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Past, present and future formation of groundwater resources in northern part of Baltic Artesian Basin

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Cambrian-Vendian Aquifer System (CVAS) is the deepest confined aquifer system used for water consumption in northern part of Baltic Artesian Basin (BAB). A regional groundwater flow and transport model (Visual Modflow) was used to investigate the paleohydrogeological scientific and contemporary management problems of CVAS. The model covers the territory of Estonia and its close surrounding, all together 88,000 km2 and includes all main aquifers and aquitards from ground surface to as low as the impermeable part of the crystalline basement. Three-dimensional distribution of groundwater heads, flow directions, velocities, and rates as well as transport and budget characteristics were simulated by the model.

Water composition was changed significantly during the last glaciations.Strongly depleted O and H stable isotope composition, absence of 3H and low radiocarbon concentration are the main indicators of glacial origin of groundwater in the Cambrian-Vendian aquifer in northern Estonia. The noble gas analyses allowed concluding, that palaeorecharge took place at temperatures around the freezing point. While in North Estonia, most of water was changed by glacial melt water, high salinity water is till preserved in Southern part of Estonia.First results of modeling suggest that during the intrusion period lasting 7.3–9.3 ka the front of glacial thaw water movement had southeast direction and reachedto 180–220 kmfrom CVAS outcrop in Baltic Sea.

Confining layer of CVAS is cut through by deep buried valleys in several places in North Estonia making possible for modern precipitation to infiltrate into aquifer system in present day. In case of natural conditions, the water pressure of CVAS is few meters above sea level and most of valleys act as discharge areas for aquifers system. Two regional depression ones have formed in North Estonia as a result of groundwater use from CVAS. Water consumption changes the natural groundwater gradient, flow direction and thereforerecharge through buried valleys has intensified as a result of decrease of groundwater pressure in CVAS and the changes in chemical composition can take place in the future. CVAS rocks outcrop in the bottom of Finnish gulf which is considered as discharge area during the natural conditions. Therefore the water intakes close to shoreline are the most sensible areas where hydrodynamics can the direction of flow and seawater can start to intrude into CVAS. The glacial water has δ18O value from -18.4 ‰ to -21.3 ‰ and the groundwater residence time measured by 14C method is from 22000 to 23000 years. Any change by seawater intrusion or leakage from buried valleys can be detected by isotopes. Radiocarbon and tritium are the isotopes which can be used with high confidence for detecting modern seawater intrusion.

Future challenges include merging of current scientific results into regional groundwater model of BAB created by the University of Latvia.