

Isotope tracer investigations of arsenic-affected crystalline bedrock aquifers in W. Africa

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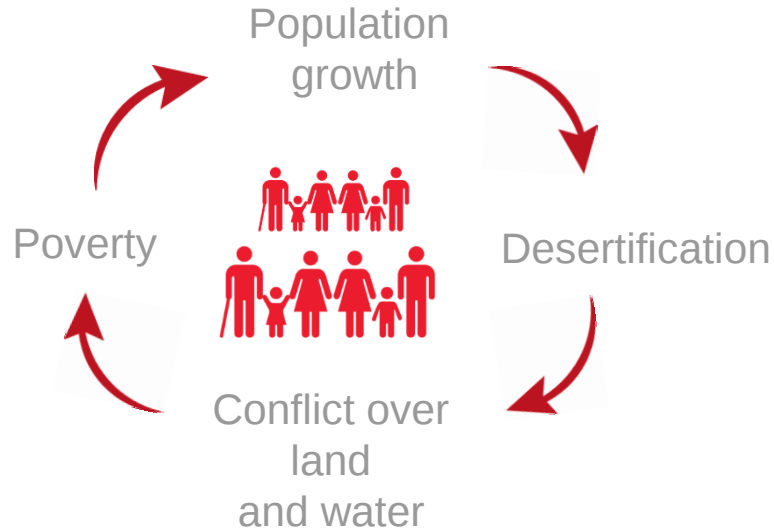
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Context



Hydrogeological system



Weathering profile:

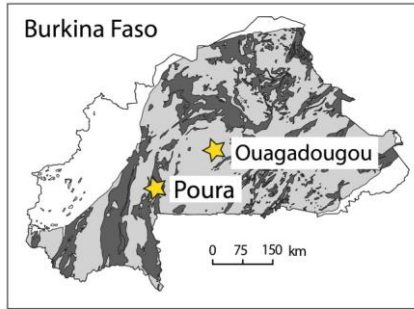
- ↓ Residual Fe-oxides
- ↓ Highly weathered, clayey saprolite
- ↓ Fissured, fractured parent rock
- ↓ Unfractured, crystalline basement, Palaeoproterozoic (> 2 Ga)

Rural water supply in Burkina



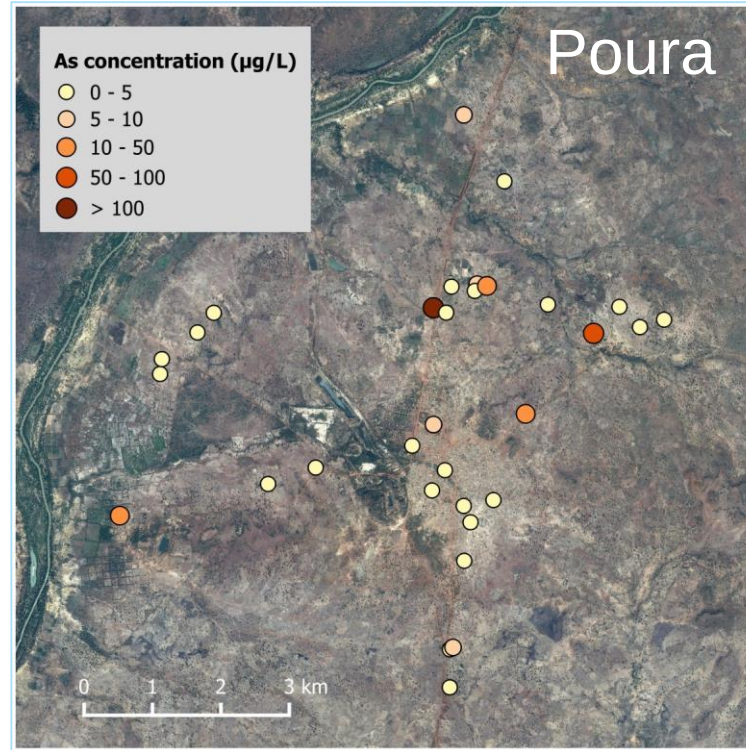
Communal tube wells
Depths: ~35-90 m
pH: 6 – 7.5
EC: 200 – 600 $\mu\text{S}/\text{cm}$

Study site



Major geological units

- Birimian Formation (2100 - 2300 Ma)
- Eburnean Granitoids (1800 - 2210 Ma)
- Taoudeni Basin (540-1000 Ma)
- Continental Terminal (23 Ma)



