Long-term changes of heavy metal and sulphur concentrations in ecosystems of the Taymyr Peninsula (Russian Federation) North of the Norilsk Industrial Complex

Alexander V. Zhulidov · Richard D. Robarts · Dmitry F. Pavlov · J. Kämäri · Tatiana Yu. Gurtovaya · J. J. Meriläinen · Igor N. Pospelov

Received: 27 April 2010 / Accepted: 14 December 2010 / Published online: 26 January 2011 © Springer Science+Business Media B.V. 2011

Abstract The Norilsk industrial ore smelting complex (Taymyr Peninsula, Russian Federation) has significantly impacted many components of local terrestrial and aquatic environments. Whether it has had a major impact on the wider Russian Arctic remains controversial as studies are scarce. From 1986 to 2004, data on heavy metal (Cu, Ni, Zn, Hg, Cd and Hg) concentrations in fish (burbot), moss, lichens, periphyton, hydric soils and snow in and around Norilsk and the most northern parts of the Taymyr Peninsula were analysed. Very high concentrations of Cu (203 μg L⁻¹ ± 51 μg L⁻¹) and Ni (113 μg L⁻¹ ± 15 μg L⁻¹) were found in the water of the Schuchya River close to Norilsk. Heavy metal concentrations in burbot liver were highest in Lake Pyasino near Norilsk compared to other study regions that were >100 km distant. From 1989–1996, Cu (121 μg L⁻¹ ± 39 μg L⁻¹ SD), Zn (150 μg L⁻¹ ± 70 μg L⁻¹) and Ni (149 μg L⁻¹ ± 72 μg L⁻¹) snow concentrations were greatest in Norilsk, but were low elsewhere. By 2004, these concentrations had dropped significantly, especially for Cu—74 μg L⁻¹ (±18.7 μg L⁻¹ SD), Zn—81.7 μg L⁻¹ (±31.3 μg L⁻¹ SD) and Ni—80 μg L⁻¹ (±18.0 μg L⁻¹ SD). Norilsk and its surroundings are subject to heavy pollution from the Norilsk metallurgical industry but these are absent from the greater Arctic region due to the prevailing winds and the Byrranga Mountains. Pollution abatement measures have been made so further investigations are necessary in order to assess their efficiency.

Keywords Heavy metal pollution · Lakes · Rivers · Soils · Burbot · Russian Arctic
Introduction

The first modern exploitation of copper–nickel ores in the region of the Norilsk copper–nickel metallurgic plant was in the twentieth century although there is archaeological evidence the copper ore deposits were first used in the Bronze Age (Blais et al. 1999). The Norilsk ore region is situated in the north of Krasnoyarsky Kray on the northwestern edge of the Sibirskaya Platform (Fig. 1). The region includes the sulphide copper–nickel ore fields: Norilskoye-1, Talnakhskoye, Oktyabrskoye, etc., as well as deposits of coal, oil, gas and non-metallic mineral resources. These resources provide the metallurgic plant with raw materials and energy for excavation and processing of polymetallic ores and production of copper, nickel, cobalt, platinoids and other metals. The smelter partially utilizes $\text{SO}_4^{2-}$ for producing sulphur.

Officially, the building of the town of Norilsk and of the plant exploiting the resources of the ore region was started in 1935. Since 1979 the local plant “Nadezhda” has been engaged in smelting polymetallic ores. Today the Norilsk industrial complex includes three smelters, two ore processing factories and several ore fields and is the largest smelting complex in the Arctic (Allen-Gil et al. 2003).

Studies undertaken of Norilsk and its surroundings revealed pollution by industrial dusts, $\text{SO}_4^{2-}$, nitrogen compounds, phenols, chlorine and heavy