



Arsenic Speciation in Surface Water at Lucky Shot Gold Mine, Alaska

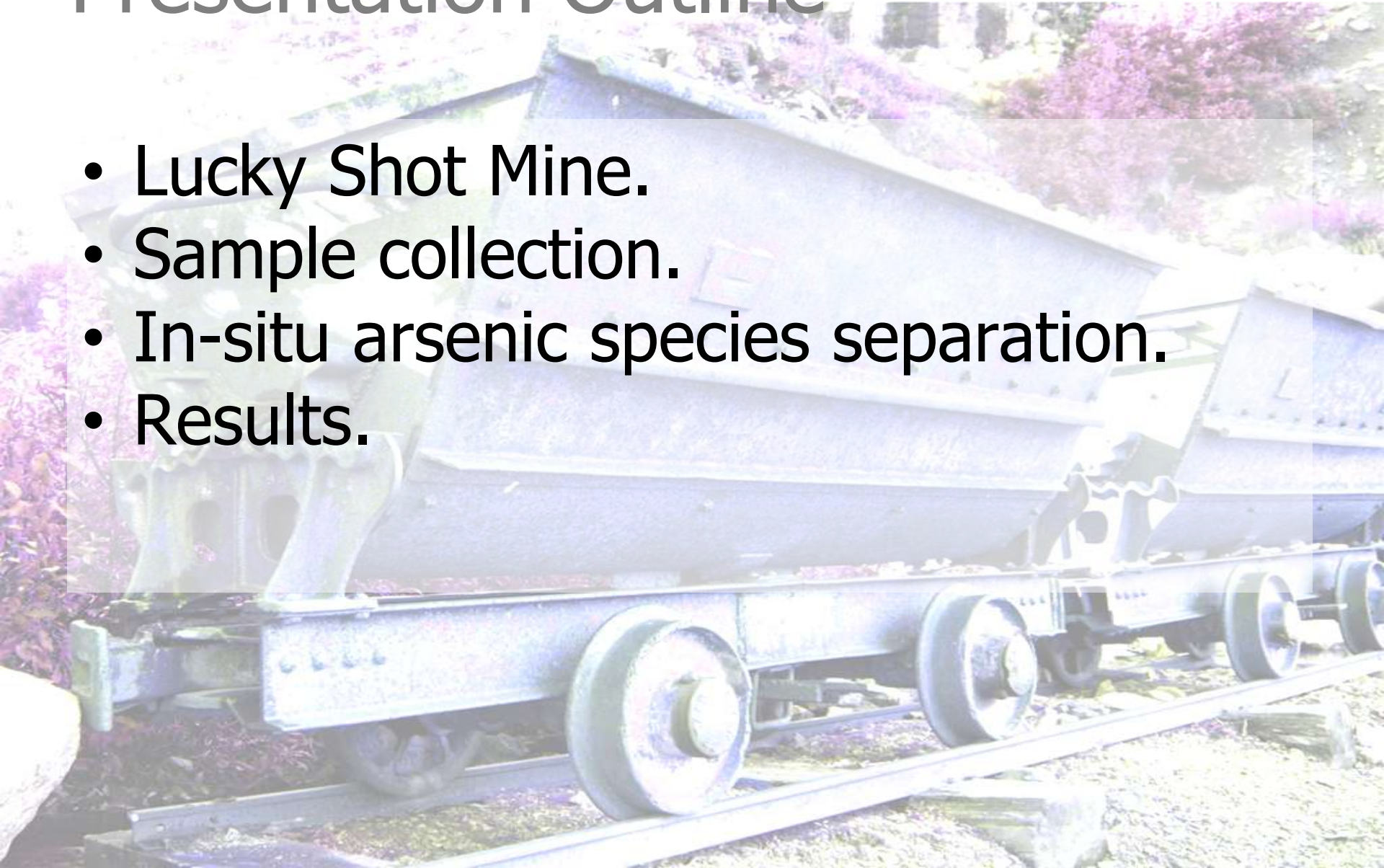
¹Keith Torrance, ¹Helen Keenan, ²LeeAnn Munk & ²Birgit
Hagedorn

¹DLCS, Dept. of Civil Engineering
University of Strathclyde, Glasgow

²Dept. of Geology
University of Alaska, Anchorage, USA

Presentation Outline

- Lucky Shot Mine.
- Sample collection.
- In-situ arsenic species separation.
- Results.



Study Area



Lucky Shot Mine, Hatcher Pass

- Gold mining started in Hatcher Pass in 1906.
- One of several gold mines in immediate area.
- Closed in 1942 with estimated production of 250,000 ounces.
- Mesothermal gold deposit.
- Deposit hosted within quartz veins within Cretaceous Willow Creek quartz diorite batholith.
- Gold is associated with pods of arsenopyrite and pyrite in the quartz veins.
- Arsenic leaching from the mine and spoil heaps.

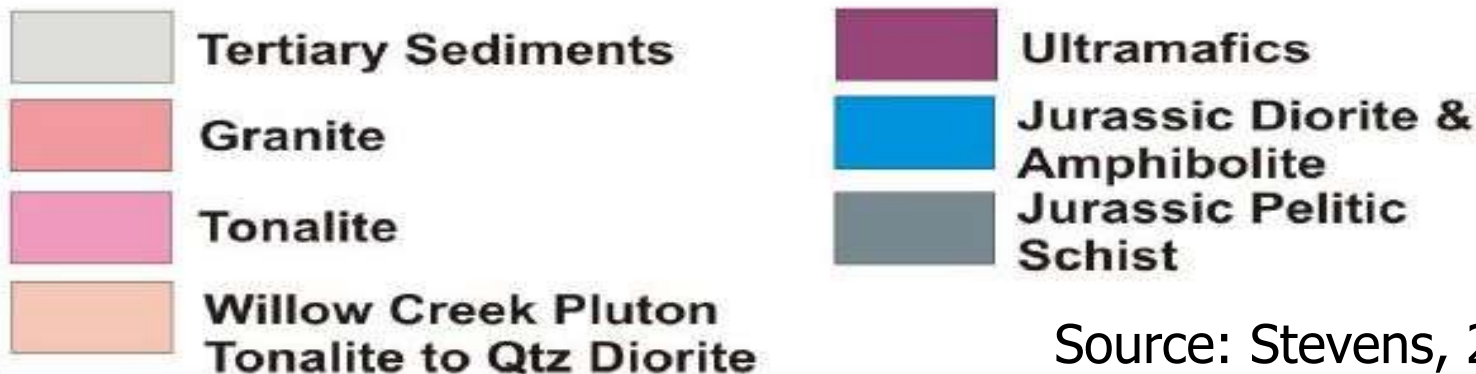
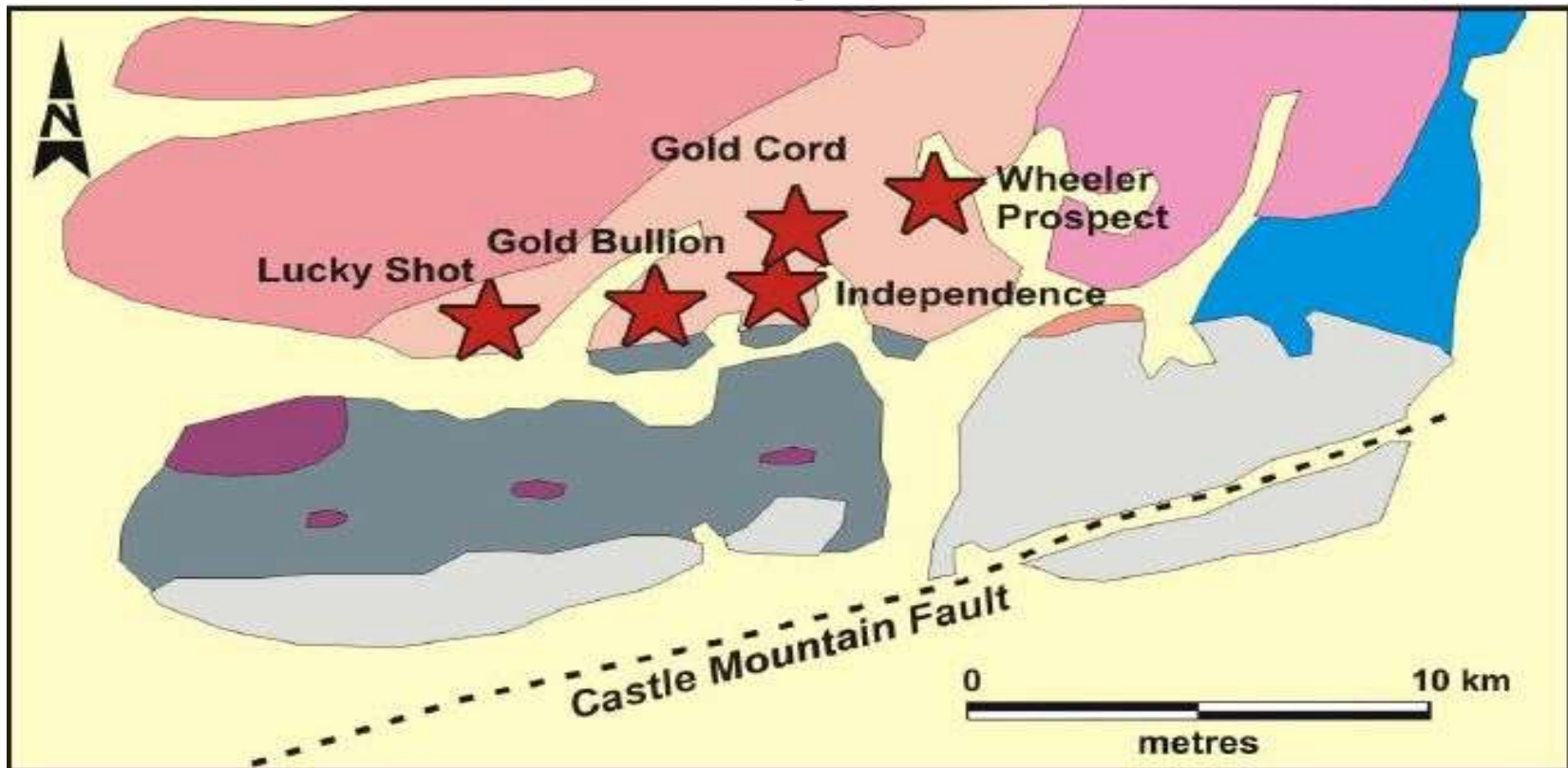
Lucky Shot Mine ~1932



