ADTI-WP2 Leaching Column Method for Overburden Analysis & Prediction of Weathering Rates

Roger J. Hornberger, Keith B.C. Brady, Barry E. Scheetz
William B. White and Stephen C. Parsons

Objectives

1. Standardize procedures
2. Improve method
   a. CO_2-enriched air
   b. Quantify particle size effects
3. Flexibility in method
4. Improved interpretations
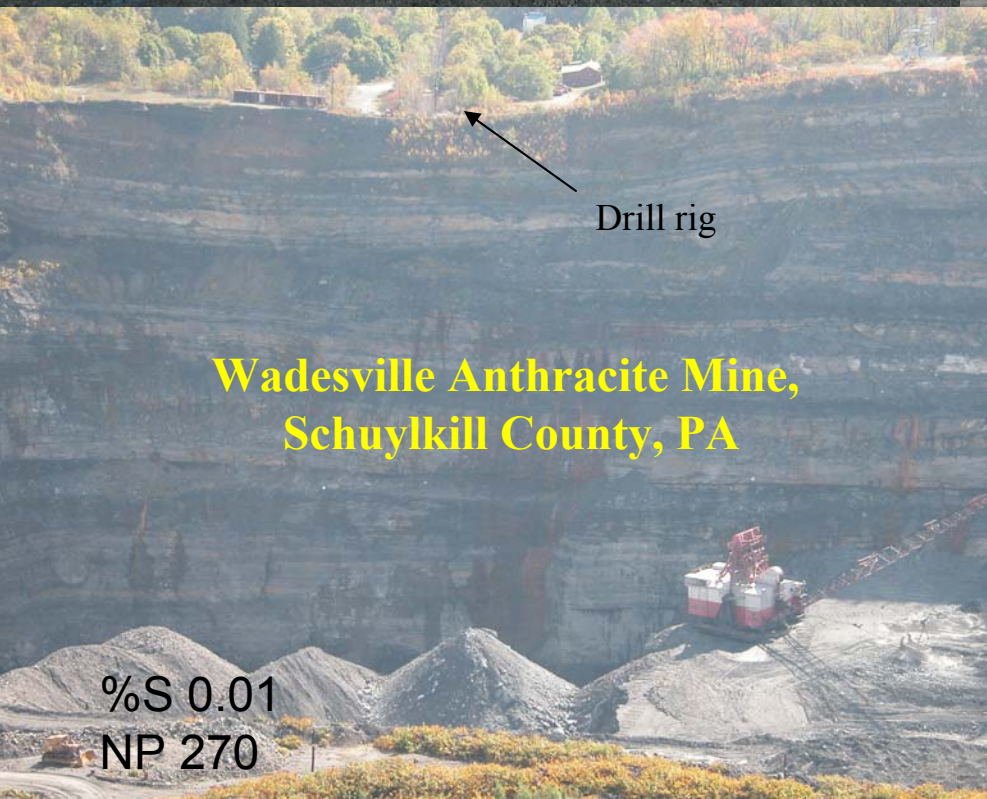
Sought a Variety of Rocks to Leach

Keith

Will

Roger

Barry

Steve

Tracy Lynn Mine
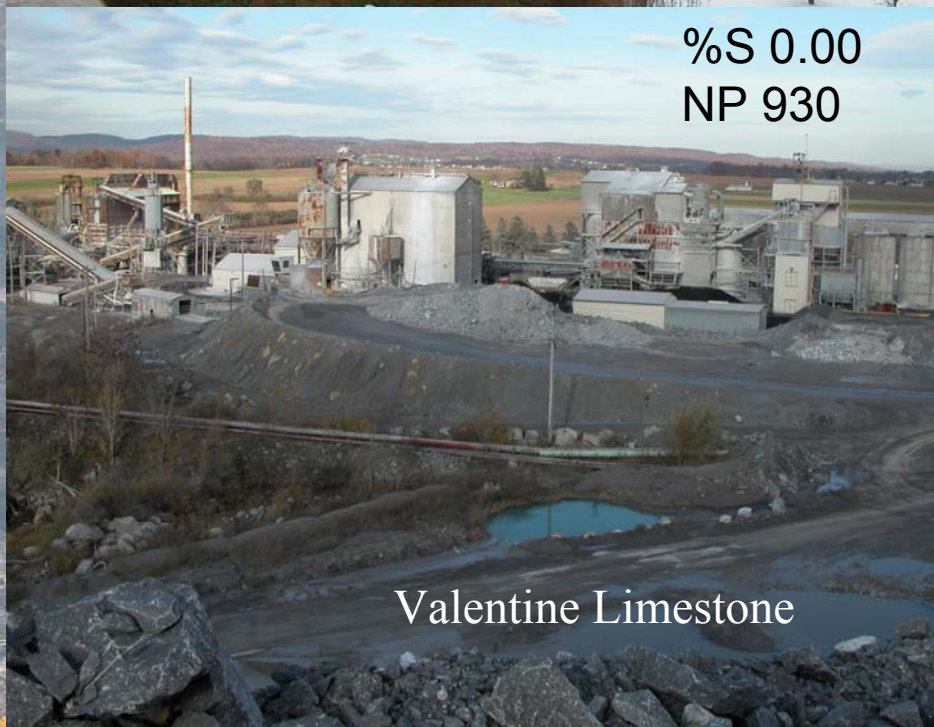
%S ~7
NP 0.0

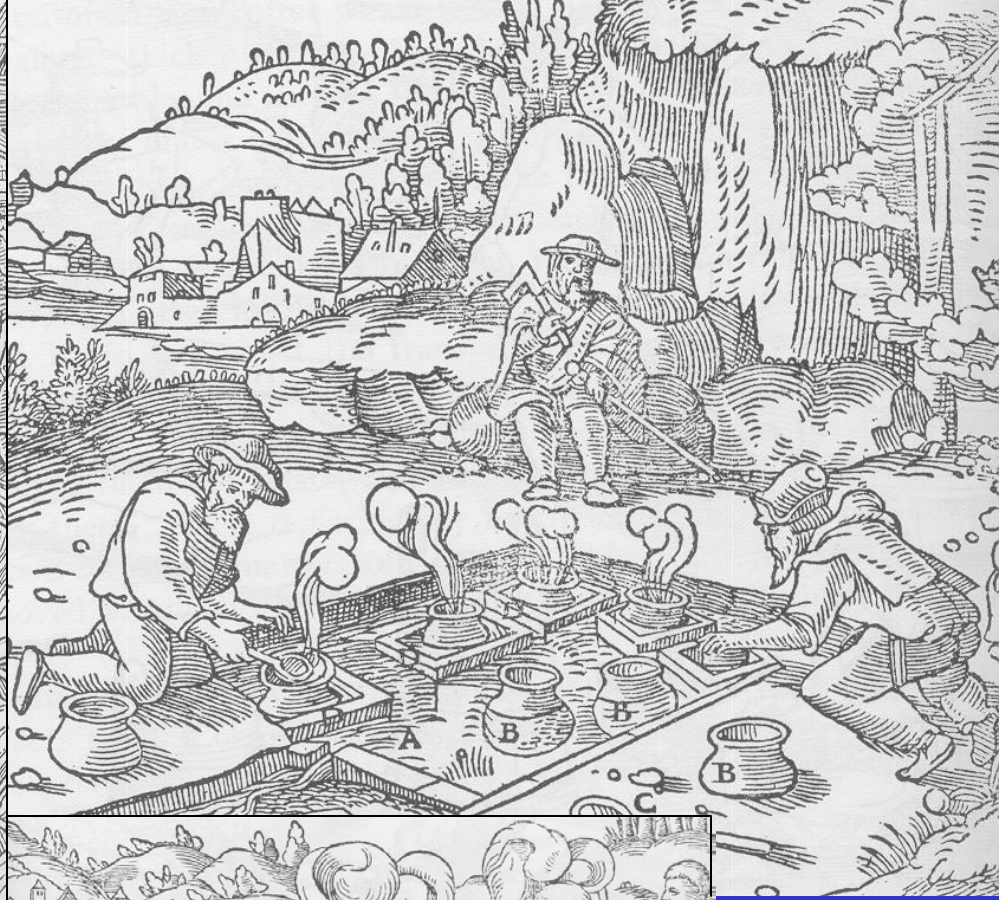Rt. 66 Brush Creek Shale Site
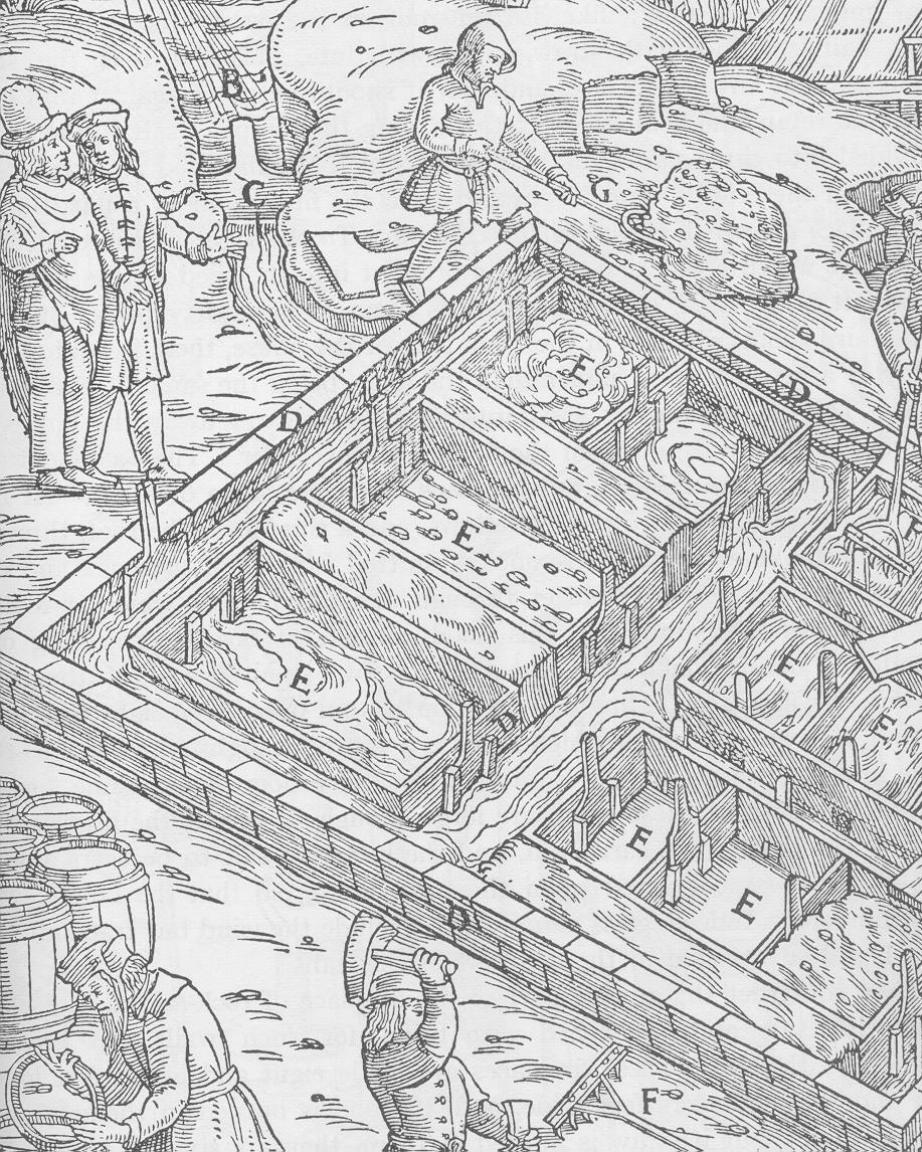
%S 0.91
NP 133

