

The slide features abstract green geometric shapes in the background. On the left, a solid green trapezoid points towards the center. On the right, a complex arrangement of overlapping translucent green triangles and polygons creates a dynamic, layered effect. The main title is centered in a large, bold, green sans-serif font.

# Fluid-rock interactions of hot springs in Da Qaidam, China

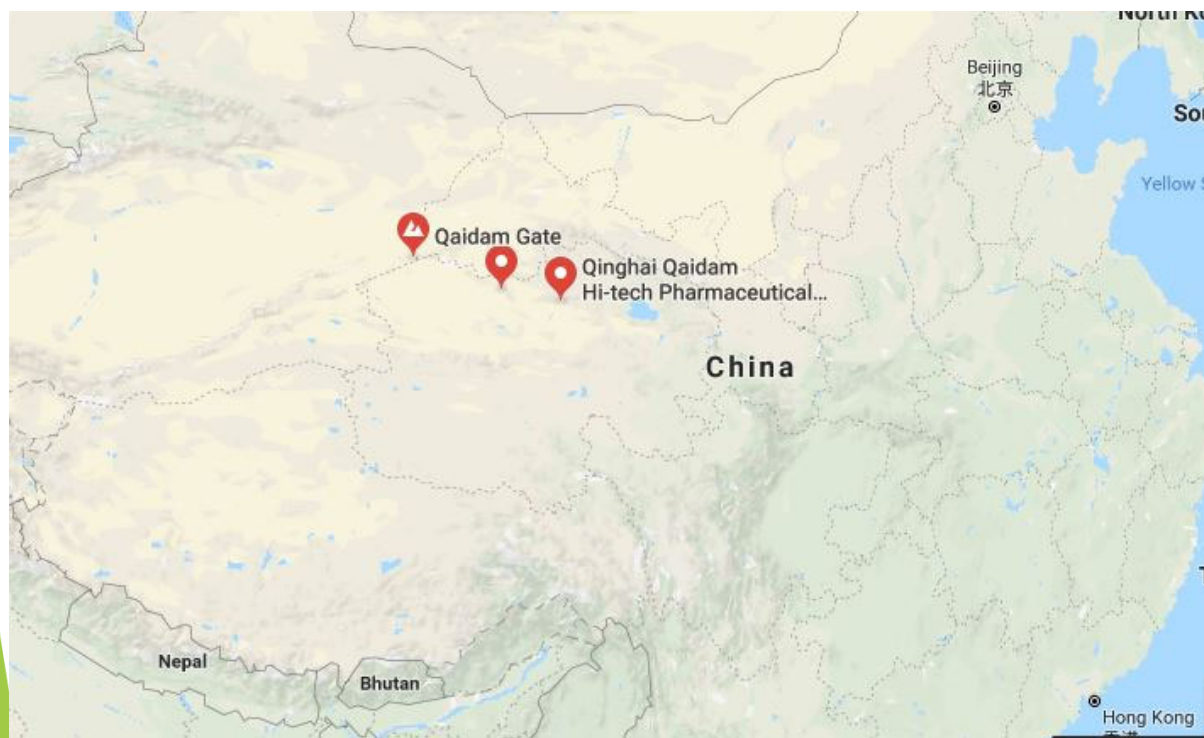
Haley Marston

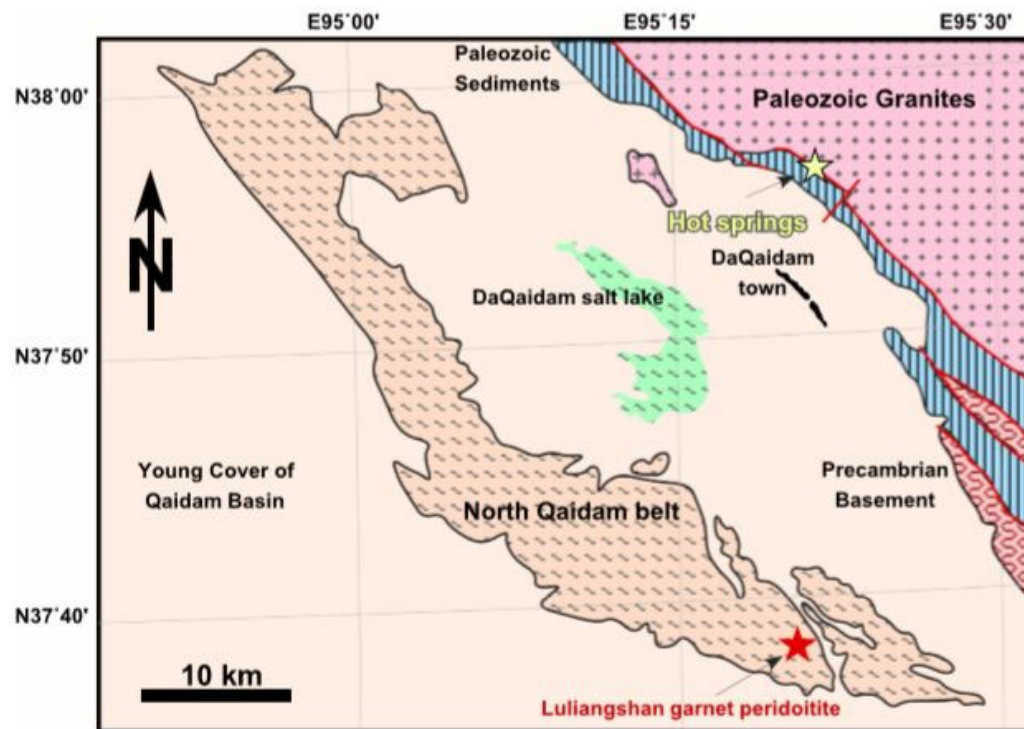
NDSU Geochemistry 2018