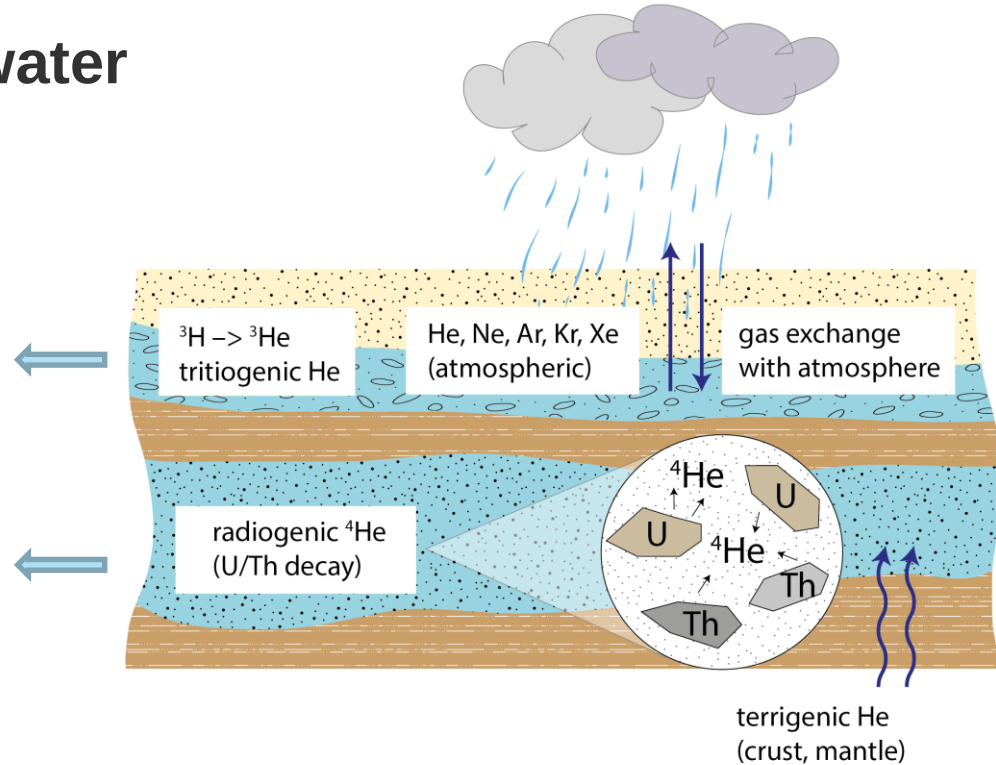
High spatial density sampling

- 29 tube wells
- Major and trace element analysis
- Seasonal variations
- Stable isotopes (^2H , ^{18}O)
- **Dissolved noble gases**

Noble gases in groundwater

Dating of «young»
groundwater (< 50 a)

