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# Characterisation of radon in Karoo Basin groundwater prior to shale gas exploration

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The prospect of unconventional shale-gas development in the Karoo Basin (South Africa) has created the prerequisite to obtaining baseline data on natural radioactivity in Karoo groundwaters. The key natural occurring radioactive material (NORM) studied was radon (222Rn) in-water activity concentrations; however, supplementary radium (226Ra and 228Ra) in-water activity concentrations and uranium (238U) in-water concentrations measurements were also included. A total of 53 sites across three provinces were sampled for groundwater and measured in the Karoo Basin, with three measurement series from 2014 to 2016. The groundwater was categorized as either shallow, mixed, or deep sources. The radon in-water baseline of the Karoo Basin can be characterised by a minimum of 0.6 ± 0.9 Bq/L, a maximum of 183 ± 18 Bq/L and mean of 41 ± 5 Bq/L. The radon in-water levels from shallow sources (< 20 ℃) were systematically higher (40 Bq/L) than for deep sources (> 20 ℃). The natural fluctuations in radon in-water levels were predominantly associated with shallow sources compared to almost none observed in the deep sources. The uranium in-water baseline can be characterised by a minimum of below detection level, a maximum of 41 µg/L, and a collective mean of 5.1 ± 0.80 µg/L. Similar to radon in-water levels, uranium in-water levels from shallow sources were systematically higher than in deep sources. The limited (six sites) radium (228Ra and 226Ra) in-water activity-concentration measurement results were very low, with a maximum of 0.015 Bq/L (228Ra). The 228Ra/226Ra ratio baseline can be characterised by a minimum of 0.93, a mean of 3.26 ± 1.33, and a maximum of 6.49. The radium isotopes activity concentrations ratio is an isotopic tracer for shale gas and hydraulic fracturing fluids. Pollution and contamination (radiological), due to unconventional shale gas development, in water resources has been noticed in the Marcellus Basin (United States). Consequently, developing and improving continuous radiological baseline systems are of importance to study the environmental effect of hydraulic fracturing.

## Summary

A novel and most comprehensive study up to date to characterize radon (NORM) within groundwaters of the Karoo. The primary aim of this study is to construct a Karoo Basin groundwater radiological baseline which could serve as a reference to study potential future radiological contamination effects due to hydraulic fracturing.

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