Geochemistry of the Flooded Kelley Mine of Butte, Montana

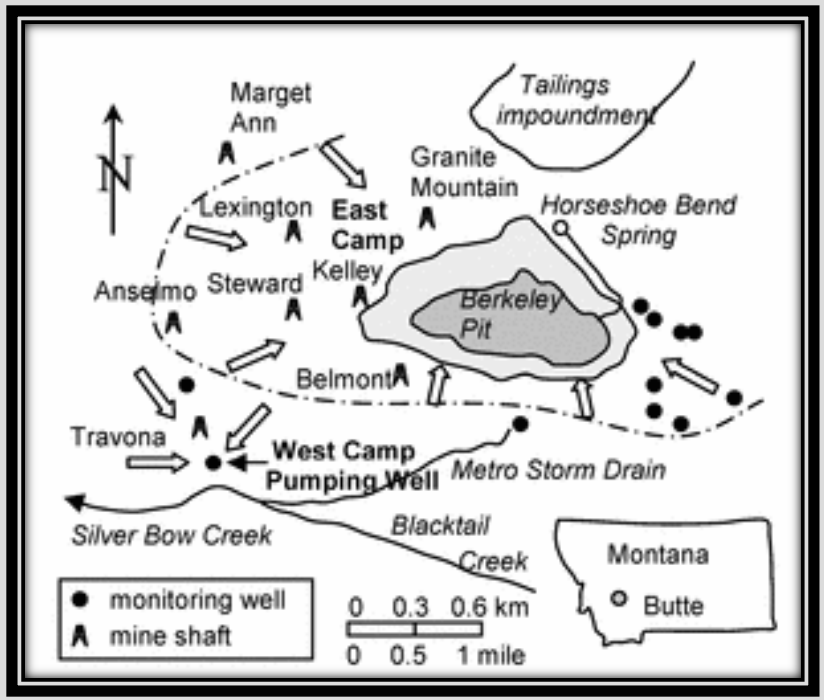
By: Jordan Cahill

NDSU Geochemistry 428/628

11/29/2012

Background

- Located near the Berkeley open pit mine
  - Butte, Montana
  - East Camp system
- Zinc and Copper Mine
- In operation until 1975
- Dewatering ceased in 1982



Current Water Conditions

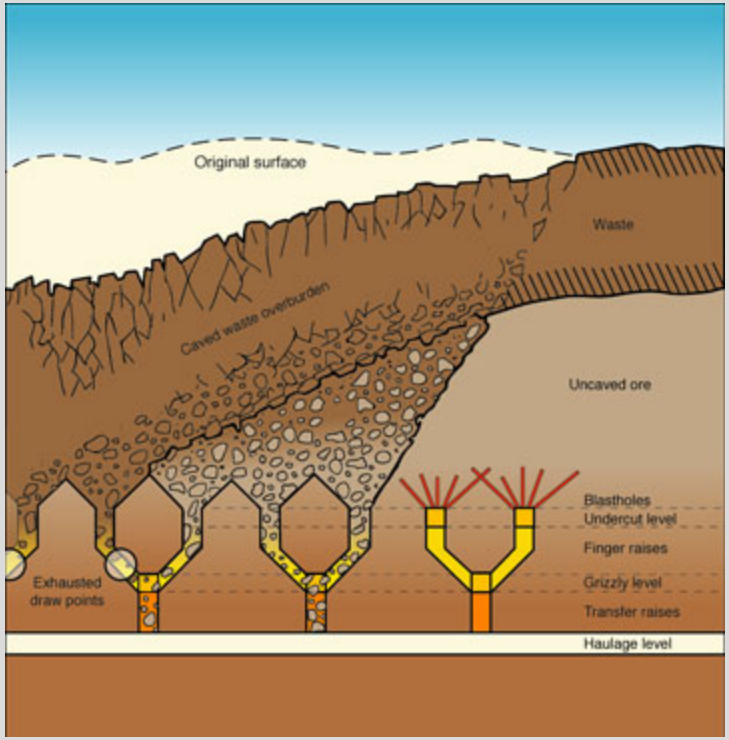
- Worst water quality of the flooded underground mines
- Highest temperature
- Lowest pH

