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THE SULPHUR CONCENTRATION OF PEAT IN FINLAND

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SUMMARY

Geological Survey of Finland (GTK) has investigated sulphur concentrations of peat in Finland since 1975. Research results based on peat sulphur data collected between 1975 and 2004 have been published by GTK in 2009 (Herranen, 2009). The present article additionally draws on new data collected in the Kruunupyy area between 2007 and 2010. The total number of samples is 38 344, which makes the data internationally significant. The mean sulphur concentration of peat in Finland was found to be 0.24%. The highest sulphur concentrations were usually found in samples taken from the basal peat layer. However, high sulphur concentrations were found also in the middle of the peat stratum and in the samples near the surface. The average sulphur concentration of the basal peat was 0.36% and of the surface peat 0.19%.

KEYWORDS: Peat, sulphur, black schist, sulphide clay and silt

INTRODUCTION

Sulphur concentration affects peat use possibilities for energy production. High sulphur content does not prevent the energy use of peat, since sulphur dioxide emissions can be reduced by joint peat-wood combustion. However, high sulphur concentration of peat is harmful for peat burning power plants. Therefore, peat producers seek to avoid peat with a high sulphur concentration. For example, operations in power plants are regulated by a system of environmental permits, which determines the concentration limit for sulphur dioxide in combustion gases.

Aim and methods

The aim of this study, conducted between 2004 and 2012 was to determine the mean sulphur concentration of peat in Finland. In addition, the study examined the regional distribution of sulphur concentration, sulphur concentration per mire and in the various parts of the peat stratum. The influence of mire type, drainage, huminosity, subsoil, bedrock and peat type to the sulphur concentration of peat were also analysed.

Statistical analyses and graphic presentation are made with SPSS statistical programme (Milton & Arnold, 1986).

The anomalous samples are excluded from counting by setting ranges to the properties. The samples are excluded only when the heat value is under 12 MJ/kg or over 28 MJ/kg, water content under 70 or over 100%, pH under 2.2. or over 7.0, ash over 25% and the dry volume weight under 20 kg/m^3 or over 220 kg/m^3.

The influence of subsoil and bedrock on peat sulphur concentration

The highest regional sulphur concentrations were found in the areas near black schists, particularly in Northern Karelia (Fig. 1). The high sulphur concentrations in Ostrobothnia (such as Kruunupyy and Kiiminki areas) relate partly to the common sulphide clay and silt in the region and partly to the black schists in the vicinity. The highest mean sulphur concentration was found in the peat of Stormossen-Lanjärvmossen (8.16%), Kruunupyy area. In Kruunupyy the sulphur concentrations are remarkable high; five of 722 samples have the sulphur concentration of over 10%, 8 over 5%, 54 over 1% and 134 over 0.5%.

Since peat is a soil type that has accumulated from decomposed mire vegetation, the subsoil and bedrock affect the sulphur concentration of peat. The influence of black schists can be seen in figure 2. The highest mean sulphur concentration was found in the basal peat layers above fine sand (0.40%) and the lowest in the samples above gravel (0.18%). The lowest mean sulphur concentration was in the area of sandstones and claystones (0.14%) and the highest in the area of quartzites and slates (0.36%) and in the area of igneous stones (0.30%). The sulphur originating from the soil through capillary action may also have an impact.

