

8 – ‘enhance our knowledge’ – I believe this paper does more than that and this phrasing sounds rather ‘incremental’

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16 – We highlight the geomorphic features. . . .
16-20 – split sentence into two
24 - ..acquired from several regions including those recently. . . .
5326- 18 – NGDC – in full
21 – flow line reconstructions
22 – interval and that
5327- 25 – what values of A were used
5328 – 3 – min and max what (b-dot ?)
6 – accumulation rate
7 – resulting in
11 – IBCSO – in full
20 – what is ‘it’ ? Slope ?
22 – would lead to a slightly
5329 – 18 – Hektoria – ambiguous which way it goes on basis of Fig 2
20 – from the southern edge of SCAR Inlet
25 – Our flowline bedform
26 – in the southern part of the Larsen-B embayment
5330 – 2 – they’re in a similar orientation but not parallel
11 –evidence of what ?
5331 – 2 – may have been developed
9 – un-named channel is called Active Sound – see <http://apc.antarctica.ac.uk/>

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- 21 – Fig 6 implies this is ice shelf but text suggests grounded ice
- 22 – should be Fig 6
- 23 – what fans ?
- 24 – How is a trough named after a snowfield?
- 5332 – 7 – use NNW to be consistent
- 14 – odd phrasing – ‘are added’
- 20 – there are more than three – do you mean it has 3 tributaries?
- 25 – NE not NW
- 26 – Along the Graham Land Coast
- 5333-1 – directed flow to
- 4 – around the N end of Anvers
- 8 – SW and NE direction – where ?
- 13 – ice divide between what and what ?
- 5334 – 18 – followed what ?
- 5335 – 2 – these topographic highs could have divided the glacial flow
- 16 – The two mechanisms could have
- 19 – has been observed
- 24 – I think the topo obstacle might be an island/nunatak rather than ice ?
- 5336 – reword this section. Need to explain the reasoning by which you define ice divides. We define ice divides based on.....x and y
- 5339 – 1-20 – this looks like methods

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5340 – 17 – Need to clarify here that the ice volume that matters in this context is that above buoyancy so actually thin ice couldn't harbour very much, whether there was large areal extent or not.

26 – different number to table

5342 – 15-18 – cite Livingstone et al 2012 (Earth Sci. Rev.) here as this paper considers many of these factors and how they differentially affect individual ice streams.

20 – be more specific about what purpose GIA modelling might serve

Title – would be helpful to insert 'LGM' or 'at LGM' in title to make study focus clearer

Grammar – The paper needs a close read – there are many instances of plurals/singular not matching and tense changes repeatedly including within sentences (e.g. 5329, 13-15). I have included examples for the first few pages but have not corrected after 5330.

Tables and Figures

Table 3: Not clear how 'systems' are defined – do they include the central parts of the AP (and therefore is underlying topography subtracted ?)

Fig 1 – see comments on place names.

Fig 3- 25m here, 30m in text

Fig 4- SSW direction doesn't make sense based on these images and orientation arrows. Also, not sure if the bedrock flutes might in fact be meltwater features

Fig 7 – images and their annotation are far too small to be readable.

Fig 8 - ...domes with ice temperature averaging...

Interactive comment on The Cryosphere Discuss., 8, 5321, 2014.

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