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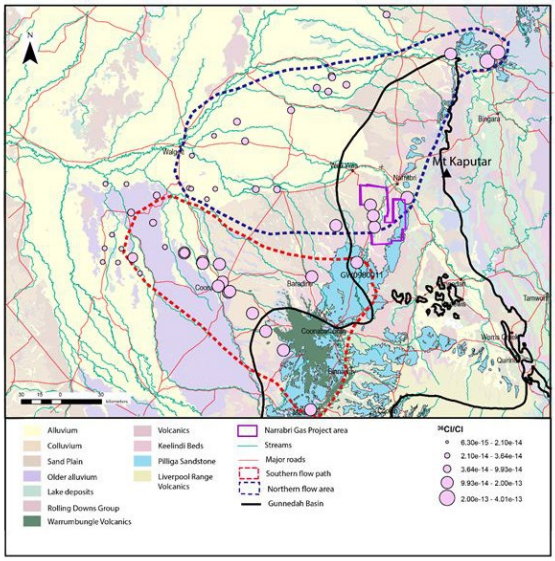
Quantifying recharge to the Pilliga Sandstone aquifer, Great Artesian Basin Australia: learnings from combining ^{14}C, ^{36}Cl and ^{81}Kr.

AXEL O. SUCKOW[1], MATTHIAS RAIBER[1], ALEC DESLANDES[1], CHRISTOPH GERBER[1], JORGE MARTINEZ[1], GUO-MIN YANG[2], WEI JIANG[2] AND KARINA MEREDITH[3]

[1]CSIRO
[2]University of Science and Technology of China
[3]ANSTO

Presenting Author: axel.suckow@csiro.au



The Pilliga Sandstone in the Coonamble Embayment in New South Wales, Australia, is part of the Great Artesian Basin (GAB), an aquifer system that underlies 22% of the Australian continent and is one of the main freshwater resources of inland Australia. Despite its significance, groundwater recharge to the Pilliga Sandstone is insufficiently constrained. Better quantifying recharge is particularly important because of competing interests between agriculture and other industries. The petroleum industry proposes to extract coal seam gas from the Gunnedah Basin underlying the Pilliga Sandstone. Groundwater flow in the Pilliga Sandstone is from the outcrops in the East (light blue in the Figure) to the West.

Here we present results of a multi-tracer study (hydrochemistry, ^{2}H, ^{3}H, $^{3}He/^{4}He$, ^{13}C, ^{18}O, ^{14}C, ^{36}Cl, $^{40}Ar/^{36}Ar$, ^{85}Kr, ^{81}Kr, $^{87}Sr/^{86}Sr$ and noble gases) that were complemented in the northern part of the project area by geophysical investigations (seismic and ground-based electromagnetics). The project area shows a distinct southern flow path (Figure) for which groundwater velocity and therefore recharge could be quantified using ^{14}C and ^{36}Cl, where the rates were further improved by ^{81}Kr. In the northern area the application of ^{14}C and ^{36}Cl was unsuccessful because of an admixture of waters from the underlying Gunnedah Basin. Groundwaters in that basin, containing the formations targeted for the CSG exploration, show very high total dissolved inorganic carbon (up to 300mMol/L) and chloride concentrations (up to 2000mg/L). Further groundwater from the Gunnedah Basin and intermediate layers to the Pilliga Sandstone has $^{40}Ar/^{36}Ar$ ratios up to 432, the highest values found in Australian groundwater so far, probably indicating partial release from old sediments by intruding dykes as indicated by a correlation with $^{3}He/^{4}He$. Small volumes of admixtures of this water discharge into the Pilliga Sandstone and overprint the age information of the ^{14}C and ^{36}Cl values. Given the success of ^{81}Kr in constraining flow rates for the southern flow path, there is great potential for ^{81}Kr to also improve flow rate estimates in the northern flow area, but access to bores at intermediate distances of the northern flow path have to-date been denied.