Chemical changes in groundwater associated with earthquakes in northern Iceland

Alasdair Skelton[a] and Erik Sturkell[b]

[a]Department of Geological Sciences, Stockholm University, Stockholm, Sweden, alasdair.skelton@geo.su.se
[b]Department of Earth Sciences, University of Gothenburg, Gothenburg, Sweden, erik.sturkell@gvc.gu.se

Samples of Ice Age meteoric groundwater have been collected from a flowing artesian well at Hafralækur in northern Iceland on a weekly basis for 14 years. These samples have been analyzed for stable isotopes values (δ^2H and $\delta^{18}O$) and element concentrations (Na, Si, Ca and K).

During our study, five M > 5 earthquakes occurred in a region within which previous empirical estimates imply that groundwater responses might be expected.

Our results show that changes of δ^2H, which can be shown to be statistical anomalies, coincided with 3 of 5 earthquakes and that changes of Na concentration, which can also be shown to be statistical anomalies, coincided with 2 of 5 earthquakes. Anomalous behavior of δ^2H started 3–5 months before each earthquake occurred.

Comparison with the global meteoric water line (GMWL) implies that anomalous behavior of δ^2H is largely due to mixing between meteoric groundwater sources. Petrographic analysis of well cuttings imply that anomalous behavior of Na concentration is largely due to release of Na caused by microfracturing of analcime that replaces plagioclase in the basaltic host rock.

Because onsets of anomalous chemical behavior occur before earthquakes, we propose to test the hypothesis that a future earthquake could be forecast based on groundwater chemical changes and if so, with what sensitivity.

References

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