Are basal fluxes the ultimate source of radiogenic ^{4}He excesses in groundwater?

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Less than 6% of groundwater in the crust is modern, the 94% being older than 50 years [1]. A correct evaluation of the resource available for humans requires valuable chronometers such as U-Th/^{4}He, for dating older groundwater. Studies worldwide have shown that the U-Th/^{4}He is hampered by large amounts of radiogenic ^{4}He, far beyond those produced at steady-state in aquifers. The cause of this "excess" helium has been mainly related to the presence of a basal He flux entering the bottom of the aquifers [2]. On the other hand, Solomon et al. [3] suggested that only a portion of produced helium in aquifer is released in water, the majority accumulating in the rock and released suddenly by stress-induced fracturing.

Large amounts of radiogenic ^{4}He up to 4.48 x 10^{-5} cm^3 STP/g$_{H20}$, 10^4 times higher than expected for U-Th *in situ* steady-state production were recently found in St. Lawrence Lowlands aquifers, QC, Canada. Radiogenic ^{4}He is correlated with ^{234}U/^{238}U-fractionation, which deviate from secular equilibrium. Modelling of the He-U data shows that enhanced fracturing of the aquifer rocks during the last ice retreat could have increased the specific surface of rocks, allowing ^{234}U and ^{4}He to be released by α-recoil and diffusion into groundwater. These results suggest that the U-He relation could be the key to quantify correctly the helium sources in a groundwater system and make it a valuable chronometer for dating older groundwater.

[1] Gleeson *et al.* (2016) *Nature Geosci.* **9**, 161–167.
[2] Torgersen &Ivey (1985) *GCA*, **49**, 2445-2452.
[3] Solomon et al. (1996) *Wat. Ress. Res.*, **32**, 1805-1013.