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Isotopic composition (oxygen and hydrogen) of groundwater in Norway – a review of current knowledge and future perspectives

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A review of current knowledge and available data covering the stable isotope composition of groundwater in Norway is presented. Furthermore, the future challenge of obtaining systematic background datasets and of integrating isotopes into the mainstream of hydrogeological observation programmes is discussed. I will summarize our experiences gained from different preliminary studies and will try to identify relationships to existing datasets, historical registrations, and networks on precipitation data.

The study of transient effects in hydrological cycles is highly topical as these are supposed to provide means for investigating the effects of climate change and increasing human activities. From a hydrogeological point of view, is critical to establish suitable tools for the large scale observation of changes in groundwater recharge and depletion, their likely controls, and the expected nature of responses to changing climate, urbanization and other human activities. In this context, stable isotopes (δ^{18}O and δ^{2}H of water) can provide an expedient instrument to investigate the general hydrological setting, connections, and pathways of various scale aquifer systems. However, we are up to now missing an expedient background dataset on hydrogeological and hydrological stable isotopes observations for mainland Norway.

Against this background, during years 2010 and 2011 the Geological Survey of Norway (NGU) organized two nation-wide sampling campaigns on the stable isotope composition of modern groundwater. These pilot studies aimed to obtain a first overview about the data ranges and natural variations to be expected. We used stations from the existing Norwegian Groundwater Monitoring Network (Landsomfattende Grunnvannsnett, LGN) to collect samples of groundwater at 55 different locations throughout Norway. As a main characteristic of these two datasets, all δ^{18}O and δ^{2}H values of the "LGN series" were well correlated and plotted close to the global meteoric water line. This essentially documents the in principal exclusively meteoric origin of these waters, and indicates that the LGN groundwaters investigated shared the same type of origin: (i) evaporation from the ocean, and (ii) isotopic enrichment by rainout (continental effect). Conversely this also indicates that other processes (re-evaporation, admixture of water with a different genesis, etc.) did not have significant influence in this dataset. In parallel, two more detailed local application studies have been conducted in unconsolidated glaciofluvial aquifers in S-Norway (eastern part of the Gardermoen / Øvre Romerike Aquifer in Akershus county, and glaciofluvial deposits at the Granli waterworks of Kongsvinger in Hedmark county). In these investigations, detailed vertical profiles obtained with multi level sampling devices displayed systematic vertical evolution of groundwater isotopic composition, and it is demonstrated how an extended local dataset can enable to discuss the discrimination between different groundwater / surface water influences, and supports the planning of groundwater exploitations and groundwater water resources management.