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Interactive comment on "The 3.6 ka Aniakchak tephra in the Arctic Ocean: a constraint on the Holocene radiocarbon reservoir age in the Chukchi Sea" *by* Christof Pearce et al.

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Tephra and cryptotephra studies are being successfully used in various kinds of paleoenvironmental research, mainly for synchronization of various marine, terrestrial and ice records. Last decades see a real boom in global tephra and cryptotephra studies, however, in many large geographical areas this technique still has not been employed. One of such areas, surprisingly, is the Arctic Ocean where no tephra research has been performed until very recently although cryptotephra has been reported from the Fram Strait connecting the Arctic Ocean with the Nordic seas (Zamelczyk et al., 2012).

The paper under review presents the first documentation of a cryptotephra from an Arctic core providing an account on particle concentrations, composition of volcanic

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glass, and grain size distribution in the sediments. The paper is well articulated, based on solid data, and is accompanied with detailed supplementary tables. This paper definitely deserves publication after only a minor revision because it opens a discussion on the applicability of tephra for dating and correlation of the Arctic Ocean sediments as well as for understanding of sediment transport and deposition patterns.

The authors focus on one specific goal - identification of the Holocene reservoir age in the Chukchi Sea based on correlation of a cryptotephra horizon between dated marine and terrestrial/ice sequences. This task requires an accurate and reliable positioning of a tephra isochron relative to the dated core levels. The authors were lucky to find geochemically distinct and well dated Aniakchak II tephra, which links their core to many 14C-dated terrestrial sites and, more important, to two Greenland ice cores where the age of this tephra is estimated with a precision of ± 3 yrs. At the same time, some issues related to tephra distribution in the Chukchi Sea sediments (and thus to the position of the Aniakchak II isochron in the core) deserve further discussion.

The authors document a >1.5 m thick zone of high glass concentrations accumulated within >700 yrs. As the upper part of the core has not yet been explored we cannot tell whether this tephra zone fades away at $\sim$550 cm or extends up core. Based on geochemical data, at least the lower $\sim$90 cm interval of this zone contains rhyolitic Aniakchak II glasses with no admixture of any other glass populations. To my knowledge this is the first reported case where geochemically identical glasses are continuously present over such a broad interval of a marine core. Bredryan et al. (2010) also reported tephra zones accumulated during $\sim$1000 yrs, however, first, in their core 1000 yrs correspond to only few cm of sediments, and second, in some cases such zones in fact may contain different tephras from the same or different volcanic systems (e.g., Bourne et al., 2013; Davies et al., 2014).

Some authors suggest placing a tephra isochron at the first shard occurrence in the core (e.g., Austin et al., 1995; Brendryen et al., 2010) while others demonstrate a complex structure of the lower boundary of a tephra layer, and suggest placing an

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isochron at the maximum glass concentrations (e.g., Abbott et al., 2014; Davies et al., 2014; Griggs et al., 2014, 2015). The authors of the paper under consideration try to find a balance between these two suggestions putting an isochron either at 711.5 (a major increase in glass contents and the first analyzed level) or at 696.5 cm (15 cm higher). I am not sure if any unambiguous decision about correct position of the isochron can be reached at this stage, however, I think this section requires more elaboration involving further ideas on mechanism of the emplacement of these glasses.

Brendryen et al (2010) and others describe centuries to millennia long lags between the initial airfall and the delivery of tephra to the ocean floor and they explain such delays by distribution of a tephra over an ice sheet, slow movement of the ice towards the sea "where it subsequently calves off tephra-laden icebergs". In the case of the Chukchi Sea, as far as I understand, the main transport mechanisms in mid-Holocene times likely are sea ice and currents rather than icebergs (which is further supported by homogeneous glass compositions). So why does the Aniakchak signal peak >58 cm above the lowermost analyzed level? Could bottom currents in the Herald canyon or redeposition from the canyon walls play a role in an unusually long vertical dispersal of identical glasses? Could a tsunami wave associated with the caldera-forming eruption (Waythomas and Neal, 1998) contribute to wide spread of the Aniakchak glasses?

The authors do not mention that the Aniakchak II glasses from airborne tephra have both andesitic and rhyolitic populations (e.g., Kaufman et al., 2012; Davies et al., 2016). Were andesitic glasses (if present in the Chukchi Sea sediments) separated into the >2.5 g/cm3 fraction? If not - why aren't they present in the larger glass concentration peaks? It is true that in some of distal airfall deposits only rhyolitic shards have been analyzed (e.g., Blackford et al., 2014) but if the authors suggest that the larger glass concentration peaks are explained by reworking of primary tephra deposits and transported to the core site by currents or sea ice (from the Bering Sea?) we would probably expect to see also andesitic shards and admixture of some other glass populations.

Neal and others (2001, p. 4), referring to Riehle and others (1999), suggest that at least

20 explosive eruptions occurred at Aniakchak in postglacial time before the Aniakchak II eruption (cited from Bacon et al., 2014). The Aniakchak II proximal pyroclastic package as well as the sequence at the Bering Sea coast includes several units (Bacon et al., 2014; Riehle et al., 2014). I wonder if this proximal record can be resolved on centennial scale because of slow paleosol accumulation over a thick pyroclastic cover. Kaufman et al (2012) reported two closely spaced visible Aniakchak tephra layers in Alaska. Could different but closely spaced in time Aniakchak eruptions contribute to a long Aniakchak signal in the Chukchi Sea core?

Hope that some of these issues could be further discussed in this paper. Please find my minor comments and additional references in the attached file

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Please also note the supplement to this comment:
http://www.clim-past-discuss.net/cp-2016-112/cp-2016-112-RC2-supplement.pdf

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