Drill rig

Wadesville Anthracite Mine,
Schuylkill County, PA

%S 0.01
NP 270

%S 0.00
NP 930

Valentine Limestone

Standardization

GEORGIUS AGRICOLA

DE RE METALLICA

TRANSLATED FROM THE FIRST LATIN EDITION OF 1556

with

Biographical Introduction, Annotations and Appendices upon
the Development of Mining Methods, Metallurgical
Processes, Geology, Mineralogy & Mining Law
from the earliest times to the 16th Century
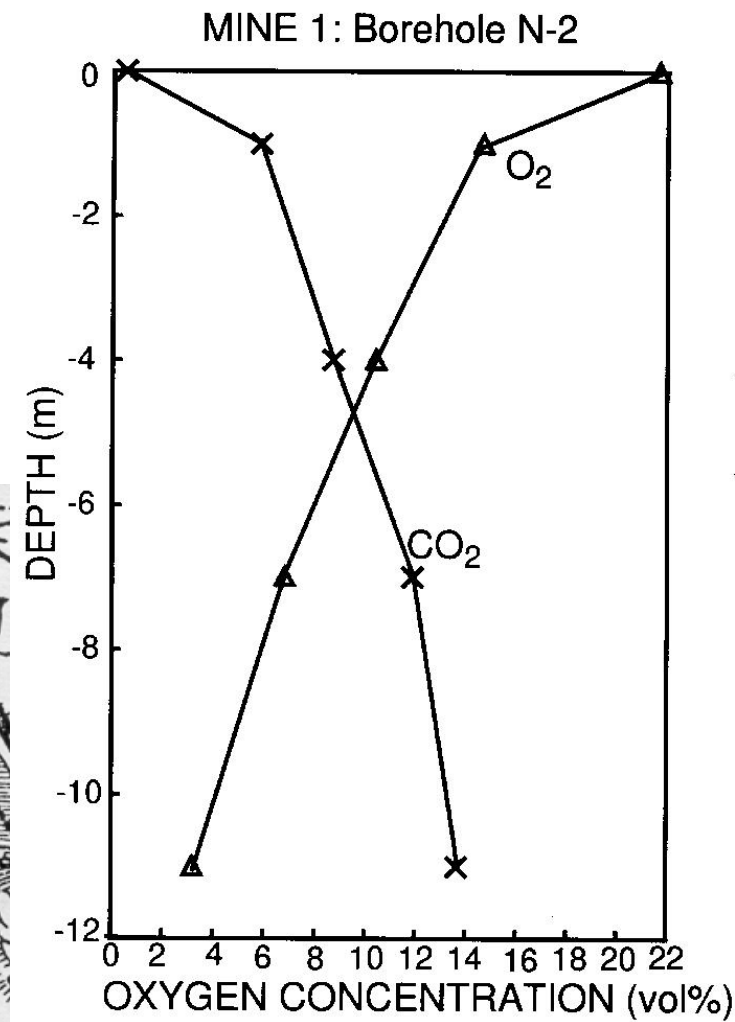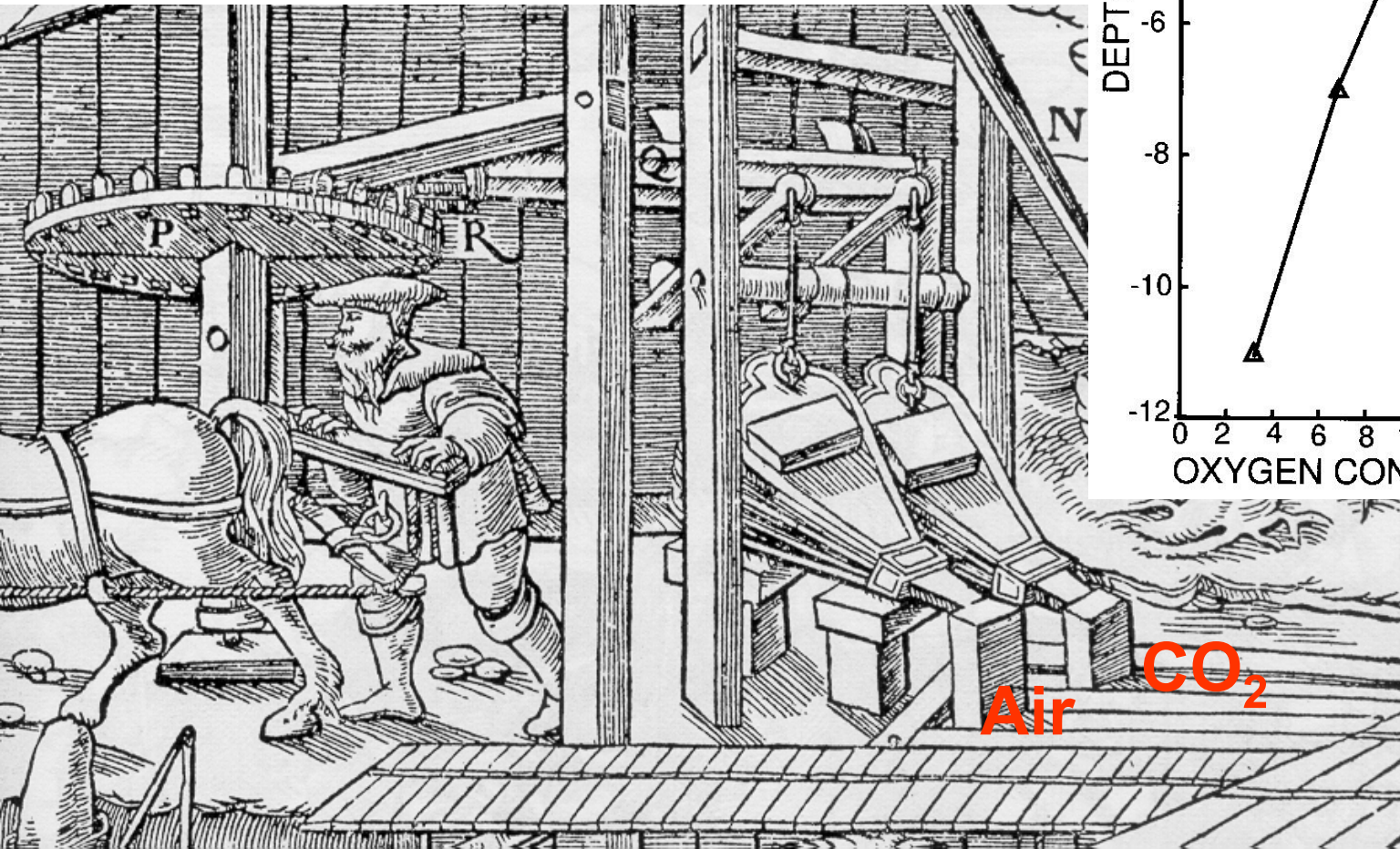
BY