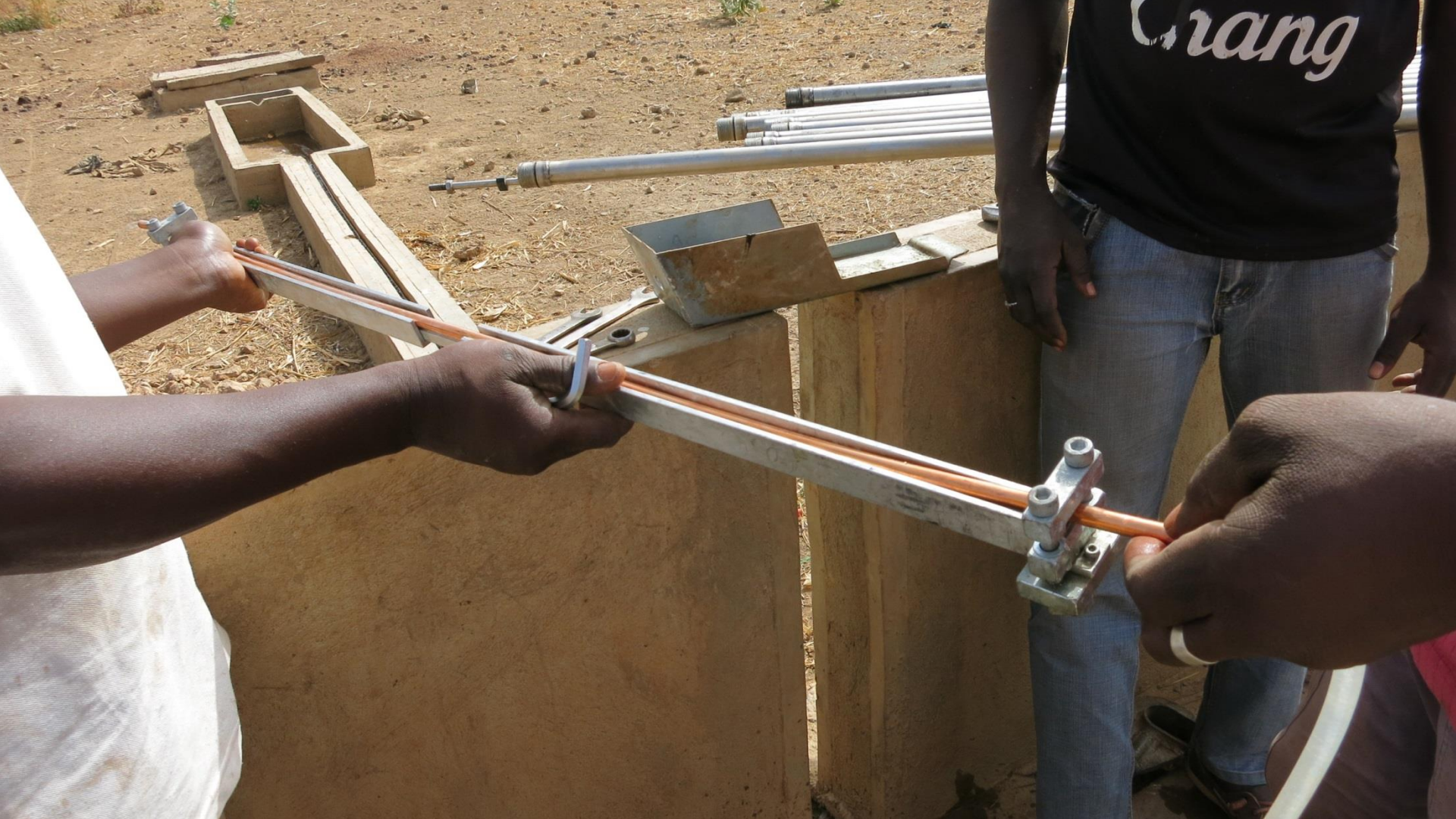
Dating of «old» groundwater
(> 10^2 - 10^3 a)



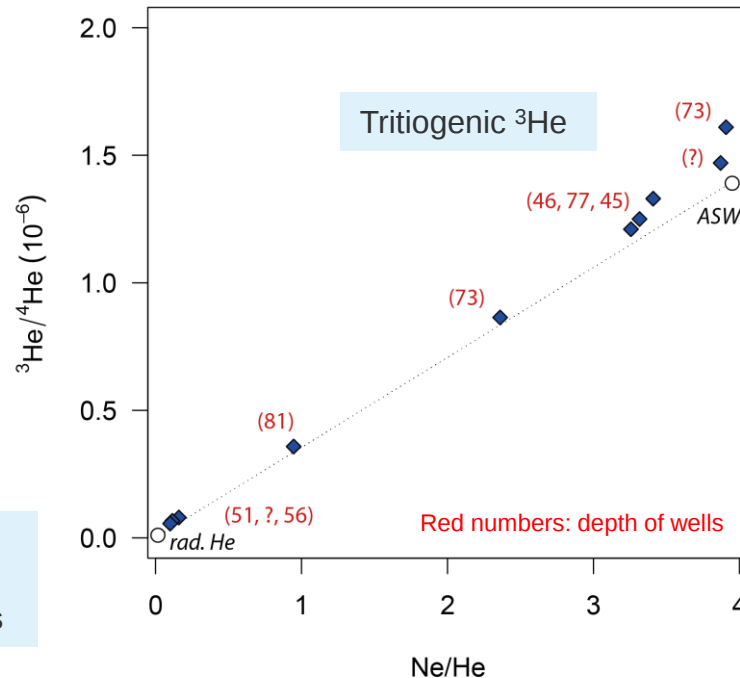
→ Each helium «reservoir» has typical $^3\text{He}/^4\text{He}$ ratios







