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The general description of major ion concentrations in groundwater of Latvia

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Latvia is situated at the North central part of the Baltic sedimentary basin where the crystalline basement is found in depth between 0.6 to 2 km. Three large aquifer complexes with distinct chemical composition of groundwater are identified: the stagnant water exchange zone where Na-Ca-Cl brine is found; the slow water exchange zone where Na-Ca-Cl-SO4 brackish water is found and active water exchange zone where the freshwater resides. These are separated by distinct regional aquicludes.

The composition of the Cl- dominated brines at the base of sedimentary basin is characterised by shift from Na+ towards Ca++ as dominant cation, partially associated with depth of the aquifer and the strength of the brine. The concentration of SO4– here is inversely linked to the concentration of Ca++ and, according to geochemical modelling, often is close to the solubility limit of the gypsum. The major ion concentrations in the E and W part of the territory are rather different. Therefore two different initial sources of the formation brine were suggested. Alternatively the observations can be explained by different thermal histories of different parts of the basin, affecting the rate of albitization – exchange of the Na for Ca in the solution due to water-rock interaction.

The groundwater composition in the slow exchange zone can be nicely explained by the mixing of fresh-water and brine residing deeper in the presence of gypsum during some but no all stages of mixing. In some shallow parts of the zone still bound by the Narva regional aquiclude freshwater is found. The question is posted – could this be a paleogroundwater originating from the extensive continental glaciations that override the territory several times during the Pleistocene? Initial isotope studies presented elsewhere seems to give negative answer to this question.

The active water exchange zone is characterised by fresh Ca-Mg-HCO_3 water with exceptions in cases where gypsum are abundant in sedimentary rocks and sulphate ion prevails. The freshwater composition seems to be mostly controlled by three minerals – calcite, dolomite and gypsum. It is suggested that clay minerals can play a significant role in controlling the relative concentrations of cations, but this is not strictly proven jet. Well documented modern seawater intrusion induced by water abstraction is found in the territory of Liepāja city. The upwelling of slat water from below can be spotted across the territory as well. These zones are usually associated with tectonic faults, enabling the upwelling of salty water across regional aquicludes. Particularly prominent is the saltwater body in the vicinity of the Riga city. Three major rives are discharging in the sea there making it a natural confluence zone of groundwater as well. The intensive groundwater abstraction in the city probably enhanced the upwelling of saltwater here, but primary it is a natural phenomenon.

The interesting question is if there is any paleogroundwater trapped in the active or slow water exchange zone of the sedimentary basin that could be distinguished from modern infiltration water due to particular isotope signal originating in the quaternary cold stages or chemical composition – remains of relict sea water or sedimentation water.

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