HERBERT CLARK HOOVER

A. B. Stanford University, Member American Institute of Mining Engineers,
Mining and Metallurgical Society of America, Société des Ingéniéurs
Civils de France, American Institute of Civil Engineers,
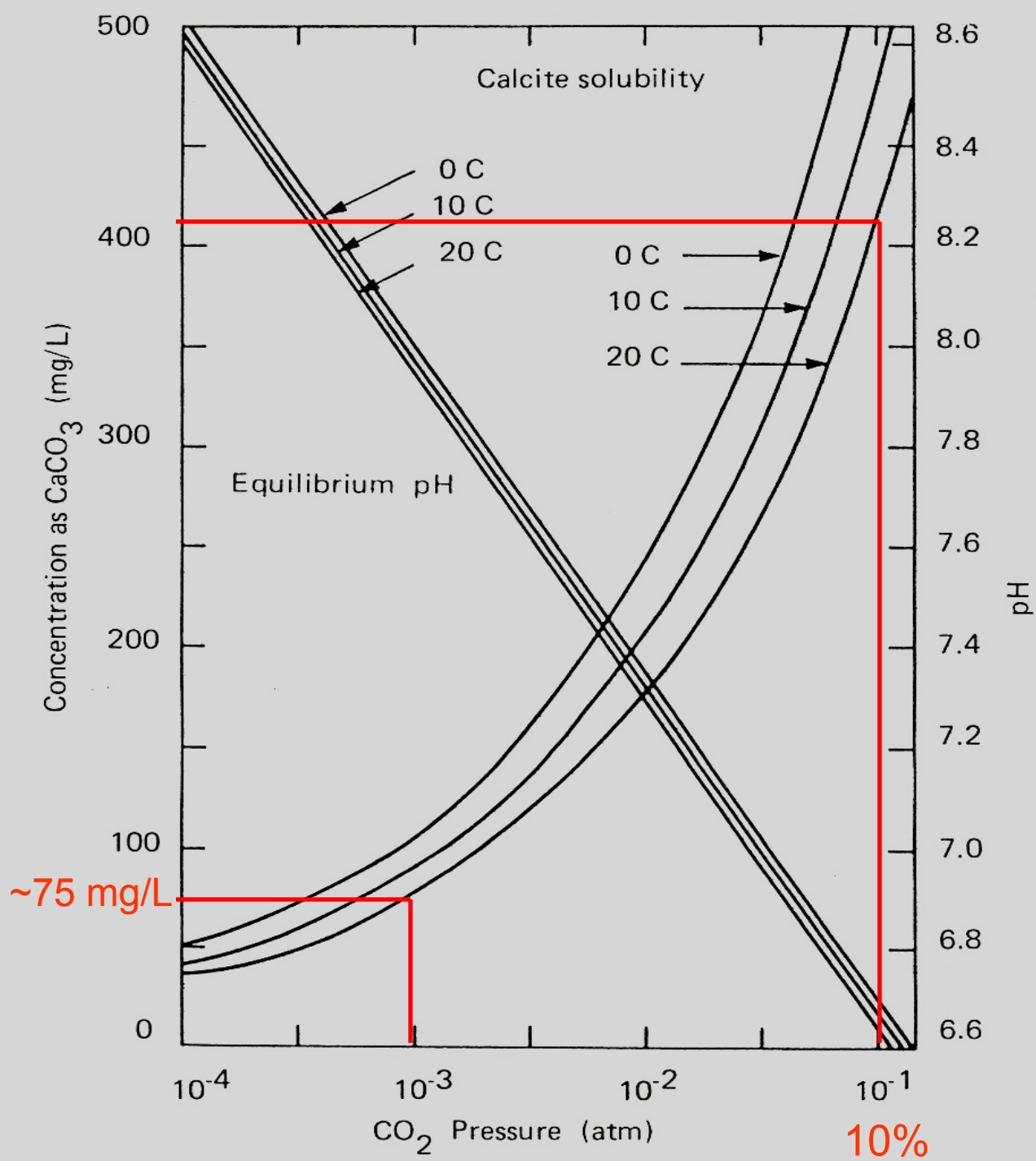Fellow Royal Geographical Society, etc., etc.
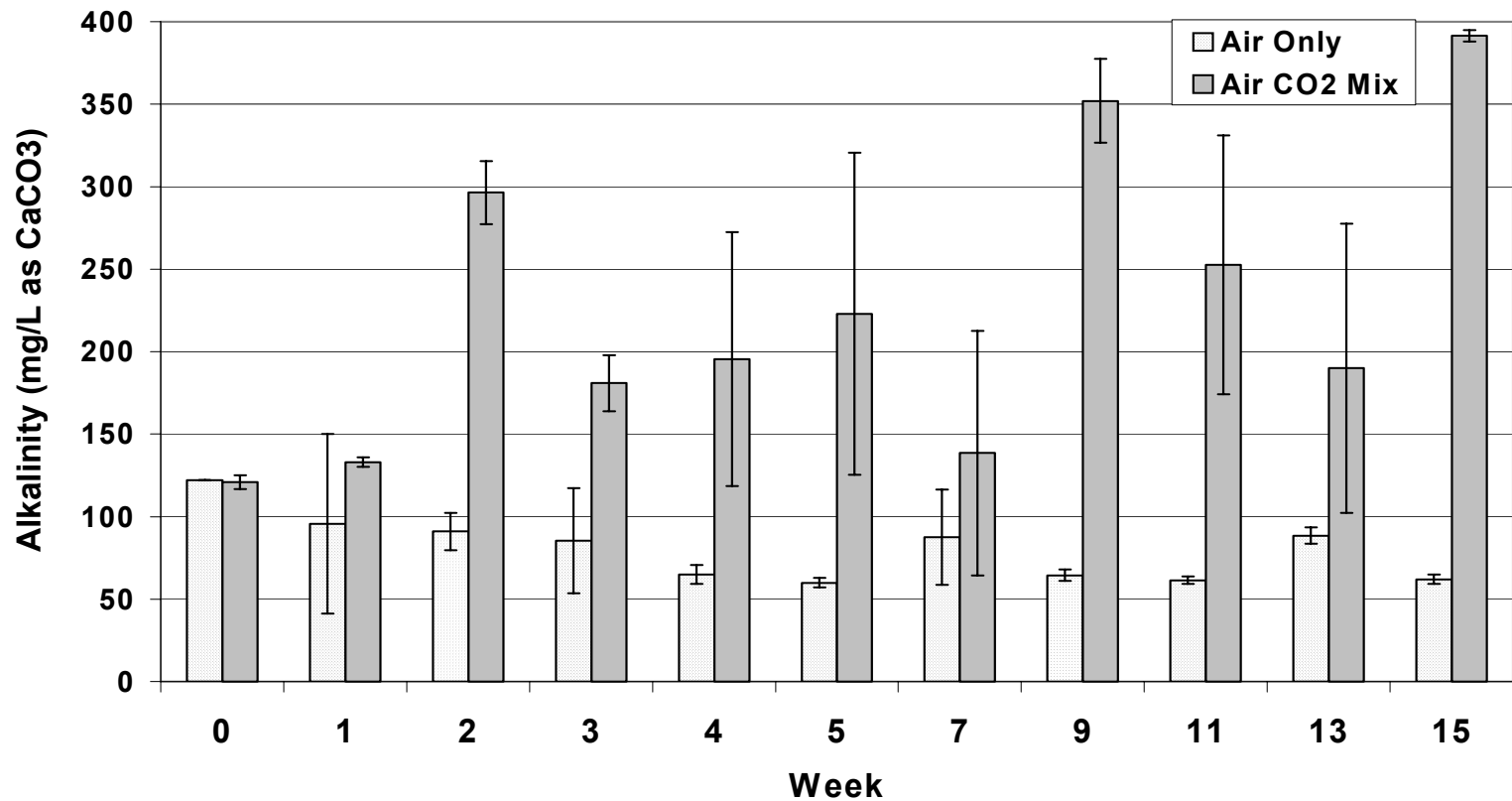
AND

