

## ***Interactive comment on “Alluvial fan dynamics in the El’gygytyn Crater: implications for the 3.6 Ma old sediment archive” by G. Schwamborn et al.***

**J. Tunncliffe (Referee)**

jon\_tunncliffe@carleton.ca

Received and published: 23 August 2012

### General Comments:

This is an excellent report on the stratigraphy of the fan/delta at El’gygytyn Crater. The study is a significant achievement in terrestrial coring at a remote site, and an important record of deposition within a bounded crater basin. There are some important implications for understanding the long-term rate of fan growth, the sediment budget of the region, and the possible effects of climatic and tectonic fluctuations on sedimentation, though the age model - thus far - remains tentative.

Detailed sedimentological analyses and proxy dating evidence for the fan are provided, based principally on correlations with existing records from coring in the catchment

C1342

lake. The fan has developed within a complex environment that includes fluctuating lake levels, changing permafrost extents, and variable rates of tectonic uplift. Some of the implications for core interpretation are explored in light of these boundary conditions.

Overall, the writing is clear and concise. The chronological and geomorphic interpretation of the core in this study relies extensively on prior studies; a reader new to the project has not had the benefit of absorbing the considerable background material: e.g., the subsurface basin geometry (from seismic transects), earlier lake cores (with their established dating chronology), and the historic sequence of lake terraces. I suggest a revision of Figure 1 and/or 2 (possibly 9), such that the reader has better orientation and a compact summary of the other study results that are incorporated into this study.

The results from sedimentological and mineralogical analyses are nicely presented; I believe the presentation of pollen work could be strengthened, since the dating correlation from the lake cores relies critically upon this. The lake level chronology becomes important later in the paper (5.2), and the authors should devote a few sentences to explaining this chronology earlier in their presentation, possibly in Section 2. Placing the terrace levels in Figure 2 and adding relevant date/elevation sequence to the log information (e.g. Fig. 8) would further help the reader visualize the sequence.

### Specific Comments:

Prior to delving into technical details, the abstract should begin with a sentence or two describing the motivating research questions and/or working hypotheses: perhaps the nature of controls such as the history and dynamics of permafrost at the lake margin? Or, the effects of tectonics, climate and water level changes? Essentially, the purpose of the study is to propose a depositional framework based on analyses of the core strata and historical reconstructions from numerous studies, mostly lake-based, at the site. Make this framework clearer.

Page 2195, line 5 and onward: there should be a fuller explanation of how pollen

C1343

assemblages are correlated amongst lake and EAFD core sediments (also, Section 4.5). The reader is not otherwise able to evaluate how well things are correlated here - this would seem to be an important linkage in the study. A figure illustrating overlapping assemblages in 5011-3, 5011-1, Lz1024, and Lz1028 or perhaps some quantitative index of similarity, would be helpful.

2197 ln. 14: there seems little to discuss in Figure 7, beyond "no obvious relation". Suggest either explaining further why this result is unexpected or important to the study, or consider using this figure slot for a dating (and/or possibly the lake-level framework), as discussed above. Consider placing the grain sorting data as an extra panel in Figure 5 - the sequence of values with depth may be more revealing than a scatter graph.

2197 ln. 16 onward: Much of what is discussed in this paragraph cannot be readily discerned in the Figure 5 (Min. Ratios). Consider re-scaling to better show the patterns.

2200 ln. 16. Figure 9: Examining Figure 4 from Melles et al (2011), I get the sense that the bedrock basin floor is considerably (300 m?) deeper than shown here. Indicate if this earlier interpretation has been revised, or otherwise resolve these two diagrams.

2200 ln 17-18 - "...a deeper position that forms the foreset beds..". Might these be bottomset beds, as in a Gilbert-type delta? Or could they be upper strata from a Pliocene Unit, as could be interpreted from the Melles et al. 2011 (Fig.4) diagram?

2201 ln. 12 and onwards: generally, this paragraph could be better structured; the discussion of the fate of fine sediment should be moved to its own preceding paragraph – as it is, it detracts somewhat from the interpretation presented here. You could also tie in the relationship between catchment mass wasting and lake core turbidite beds (2206 ln. 20 onward) in this paragraph.

