

# Country-wide mapping and environmental risk management of sulphur-rich black shales using geophysics and geochemistry

KIRSTI LOUKOLA-RUSKEENIEMI, EIJÄ HYVÖNEN,  
JOUNI LERSSI AND JAAKKO AURI

Geological Survey of Finland

Presenting Author: kirsti.loukola-ruskeeniemi@gtk.fi

Geological Survey of Finland has mapped the distribution of black shales in Finland using airborne geophysics and geological, petrophysical and geochemical studies [1] (Fig. 1). Black shales contain over 0.5% of organic C and have in most cases deposited on seafloor in anoxic conditions. Black shale is a heterogeneous rock type: rock assemblage, mineralogy, textures and chemical characteristics vary due to differences during primary deposition and subsequent metamorphic and tectonic deformations (Fig. 2).

It is not recommended to drill wells into S-rich black shales and related soils since the quality of groundwater may be poor [2-6]. Environmental risks increase if the black shale unit is over 3 m thick and the concentration of S exceeds 3%. During the last glaciation ice consumed the upper layers of the bedrock in northern countries. Glacial till and glaciofluvial deposits rich in black shale materials are found following the direction of the ancient ice flow.

While developing the risk management procedure for S-rich black shales and related soils we have applied, for example, the lessons learnt during the risk management of As-rich bedrock and soils in Saxony [7]. The distribution of S-rich black shales should be taken into consideration in regional planning since they may generate acid drainage to surface waters if exposed to weathering during anthropogenic activities such as road construction.

**Fig. 1.** The black shale units of Finland (shown with violet lines). ‘Study sites’ refer to prospects where more detailed geochemical and petrophysical studies were carried out to verify the geophysical interpretations.

**Fig. 2.** Sulphide-rich black shale from the Talvivaara Ni-Zn-Co-Cu deposit (Fig. 1), Terrafame Sotkamo mine. Photo: K. Loukola-Ruskeeniemi

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