LOU HENRY HOOVER

A. B. Stanford University, Member American Association for the
Advancement of Science, The National Geographical Society,
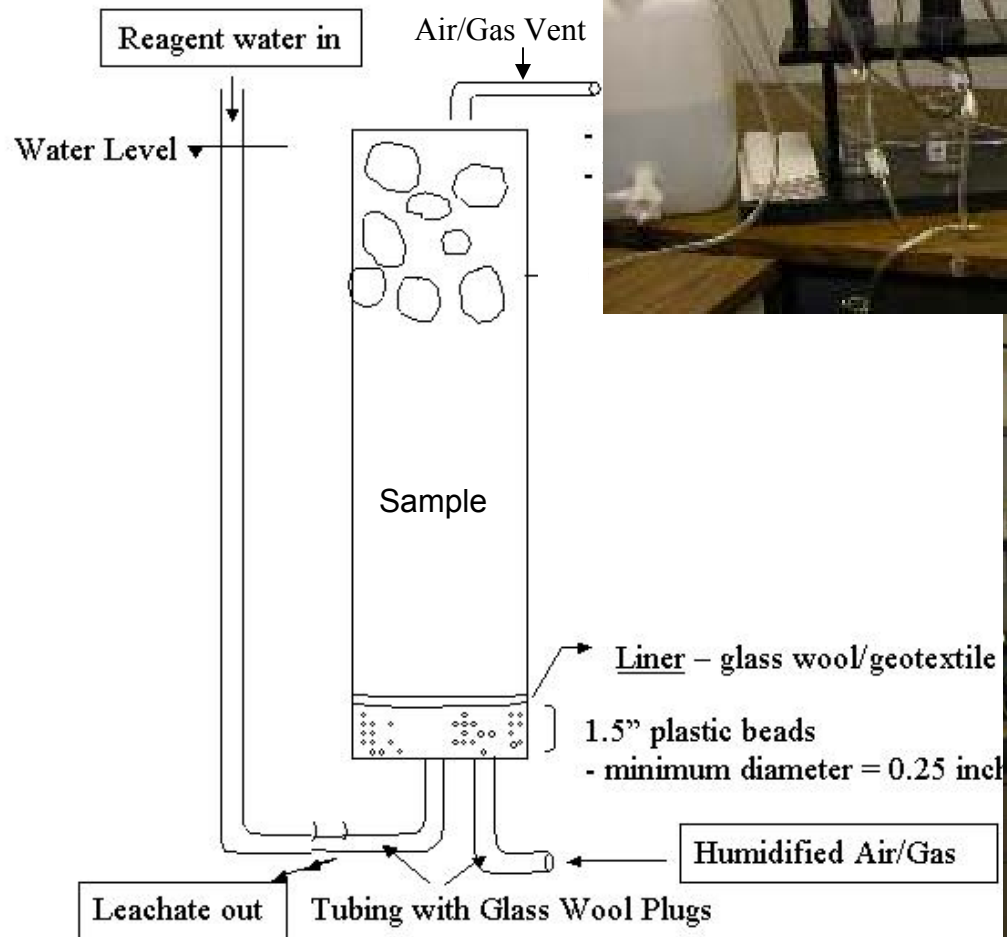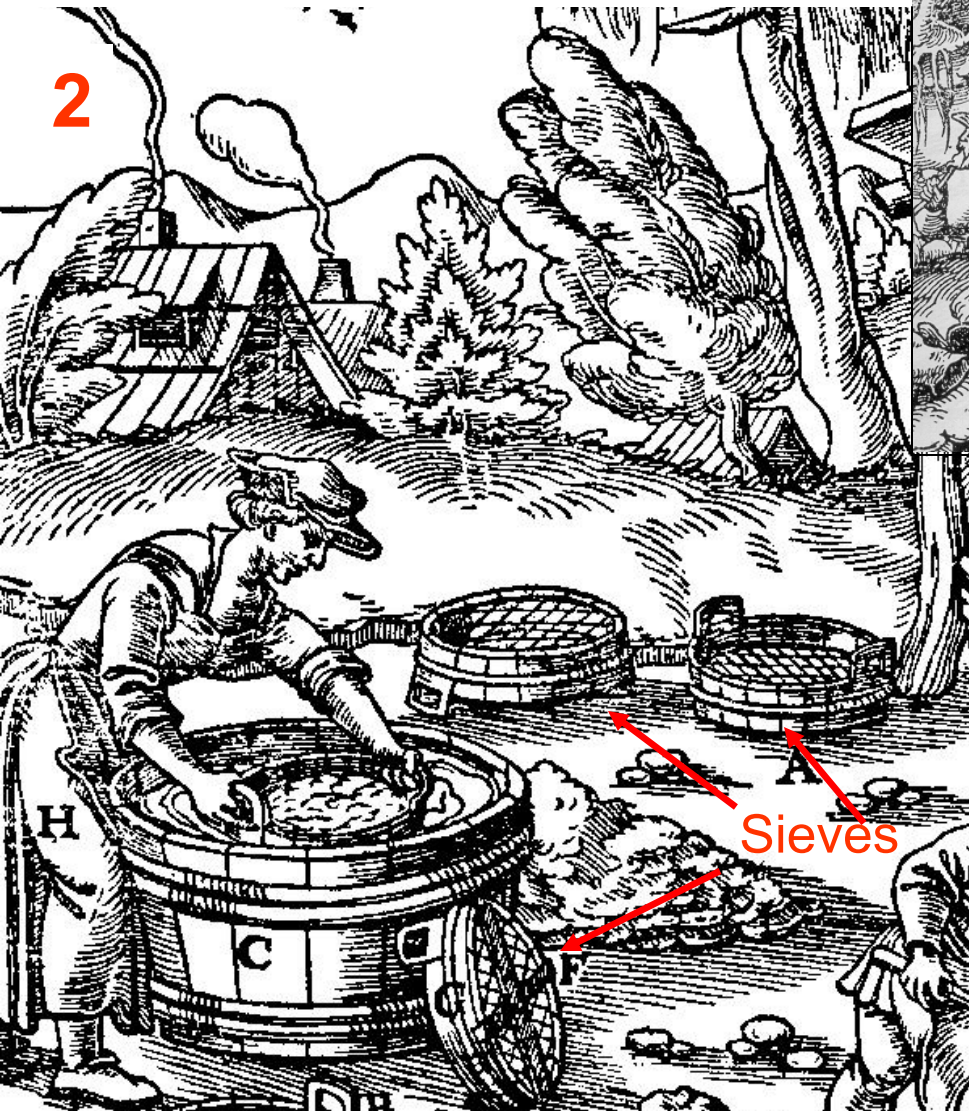Royal Scottish Geographical Society, etc., etc.

