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Multi-disciplinary approach in volcanic areas: case study of Kamchatka, Far East of Russia

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Volcanic ash is associated with a considerable proportion of the Earth's land surface. At the same time, it is estimated that 15% of the land surface is affected by permafrost and glacial ice. As a consequences volcanic ash may play an important role in the aggradation and degradation of cold regions (Kellerer-Pirklbauer et al., 2007; Froese et al., 2008). An understanding of the influence of volcanic ash on these frozen areas allows for more accurate prediction of their stability in the future and provides a better knowledge of the factors affecting past climates, soils and soil stability. Vital to making accurate predictions is an understanding of the thermal properties of volcanic ash (Juen et al., 2013). For example, even for the same region of Kamchatka in eastern Russia volcanic ash may have not only different ages, different chemical composition of the glass, but also different weathering stages, mineralogical composition, and water saturation, furthermore, these ashes may be permanently frozen or unfrozen, all of which may affect their thermal properties (Kuznetsova & Motenko, 2014). These differences might be the reason why the critical thickness of tephra, at which the effect on ice and snow is rather insulating than ablative, for the volcanic material from different volcanoes may vary so much. The determined values of critical thickness deviate from 24 mm reported by Driedger (1980) for the glaciers at Mt. St. Helens, USA, and by (Manville et al., 2000) for tephra erupted in 1996 by Mt. Ruapehu, New Zealand, to <5.5 mm for tephra from the 1947 eruption of Hekla volcano and from Villarica volcano, Chile, reported by Kirkbride and Dugmore (2003) and by Brock et al. (2007). So far the reasons of disparity are not known. Ayris and Delmelle (2012) assumed that the particle size and porosity might be the reason. Taking into considerations that during ablation period tephra covering the glaciers is wet, thermal conductivity of this material should not be overlooked (Kuznetsova et al., 2012).

Of particular importance in understanding the thermal behavior of frozen soils is a knowledge of their unfrozen water content. In the glacier interlayers the unfrozen water between ice and particles can work as lubricants to modify the stress transfer at the contacts between ice-particle and particle-particle through indirect influence on relaxing the interaction between particles and ice (Moore, 2014).

The paper discusses the application of multidisciplinary research on volcanic material covering permafrost and glaciers in volcanic areas. In cold environments, volcanic ash is widely used in different science disciplines in process-based studies examining paleoclimate reconstruction; the influence of permafrost aggradation and degradation; influence of tephra on snow and ice ablation; glacier fluctuations, volcanic glass weathering and new minerals formation (e.g. allophane, palagonite). The special properties of volcanic ash are critically reviewed particularly in relation to recent research in Kamchatka in the Far East of Russia. Of particular importance are the thermal properties and the unfrozen water contents of ash layers and the rate at which the weathering of volcanic glass takes place.