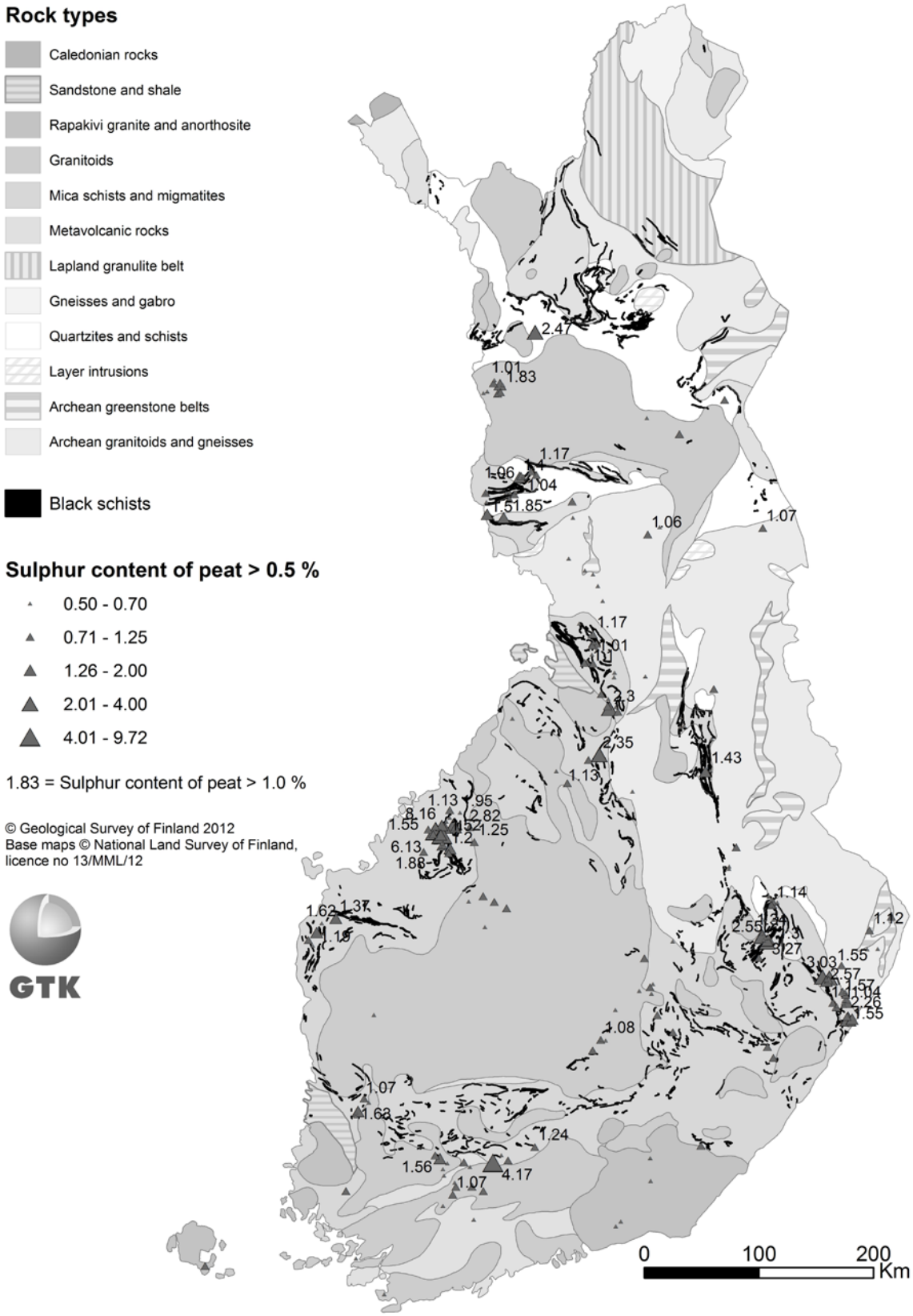

Fig. 1. The largest measured mean sulphur contents of peat in mires of Finland with respect to bedrock geology in the peat inventory data of GTK. Bedrock geology is from Bedrock of Finland (Geological Survey of Finland, www-document). The areas of black schists are situated according to Arkimaa *et al*., 2000.