Improvement
Increase Pco$_2$

MINE 1: Borehole N-2

OXYGEN CONCENTRATION (vol%)

DEPTH (m)

O$_2$

CO$_2$

Air **CO$_2$**

Calcite solubility

Concentration as CaCO$_3$ (mg/L)

0 C
10 C
20 C

0 C
10 C
20 C

Equilibrium pH

pH

~75 mg/L

CO$_2$ Pressure (atm)

10%

Results from 2002: CO$_2$ Mix, Higher Alkalinity

Leaching Column (Flexibility)

Reagent water in

Air/Gas Vent

Water Level ▼

Sample

Liner – glass wool/geotextile

1.5" plastic beads
- minimum diameter = 0.25 inch

Humidified Air/Gas

Leachate out   Tubing with Glass Wool Plugs

Particle Size Distribution & Surface Area

Sieves

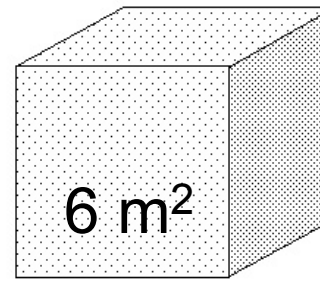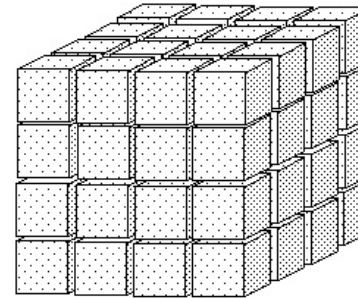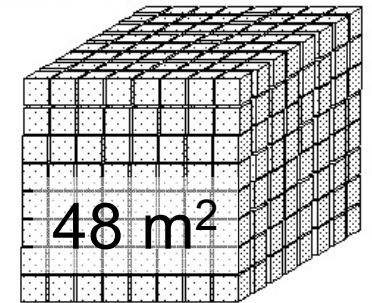| Sieve Size mm	Percent of Total Weight
9.52	0
4.76	40
2.00	25
1.19	10
0.50	10
0.25	5
<0.25	10

Surface Area

1 m

6 m²
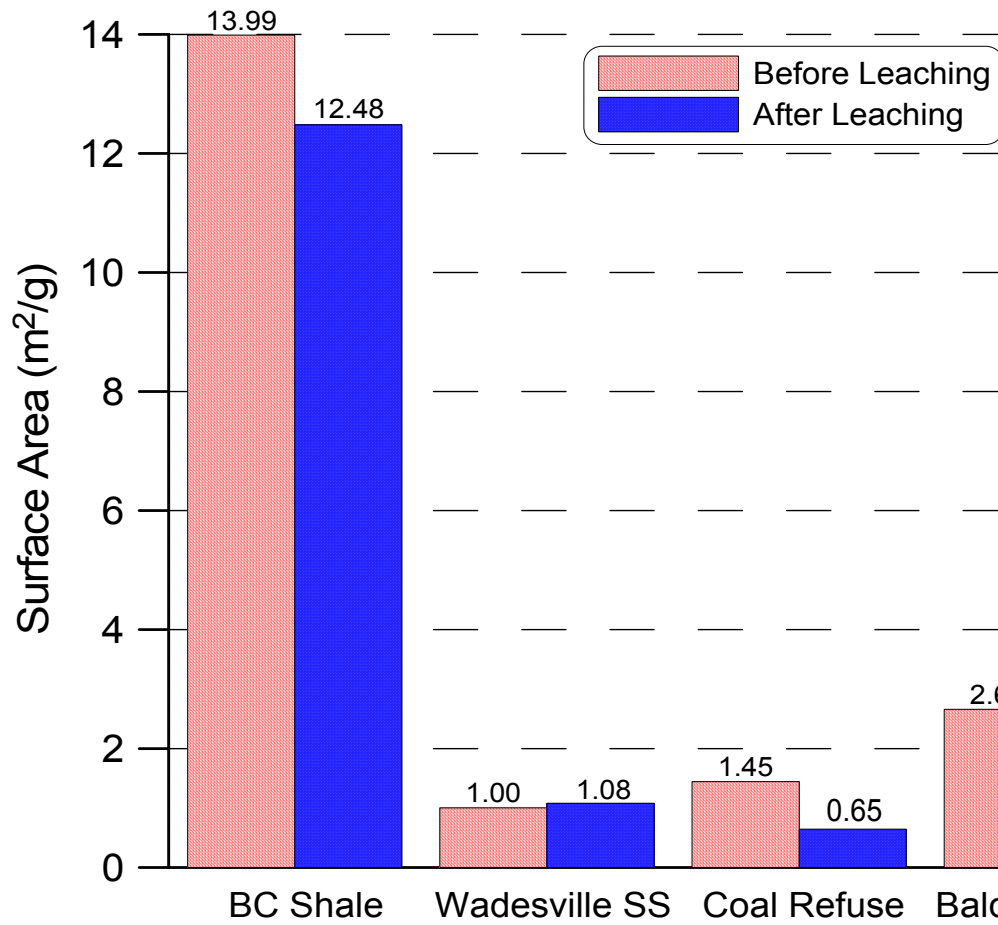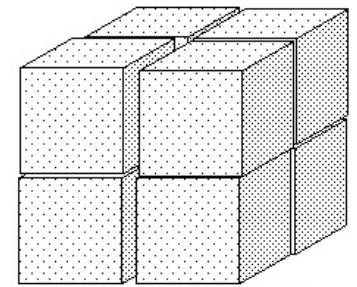
Pieces half the original size.
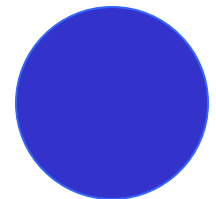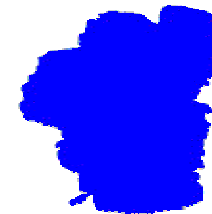Twice the surface area

