Tectonics matter: Geoscientists probe geochemistry, microbial diversity of Peruvian hot springs

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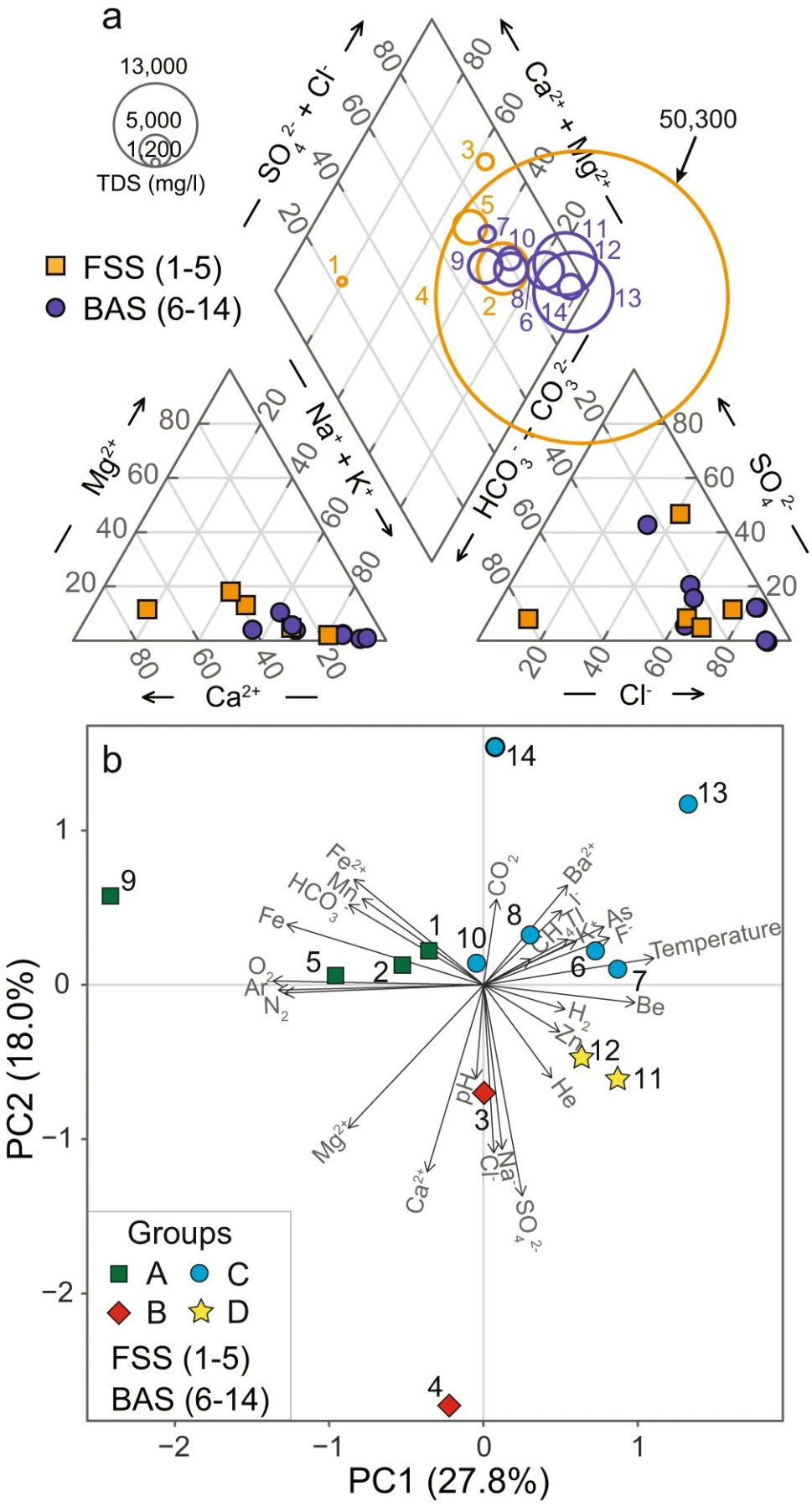
a
13,000
5,000
1,200
TDS (mg/l)
50,300
FSS (1-5)
BAS (6-14)
$SO_4^{2-} + Cl^-$
$Ca^{2+} + Mg^{2+}$
$Na^+ + K^+$
$HCO_3^- + CO_3^{2-}$
Mg^{2+}
Ca^{2+}
Cl^-
SO_4^{2-}
b
PC2 (18.0%)
PC1 (27.8%)
Groups
A C
B D
FSS (1-5)
BAS (6-14)
Temperature
Fe
Mn
HCO_3^-
Fe^{2+}
CO_2
Ba^{2+}
F^-
As
O_2
Ar
N_2
H_2
Be
Zn
He
pH
Mg^{2+}
Ca^{2+}
Cl^-
Na^+
SO_4^{2-}

Geochemistry of 14 hot springs in the flat-slab and back-arc regions of Peru. **a** Piper diagram showing the major ion chemistry and TDS for flat-slab springs (FSS) and back-arc springs (BAS; note Sp. 4 TDS). **b** Principal component analysis (PCA) based on the measured aqueous, gas, and isotope geochemistry. Springs separate into four groups FSS into A&B; BAS into C&D, with one major exception (Sp. 9). This lower temperature BAS falls into PCA group A. Credit: *Communications Earth & Environment* (2023). DOI: 10.1038/s43247-023-00787-5

South America's Andes Mountains, the world's longest mountain range and home to some of the planet's highest peaks, feature thousands of hot springs. Driven by plate tectonics and fueled by hot rock and fluids, these thermal discharges vary widely in geochemistry and microbial diversity.

Utah State University geoscientists, along with colleagues from Montana State University, examined 14 hot springs within the southern Andes in Peru and discovered microbial community composition is distinctly different in two tectonic settings.

Dennis Newell, associate professor in USU's Department of Geosciences, and recent USU graduate Heather Upin, MS 2020, report findings in *Communications Earth & Environment.*

"We know tectonic processes control hot spring temperature and geochemistry, yet how this, in turn, shapes microbial community composition is poorly understood," says Newell, USU Geosciences graduate director.

The scientists collected geochemical and 16S ribosomal RNA gene

sequencing data from hot springs in regions with contrasting styles of subduction—flat-slab and back-arc—and noted similarities in pH but found differences in geochemistry and microbiology.

"Flat-slab hot springs were chemically heterogeneous, had modest surface temperatures and were dominated by members of the metabolically diverse phylum Proteobacteria," Newell says.

Utah State University geoscientist Heather Upin collects a microbial sample from Aguas Calientas Pinaya in Peru's southern Andes. She and USU colleague Dennis Newell published findings about microbial diversity in Peruvian hot springs. Credit: Dennis Newell/USU

In contrast, the back-arc hot springs were more geochemically homogenous, had hotter water, exhibited high concentrations of dissolved metals and gases, and were home to heat-loving archaeal and bacterial organisms.

"These results tell us tectonics matter when it comes microbial community make-up, but little research has been conducted around the world to demonstrate this," Newell says.

Further investigation, with efficient genomic research, at sites around the globe could reveal how microbes have evolved in tectonically diverse environments, he says.

More information: Heather E. Upin et al, Tectonic settings influence the geochemical and microbial diversity of Peru hot springs, *Communications Earth & Environment* (2023). DOI: 10.1038/s43247-023-00787-5

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