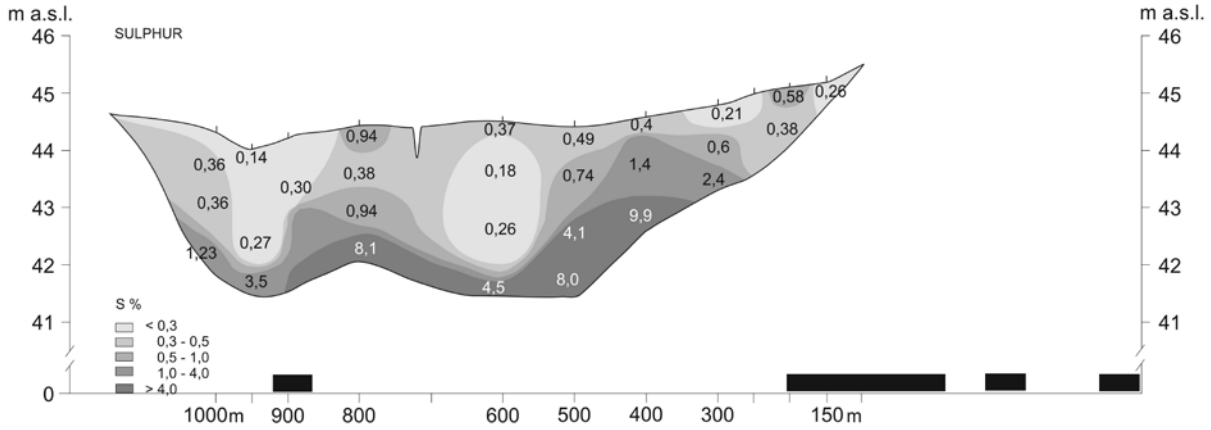

Fig. 2. The variation of sulphur content of peat in peat profile of Saarisenojanniitty, Kiiminki. The location of black schists in underlying bedrock has separated with black bars (Virtanen & Lerssi, 2008, 2012).

The influence of peat type, peatland type and drainage on peat sulphur concentration

The mean sulphur concentration of the data is 0.24%. In *Sphagnum* predominant peats the mean sulphur concentration was 0.20%, in *Acutifolia*-groups weakly decomposed *Sphagnum* peat 0.07%, in *Carex* predominant peats 0.27% and in *Bryales* predominant peats 0.42%. *Bryales* (0.24%) and *Carex* (0.20%) peats have the clearly highest medians. The weakly decomposed *Spagnum* peats have the clearly lowest medians: *Acutifolia* type (0.06%), *Palustria* type (0.07%) and *Cuspidata* type (0.09%). In highly decomposed peats the deviations are remarkable, and thereby outliers and extreme outliers are numerous. The standard deviation value in *Bryales* peats is highest (0.59), whereas in *Carex* peats it is 0.37 and in *Sphagnum* peats 0.36 (Fig. 3).

The majority of the data values are near the mean value (0.24%). 89.9% of assays lay within a very narrow concentration interval of 0.04–0.37%. Only sixteen of all samples have the sulphur concentration of over 10%, 43 over 5%, 785 over 1% and 2340 over 0.5%. In addition, the ash content of peats with high sulphur content is high. If the sulphur content is over 10%, the mean ash content is 26.9% (none of the samples is excluded in this case). Respectively, if the sulphur content is over 5%, the mean ash content is 20.1%. If the sulphur content is over 1%, the mean ash content is 8.5%. If the sulphur content is over 0.5%, the mean ash content is 7.0%.

As the decomposition degree rises, the sulphur concentration of all peat types usually increases. In *Sphagnum* peats the distribution of sulphur is most even and the concentration levels lowest. In *Carex* peats there is little bit more dispersion and the concentration levels slightly higher. In *Bryales* peats there is most dispersion and the concentration levels highest.