Pieces one quarter the original size.
Four times the surface area

LBR 3/2002

48 m²

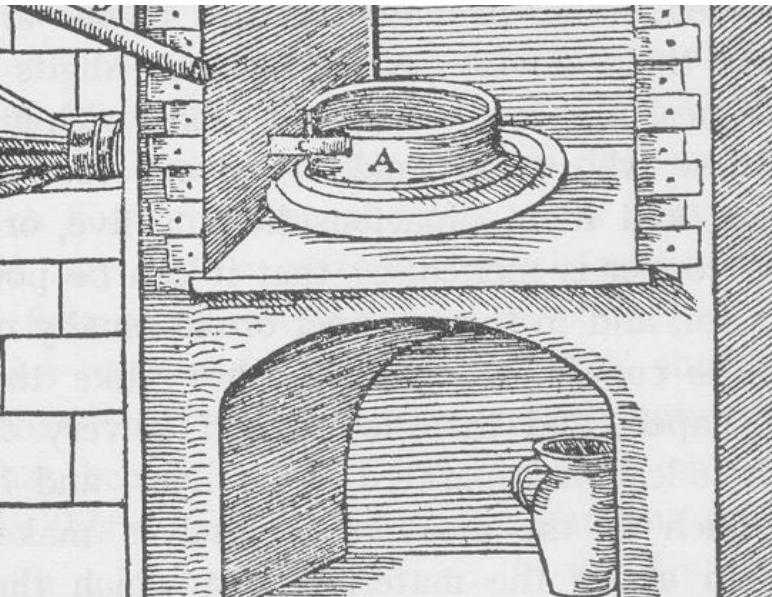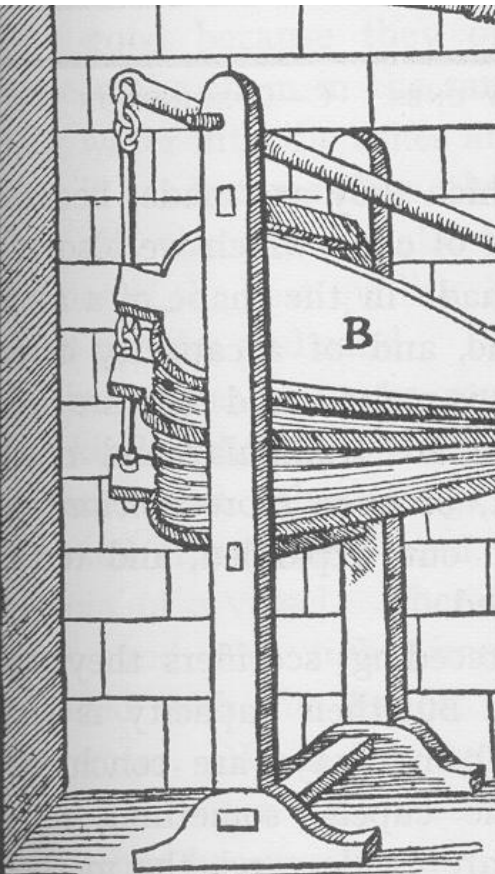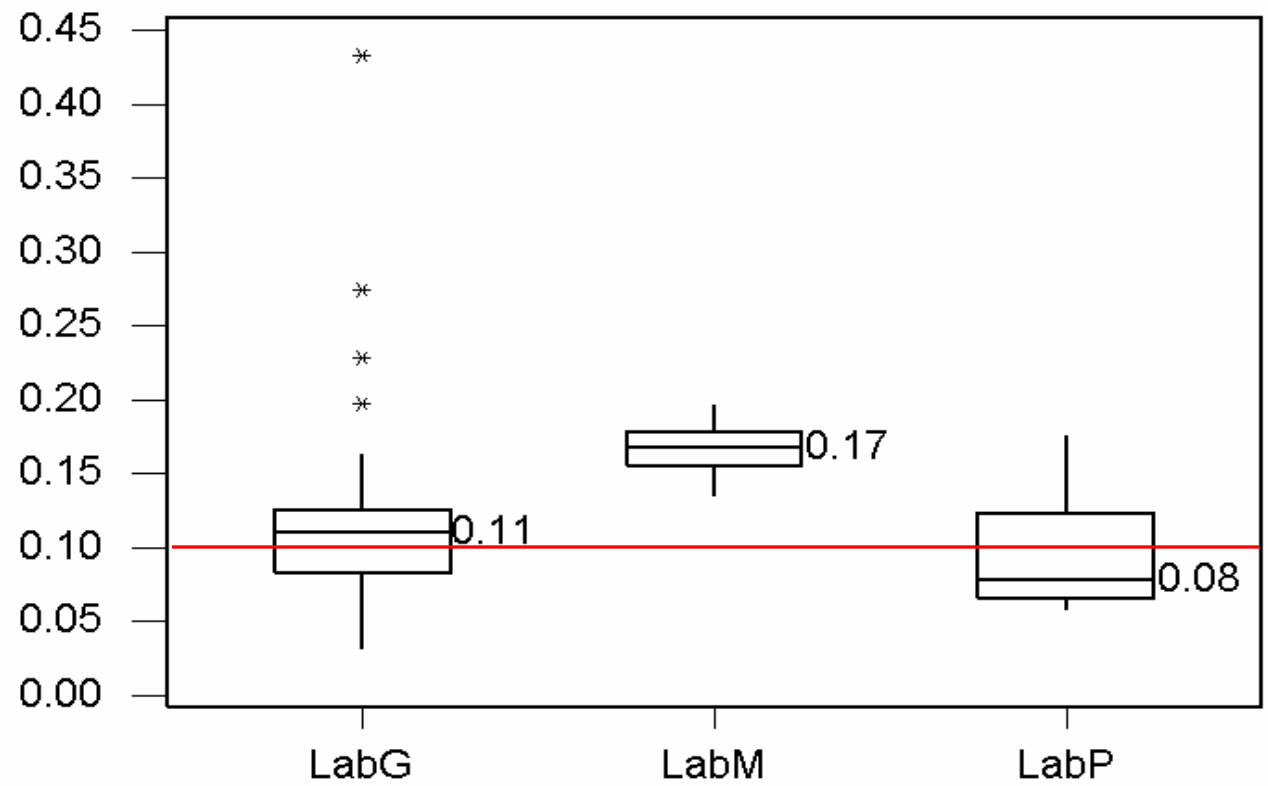Pieces one eighth the original size.
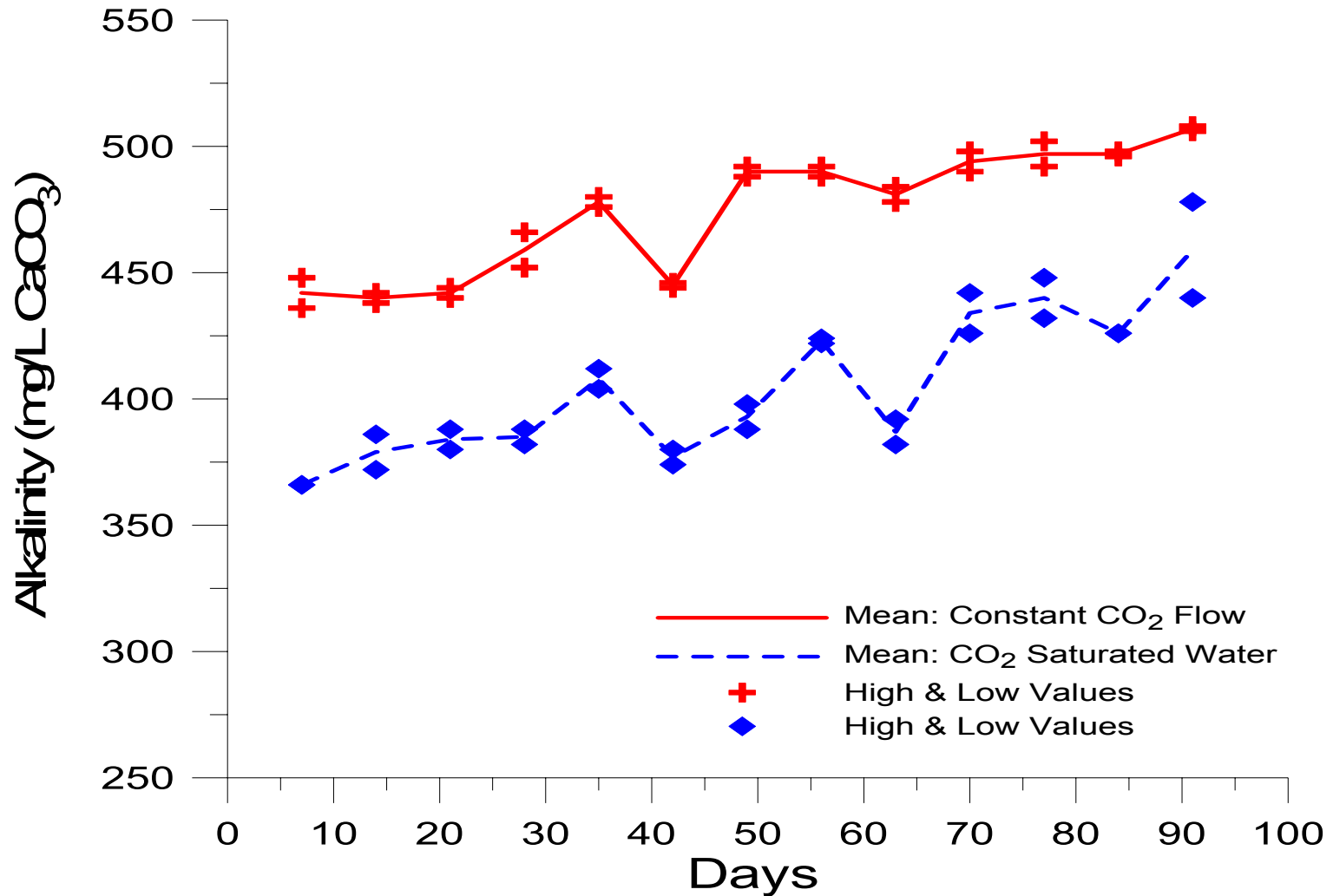Eight times the surface area

Particle Size

Surface Area (m²/g)

Before Leaching
After Leaching

	Before Leaching	After Leaching
BC Shale	13.99	12.48
Wadesville SS	1.00	1.08
Coal Refuse	1.45	0.65
Bald Eagle SS	2.66	

