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Reconstruction of groundwater formation in the Baltic Artesian basin through water stable isotopes

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Subsurface hydrology of the Baltic Artesian basin has changed rapidly during the Quaternary period. Glacial and several interglacial phases as well as the change in the sea level led to complicated subsurface hydrology and a large difference in groundwater chemical as much as isotopic content. Baltic artesian basin fully covers territory of Latvia, Lithuania and Estonia; also parts of Poland, Russia, and Belarus are included.

This work aims to give better overview of the complexity of the groundwater recharge and discharge dynamics beyond country borders, taking into account only shared geological framework, common climate conditions and development during the Quaternary period. To maintain better understanding of the processes that took part in the formation of groundwater that can be observed nowadays several methods were applied placing major emphasis on the new oxygen and hydrogen stable isotope ratio results. Additionally large scale modeling as well as hydrochemistry and trace element concentrations was used.

Paleowaters usually are isotopically lighter, that facilitate to detect their presence. Earlier investigations in the northern part of the basin indicated glacial melt water intrusion in the Cambrian-Vendian aquifer corrected radiocarbon age suggests that this meltwater intrusion took place during the late Weichelian.
Several radiocarbon and stable isotope studies in groundwater have been done at the southern part of the basin as well reporting extensive groundwater recharge during the Late Pleistocene in the Devonian aquifers; authors suggest that recharge took place under different recharge mechanisms compared with the northern part.

So far no similar studies were accomplished in the central part of the basin, thus to make clearer picture and possibility to find the mixing line between groundwater bodies of different origin, the new groundwater samples were collected from more than 200 wells mainly in the territory of Latvia. New stable isotope samples were taken from all sedimentary aquifers up to 2 km depth. Ratios of δ18O vary in a wide range, from the less depleted -4.56 ‰ VSMOW in the brines to more depleted values in the middle and lower Devonian aquifers -13.1 ‰ VSMOW. So far by stable isotope signal no glacial meltwater were detected, although obtained results can suggest boundaries of groundwater bodies formed under different conditions.

In the upper part of the basin groundwater of meteoric origin predominate. Ratios in unconfined aquifers have large seasonal fluctuations and reflect isotopic signature of poorly mixed modern precipitation. However in the deepest aquifers the formation of groundwater took its part before Quaternary period, as concentrations of ions, trace elements as well as TDS are very high and may be evidence of absolutely differing recharge time and mechanism. Nevertheless in aquifers represented by delayed water exchange zone, were water exchange is slower and more intensive mixing between different end members take part, chemical composition as well as isotopic signal can't be explained easily. Thereby more likely remains of groundwater recharge during Pleistocene can be found here.

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