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SALT MINERALS IN EFFLORESCENCES ON SOIL SURFACE OF HUNGARY

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The study of salt efflorescences in various environments contributes to the knowledge of salt accumulations, their processes and factors of formation.

Quite a number of occurrences are known all over the world, but very few places are described in Europe (GUMUZZIO *et al*., 1982; GUMUZZIO & CASAS, 1988; VIZCAYNO *et al*., 1995). Samples of salt efflorescences north of the Mediterranean region have not been systematically collected in Europe.

Salt-affected soils cover large area (~7%) in Hungary, mainly in the Great Hungarian Plain. Accumulations of salts are due to the sodium dominated shallow-depth groundwater.

In the years 1998–2005, 176 promising sites for occurrences of salt efflorescences were visited, out of which salt minerals on soil surfaces were found at 39 sites.

Soils were described and sampled by the Hungarian standard methods for soils survey (SZABOLCS, 1966). Soil routine, chemical and mineralogical analyses were done according to Hungarian standard methods (BUZÁS 1988, 1993). To determine salt minerals XRDA and SEM-EDXRA were used.

In the past (before 1998) 107 spots (at 65 villages) were listed (data compiled from earlier publications) and in the 19th and early 20th century salts could be found in a great extent and in large amounts. In consequence of dropping groundwater level the extent of salt efflorescences was reduced in time. Occurrences were much more frequent in the regions of Danube–Tisza interfluve and Nyírség in the past than today. Concerning the anion compositions of salts, sodium carbonate and carbonate-chloride associations were very common in the past.

Our studies showed that sodium-bearing minerals were dominant, magnesium sulphates occurred only once. Mixed-cation salts (burkeite, bloedite) were very rare. In the salt efflorescences, sodium chloride (halite), sodium sulphate (mirabilite and thenardite) as well as sodium carbonate minerals (nahcolite, natron, thermonatrite and trona) were determined. These represent the first descriptions of burkeite and nahcolite in Hungary. In the salt mineral associations, sulphate, sulphate-chloride, carbonate-sulphate-chloride mineral associations are common. Sodium carbonate mineral associations have also been found, which are very rare associations all over the world.

Salt minerals were found on the surface of soils like Solonchak, Hyposalic Fluvisol (appr. WRB), Salic Solonetz (appr. WRB), Mollic Solonetz (appr. WRB) and other soils *e.g.* Salic Fluvisol (appr. WRB). Efflorescences were found only on soils where the average ECe-values of surface horizons were above 4.8 dSm^{-1}. The anion composition of 1:10 water extracts of soil surface horizons was plotted on the CO_3–SO_4–Cl triangle. The plots were very close to the plot of the dominant anions of the minerals of the salt efflorescences.

Salt efflorescences were found on bare spots and only in a few plant associations, mainly *Puccinellietum limosae* and *Camphorosmetum annuae*. Groundwater level was generally close to the surface (80–250 cm in soils examined by opening a pit). Groundwater chemistry was also correlated with the dominant anion of the salt efflorescences but the relation was not so strict as compared to the case of the 1:10 water extracts of the soil surface horizons.

As a conclusion, salt efflorescence in Hungary varied in time and space. Relationships could be determined between salt minerals in efflorescences and soil type, soil properties as well as environmental parameters like vegetation, and level and chemistry of groundwater.

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