# Introduction

- ▶ Central China, Northwestern portion
- ▶ Qilian Mountains
- ▶ Bathing and recreation
- ▶ Qaidam Basin
- ▶ Spring 9.5 km north of the city







# Background

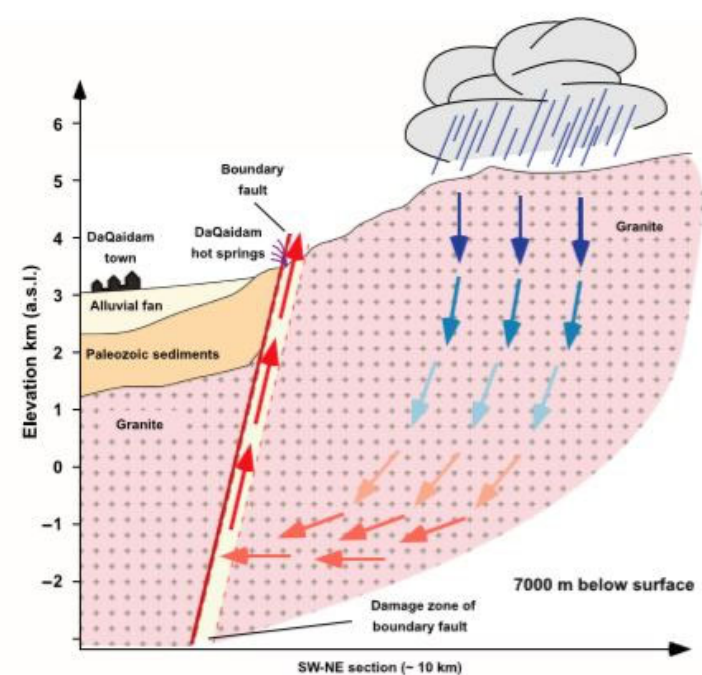
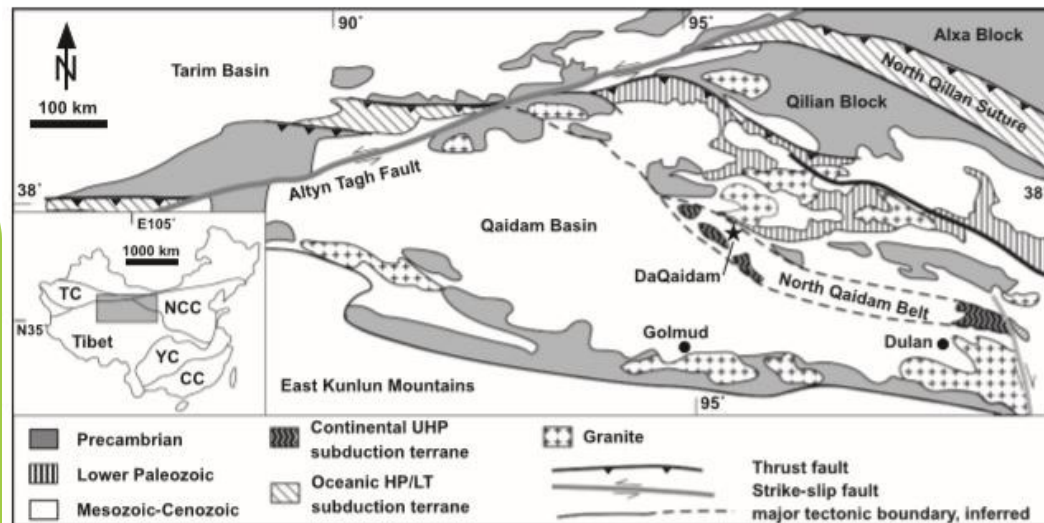
- ▶ Unrelated to magma activity- rare exceptions
- ▶ Below boiling
- ▶ Surface composition = chemical + transport reactions
- ▶ Subsurface circulation
- ▶ Located at brittle upper crust
- ▶ Deep circulations along fault lines
- ▶ Solutes are a combination of older rocks and newer fractured rocks