Lucky Shot Mine 2011

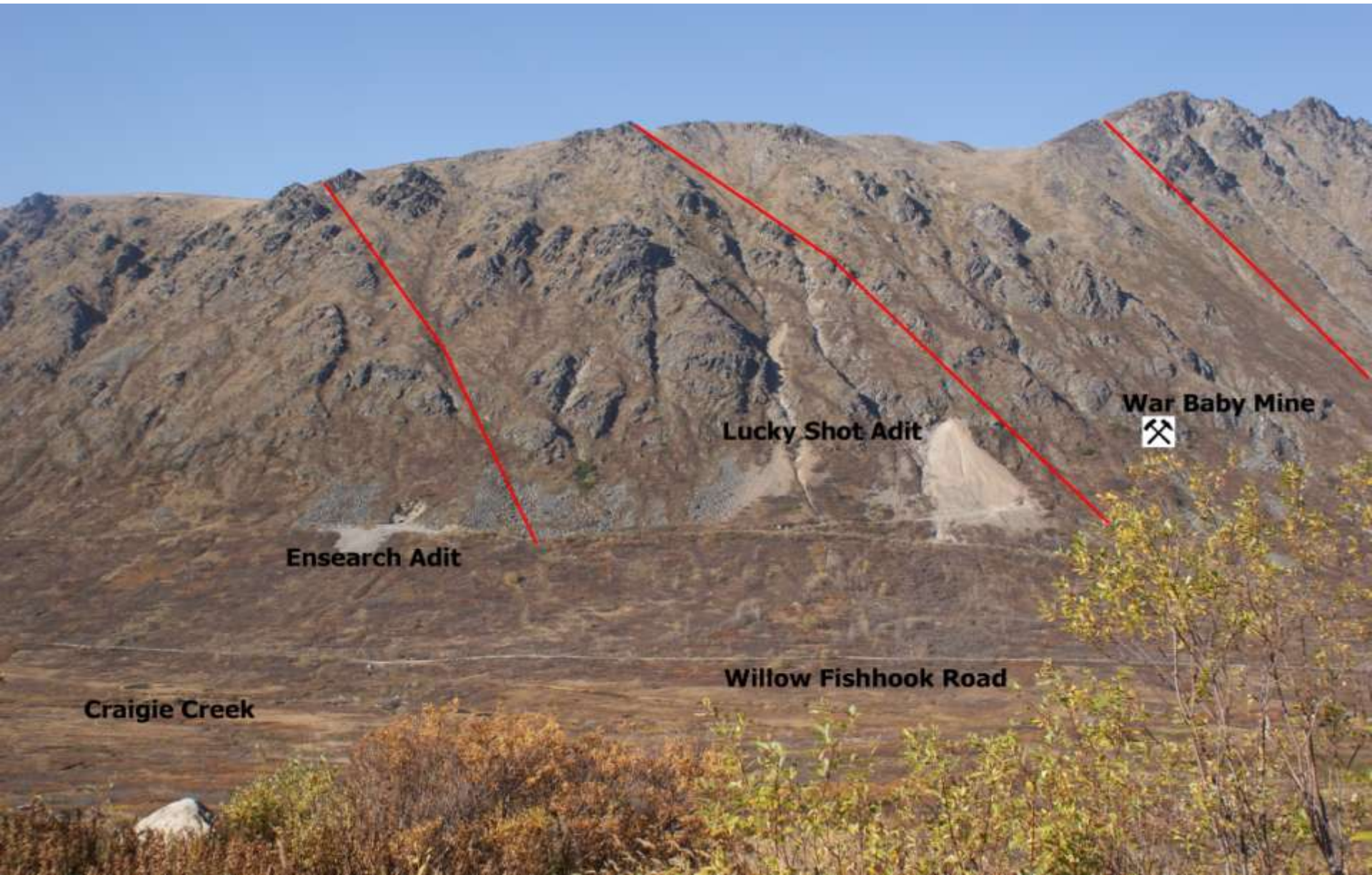


Hatcher Pass Geology



Source: Stevens, 2010

Hatcher Pass Geology



Ensearch Adit

Lucky Shot Adit

War Baby Mine



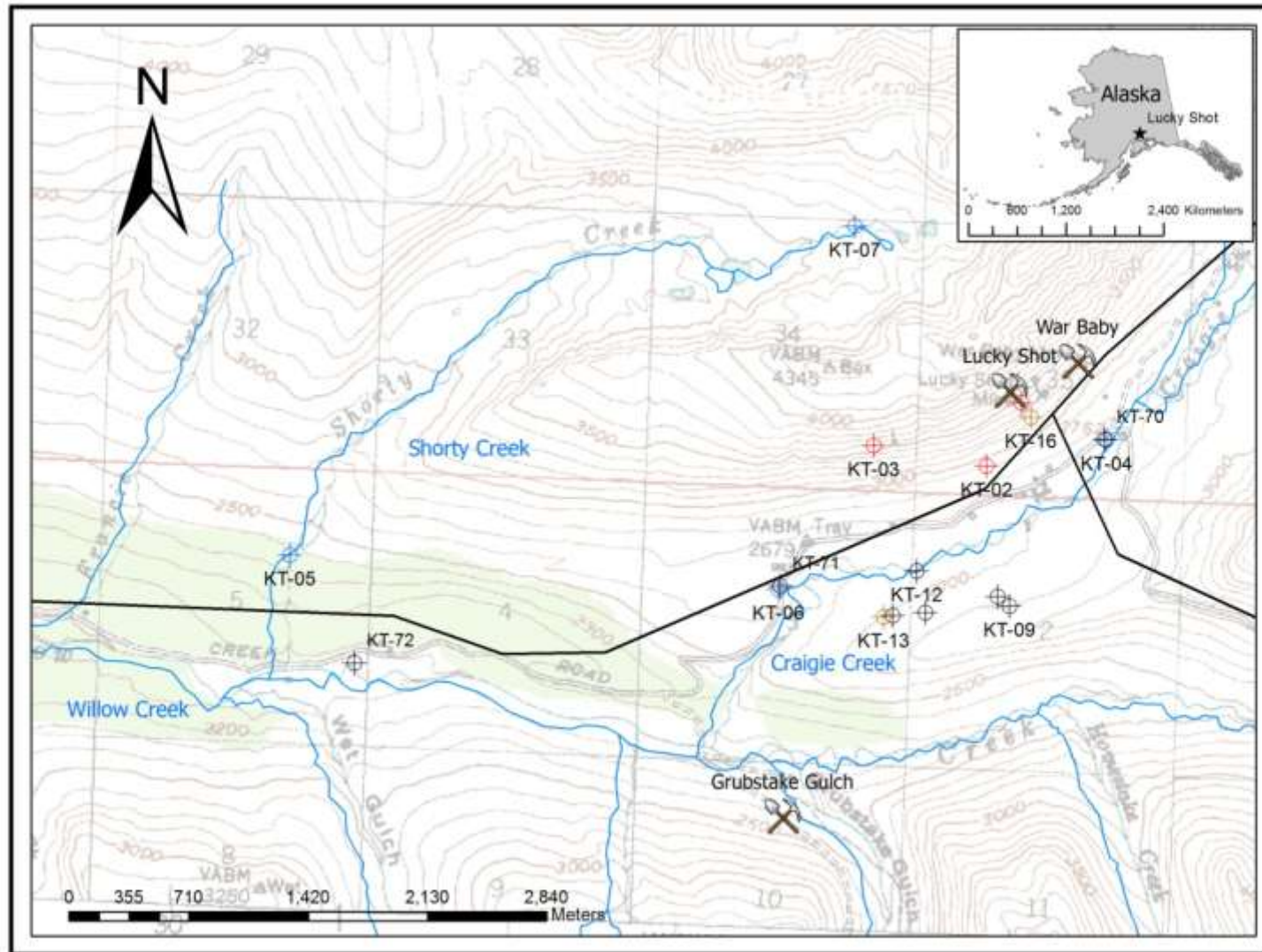
Willow Fishhook Road

Craigie Creek

Sample Collection



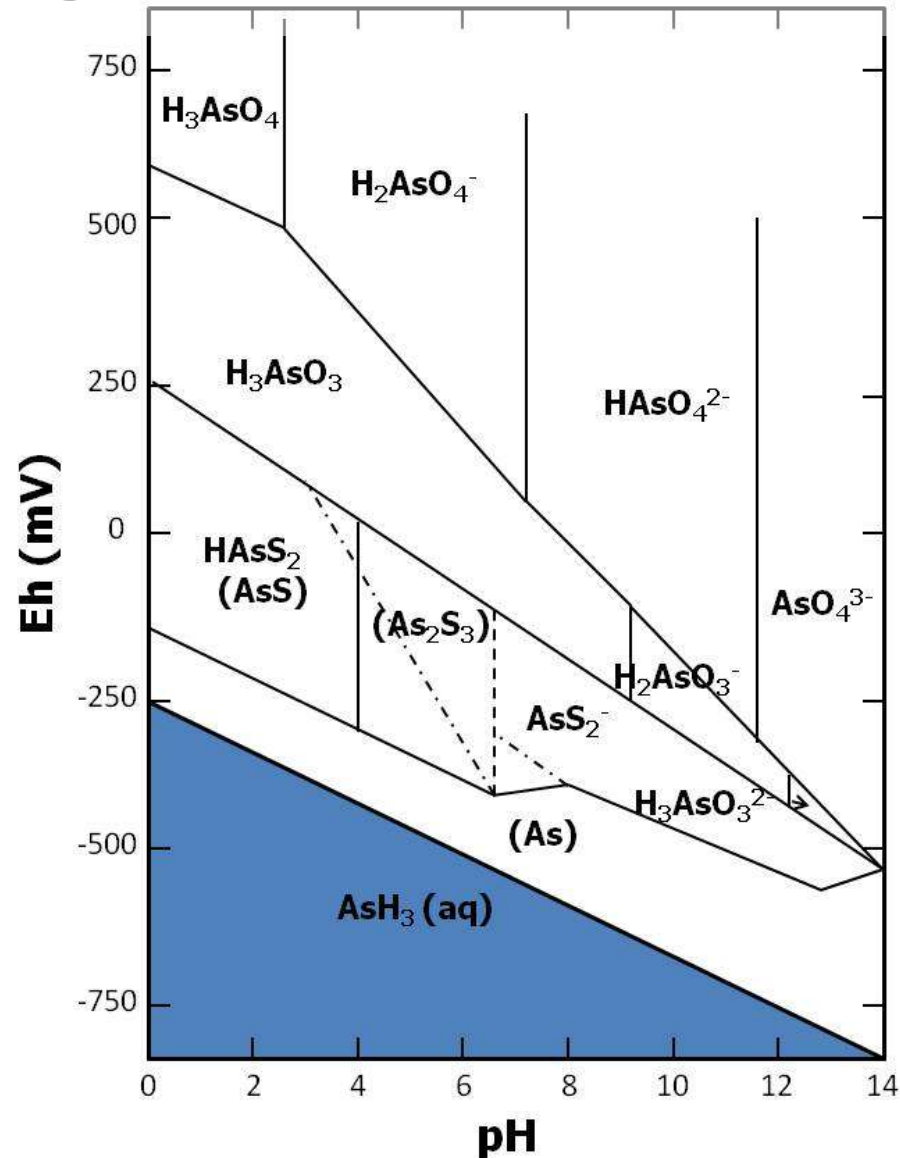
Sampling Locations



Arsenic Speciation in the Field

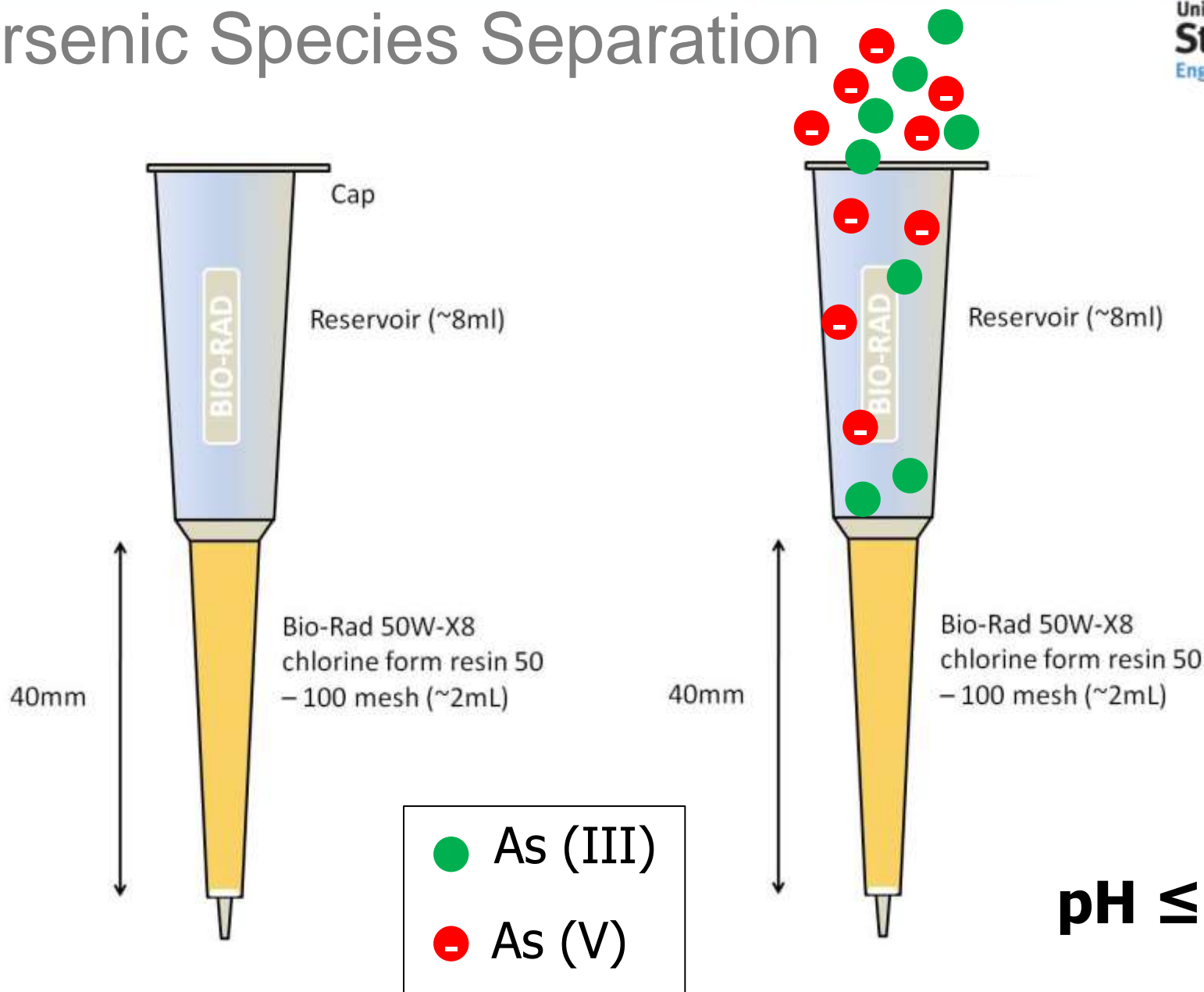


Eh-pH Diagram for Arsenic

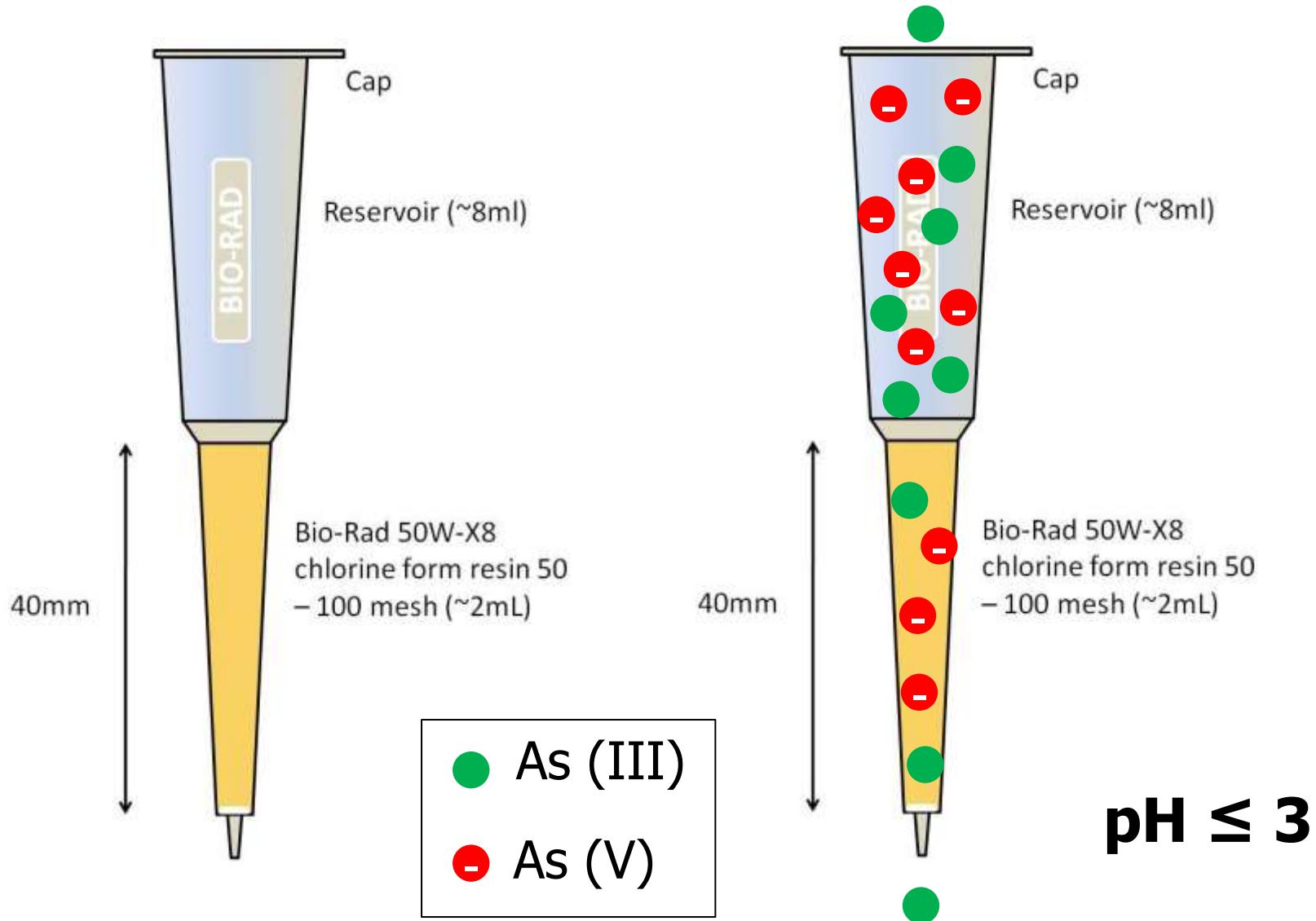


Adapted from
Ferguson & Gavis,
1972

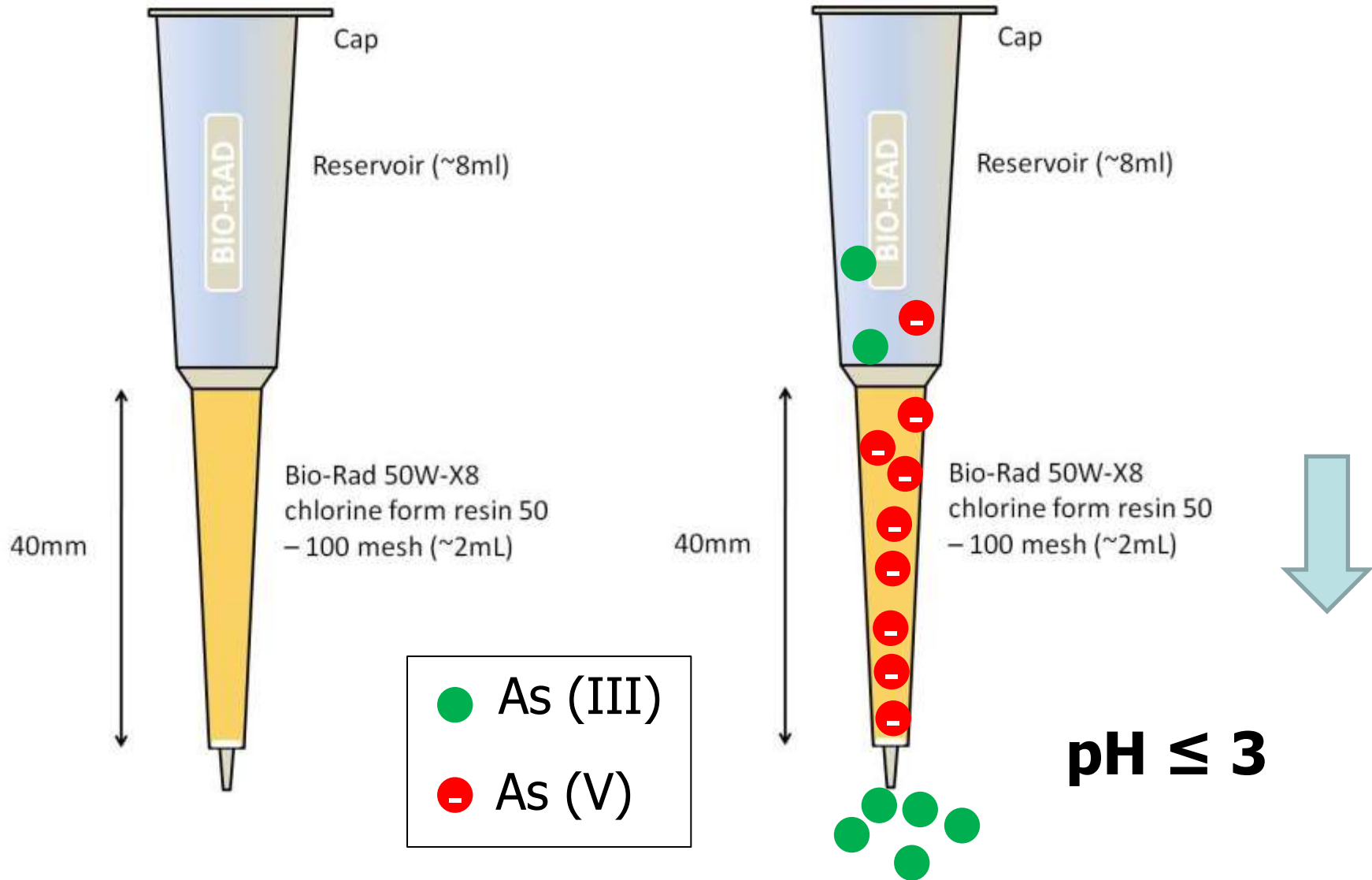
Arsenic Species Separation



