Accumulation of iron-bearing minerals in soils during saline groundwater discharge

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Accumulation of iron in soils during saline groundwater discharge is generally occurred in arid ecosystems. This process can be caused by technogenic factors in the cold and humid landscapes. For example, the formation of the "iron hats" on soil in the river valleys near the Verkhnekamskoye potassium-magnesium deposit (Russia) was investigated.

The main source of water-soluble salts is the salt tailings from Potash Mining. The Na-Cl filtration waters from the salt tailings penetrate to groundwater forming areolas of saline groundwater. The saline technogenic groundwater promotes the leaching and ion exchange processes in rocks. As a result, the groundwater has higher Na, K, Ca, Mg, Fe, and SO_4^{2-} contents. The iron content in groundwater reaches 1.38 mg/L.

The saline groundwater is discharged into the Lyonva valley where the march formation is accrued. The sources of iron are iron-enriched Sheshma sediments, soil minerals, salt tailings, and clay slimes. The groundwater salinization sharply increases K^+, Na^+, Cl^-, and SO_4^{2-} contents in the valley soils. The sum of toxic salts in soils is about 1.5wt.%, which corresponds to the very high degree of soil salinity. The high content of sulfates (191-429 mg/L) in the saline groundwater and microbiological activities lead to hydrogen sulfide settings in the soils. The reddish-yellow iron-rich precipitates were formed on the soil surface in the saline groundwater discharge area. The insoluble part of the samples collected from the top soil horizon (0-3 cm depth) has the highest content of iron minerals (up to 84.9%) and Fe-bearing plant residues (up to 20%). Also, the spongy and gel-like organic materials as well as the siliceous remains of diatoms are enriched in Ca, Fe, Cl, K, Na, S, and P. The lower soil horizon (3-30 cm depth) consists of black gel-like phases with the high content of plant residues. The insoluble part of the samples contains up to 84% hydrogoethite. Other iron minerals (e.g., hematite, magnetite, hydrotroilite) were identified.

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