

## ***Interactive comment on “Petrophysical characterization of the lacustrine sediment succession drilled in Lake El’gygytgyn, Far East Russian Arctic” by A. C. Gebhardt et al.***

### **Anonymous Referee #1**

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This manuscript addresses petrophysical and geochemical properties of drill cores from an exciting project that shed spectacular new light on long paleoclimatic reconstructions from the Arctic. The El’gygytgyn Drilling project yielded unique high-resolution and continuous paleoenvironmental terrestrial record covering the full Quaternary and the Late Pliocene. Gebhardt’s paper is integrated in a special volume. It presents good-quality data that is worth to be reported and complements the other studies completing the suite of data analysis and paleoenvironmental interpretations. I see some issues on the organization of the manuscript, as it presents a complex cocktail of various datasets, starting from seismic data, downhole logging data, core-logging data and various geochemical proxies. The title mentions only petrophysical

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data, which is a bit confusing. The paper refers extensively to a lot of data that have been published before, and the authors should state a bit more clearly what is new in this submission (I assume logging data, some of the core logging data as well). There are for instance 3 pages of lithological description, that has been all discussed before. Some of the paragraphs repeat statements, as some data is presented upfront (lithology) and some interpretations are also presented early and late in the manuscript.

The paper is written partly not very carefully: there are for instance repeating subtitles: The 4.2 title is the same as 4.3; and 5.1 the same as 5.2, very confusing. I also don't understand the Chapter 5 overall title (variability in lacustrine succession), this is unclear, what is meant here, the entire paper discusses these variations, what is special now in Chapter 5?

There are also some sections, which are highly repetitive: For instance (I refer as page/line numbers, but I used a pdf that starts at page 1, the online version starts now at p. 351) 14/20-15/5: 12 lines of total and mostly word-by-word repetition of what has been said higher above in the chapter 2.2! There are also highly inconsistent and repetitive paragraphs: what is now valid? reflection or refractions? Vp? 5/22: '...The lacustrine sediments can be divided into two units by means of refraction data; the upper unit is characterized by a seismic velocity of 1550ms<sup>-1</sup> and a thickness of about 170 m, the lower unit by 1650 m s<sup>-1</sup> and a variable thickness of 190 m on top of the uplift ring structure to 290 m in the surrounding basin (Gebhardt et al., 2006)'. 14/13: 'Seismic reflection data exhibit that Unit I can be subdivided into an upper, well-stratified Subunit Ia and a lower, 15 more chaotic sedimentary Subunit Ib (Fig. 2). Acoustic velocities are around 1550 to 1650 m s<sup>-1</sup> for both Subunits, pointing at unconsolidated sediments. So the authors should reorganize all these issues bit to overcome these structural issues.

My main point to be mentioned is the interpretation of the clusters. There are two kind of clusters, 1-3, and I-IV. This should be more clearly mentioned, that these are two different issues. In general I can follow that these clusters represent somehow distinct

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classes, but I have my doubts whether they are that important, as they either may show obvious changes that have been extensively described lithologically (for instance I don't need a cluster analysis to distinguish the impact breccia). But there is also too much emphasis given to these clusters, and they may be overinterpreted, some example: I don't agree with the remark 18/5-8: '...that these two sediment types do not differ in their petrophysical characteristics...': and would expect from the redeposited layers higher densities than from pelagic sediments. Are Facies F densities surely not higher than those of pelagic sediments? The authors reduce the term 'petrophysical' to their cluster formation, but it might be cleaner just to discuss the pure physical properties. I also don't agree with the statement on 20/25: just the fact that resistivity is rather stable does not mean that petrophysical properties overall are stable. Density and magnetic susc. show in fact large scatter. The clustering might be correctly done, but is clearly biased, and eventually, the cluster forces the variety of properties into a scheme so that some important differences are lost. So maybe a simple discussion of the properties would also be very useful. The complex Fig. 6 does not really contribute more than was already known from classic lithologic interpretation, which reflects the numerous and extensive references to previously published analytical and interpretational papers of The El'gygytgyn cores.

Other key comments: 21/1-6: This statement is wrong. Large catchments also have always the same catchments lithology. The cores show also variable lithology, so again, a same cluster does not mean same lithology! Catchment alone only represents the detrital fraction, we know from lithologic analysis that the authigenic fraction of the sediment is at least as important, or at least more diagnostic on past environmental changes.

Facies D: the statement '... Laminae are characterized by distinct lower boundaries and a coarsening upward sequence from silt to clay with a higher total clay content than in Facies A....' sounds very much like a turbidite to me. The authors mention enhanced fluvial input. Are these flood-induced turbidites, i.e. underflow or hyperpycnal flow

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deposits?

Seismic units II and III are masked by multiples? But where are they? Or are these lithologic units? (How can you define seismic units, when they are fully masked by the multiple?) They are not even shown on the data. Or are they based on refraction data? I also don't see so well the Ia-Ib unit boundary on the seismic figure. The seismic sections should be shown larger with better resolution to give credit to the data. This comment also refers to: 15/10: '... Subunit Ia conformably overlies Subunit Ib with a clear and distinct boundary in between....'. So how is the boundary then recognized? Change in seismic facies?

18/18: K and Th are indicative of clay minerals, not grain size! I cannot follow the discussion of grain size K and Th contents!

Detailed comments

Add commas after 'which' (e.g. first sentence of abstract)

Second sentence of Abstract: replace former and latter with upper and lower

3-25: 'Mid Pliocene' not 'Mid Pleistocene'

Fig. 2: Seismic profiles too small, I would make these larger, they are important for this paper. Caption: Is 'lilac' a color?

5/27: '...turbidites are not deposited in the proximal parts...' needs to be reworded.

6/25: '...composite profile was composed...' should be reworded....was defined....or something similar.

10/13: '...were only approximately 33 mm thick, which is beyond of what our Geotek MSCSL can measure reliably..' It is surely not ideal to measure GRAPE on split core. But the authors mean with 'beyond' that 33 mm is large enough, correct?. The sentence reads as if the cores were too thin to be measured reliably.

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11/5ff.: But defining the composite section often changes total length of cores as one jumps from one hole to the other. This cannot be compensated by a constant shift. Was that a significant issue?

13/2-3: 5- or 6-digits accuracy are an illusion! Round appropriately!

14/17: '...Subunit Ia has a relatively flat surface (YOU MEAN THE LAKE FLOOR?) in large parts of the basin, but the bathymetry is sometimes rough in the more proximal areas where mass movement deposits occur frequently in the upper layers or on top of the sediments'. WHAT IS MEANT WITH 'ON TOP OF THE SEDIMENTS'?

15/18: How are these faults related to uplift structure? unclear how this structure produces faults.

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