Arsenic Species Separation



Arsenic Species Separation



Column Qualification

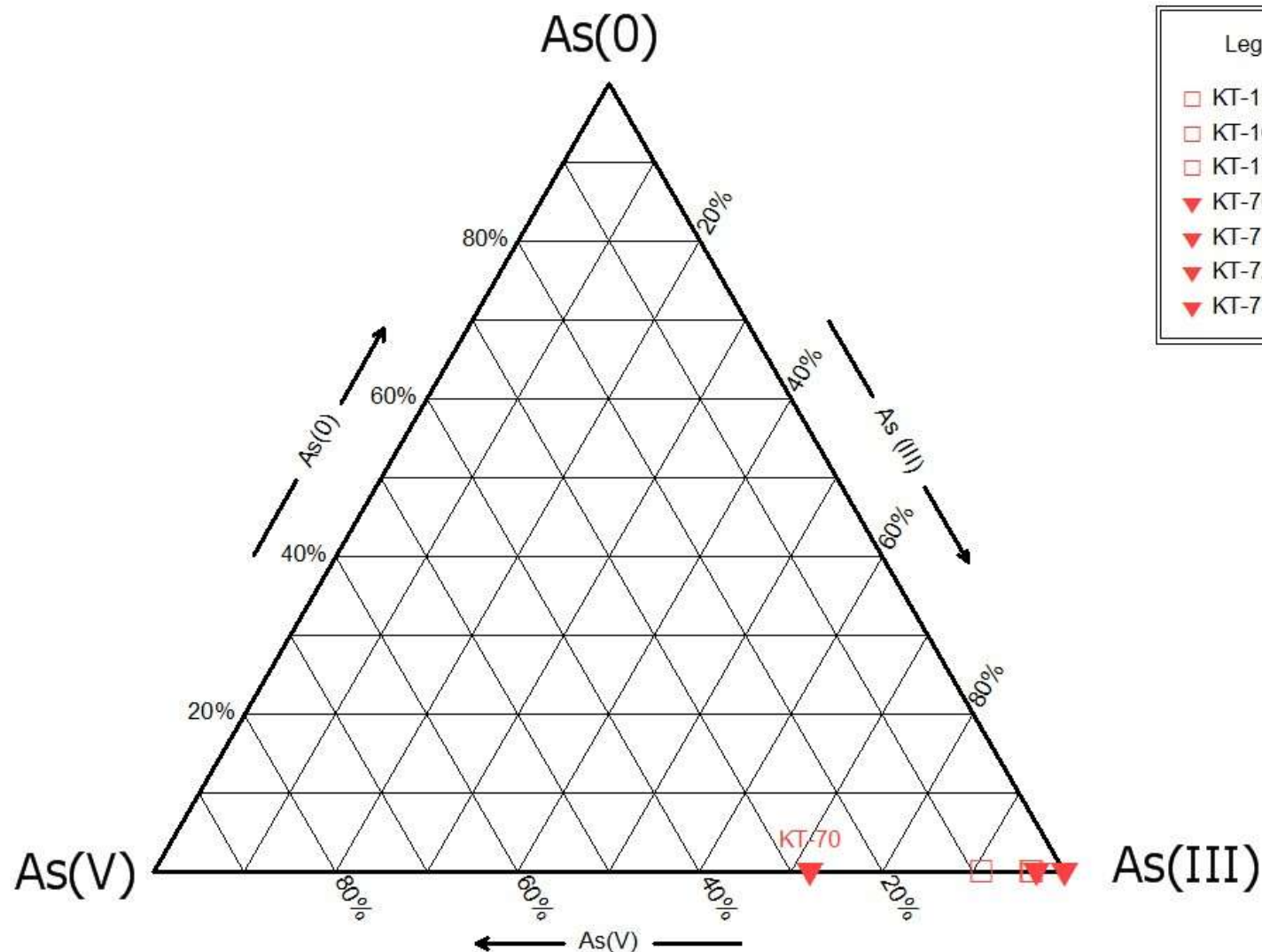
		Standard		
		As(III)	As(V)	As(III) + As(V)
Eluted arsenic concentration		55.74 $\mu\text{g mL}^{-1}$	109.11 $\mu\text{g mL}^{-1}$	108.50 $\mu\text{g mL}^{-1}$ (45.5 $\mu\text{g mL}^{-1}$)
Eluted arsenic concentration	pH = 1.0	53.87 $\mu\text{g mL}^{-1}$	<0.6 $\mu\text{g mL}^{-1}$	43.90 $\mu\text{g mL}^{-1}$
Eluted arsenic concentration	pH = 2.5	54.02 $\mu\text{g mL}^{-1}$	<0.6 $\mu\text{g mL}^{-1}$	43.68 $\mu\text{g mL}^{-1}$
Efficiency		97%	100%	97%

Arsenic Speciation

Results

Sample ID	Location	Total As μgL^{-1}	Separated As μgL^{-1}	As(III) μgL^{-1}	As(V) μgL^{-1}	%As(V)
KT-01	Lucky Shot Adit	648.42	674.76	674.76	-26.34	-4.1%
KT-02	Ensearch Adit	11.07	12.28	12.28	-1.21	-10.9%
KT-03	Coleman Adit	60.63	49.39	49.39	16.40	24.9%
KT-10	Borehole MW-14	63.86	43.56	43.56	10.32	19.2%
KT-12	Borehole MW-18	<LOD	<LOD	<LOD	<LOD	<LOD
KT-16	Lucky Shot Tailings	752.51	725.74	725.74	26.8	3.6%
KT-70	Craigie Creek	1.27	0.91	0.91	0.36	28.4%
KT-71	Craigie Creek	4.43	4.30	4.30	0.13	2.9%
KT-72	Willow Creek	1.79	1.79	1.79	0.0	0.0%
KT-73	Willow Creek	1.40	1.45	1.45	-0.05	-3.6%