Temp	pH	Ca	Mg	Na	K	Fe	Mn	HCO3
31.3	4.61	491	395	83	62.9	1770	186	ND
SiO2	**SO4**	**Cl**	**Al**	**As**	**Cd**	**Cu**	**U**	**Zn**
78	7740	25	34100	9610	36	47	8	313000

ND= Not Determined
Concentrations in mg/L

Factors Contributing to Current Water Conditions

- Home of the dewatering pumps
- Block caving occurred
  - Creation of caverns
- Located below Berkeley pit leach pads
  - Assist in removing minerals from water

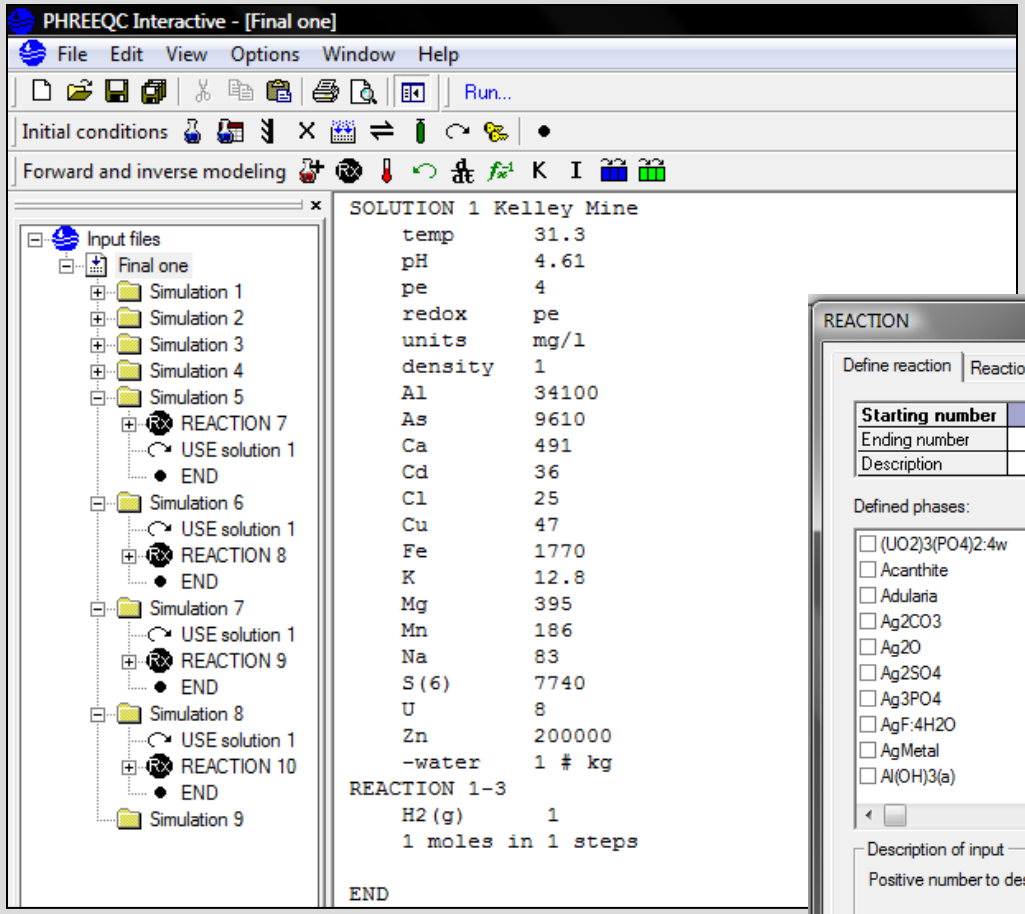


http://www.resolutioncopper.com/sdr/2011/_img/block-caving.jpg

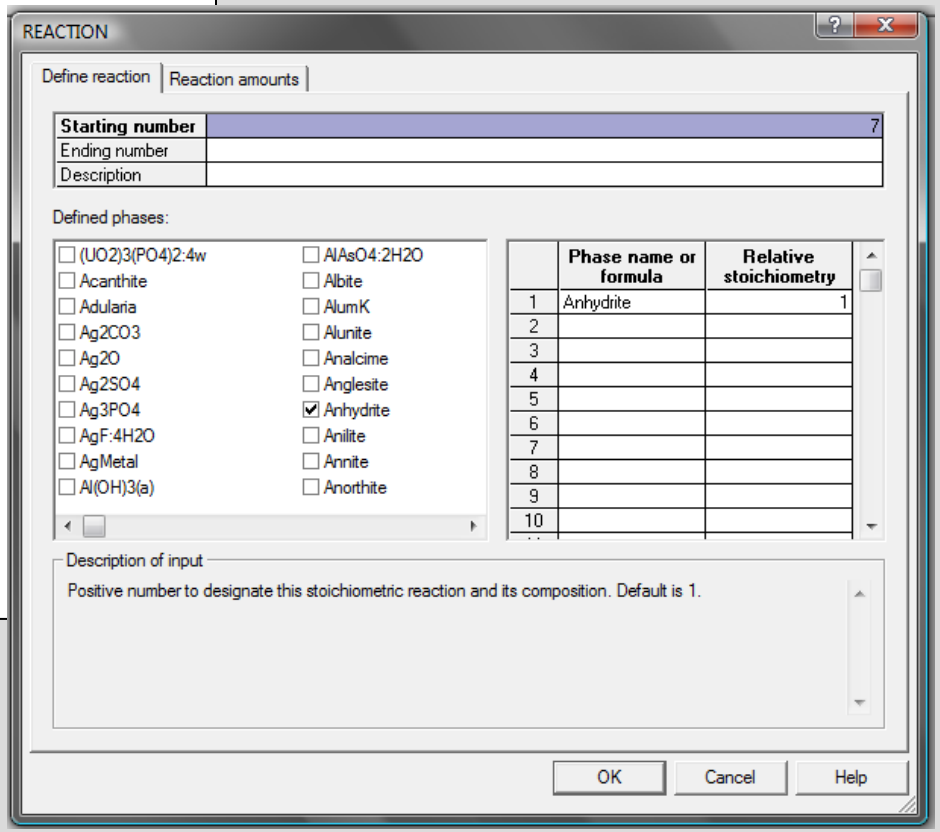
Focus for PHREEQC

- High concentrations of As
- React different substances with the mine water to identify when As bearing minerals will precipitate
- As minerals to focus on
  - Orpiment (FeAsS)
  - Realgar (AsS)
  - Native As