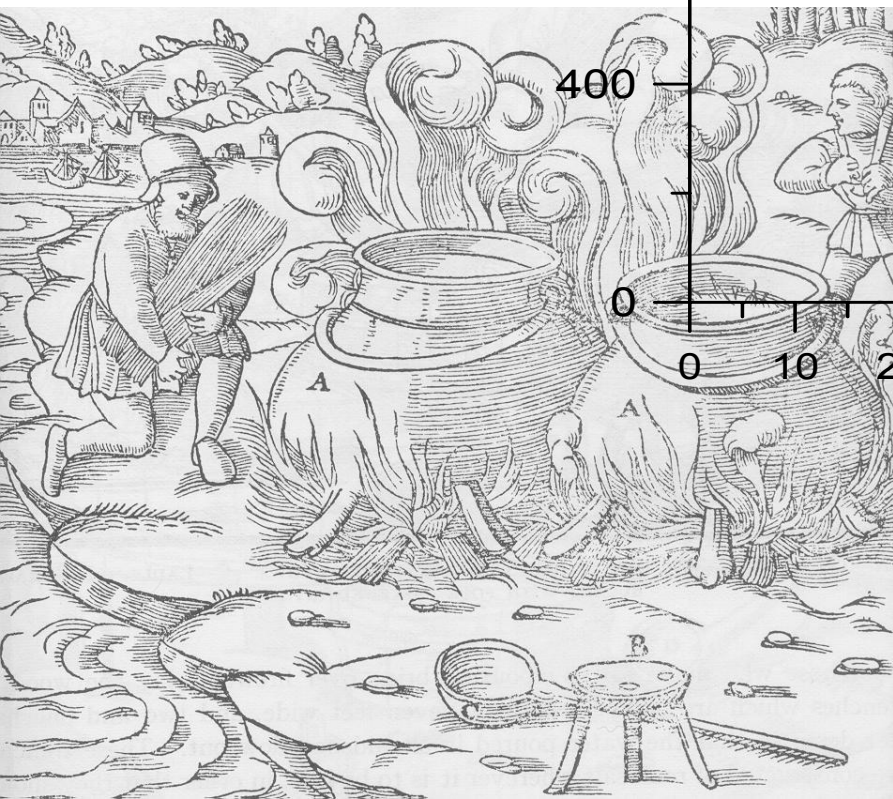## Shape

Partial Pressure CO$_2$

Interpretations

Carbonate Dissolution & Alkalinity Generation
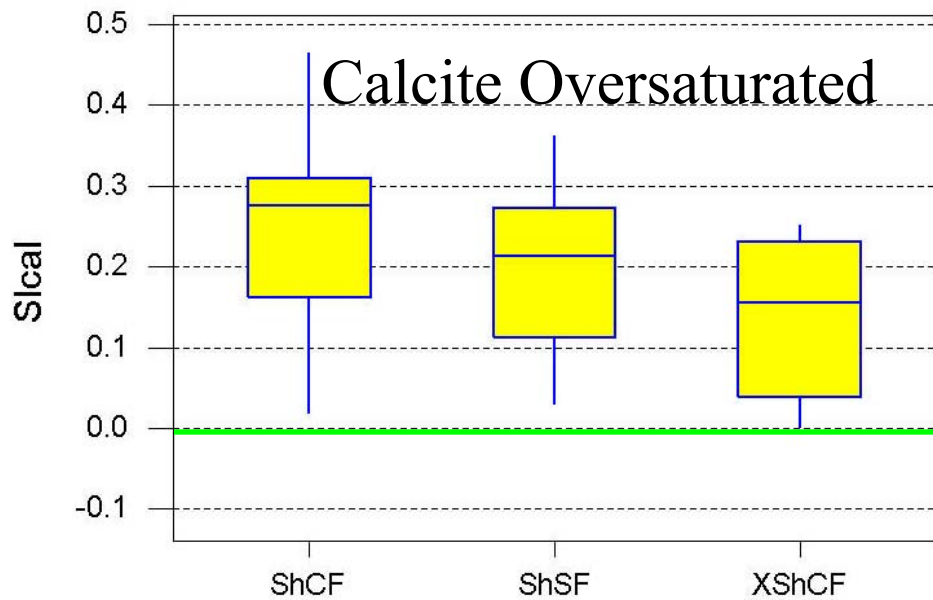
Brush Creek Shale
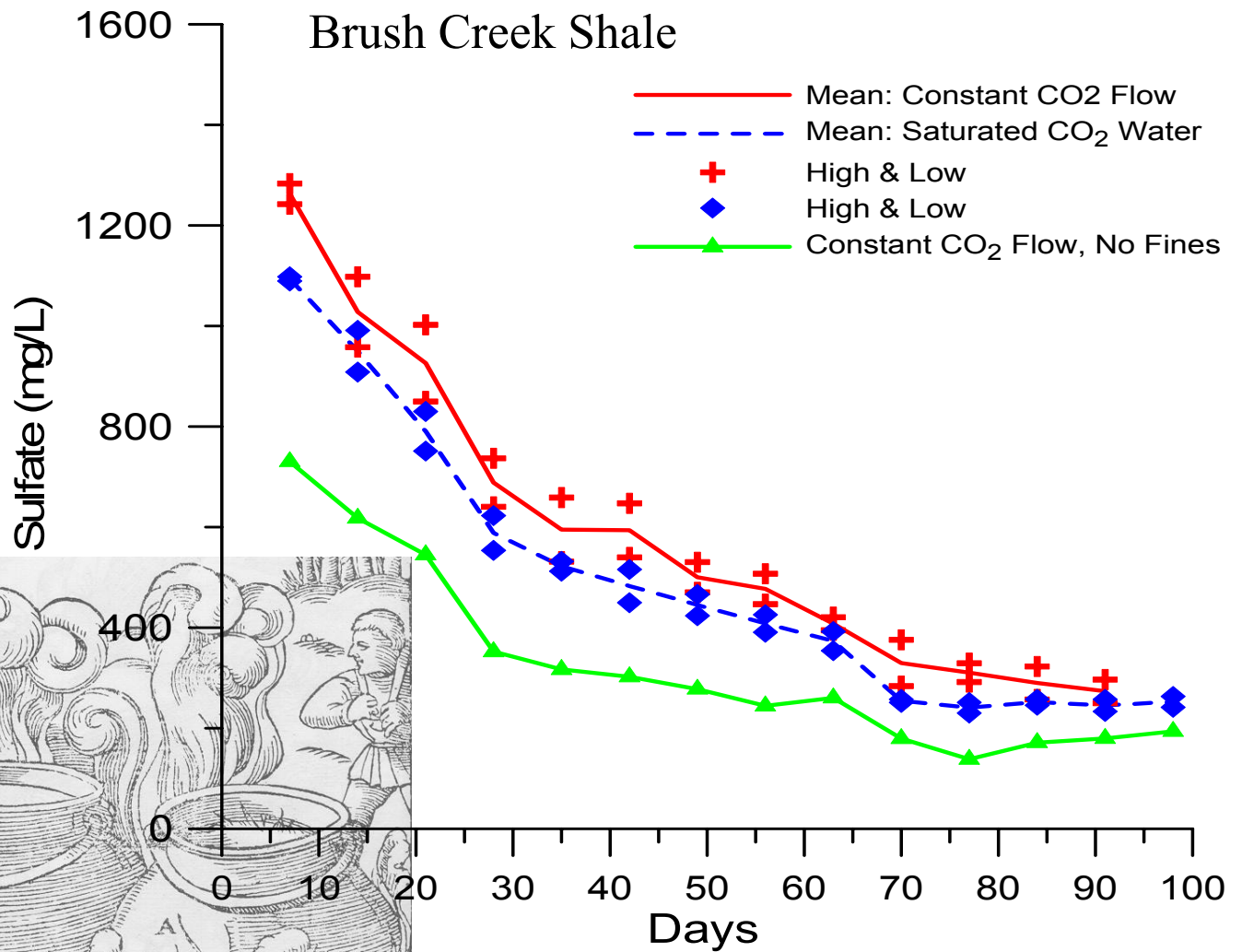
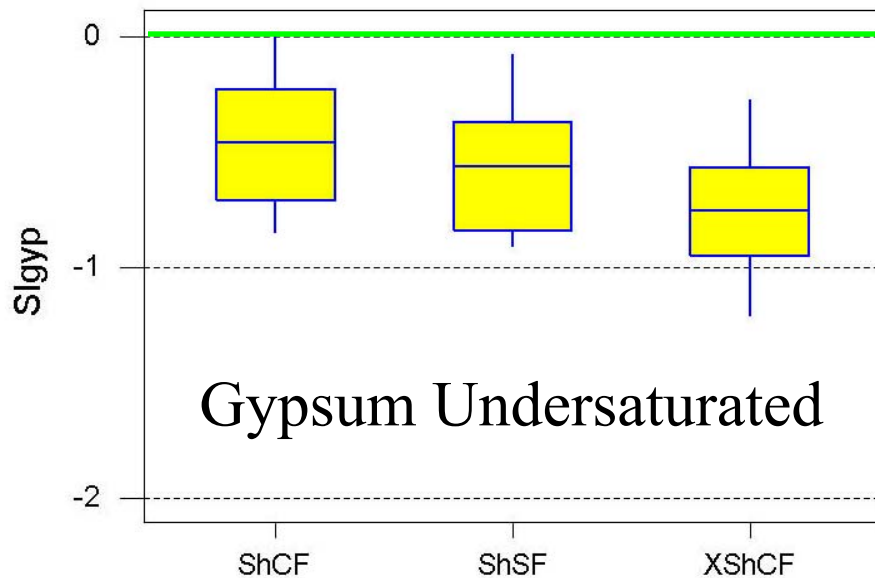Pyrite Oxidation &
Sulfate Production

Cumulative Load (Mass) of $CaCO_3$ & Sulfur
(or How much weathered each week?)

