

Interactive comment on “Lena River Delta formation during the Holocene” by D. Bolshiyarov et al.

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Dear anonymous Referee #1, We understand your questions and your doubts about our demonstrations of sea level fluctuations during Holocene. Discussed article is a first our experience to publish results of the Lena River Delta investigations in English. All previous articles have been published in Russian. And the main our results devoted to Lena Delta formation published in 2013 as a book named after “Origin and development of the Lena River Delta”. In discussing article we could not demonstrate all data which we took from Delta during 15 years of joint Russian-German investigations. In the article we tried to attract attention of investigators to origination of so-called peat in a huge space of the Arctic, not only in the Lena Delta but in many places of Eurasian Arctic coast from Svalbard to Chukotka. You are right that Delta constructed during

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repeated periods of erosion and accumulation. But these periodical processes were caused by base level of erosion fluctuations. During high level stages of the Laptev Sea big volumes of allochthonous organic material concentrated in closed estuaries and bays. An existence of closed areas of water due to destructed remnants of Ice Complex massifs was a specific situation in Lena River Delta every time during its formation. In such closed bays sedimentation of organic material took place. Huge volume of so-called peat is a main peculiarity of Lena Delta construction. Other deltas and estuaries of Siberian rivers (Ob, Enisey, Pyasina, Khatanga etc.) include some volume of organic sediments in geological bodies of islands. But Lena Delta islands consist of more than 50% of layered organic material. More than 8 meters of peat could not be sedimented during short (hundreds years, millennium) period of time. There are not peats more than 1 m thick in the Arctic. If we find organic sediments there more than 1 m thick it means that this sediments is an alochthonous sediment concentrated in water bodies. Very good laminations in an organic-mineral stratas is a good evidence of their's sedimentation in water conditions. His idea is the main idea of the article. There are plenty evidences of sea level fluctuations in Holocene in the Lena Delta River. There are Holocene marine terraces up to 15 meters high on the shoes of Laptev Sea, along sea side of the Lena Delta and on other shores and islands of the Arctic. These data are not in the article but discussed wide in the book "Origin and development of the Lena River Delta". We coul not demonstrate these data in the article but refered to the book. If the article concentrated more on showing evolution of Delta lobes it could not be published in Biogeosciences Journal. All these questions we discussed in the mentioned book. For the discussing article we chose another idea. This idea is an origin of organomineral sediments and the role of carbon rich sediments in the Lena River Delta evolution. P 4090, second line. Here we try to explain that Holocene sediments like Ice Complex deposits and formed in similar conditions only. There is no space to discuss this very important question in small article. In the mentioned book we are trying to prove that as in Holocene as at the end of Late Pleistocene (60-20y.b.p) level of Arctic Ocean was close and sometime above modern sea level. It was a main reason to Ice

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Complex formation. Now and then sea cost was under influence of River fresh waters especially in closed basins of Lena Delta. That is why it is very difficult to find marine organisms, marine chemistry signals in the permafrost soils. We have found them. But other investigators don't want to find such evidences, which are in contradiction with predominant idea of low position of sea level 60-20 thousands years ago and at the beginning of Holocene. We have also geomorphological evidences of high sea level stands during Ice Complex formation (IC ingressive terraces of 40-50 m above modern sea level in all river valleys of Taimyr Peninsula and in the Lena River mouth Region). We also found marine salts in sediments of sea side first Holocene terrace of the Delta (Shwamborn et.al 2004). It is impossible to discuss all this data in a short article if there is published book devoted to these problems. P.4102, 7 line. May be you have not fined this reference in metioned article. We could not find this article immediately to check our mistake. But the problem is not here. You can find saline sediments on page 37 of article "Late Quaternary Sedimentation History of the Lena Delt" by G.Schwamborn, V.Rachold, M.Grigoriev and M.Krbetchek (GeoLines 11. 2000. 35-38). But colleagues explain salt sediments of Sagastyr Island by aerosols and exclude marine influence on Delta. We think that marine salts in sediments could not be explained by aerosols because the water around Delta is fresh for 10-20 km distance. It is impossible to prove marine salts in Delta sediments without marine waters ingression towards the Delta. It is very common reason to propose aerosols when marine influence must be excluded from examination. The same situation in Antarctic investigations of marine terraces. Salt lagoons sediments on height up to 100-110 m in Antarctic oasises are explain- ing by aerosols at that time when oasises surrounded by shelf ice for tens kilometers. P.4088, 18 line. Yes, we used uncalibrated radiocarbon ages because there are many such datings which have been used by our Russian colleagues in described region for the first time. There is a second reason why we don't used such ages. We don't believe in rightness of corrections in 14C dating process. Nobody could explain a real physical sense of 14C corrections. And datings is an additional data in our constrac- tion only. In any case (calibrated or uncalibrated ages) we can see a very short time

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of organomineral sedimentation in Lena Delta. Yes we can correct expression of ages and make them uniform. In our mind an estuarine terrace is that terrace which formed in an estuary. Terraces of Lena Delta formed in estuaries exactly. As we mentioned the Delta space during terraces forming process was restricted by remnants of destroying Ice Complex massifs and massif of Arga Island, always. Sea level fluctuations (tides, pilings up of water, decades, century, millennium of scale fluctuations) are very important for constructing of any delta. There are many geomorphological evidence of this thesis. In themselves terraces are a main evidence of their's costruction in closed bays or estuaries. The same situation with our understanding of marine terraces. What do you think if you see terraces or steps of terraces on a sea shoreline? We think that these terraces formed by sea. Sometimes we can find marine organisms in sediments of terraces, sometimes not because terrace could be forms by processes of abrasion. In such case sediments are free from marine organisms. In a case of Lena Delta marine terraces sometimes free from marine organisms because water along sea side of Lena Delta was fresh during sedimentation and terrace formation. Sometimes our predecessors have found and sometimes we found marine organisms in marine, estuarine sediments of terraces. We found them even in the Ice Complex sediments. All these questions discussed in a mentioned book. Volume of article dos' not permit to discuss all this problems. Fig. 2 is an illustration for claim of weak variability of sedimentation conditions. There are no changes in spore and pollen spectrums. It means that organic deposits sedimented during short period of time. Fig. 5. Ages are not calibrated. Yes, here coarse sediments means gravel. Here is a mistake in a legend. A correct spelling is "Melted ice water sediments". Not melted ice sediments. There was a small glaciation in mountain area and on Arga Island of the Delta during the Little Ice Age (500-200 years ago). Melted ice water was very important factor of erosion relief construction and for sedimentation of coarse material in the Delta. All these data discussed in mentioned book. The geomorphological map was constructed with analysys of mach more data thn we can discuss in the article. That is why we refered to this book when discussing geomorphological construction or paleoevents. Fig. 7. As we

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propose that organomineral sediments is evidence of sedimentation in closed water basins connected with sea, we can present on fig. 7 high and low sea level stands during Holocene accordance with ^{14}C ages of such sediments. Fig 8. Stages 40-30 and 17-15 Ka had been shown because they help to understand that sea level fluctuations and organic sedimentation took place periodically both in Late Pleistocene and in Holocene. Reference for data is on a page 4102, line 21. Thank You for questions, discussion and founded mistakes. Dmitry Bolshiyarov, Alexander Makarov

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