

Interactive comment on “Maskevarri Ráhppát in Finnmark, North Norway – is it an earthquake induced landform complex?” by R. Sutinen et al.

R. Sutinen et al.

raimo.sutinen@gtk.fi

Received and published: 16 April 2014

Response to Referee Michael Sebrier; (1) Rather than being negative, we raised an alternative option for the genesis of the Maskevarri Ráhppát. This was because it has been previously classified as push moraine of the Tromsø-Lyngen sub-stage in Finnmark (Sollid et al., 1973), marginal moraine by the Nordkalott Project (1986), and as ablation hummocky moraine in the Quaternary map by Olsen et al. (1996). Push moraine involves active ice movement whereas ablation moraine is developed in stagnant ice conditions and often from supraglacial debris. On the basis of morphology (surface roughness, anastomosing esker pattern, absence of surface streamlining) and sedimentary-anisotropy (parallel-to-ridge crests of the sinusoidal eskers) we argue that other mechanism than ice-frontal pushing or stagnant ablation is needed to explain the

C285

Maskevarri Ráhppát.

(2) Due to lithospheric plate stresses and glacio-isostatic rebound postglacial fault deformations are common features in northern Fennoscandia. The faults most commonly are trending NE-SW, yet the lineaments and faults in Finnmark are trending WNW-ESE (Roberts et al. 1997 *Tectonophysics* 270, 1-13; Ottesen et al. 2008 *Quat. Sci. Rev.* 27, 922-940; Tanner 1930 *Bull. Geol. Finl.*). Even though the latter orientation is also found at Maskevarri, reactivation of the old structures should be seen indirectly as landslides (Sutinen et al. 2009 *Global Planet. Change* 69, 16-28), Pulju moraines and anastomosing esker systems (Sutinen et al. 2014 *Global Planet. Change* 115, 24-32) and/or seismites (Lagerbäck and Sundh 2008 *Sver. Geol. Unders.* C386; Brandes and Winsemann (2013 *Int. J. Earth Sci.*). The only evidence suggesting indirectly seismic event(s) was the anastomosing esker system on the slope of the Maskevarri fell. Since we don't have diamond drillings to verify the PGFs (cf. Sutinen et al. 2014 *Int. J. Appl. Earth Obs. and Geoinf.* 27, 91-99) we have replaced the term three terraces by three elevations, the word escarpment has also been removed. It is our conjecture that earthquake(s) occurred subglacially in a similar manner as the Kultima fault in Finnish Lapland (Sutinen et al. 2014 *Global Planet. Change* 115, 24-32).

(3) In the revised MS, two new paragraphs (w. citations) has been added to discuss on the periglacial features. We have argued that pingos and palsas are typically located on flat terrains (Jones et al., 2012 *Geomorphology* 138, 1-14; Seppälä, 2011 *Quat. Res.* 75, 366-370; Tabuchi and Seppälä, 2012, *Polar Science* 6, 237-251; Wetterich et al., 2012 *Quat. Sci.Rev.* 39, 26-44), not on the slope of the fell. Also, pingos tend to be formed of soft-sediments, palsas are ice-cored peat hummocks. We are aware that in some cases thermokarst features can develop on push moraines, such as those in Yukon, Canada (Lenz et al. 2013 *Palaeogeogr. Palaeoclim. Palaeoecol* 381-382, 15-25). Soft-sediments are absent in the Maskevarri Ráhppát. The lake/pond pattern in Maskevarri is different from talik lakes in the arctic (Grunblatt and Atwood, 2014. *Int. J. Appl. Earth Obs. and Geoinf.* 27, 63-69; Morgestern et al. 2013 *Geomorphology*

C286

201, 262-379). One of the arguments is that no evidence has been found to indicate that permafrost persisted through the Holocene in the Maskevarri area (Lilleøren et al., 2012, *Global Planet. Change* 92-93, 209-223). Although mountain permafrost is commonly found in Norway (Lilleøren et al., 2012, *Global Planet. Change* 92-93, 209-223) and many of the mountain rockslide deformations in northern Norway are permafrost-controlled (Blikra and Christiansen, 2014 *Geomorphology* 208, 34-49), the morphology of the rockslide talus deformations is, however, dissimilar to bouldery esker ridges and mounds in Maskevarri Ráhppát.

(4) Sinusoidality of the esker (esker-like) ridges strongly emphasizes the presence of subglacial water and suggests the origin to be associated with full-pipe flow mechanisms, not time-transgressive evolution at the ice margin (Banerjee and McDonald 1975 *Spec. Publ. Soc. Econ. Paleont. Miner., Tulsa* 23, 132-154; Clark and Walder 1994 *Geol. Soc. Am. Bull.* 106, 304-314). Possible source of water may be attributed to lithospheric hydromechanics (Neuzil 2012 *Geofluids* 12, 22-37) and the triggering mechanism may have been subglacial earthquake (or glacial earthquake; Ekström et al., 2006 *Science* 311, 1756-1758; Nettles and Ekström, 2010 *Annu. Rev. Earth Planet. Sci.* 38, 467-491; West et al., 2010 *Geology* 38, 319-322). A new paragraph on the esker sedimentation/network has been added into the discussion of the revised MS.

Interactive comment on *Solid Earth Discuss.*, 6, 321, 2014.