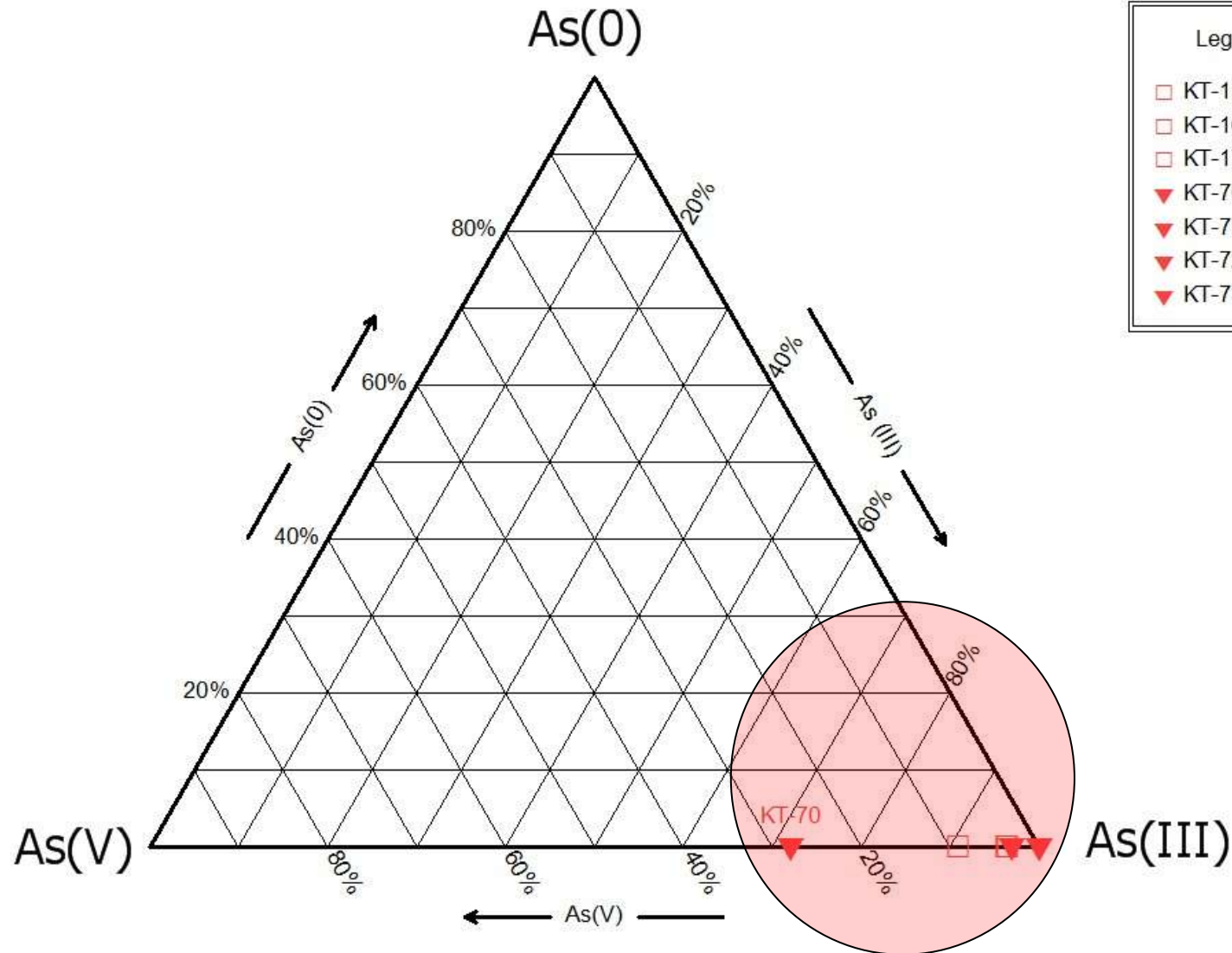
Arsenic Speciation



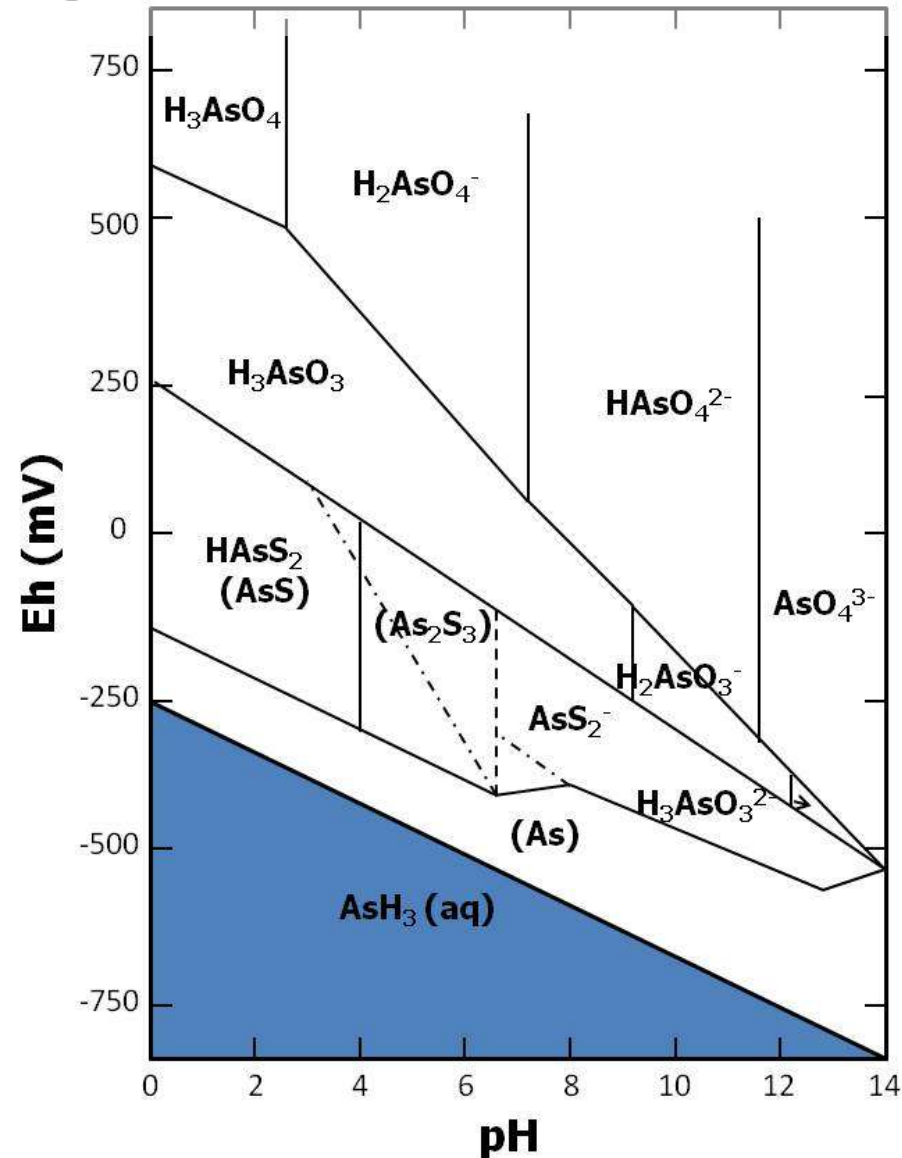
Legend

- KT-15
- KT-16
- KT-17
- ▼ KT-70
- ▼ KT-71
- ▼ KT-72
- ▼ KT-73

Arsenic Speciation

