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Isotope hydrological study of soil salinization in a sodic grassland on the Hortobágy, Hungary

István Fórizs[1], László Kuti[2], Tibor Tóth[3]

[1]Laboratory for Geochemical Research, Hungarian Academy of Sciences, H-1112 Budapest, Budaörsi út 45., Hungary, e-mail: forizs@geochem.hu
[2]Geological Institute of Hungary, H-1443 Budapest, Stefánia út 14., Hungary
[3]Research Institute for Soil Science and Agricultural Chemistry, Hungarian Academy of Sciences, H-1022 Budapest, Herman O. út 15, Hungary

Introduction

The lowest part of the Carpathian Basin is the Great Hungarian Plain (GHP) with an average elevation about 100 m a.s.l. Many regional groundwater flow system has its discharge area on the GHP, where the annual rate of evaporation exceeds the amount of precipitation. As the result of this negative water balance salt, originally carried by the old groundwater, accumulates in the soil horizon causing problems for the agricultural activity.

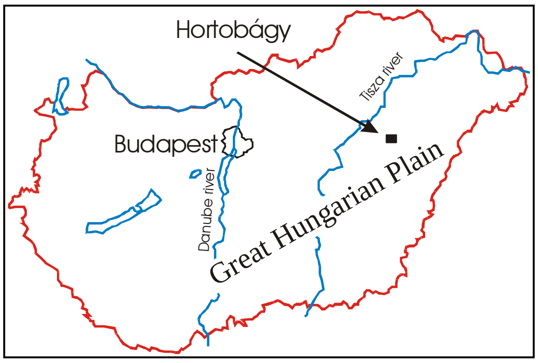

Fig. 1. The sketch map of Hungary with the indication of the studied area.

One of the most characteristic native sodic grassland of Hungary, the Nyírőlapos, a small area of 600x800 m site on Hortobágy (Great Hungarian Plain, Fig. 1) was selected for studying the salt accumulation in the soil by different methods: water level observation, soil bulk electrical conductivity (EC_a), water chemistry, and stable oxygen and hydrogen isotope analyses.

In this presentation mostly the stable isotope data will be evaluated with reference to the salt accumulation. The evaluation of time series of EC_a data has been published elsewhere (Tóth et al. 2002).

Results and interpretation

Water samples were taken from monitoring wells at 9 points in every month for chemical analysis. During the sampling campaign of 5 June 2002 water samples were taken for stable isotope measurements as well. At five out of nine points three wells were installed for monitoring water at different depths. The bottoms of the shallowest wells are at two meters below the water table (usually 3-4 meters below the ground surface). The bottoms of the medium deep wells are at about 6 meters below the ground surface, and the bottoms of the deepest wells are at about 10 meters below the ground surface.

The stable hydrogen and oxygen isotope data are shown on Fig. 2. The points are distributed along a line of $\delta D = 7.4953*\delta^{18}O - 0.949$, which is under both the Global Meteoric Water Line (GMWL) and the Groundwater Line of the Carpathian Basin (CGWL). The slope of the line (7.5) is a little bit lower then 8 indicating the effect of the local evaporation. The delta values vary in a wide range (δD -85.5‰ to -58.4‰; $\delta^{18}O$ -11.18‰ to -7.59‰). The $\delta^{18}O$ value of the infiltrating water in Hungary is -9.3± 0.4‰ (Deák et al. 1996), so $\delta^{18}O$ values of ≥ about -8.8‰ indicate heavy isotope enrichment by evaporation. Usually these latter samples have the highest TDS (total dissolved solids) values. At the other end of the line the $\delta^{18}O$ values are more negative then those infiltrated during the Holocene era (<-10‰), so these very negative $\delta^{18}O$ values may indicate water infiltrated during the latest glaciation. The studied area is a discharge area of a regional flow system, whose recharge area is the karstic Bükk Mountains north of Hortobágy. The $\delta^{18}O$ values of the ascending water nearby the studied area are between -11.5‰ and -11.8‰ in the depth range of 30-60 meters, which clearly indicates that this ascending water was infiltrated during the Ice Age. Stute & Deák (1989) published δD and $\delta^{18}O$ data for the deep groundwater circulation systems under the GHP (see Fig. 2). It is interesting to notice that the majority of these points are distributed along the CGWL, but some of them appear around the water line of the studied area, mostly those with $\delta^{18}O$ values of < -10.5‰. This fact that deep, undisturbed groundwater samples show up under the GMWL may be explained by two reasons. 1) The water infiltrated from a precipitation which originated from a place where the relative humidity of air was high, or 2) the infiltrating water suffered evaporation effect during the infiltration. Both can be imagined during the Ice Age, because the climate was cold and dry.