2201 ln. 13-14: "relatively massive nature of the sand" in Unit 3 suggests mass wasting, though Figure 3 and Section 4.2 indicate at least two horizontally stratified sand units. Section 5.2 discusses transgression deposits in this unit. You may want to re-

C1344

frame your interpretation here to better explain the variability and complexity of this unit, given the imprint of lake-level changes.

2201 ln. 20 - how is the suspended load lost via wind? Do you mean the finer sediment fractions on banks or exposed bars, before potential entrainment by water flow?

2202 ln. 4. Lz1024 should be on the map (e.g. Fig 1,2 and/or 9), and its strata and dating framework should be introduced along with 5011-1, earlier in the paper. Also, consider incorporating the dating framework of PG1351.

2202 ln. 12 onward: it would be helpful to provide some basic quantitative measures of channel and/or fan surface slope, channel widths, etc. This allows the reader to compare, roughly, this system to others in their experience. Words such as 'coarse' or 'steep' (throughout the paper) should have some frame of reference. Any other observations of the modern channel sedimentology (Dmax, fining gradient, gravel/sand transition, etc.) would also help to characterize the system.

2203 ln. 26-27 - "...documented in unit 3 of the core." This should be introduced clearly in the previous section.

Technical Corrections:

2188 ln. 15: note that 'active layer' has a different meaning in the fluvial literature. Specify the permafrost active layer.

2188 ln. 21-22: "Slope processes...that take place..."

2189 ln. 15 - "...conditions that link catchment processes and mass-wasting". This sentence is not clear. Do you mean mass-wasting, as represented in the lake records?

2189 ln. 18 - indicate the composite length of core 5011-1 here - ~500 m?

2189 ln. 22-23 "Permafrost dynamics might trigger sediment import into the lake".. govern sediment import, perhaps?

C1345

2189 ln. 25 - "...on the permafrost ramp.." is vague, and does not help the reader to situate the site. How about "mid-fan"?

2190 ln. 10-11 - "...consequences of interpreting the ... archive". The meaning of this sentence is not entirely clear.

## 2. Geographical setting

2190 ln. 15 - state here that the lake is 175 m deep, rather than later on page 2191 (ln. 17)

2191 ln. 12 - "A lateral succession..". Does this mean a succession moving away from the lake shore? Explain.

2191 ln. 14 - "...has been dated.." cite the study, and ideally the dating method.

2191 ln. 18 - "...up to 1 km wide" - do you mean 1 km from shore?

2191 ln. 25-26 - "the coring site is locate.."

2191 ln. 29 - the fan margin is arcuate?

2192 ln. 6-7 - Suggest: "The feeder channel of the EAFD and the channel feeding a small fan-delta immediately to the south.."

2192 ln. 10-11 - the ground is mostly dry in summer.

2192 ln. 11-12 - "It is clear that..." How is this clear (no need for 'may' if it is indeed clear)? From the lake cores?

2192 ln. 12 - I believe fluvial and alluvial are used synonymously here - one will do.

## 3. Materials and methods

2193 ln. 6 - "...transit layer contacts." = gradational contacts?

2193 ln. 13-15. Consider rephrasing: e.g. "...and documenting core sections with refined descriptions and digital photography."

C1346

2193 ln. 25 - Suggest: "Conventional sieving techniques were carried out in the course of analysing subsamples..."

## 4. Results

2195 ln. 11 - "From field observation it is clear..."

2195 ln. 18 - "... the shoreline barriers thus act as sediment traps;.." or, "the shoreline barrier system thus acts as a sediment trap;.."

## 5. Discussion

2200 ln. 7 - "...is a progradational sediment transport..". This clause needs to be revised.

2201 ln. 2-3 - "...triggered by gravity.." - perhaps: incited by oversteepening of the depositional slope?

2201 ln. 15 - "...and this is thought to.."

2201 ln. 27 - "...end of the slope sediment transport" -> cascade, or system.

2202 ln. 12 - "...on the tundra surface.."

2202 ln. 18-19 - "...associated with the Allerod given the similar pollen spectra.."

2203 ln. 10 - "...leads to its classification.."

2203 ln. 12 - "...an alluvial fan.."

2206 ln. 15 - "...rupture the area.." - perhaps 'shake' the area?

2207 ln. 13 - "...supports mass wasting" - do you mean it conveys material from mass wasting, or mass wasting occurs on the foreslope of the delta? Clarify.

---

Interactive comment on Clim. Past Discuss., 8, 2187, 2012.

C1347