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Conference Abstract

Hydrogen and Dark Oxygen drive Microbial Productivity in diverse Groundwater Ecosystems

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Abstract

Around 50% of humankind relies on groundwater as a source of drinking water. We investigated the age, geochemistry, and microbiology of 138 groundwater samples from 87 monitoring wells (<250 m depth) located in 14 aquifers in Canada (Fig. 1). Geochemistry and microbiology showed consistent trends suggesting large-scale aerobic and anaerobic hydrogen, methane, nitrogen, and sulfur cycling carried out by diverse microbial communities. Older groundwaters, especially in aquifers with organic carbon-rich strata, contained on average more cells than younger groundwaters, challenging current estimates of subsurface cell abundances. We observed substantial concentrations of dissolved oxygen in older groundwaters that could support aerobic lifestyles in subsurface ecosystems at an unprecedented scale. Metagenomics, oxygen isotope analyses and mixing models indicated that “dark oxygen” was produced *in situ* via microbial dismutation. We show that ancient groundwaters sustain productive communities and highlight an

overlooked oxygen source in present and past subsurface ecosystems of Earth Ruff et al. 2023).

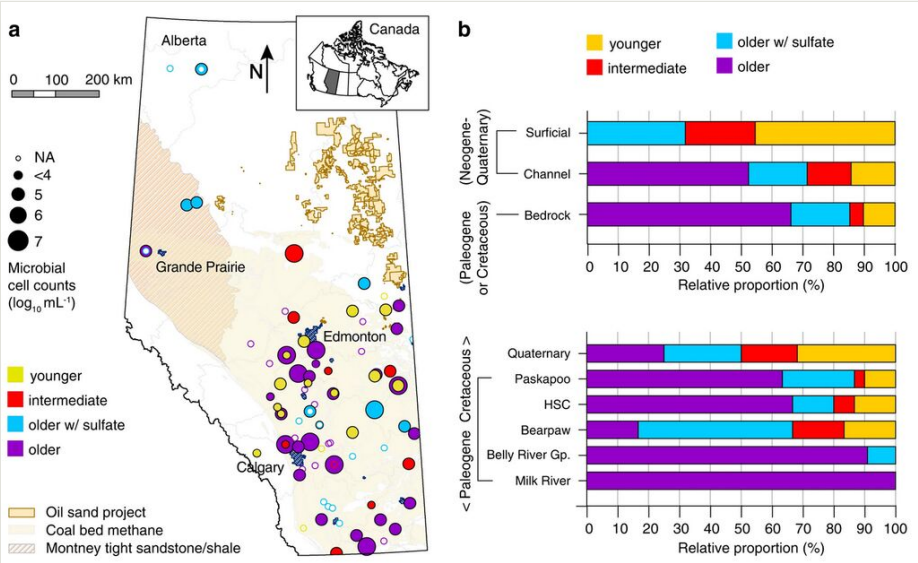

Figure 1. doi

a) Location of studied groundwater wells within the energy resources context of the province of Alberta. Colors indicate the groundwater age at each well (yellow: younger waters; red: intermediate age; blue: older waters that are sulfate-rich; purple: older waters with little sulfate). Circle size represents average microbial cell numbers in the groundwater samples, ranging from 10^4 (smallest full circle) to 10^7 cells per mL (largest circle). The map was created using Arc-GIS v10.8 **b)** Relative proportion of water types in the surficial, channel, and bedrock sediments, as well as in major geological formations of Alberta, showing that groundwater geochemistry evolved with the increasing age of the formations. *NA* not assessed, *HSC* Horseshoe canyon, *Gp.* Group. This figure was published in Ruff et al. (2023)Nature Communications 14, 3194.

Keywords

Aquifer, Cell Numbers, Biogeography, Barcoding, 16S, Metagenomics, Methanotrophy, Methanogenesis, Chlorite dismutase, Nitric Oxide Dismutase, Isotope Geochemistry

Presenting author

Marc Strous

Presented at

ISEB-ISSM 2023, poster presentation requested in Theme 1, Natural Settings (Subsurface and subseafloor or Freshwater, groundwater, and rivers) or Theme 4, Microbial diversity and ecology (Microbial diversity and ecology or Microbial geochemistry and geomicrobiology). This poster would cover similar, but not identical information to Dr. Ruff's invited lecture.

Conflicts of interest

The authors have declared that no competing interests exist.

References

- Ruff SE, Humez P, de Angelis IH, Diao M, Nightingale M, Cho S, Connors L, Kuloyo O, Seltzer A, Bowman S, Wankel S, McClain C, Mayer B, Strous M, et al. (2023) Hydrogen and dark oxygen drive microbial productivity in diverse groundwater ecosystems. Nature Communications 14 (1). https://doi.org/10.1038/s41467-023-38523-4