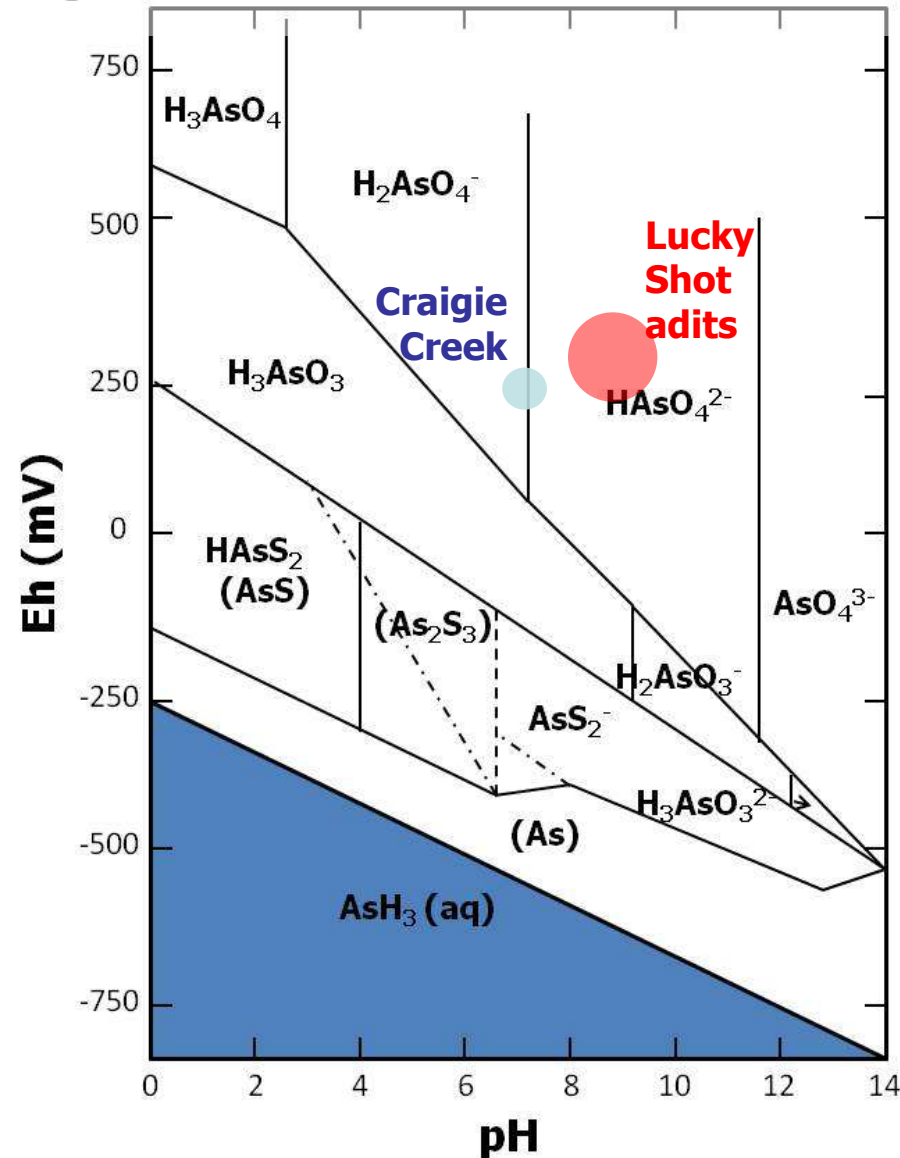


Eh-pH Diagram for Arsenic



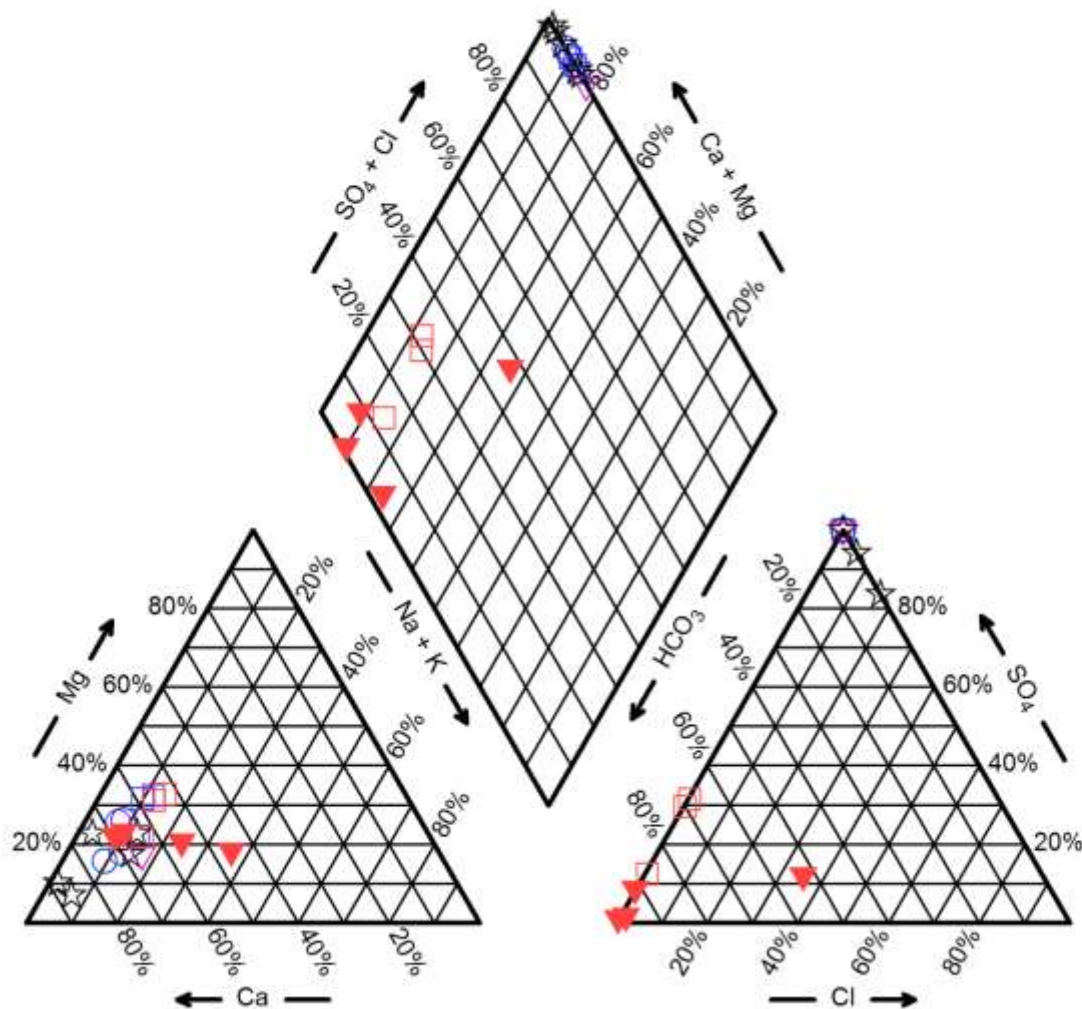
Adapted from
Ferguson & Gavis,
1972

Eh-pH Diagram for Arsenic



Adapted from