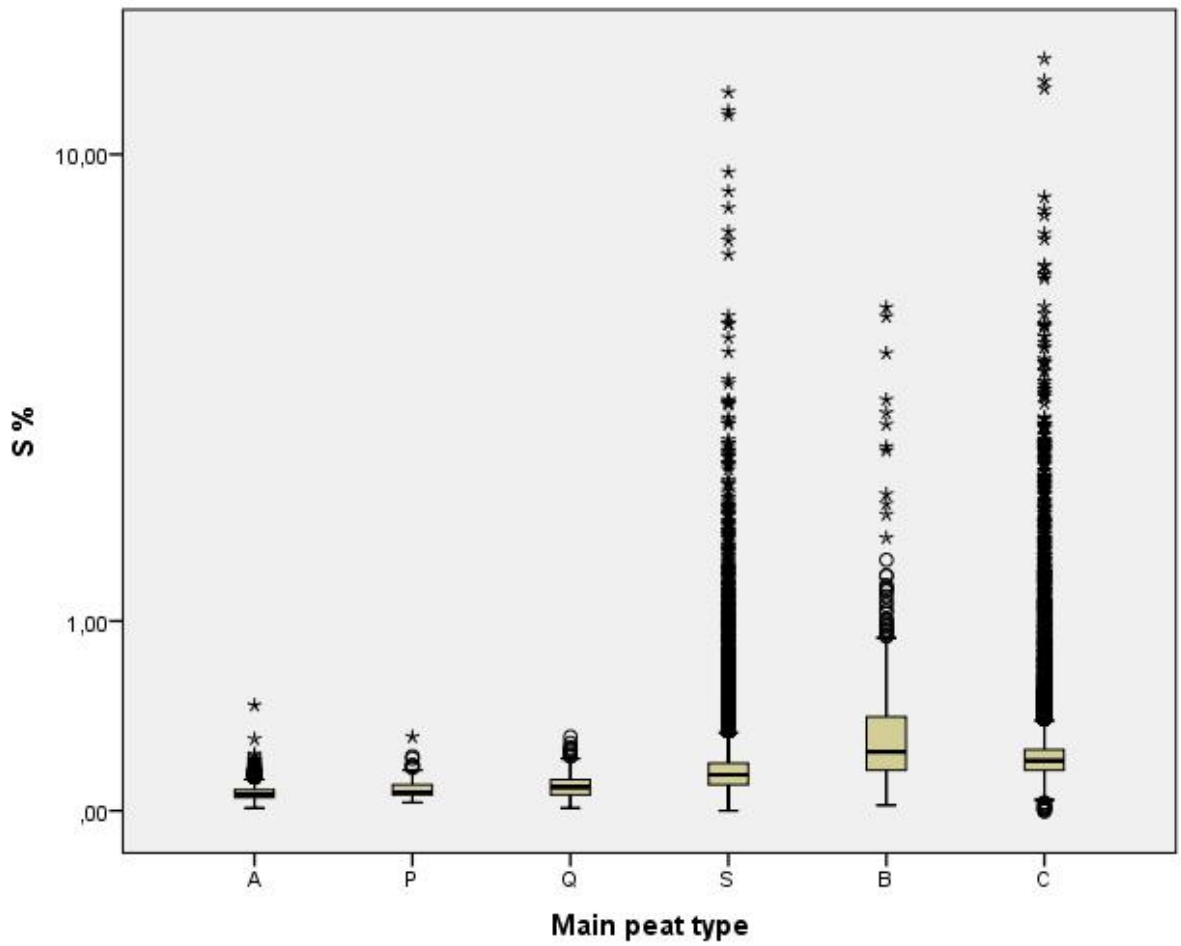

Fig. 3. The sulphur content of main peat types (N=32 557).

The mean sulphur concentration is highest in *Phragmites*-bearing *Bryales* peats (PRB-peat, 1.13%) and *Sphagnum* peats (PRS-peat, 0.89%) and *Scirpus*-bearing *Carex* peat (SPC-peat, 1.09%). The highest sulfur concentrations are often related to the peats that have *Phragmites*(PR), wood (L) or *Menyanthes* (MN) as an extra element. These peats often additionally have rising ash concentration and also low heating value. The main peat type is generally *Sphagnum-Carex* peat (SC-peat). 57.4% of the peat samples are *Carex* predominant, 41.4% *Sphagnum* predominant, and 1.2% *Bryales* predominant.

The highest sulphur concentrations were found in samples taken from real spruce mires (mean 0.68%). These have also the clearly biggest standard deviation value (1.60). High sulphur concentrations were also found in drained peatland forest types and in pine bogs and *Hypnum* fen types. Poor fens with pools, raised bogs and *Sphagnum fuscum* bogs were the mire types with the lowest mean concentrations of sulphur.

CONCLUSIONS

The sulphur concentration of peat is normally low, but in the vicinity of black schists and in the sulphide clay and silt regions it can be high. In general, the highest sulphur concentrations are found in the basal peat layer and the lowest in the surface peat layer.

The sulphur concentration of peat has remarkable regional effect on peat usage and on the condition of waters. Therefore, when planning the peat production, the peats with high sulphur concentration chiefly in the vicinity of black schists (Fig. 1) and in the sulphide clay and silt regions of Ostrobothnia should be left outside the peat production. The drainage frees sulphur from subsoil to easily soluble sulphate form. This is harmful especially in the sulphate land areas of Ostrobothnia, where the rivers suffer from acidification.

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