

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

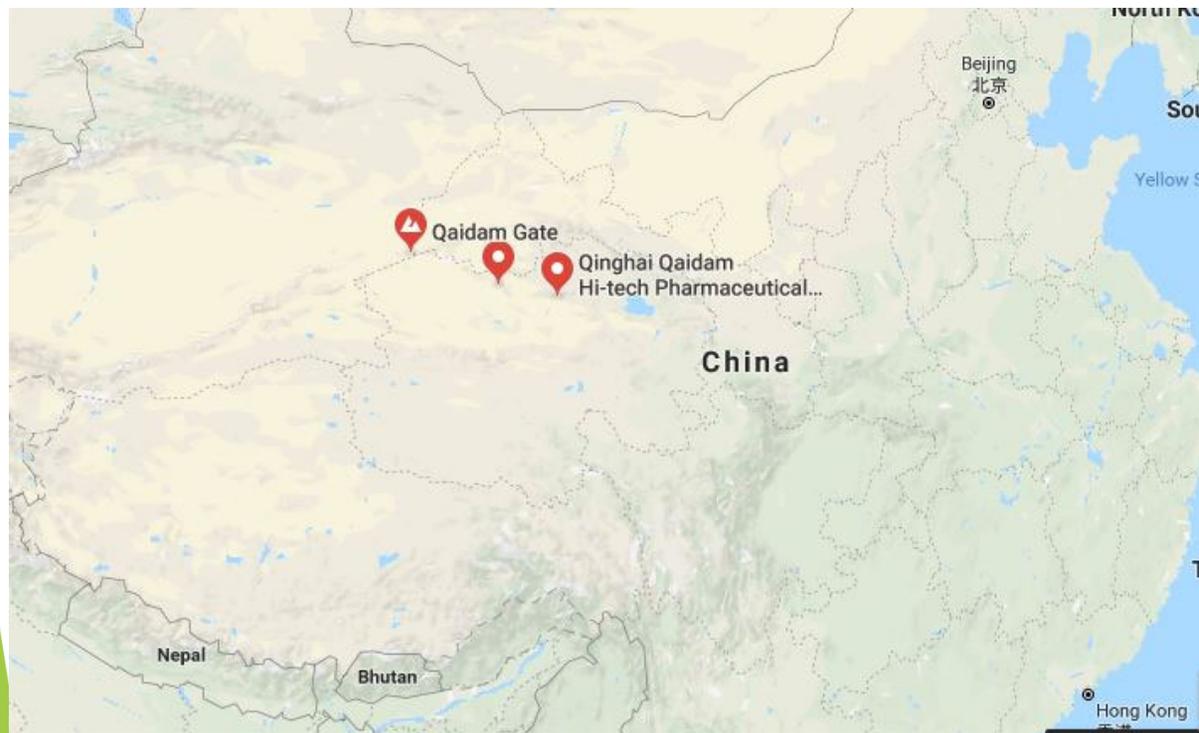
Haley Marston

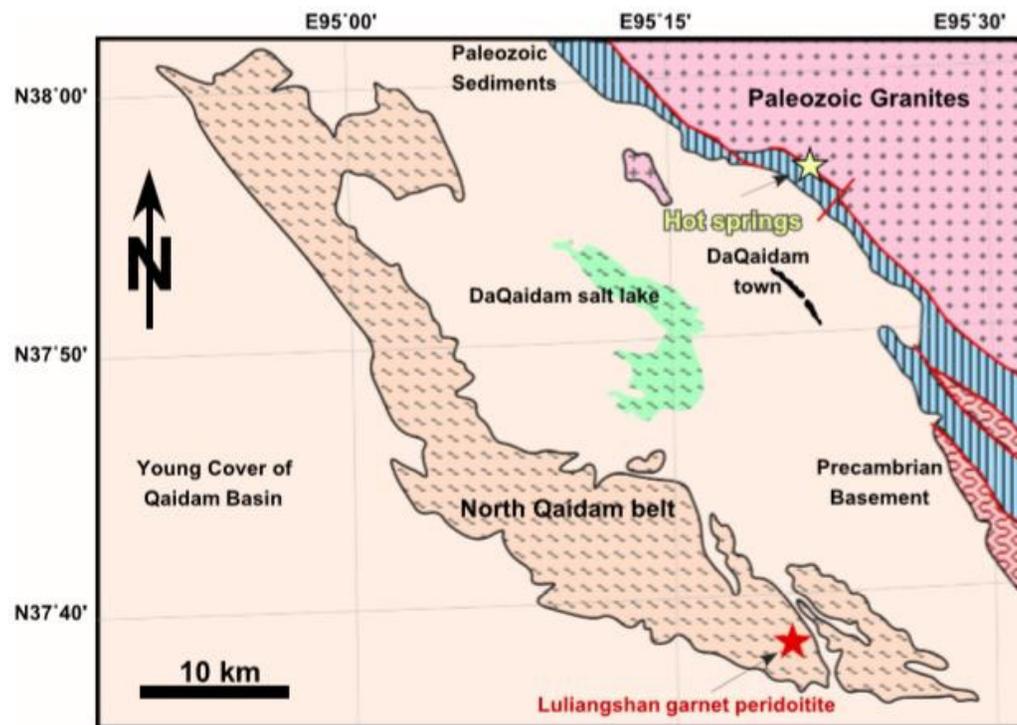
NDSU Geochemistry 2018

Introduction

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







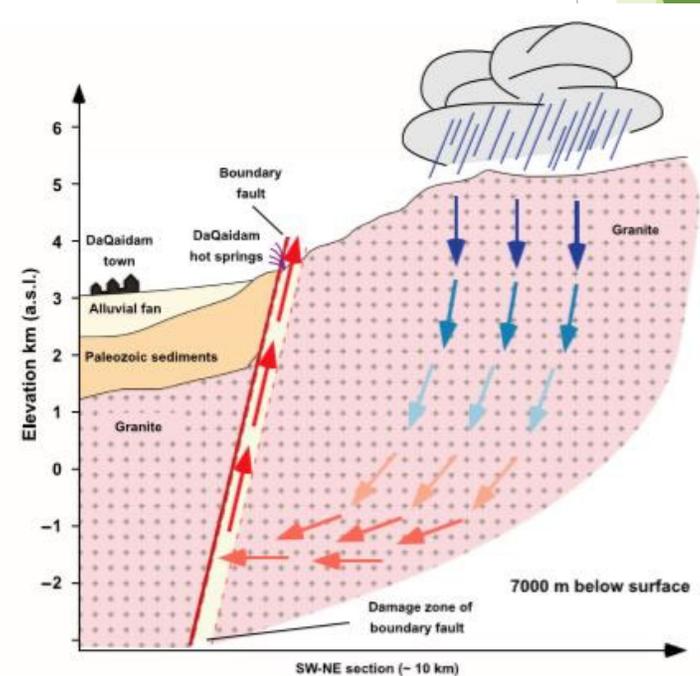