Ferguson & Gavis,
1972

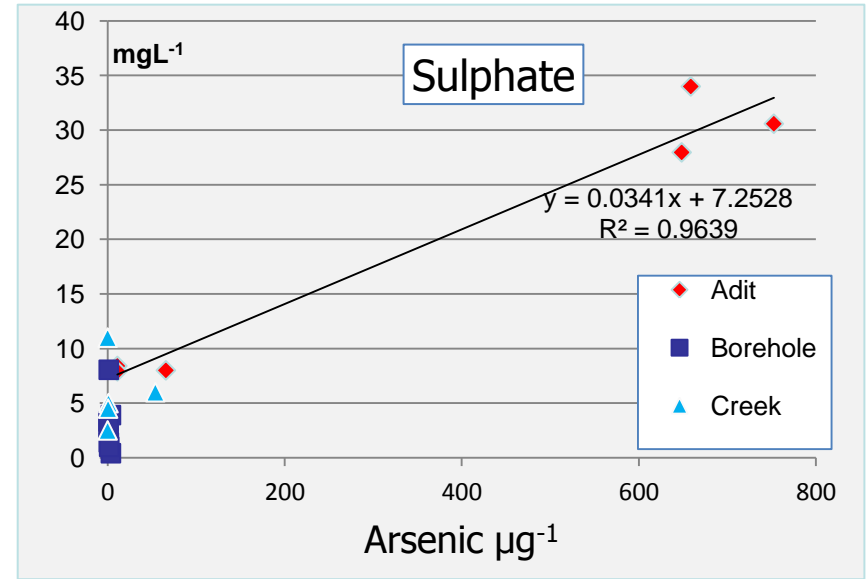
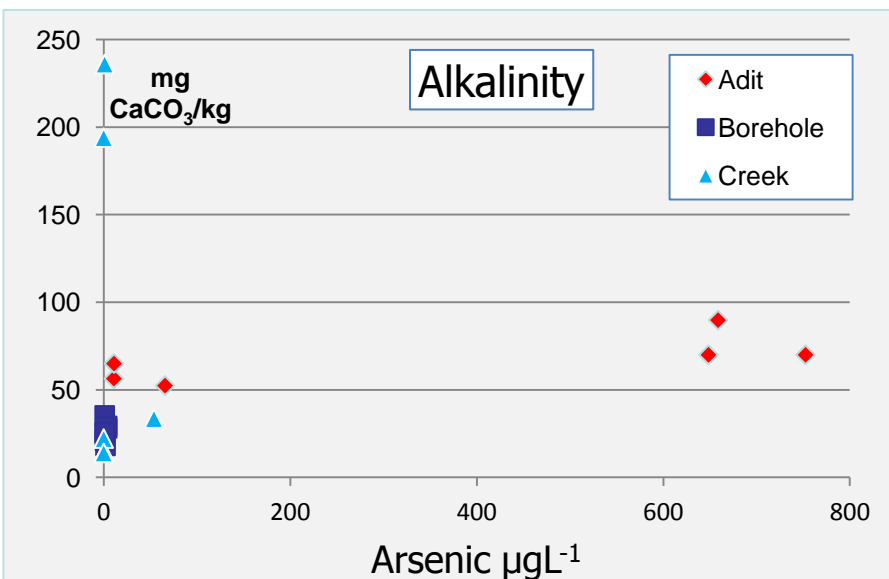
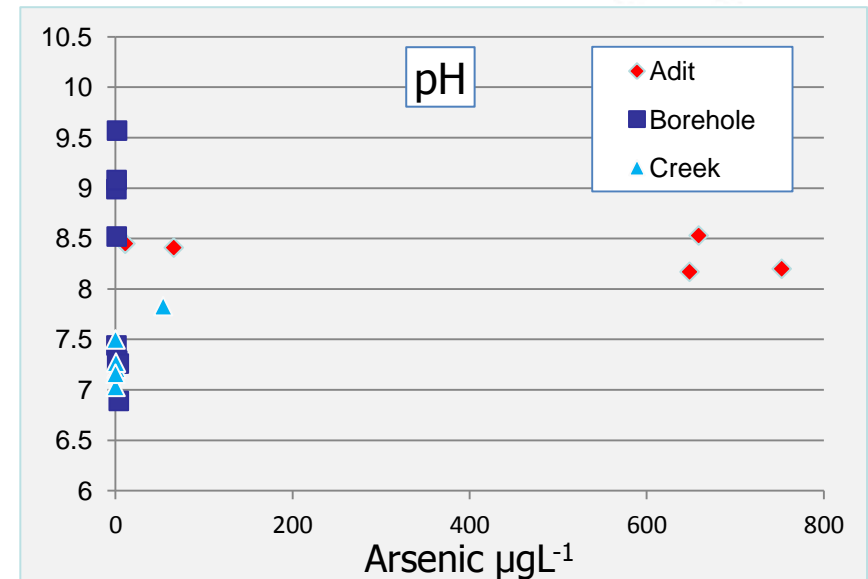
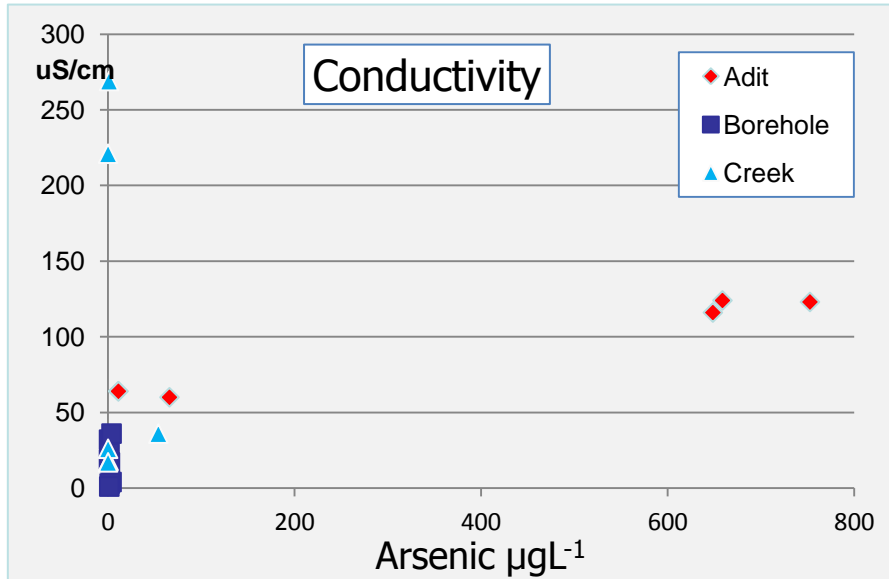
Piper diagram



