Underground production of ^{81}Kr detected in subsurface fluids

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The potential of ^{81}Kr for dating old groundwater has been demonstrated in an increasing number of studies [1,2]. In some cases the measured ^{81}Kr concentrations were below detection limit [3] in agreement with the expectation that underground production of ^{81}Kr by fission of ^{238}U or ^{235}U is very low because the nuclide is shielded by stable ^{81}Br. Production by neutron capture by ^{80}Kr was estimated to be of similar and neglibile importance [5].

These theoretical estimates contrast with ^{81}Kr/Kr ratios R [4] we observed in fracture waters of the Withwaters-rand and Ventersdorp Supergroups [4]. Three of four samples collected in deep gold and diamond mines showed significantly higher ratios than the atmospheric equilibrium value, Ra. In the Beatrix Mine a R/Ra value of 5 was measured in 2012 and confirmed in a completely independent duplicate measurement in 2016. One sample from the Transvaal dolomites, where the uranium concentrations are lower showed a R/Ra <1. Thus very high U and Th concentrations in the rock are certainly a prerequisite for this ingrowth of ^{81}Kr in the subsurface but not sufficient if previously published fission yields and production cross sections are assumed [5]. In the paper possible production scenarios are presented that may explain the observed high ^{81}Kr values.

[1] Aggarwal et al (2015), Nature Geoscience, 8/1, 35-39 [2] Sturchio et al (2004), Geophysical Research Letters, 31/L05503, , [3] Gerber et al (2017), Geochimica et Cosmochimica Acta, 205, 187-210, [4] Onstott et al (2009), Geomicrobiology J. 26, 269. [5]. Lehmann et al (1993), WRR. 29, 2027.