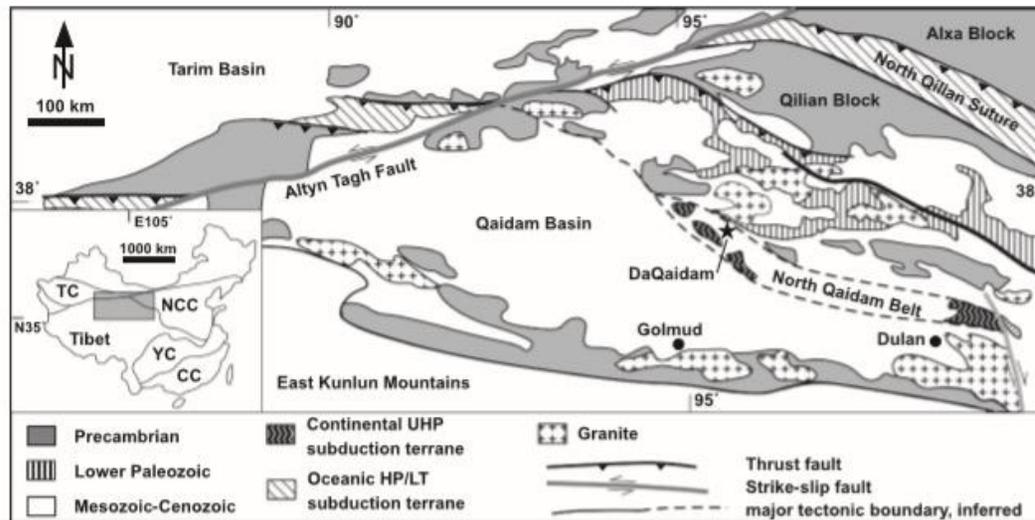
Background

- ▶ 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 a search result on the EBSCOhost platform. The top navigation bar includes the EBSCOhost logo and the search query: "Deep hydrothermal fluid-rock interaction: the thermal springs of Da Qaidam,..."