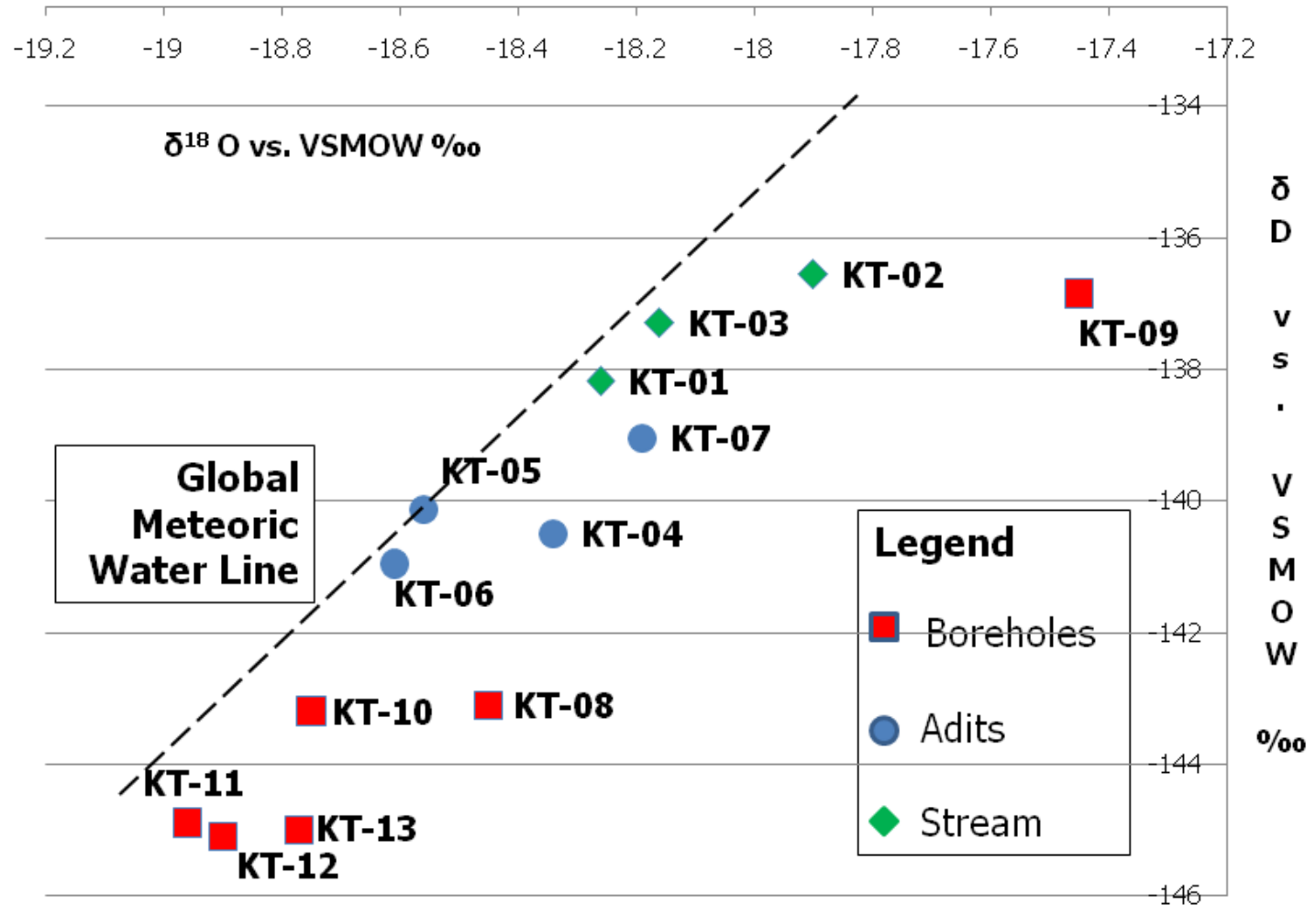
Legend

- KT-01
- KT-02
- KT-03
- KT-04
- KT-05
- KT-06
- KT-07
- ☆ KT-08
- ☆ KT-09
- ☆ KT-10
- ☆ KT-11
- ☆ KT-12
- ▽ KT-13
- KT-15
- KT-16
- KT-17
- ▼ KT-70
- ▼ KT-71
- ▼ KT-72
- ▼ KT-73

Geochemistry



Stable isotopes



Summary

- High arsenic content (700ppb) in Lucky Shot adit mine water; rapidly diluted in Craigie Creek.
- Correlation with sulphate content ($R^2 = 0.96$) confirms source of arsenic as arsenopyrite.
- pH of water is circum-neutral. Possible buffering from epidote veins?
- Over 90% of water soluble arsenic is in the form of As(III).



Thanks to:

LeeAnn Munk, UAA, Alaska
Birgit Hagedorn, UAA Alaska
Jeremy Stariwat, Terrasat Inc.
William Burnett, Yukuskokon Professional
Services, LLC.
Scott Eubanks, Lucky Shot Mine.
Mac Robertson Scholarship
SEGH



Questions?

keith.torrance@strath.ac.uk