Gases in Bedrock Groundwater: Geochemical Potential for Sustaining Deep Life

R. KIETÄVÄINEN[1]* AND L. AHONEN[1]

[1]Geological Survey of Finland, 02151, Espoo, Finland
(*correspondence: riikka.kietavainen@gtk.fi)

Geochemistry of gases plays an important role in the safety assessment of geological disposal of nuclear wastes. Within fractured bedrock, the fluid phase can both mobilize and disperse potentially hazardous or corrosive compounds, such as ^{14}C or sulphide, as well as provide energy and nutrients to deep-dwelling microorganisms. Indeed, some of the most important electron donors in anoxic deep biosphere, including H_2 and CH_4, are gases.

In order to provide data needed to address the question on geochemical constraints of biological activity at nuclear waste repository depths, we made a literature and database survey and collected geochemical data from deep drill holes and mines in Finland. Gas data were found from 20 separate localities, of which, the absolute concentrations of gases were available from 11 locations. The sites include both drill holes and deep mines in central and southern Finland with the deepest samples from 2480 m below surface.

Based on the dissolved gas composition, deep groundwaters were divided into CH_4-dominated and N_2-dominated types. Other commonly detected gases included H_2, He, Ar and occasionally CO_2, although significant variation existed between different sites and with depth.

At least partly the variation in the gas phase could be related to differences in lithology, which has been found to correlate also with microbial community structure [1,2]. Another controlling factor is the residence time of water within the bedrock, which expands to tens of millions of years [3]. Methane-dominated groundwaters also had higher gas/water ratios clearly indicative of accumulation of gas after groundwater recharge in the crust.

Site to site as well as depth dependent variation should be taken into account and can be used to predict changes related to, for example, different rock types and will give valuable information to be used in the assessment of biogeochemically induced risks at nuclear waste repository sites.

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[1] Kietäväinen *et al.* (2013) *Appl Geochem* **32**, 37-51. [2] Kietäväinen *et al.* (2017) *GCA* **202**, 124-145. [3] Kietäväinen *et al.* (2014) *GCA* **145**, 159-174.