On the left sidebar, there are several options for viewing the record:

- Detailed Record
- PDF Full Text
- Source: Geofluids
- Date: November 1, 2016
- Inside this work
- Full Text Contents

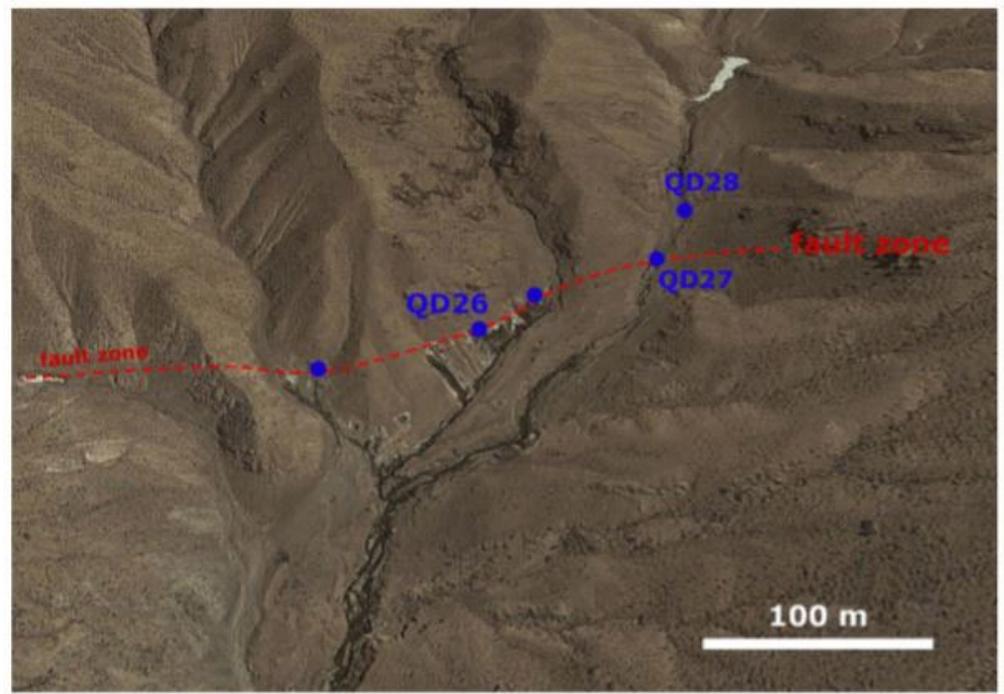
A table of contents is visible, listing the following items:

1 - 5 6 - 10	
Deep hydrothermal fl...	711
The effects of basem...	729
Potential seal	752

The main content area displays the journal title "GEOFLUIDS" and the article title "Deep hydrothermal fluid-rock interaction: the thermal springs of Da Qaidam, China". The authors are listed as I. STOBER¹, J. ZHONG², L. ZHANG³ AND K. BUCHER⁴. The abstract begins with "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: Na^+ , Cl^- , SO_4^{2-} , HCO_3^- , and H_3BO_3^0
- ▶ Dissolved: NaCl , Na_2SO_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 ₂ (B ₄ O ₅ (OH) ₄):8H ₂ O
Boric_acid	-0.22	0.09	0.31	B(OH) ₃

25 C

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

- ▶ However, some are not as over saturated:

Gypsum	0.21	-4.48	-4.69	CaSO ₄ :2H ₂ O
Gypsum	0.14	-4.39	-4.53	CaSO ₄ :2H ₂ 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 ₂ (B ₄ O ₅ (OH) ₄) : 8H ₂ O
Boric_acid	-0.29	0.08	0.37	B (OH) ₃
Gypsum	0.24	-4.50	-4.74	CaSO ₄ :2H ₂ O

71.8 C

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

