

The hydrochemistry of crystalline bedrock groundwater in Norway

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1604 groundwater samples collected from Precambrian and Palaeozoic crystalline bedrock aquifers and 72 groundwater samples from Quaternary aquifers were analysed for radon, pH, and major and minor elements. A representative subset of 476 samples of bedrock groundwater was further analysed for trace elements.

There appears to be a degree of lithological control on radon, fluoride, uranium and many trace elements, typically manifested as elevated concentrations in granitic groundwaters and depletions in anorthositic groundwaters. However, even within a distinct lithology, the concentration of a particular element in groundwater may span over 4 orders of magnitude, suggesting that other (kinetic and hydrodynamic) factors are equally important. A significant percentage of the analysed hardrock groundwaters do not fulfil the Norwegian standards for drinking water quality (the following as percentages of the n=476 subset), e.g. pH: 7%, Rn: 17%, F: 16%, Na: 1.5%, Fe: 14%, Mn: 26%, Al: 3.8%, Zn: 2.3%, Ba: 8.4%, As: 1.5 %, and U: 12 % (using US norm).

pH values range from 5.4 to 9.8 in the crystalline bedrock groundwater dataset, with a predominance between 8.0 and 8.3, irrespective of rock type, suggesting buffering by the calcium carbonate system. Geochemical modelling indicates that pH values above 8.3 may possibly be due to exhaustion of this buffering system by calcite precipitation, as well as by cation exchange against sodium. pH has also been shown to influence the concentrations of many elements in groundwater. Groundwaters from Quaternary sedimentary aquifers in Norway are generally less mature than their bedrock counterparts, with lower pH values and concentrations of Rn and F well below drinking water norms.

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