# Local Geology

- ▶ Tectonic activity
- ▶ Multiple faults
- ▶ Granite base, sediments deposited on top, topped with alluvial deposits
- ▶ Qilian Block
- ▶ Evaporative deposits- Salt flats and Gypsum deserts



# Why I chose this topic

- ▶ Fascinated by hot springs
- ▶ How they're heated
- ▶ Where they're located
- ▶ Hot thermal water mixing with cold surface water



# Source of data

- ▶ EBSCO
- ▶ <https://web-a-ebSCOhost-com.ezproxy.lib.ndsu.nodak.edu/ehost/pdfviewer/pdfviewer?vid=1&sid=113459fa-e071-4080-a49e-a3b8e5ba12fc%40sdc-v-sessmgr02>

The screenshot shows the EBSCOhost interface. On the left, there is a sidebar with the EBSCOhost logo, a 'Detailed Record' icon, a 'PDF Full Text' icon, and a table of contents. The main content area displays the journal title 'GEOFLUIDS', the article title 'Deep hydrothermal fluid-rock interaction: the thermal springs of Da Qaidam, China', the authors 'I. STOBER<sup>1</sup>, J. ZHONG<sup>2</sup>, L. ZHANG<sup>3</sup> AND K. BUCHER<sup>4</sup>', and the abstract text.

EBSCOhost

Detailed Record

PDF Full Text

Source: Geofluids  
Date: November 1, 2016

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**GEOFLUIDS**

Geofluids (2016) 16, 711–728 doi: 10.1111/gfl.12190

**Deep hydrothermal fluid–rock interaction: the thermal springs of Da Qaidam, China**

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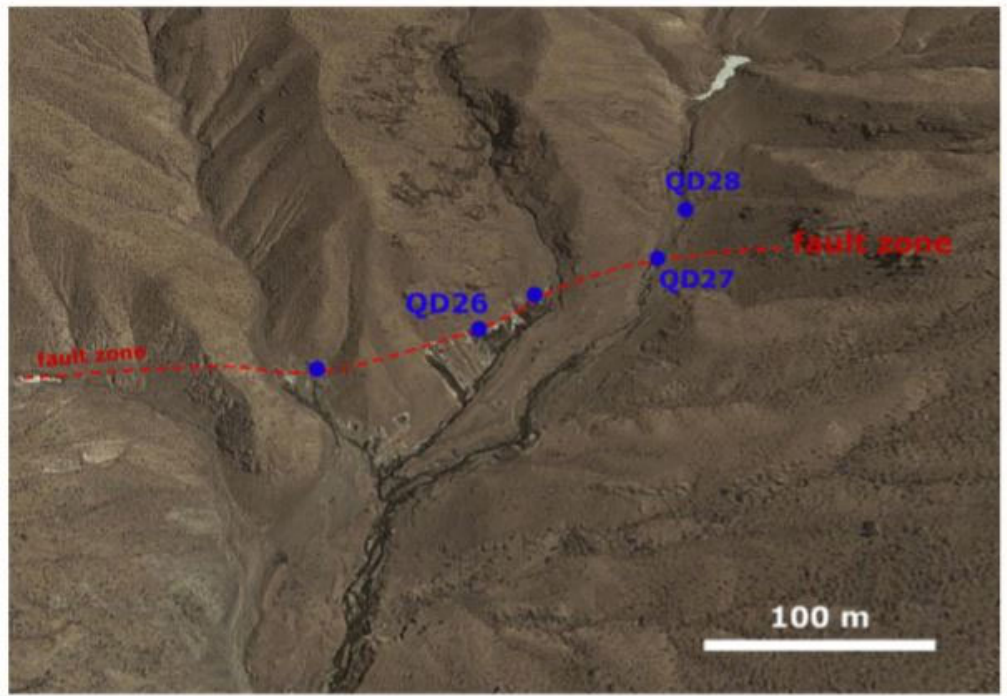
**ABSTRACT**

