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Metals in soils of erosional systems in forest zone

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Basin approach is attracting increasing attention in modern geosciences because of its significance for pollution monitoring both at a large (regional) and small catchment (local) scale. The implication of this approach in geochemical studies faces many difficulties which arise mainly from methodological aspects. This paper presents a case study dealing with geochemistry of two small erosional systems - a gully and an aged balka - located in the southern taiga zone of European Russia (the Protva river basin).

The erosional forms have been considered as integrated systems comprising slopes, bottoms, detrital fans as well as surrounding areas as sources of solid matter. We used chemical composition of topsoil (total concentrations of Ti, Zr, Mn, Co, Zn, Cu, Pb, Cr, V, Ni, Sn, Sr, Ba and concentrations of the acid-extractable Fe, Mn, Co, Zn, Cu, Pb, Cr, Ni) to explore the role of granulometry, pH and transport processes in geochemical differentiation of the systems.

Spatial variations in topsoil granulometry across surrounding areas, slopes and bottoms of the studied systems indicate a removal of finer material through the gully system and accumulation of silt and clay-size particles within the balka. The statistical analysis has proved that the behavior of the majority of the metals in the studied systems is controlled by distribution of medium silt and clay fractions (in the gully) and by coarse and medium silt (in the balka). Total concentrations of Ti, Mn, V, Zn, Zr and the abundances of acid-extractible forms of all studied metals except of Ni are higher is the soils of balka. The young gully system operate as a transit system: total concentrations of Mn, Ti, Zr, Ba, Sr, V, Pb (as well as Zn, Cr) and the abundances of acid-extractible compounds of Mn, Co, Pb (as well as Cu, Zn, Ni) are decreasing from the gully's interfluve and slopes to its bottom. The balka system has the same trends for Mn, Ti, Ba, Co, Cu and mobile compounds of Pb, Co, Ni. However for some elements it operates as accumulative system (Fe, Cu, Zn and Cr).

From upper to lower reaches of the studied systems, the content of humus and silt fraction is decreasing. In the gully, the content of Ba, Ti, Cr, V (Mn, Sn, Zr) and acid-extractable compounds of Mn, Cu, Pb, Zn, Co are decreasing as well. In the balka a similar trend was found for concentrations of Ni, Cu, Sn (Pb) and acid-extractable Fe, Mn, Cu, Pb, Zn, Co, Cr, Ni. Such spatial patterns in the studied systems imply losses of elements through migration processes in the systems.

It has been concluded that the studied forms can be considered as open accumulative and transferring systems. The magnitude of metal accumulation or transfers depends mainly on the morphology and lithological features of the systems; the prevailing mechanism of metal migration through gullies and balkas seems to be suspension transfer, in association with clay and silt particles.