The water line of the samples of the studied area is a mixing line, where the old ascending water mixes with the infiltrating water from the modern precipitation.

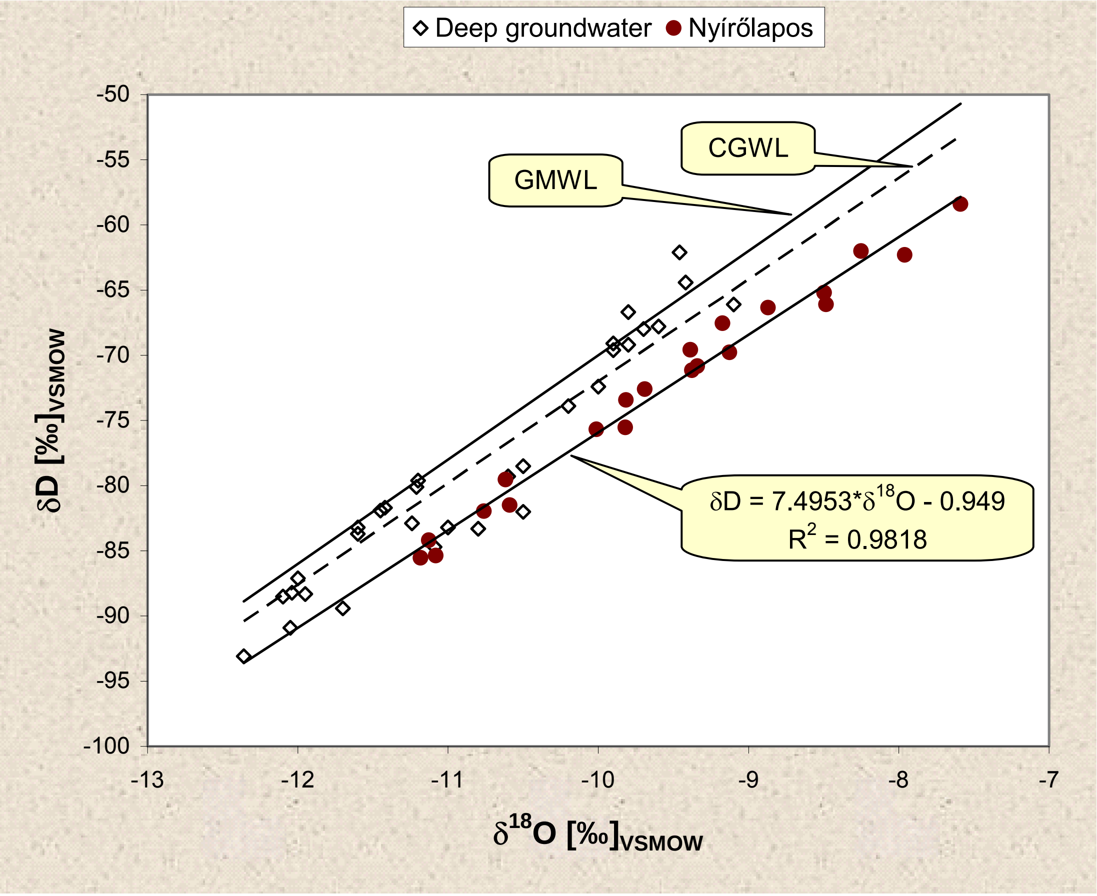

Fig. 2. The δD-δ^{18}O plot of the water samples from Nyírőlapos (solid symbols), and of deep groundwaters from different part of the Great Hungarian Plain (open symbols, Stute & Deák 1989). GMWL = Global Meteoric Water Line δD = 8*δ^{18}O + 10 ; CGWL = Groundwater Line of the Carpathian Basin δD = 7.8*δ^{18}O + 6, Deák 1995).

The spatial distribution of mixing ratio is not homogeneous, see Fig. 3. The flux of the up-welling water is maximum, where the permeability of the alluvial sedimentary layers is highest, e.g at about the 5100-9900 m relative coordinates (Fig. 3). At some sites the δ^{18}O values of the deeper water samples are less negative than that of the shallowest one, while at other sites this relation is the opposite, indicating a very complex mechanism of the mixing process.