PHREEQC Modeling Imput

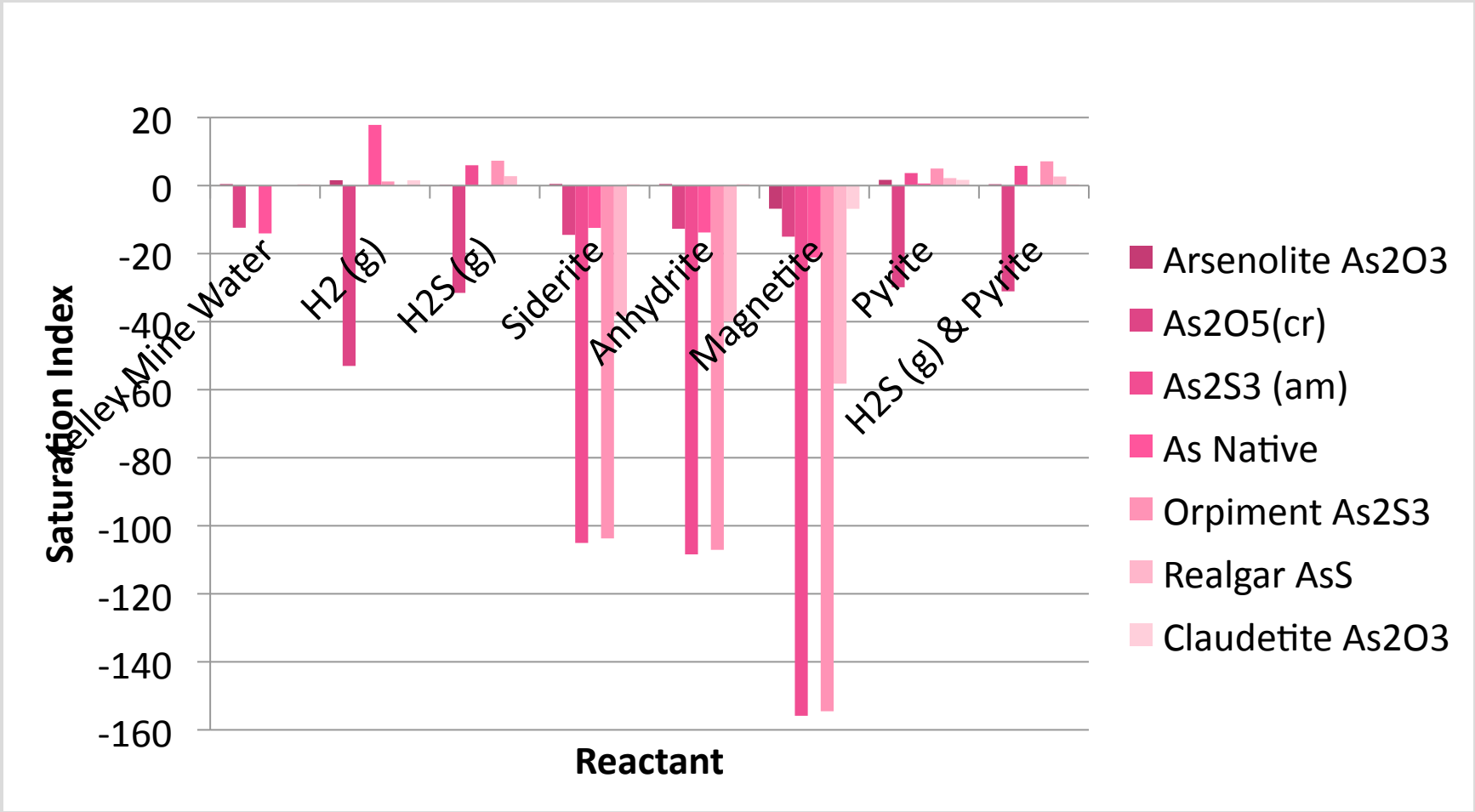


Solution Imput



Reaction Function

PHREEQC Modeling Results



PHREEQC Modeling Results

Reactants with precipitated As bearing minerals

Kelley Mine	H2 (g)	H2S (g)	Siderite	Anhydrite	Magnetite	Pyrite	H2S (g) & Pyrite
Arsenolite	Arsenolite	Arsenolite	Arsenolite	Arsenolite		Arsenolite	Arsenolite
Claudetite	Native As	As2S3 (am)	Claudetite	Claudetite		As2S3 (am)	As2S3 (am)
	Orpiment	Orpiment				Native As	Orpiment
	Claudetite	Realgar				Orpiment	Realgar
		Claudetite				Realgar	Claudetite
						Claudetite	

Conclusion

- No precipitation of any As bearing minerals in the reaction with magnetite
- In every other case at least two of the As bearing substances precipitated
- Would focus on reactants containing Fe, S, H
- PHREEQC has some limitations
  - Couldn’t handle Zn concentration

Sources

- Gammons CH, Duaime TE (2006) Long-term changes in the geochemistry and limonology of the Berkeley pit-lake, Butte, Montana. Mine Water Environ 25:76-85
- Gammons CH, Metesh JJ, Snyder DM (2006a) A survey of the geochemistry of flooded mine shaft water in the Butte District, Montana. Mine Water Environ 25: 100-107
- Gammons CH, Poulson SR, Metesh JJ, Duaime TE, Henne AR (2003) Geochemistry and isotopic composition of H2S-rich flooded mine waters, Butte, Montana. Mine Water Environ 22: 141-148

http://mw2.google.com/mw-panoramio/photos/medium/74785930.jpg