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Geochemical evolution of groundwater in Cambrian-Vendian(Ediacaran) aquifer of Baltic Basin

V. Raidla (1,2), E. Karro (1), K. Kirsimäe (1), A. Marandi (1,2) and **R. Vaikmäe** (2)

(1) Department of Geology, University of Tartu, Estonia, (2) Institute of Geology at Tallinn University of Technology, Estonia (rein.vaikmae@ttu.ee / Phone: +372-6202-005)

Cambrian-Vendian (Edicaran) aquifer system is a confined water-body found in western and north-western part of the East-European Platform where siliciclastic sandstone and claystone facies rocks of Cambrian and Ediacaran age are distributed. The Ediacaran deposits within the platform are known as Vendian complex and the aquifer is traditionally named as a Cambrian-Vendian (C-V) aquifer system. In most part of the deeply buried ($>$1000 m) aquifer the fluids within the system are represented by typical Na-Ca-Cl basinal brines(formation waters) which have salinities (total dissolved solids – TDS) of $>$ 20 g l^{-1}. However, in shallowly buried marginal areas of the aquifer, particularly in northern part of the Baltic Basin, where the aquifer rocks outcrop to surface, the water is fresh (TDS $<$ 1 g l^{-1}), drinkable and used in public water supply. The fresh water at the northern margin of the Cambrian-Vendian aquifer has an unusual stable isotope composition of depleted δ^{18}O in the range of -18 to -22 ‰ VSMOW, whereas the isotopic composition of the present day precipitation is only -8 to -11 ‰ VSMOW (Vaikmäe and Vallner, 1989).

The spatial variation in water geochemistry and stable isotope composition suggest mixing origin of water of three end-members – undersaturated glacial melt water of last Ice Age, Na-Ca-Cl composition Basin brine and recent meteoric water. In a temporal scale the mixing has occurred in two stages. First, the intrusion and mixing of isotopically depleted glacial waters with basinal brines occurred during the Pleistocene glacial periods when the pressurised subglacial melt-water penetrated into the aquifer. This interpretation is also supported by water ^{14}C measurements of the Cambrian-Vendian groundwater with carbon activity between 1.3 and 5.9 pmc sug-

gesting groundwater residence ages for >10,000 years (Vaikmäe et al., 2001). The second stage of mixing takes place today by intrusion of meteoric waters through deep valley systems that incise the protecting aquitard in northern Estonia. This type of mixing is further enhanced by intensive water pumping of C-V in north Estonian production wells that have created large depressions (max. -50 m of natural potentiometric level) at major industrial sites (Vallner, 1997).

The freshened water at the northern margin of the basin has acquired a partial equilibrium with rock matrix of the aquifer. The Ca and Mg activities of C-V water show good linear correlation (R^2 >95, p<0.001) which agrees with the equilibrium boundary of (sedimentary disordered) dolomite and calcite suggesting that the water has attained or is nearly in the equilibrium with these phases that are common cement minerals in Cambrian-Ediacaran sediments (Raidla et al., 2006). This interpretation is supported by dolomite and calcite saturation indexes of 0 ± 1 in freshened part of aquifer. However, in deeper, high TDS brine dominated part, the water is supersaturated in respect to dolomite and calcite (SI up to 6). The isotope data of S and C indicate that bacterial activity has greatly influenced the formation of carbonate composition in the C-V aquifer. Nevertheless, in respect to silicate matrix (quartz, K-feldspar, illite-chlorite-kaolinite clay mineral assemblage) the water is far from mineral equilibrium and the silicate minerals do not influence the water chemistry.