Results: Helium isotopes

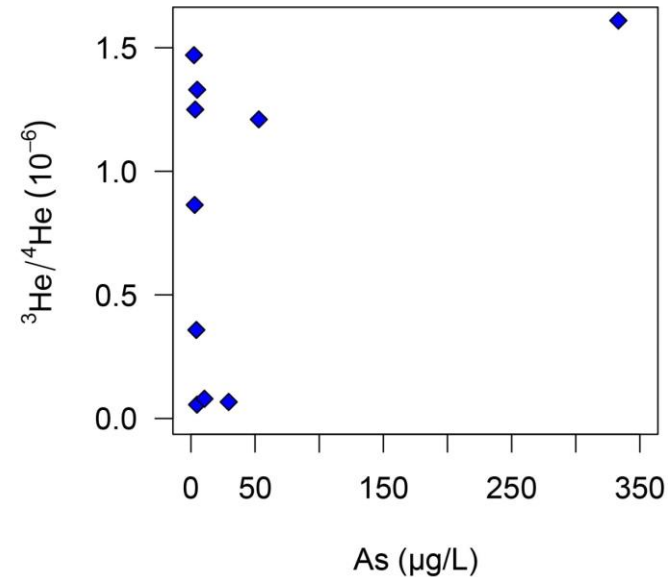
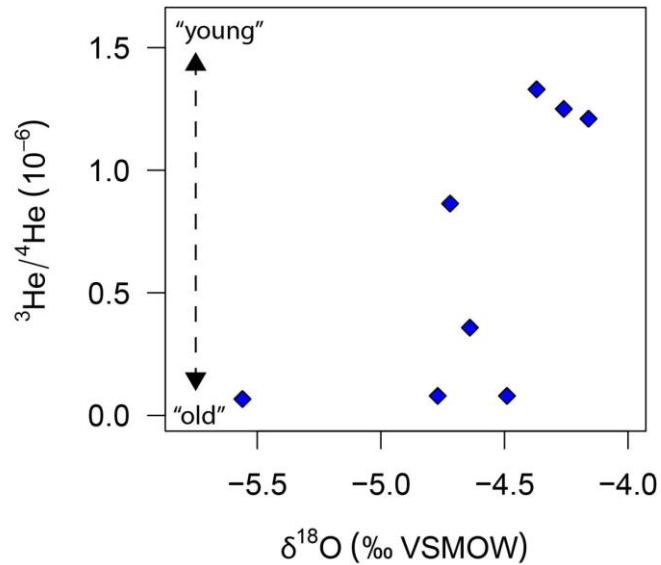


Radiogenic/crustal He
endmember
→ Residence time $> 10^3$ yrs

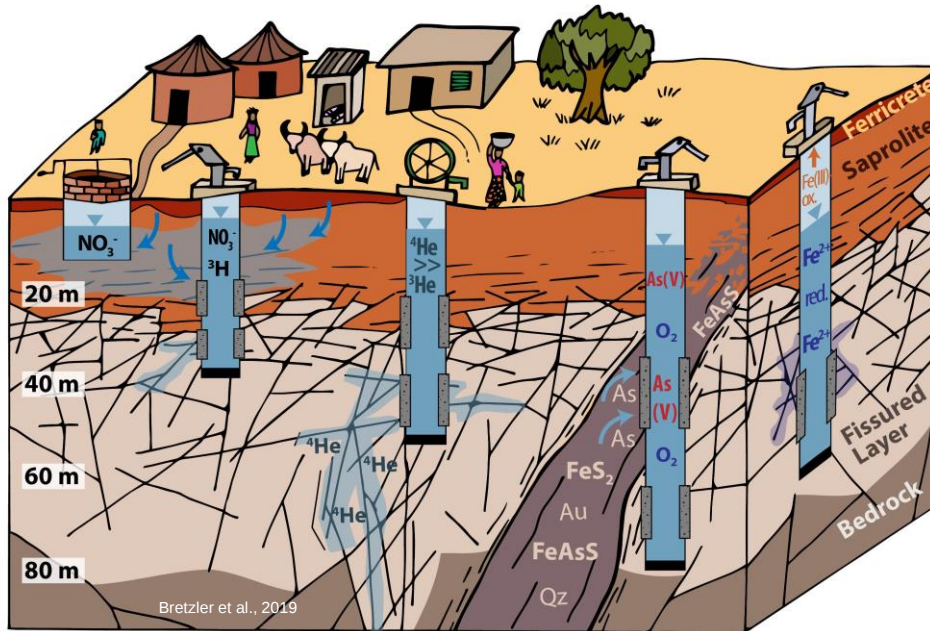
ASW: Air-saturated water,
atmospheric endmember
→ Modern recharge,
residence time < 60 yrs

Bretzler et al. (2019)

Helium vs. $\delta^{18}\text{O}$ and arsenic



Summary



1)

2)

3)

- 1) Dug wells and shallow tube wells dominated by **modern recharge (< 60 a, measurable tritium)**, some anthropogenic pollution (NO₃⁻)
- 2) Groundwater with long residence times (**> 10³ years, high ⁴He concentrations**) from fractures isolated from the modern water cycle.
- 3) Geogenic As contamination in wells dissecting mineralised zones. No visible relationship between As conc. and groundwater residence time.