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Discussions

Interactive comment on "Organic matter composition and stabilization in a polygonal tundra soil of the Lena-Delta" *by* S. Höfle et al.

Anonymous Referee #2

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This study deals with with stabilization mechansisms of organic matter in permafrost soils, being assessed by a combination of biomarker studies, 13C NMR spectroscopy and 14C analysis in functionally different soil fractions. The topic is of high relevance and absolutely fits to Biogeosciences Discussions. Also the message of the study that mineral protection of organic matter against decomposition is not very important in the investigated permafrost soil appears to be plausible.

As much as I like the study in principle, I do have some major concerns with it.

General comments:

My first concern addresses the representativeness of samples. In studies working in sedimentary systems it is very normal to study just one core, but often with dozens of

individual depth increments. Also spatial variability in lake or marine sediments quite often is not very large. In contrast, spatial variability is one of the very basic characteristic of soils. This holds particularly true for permafrost soils. With this respect, I do not think that it is sufficient to analyze four horizons of one profile only. Can there be a generalization from data of one pit only? For the moment, it can be just considered true for this small individual soil profile. And even with this respect, nothing is said how spatial heterogeneity at the scale of the profile was considered during sampling of the pit. A revised version should consider replicated analysis of other profiles.

My second query concerns the occluded organic matter fractions. It has to be highly appreciated that the authors transported the samples in a frozen stage, thus preventing formation of artefacts concerning aggregation by drying. However, does the soil really show an aggregated structure? To my knowledge most arctic soils possess a coherent soil structure (and hence are not aggregated) due to high water contents in large parts of the profile. An exception might be mineral topsoils, where rooting and smaller water content may favor aggregation. But the authors reported largest protection of organic matter in soil aggregates at greater active layer depth and within the permafrost. Here, I hardly can imagine any aggregation effect on organic matter stabilization.

With this respect, I would like to ask the authors to present some data on soil structure in the different horizons. Generally, a soil description is almost completely lacking. What was the sampling strategy, according to soil horizons or to sedimentation layers? What is the soil type? When talking about formation of organo-mineral associations as one possible stabilization mechanism, wouldn't it be important to know something about the mineral counterparts? Are they so-called active minerals in the soil, or is the mineral assemblage dominated by compounds of low reactivity?

A last comment addresses the conclusion that chemical recalcitrance may play a considerable role in permafrost soils. This statement is well based on the biomarker studies, the 13C NMR results and the 14C data, showing that organic matter has not been much transformed, despite the old 14C age. Indeed it looks like that almost all frac-

tions are showing roughly the same 14C age than the bulk soil; just free particulate organic matter (i.e., fresh plant residues) is younger and the fine sand is older. In this fraction the organic carbon concentration is pretty small, and I am wondering if parts of the organic carbon in this fraction has been inhereted with the fluvial deposition of the sediments. Further, it would be nice if the authors can work out a bit closer what do they mean with recalcitrance. Is it that the plants at the site are build up by recalcitrant substances or is it rather the specific soil environment that is responsible for the high 14C age?

Minor comments:

p. 12344, l. 7 "... surprisingly low and strongly increasing apparent 14C ages ..."; "low" has to be repaced by "high", or?

p. 12345, l. 10-12 There are a few studies dealing with the plant material and soil organic matter in the hinterland of Laptev Sea.

p. 12348, l. 28 A mass recovery of 97-99%from the 8 fractions is simply great.

p. 12351, l. 6 What is "decomposed organic litter layer"? Decomposition of litter usually leads to the formation of Oe or Oa organic surface layers, or – as is the case here, considering a total organic carbon concentration of 30 g/kg – to incorporation into the mineral soil and formation of a mineral A horizons.

p. 12351, l. 7-8 Mosses do not have roots.

p. 12351, l. 12-13 The authors report that they were sampling a sand lense (from 6-11 cm). Is it really just a lense or is it rather a whole layer, characterizing some sedimentation events. Again, this stresses on the importance of a more representative soil sampling.

p. 12354, l. 9 The term "upper permafrost soil" is not correct, as the active layer is also part of the permafrost soil; rather call it "upper permafrost layer".

p. 12357, l. 6 Here, the authors are stating that there is no cryoturbation in the soil, while at p. 12356, l. 20 the texture difference was explained to be partly due to cryoturbation. What is true?

Interactive comment on Biogeosciences Discuss., 9, 12343, 2012.