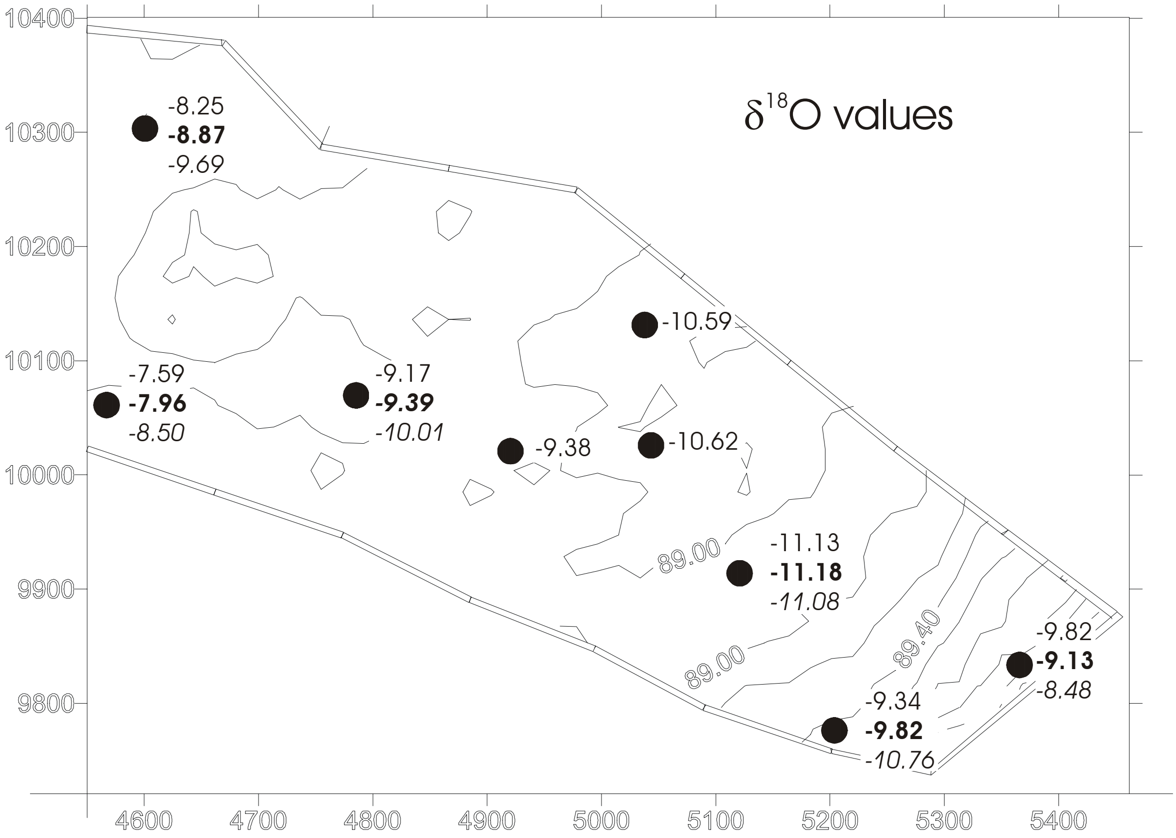

Fig. 3. Elevation map of the studied area, Nyírőlapos. The x and y axes are relative positions in meters along the West-East and South-North directions. The δ^{18}O values of the water samples are indicated. At those sites, where there are three numbers, the first one is the δ^{18}O value of the shallowest well (3-4 m from the surface), the second number (in bold) is the δ^{18}O value of the medium deep well (6 m below surface), and the third number (in italic) is the δ^{18}O value of the deepest well (10 m below surface). Where there is only one number it refer to the shallowest well.

References

Deák, J., 1995. Groundwater recharge studies on the Great Hungarian Plain by environmental isotope data. VITUKI (Water Resources Research Centre, Institute of Hydrology) Report, Budapest (in Hungarian).

Deák, J., Deseő, É., Böhlke, J.K., Révész, K. 1996. Isotope hydrology studies in the Szigetköz region, Northwest Hungary. In Isotopes in Water Resources Management (Symp. Proc. Vienna, 1995) Vol. 1. IAEA: Vienna, 419-432.

Stute, M., Deák, J., 1989. Environmental isotope study (^{14}C, ^{13}C, ^{18}O, D, noble gases) on deep groundwater circulation systems in Hungary with reference to paleoclimate. Radiocarbon 31(3), 902-918.

Tóth, T., Kuti, L., Fórizs, I., Kabos, S., Douaik, A., 2002. Spatial and temporal aspects of soil salinization in a sodic grassland. In: Á.F. Cano, R.O. Silla, A.R. Mermut (eds) Sustainable use and management of soils in arid and semiarid regions – SUMASS 2002. Cartagena, Murcia, Spain, 22-26 September 2002, Vol. I, 277-288.

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Autor(en)/Author(s): Forizs Istvan, Kuti Laszlo, Toth Tibor

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