Hot water flows from springs along the border fault system at the SW rim of the Qilian Mountains near the city



# Sample collection

- ▶ 2 samples directly from outflow points (QD26)
- ▶ Thermal spring bordering the brook (QD27)
- ▶ Cold water meters upstream (QD28)
- ▶ Bottles were filled completely
- ▶ Temperature, pH, and EC in the field



## Previous work

- ▶ Ions:  $\text{Na}^+$ ,  $\text{Cl}^-$ ,  $\text{SO}_4^{2-}$ ,  $\text{HCO}_3^-$ , and  $\text{H}_3\text{BO}_3^0$
- ▶ Dissolved:  $\text{NaCl}$ ,  $\text{Na}_2\text{SO}_4$ , carbonate, and borate
- ▶ Salt components considered using SALT NORM - corresponds to the sinter they found
- ▶ PHREEQ and LLNL database used to calculate ions in solution
- ▶ Leaching experiments were done on rock samples

# My work

- ▶ Changed  $p_e$  values from default of 4 to 8
- ▶ What would happen if the temperature was cooled?
- ▶ Warmed?



# Results

- ▶ All of the ion concentrations were the same, however the elemental values were different
- ▶ The elements became further undersaturated
- ▶ The minerals were not affected at all

## pe=4 (Default)

K	-49.20	12.45	61.65	K
C	-36.95	17.73	54.68	C
C(g)	-137.53	17.73	155.26	C
Ca	-93.72	26.52	120.24	Ca
Ca(g)	-114.75	26.52	141.26	Ca
B	-73.65	20.66	94.31	B
B(g)	-151.51	20.66	172.17	B
Aragonite	1.84	3.15	1.31	CaCO3

## pe=8

K	-53.20	8.45	61.65	K
C	-52.95	1.73	54.68	C
C(g)	-153.53	1.73	155.26	C
Ca	-101.72	18.52	120.24	Ca
Ca(g)	-122.75	18.52	141.26	Ca
B	-85.65	8.66	94.31	B
B(g)	-163.51	8.66	172.17	B
Aragonite	1.84	3.15	1.31	CaCO3

## Results (continued)

- ▶ If the water would be cooled to room temperature (25 C)..
- ▶ A trend of precipitation occurs:

71.8 C

Borax	0.34	14.32	13.98	Na <sub>2</sub> (B <sub>4</sub> O <sub>5</sub> (OH) <sub>4</sub> ) : 8H <sub>2</sub> O
Boric_acid	-0.22	0.09	0.31	B (OH) <sub>3</sub>

25 C

Borax	2.38	14.42	12.04	Na <sub>2</sub> (B <sub>4</sub> O <sub>5</sub> (OH) <sub>4</sub> ) : 8H <sub>2</sub> O
Boric_acid	0.27	0.11	-0.16	B (OH) <sub>3</sub>

- ▶ However, some are not as over saturated:

Gypsum	0.21	-4.48	-4.69	CaSO <sub>4</sub> :2H <sub>2</sub> O
Gypsum	0.14	-4.39	-4.53	CaSO <sub>4</sub> :2H <sub>2</sub> O

## Results (continued)

- ▶ If the hot spring would continue to heat to 80 C..
- ▶ Hotter temperatures were tried, however were not possible with the concentrations of the ions in solution
- ▶ 80 C

Borax	0.02	14.30	14.28	Na <sub>2</sub> (B <sub>4</sub> O <sub>5</sub> (OH) <sub>4</sub> ) : 8H <sub>2</sub> O
Boric_acid	-0.29	0.08	0.37	B(OH) <sub>3</sub>
Gypsum	0.24	-4.50	-4.74	CaSO <sub>4</sub> :2H <sub>2</sub> O

71.8 C

Borax	0.34	14.32	13.98	Na <sub>2</sub> (B <sub>4</sub> O <sub>5</sub> (OH) <sub>4</sub> ) : 8H <sub>2</sub> O
Boric_acid	-0.22	0.09	0.31	B(OH) <sub>3</sub>
Gypsum	0.21	-4.48	-4.69	CaSO <sub>4</sub> :2H <sub>2</sub> O



# Conclusions

- ▶ The pe value affects the elemental's values, not any compounds
- ▶ If the hot springs cool down it could be dangerous (Heller, 2017)
- ▶ They aren't able to get much hotter
- ▶ Increased temperature continues to oversaturate solids

Questions?