1. Calculated Mass of **Sulfur** and **$CaCO_3$** in Column
using total percent sulfur (%S) and neutralization potential (NP)

2. Determined amount of **sulfur** weathered from:
   sulfate x volume of leachate*

3. Determined amount of **$CaCO_3$** weathered from:
   (HCO_3 + alkalinity neutralized) x volume of leachate.
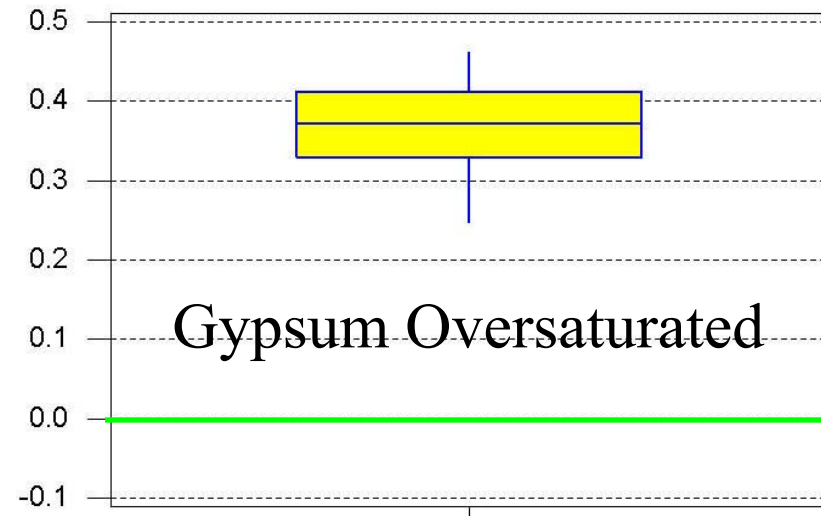   Alkalinity neutralized calculated from SO_4*

* For this to work must be undersaturated w/ respect to gypsum

Calcite Oversaturated
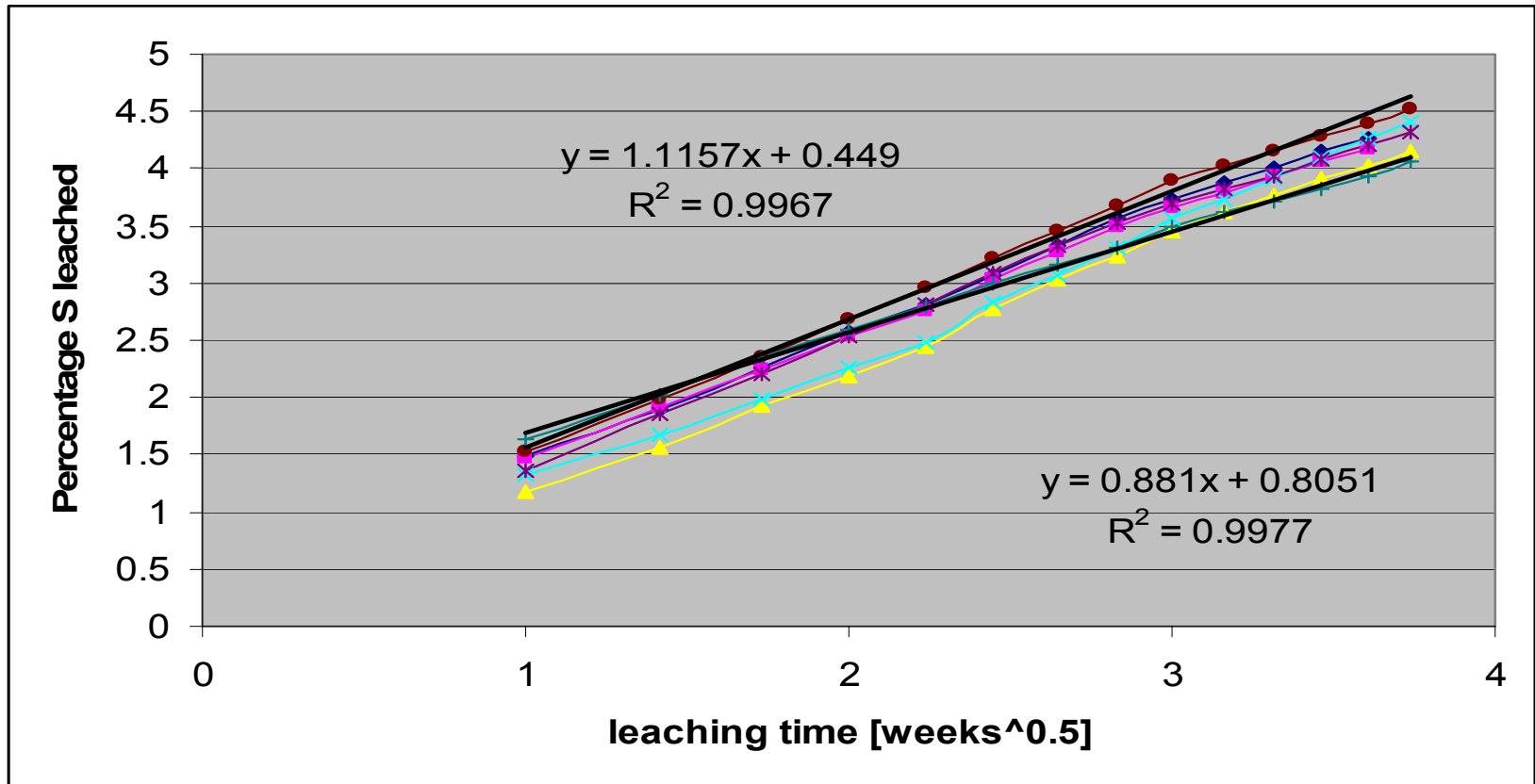
Brush Creek Shale

Gypsum Undersaturated

Effects of Solubility on Interpretations
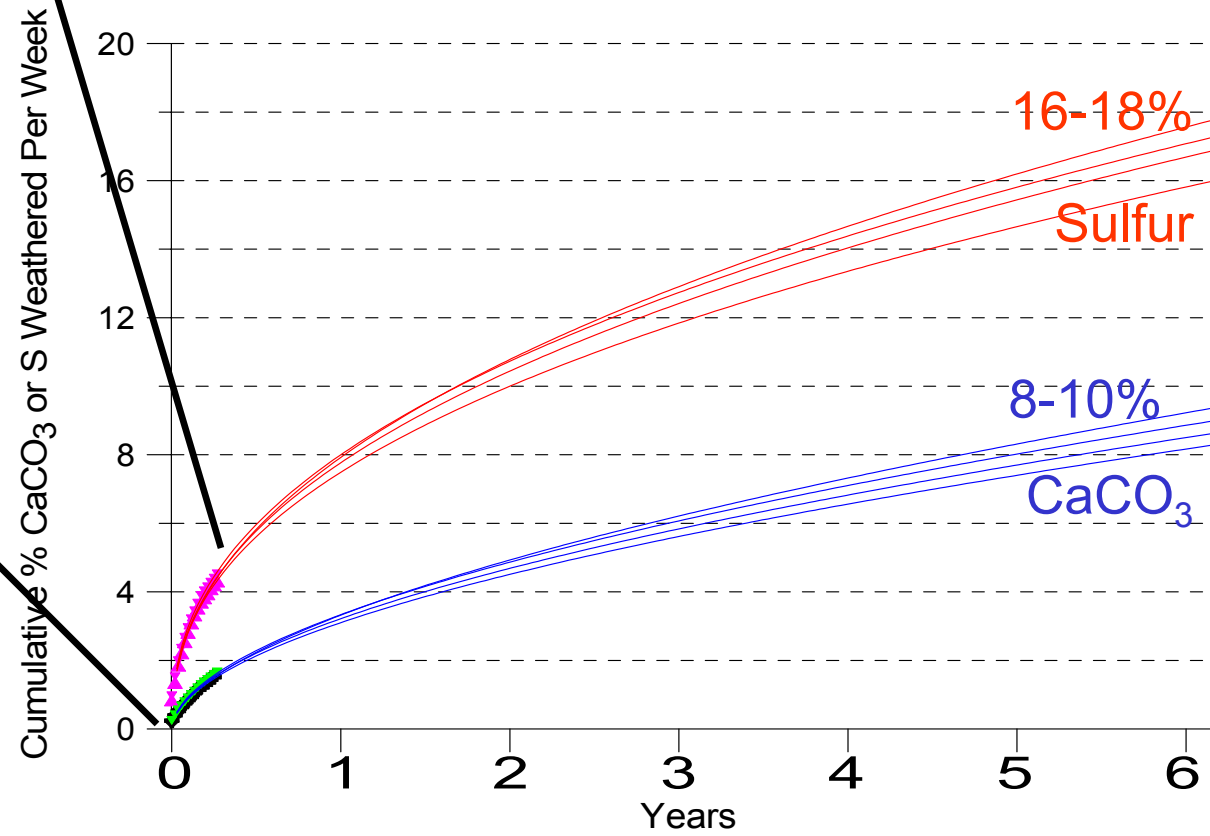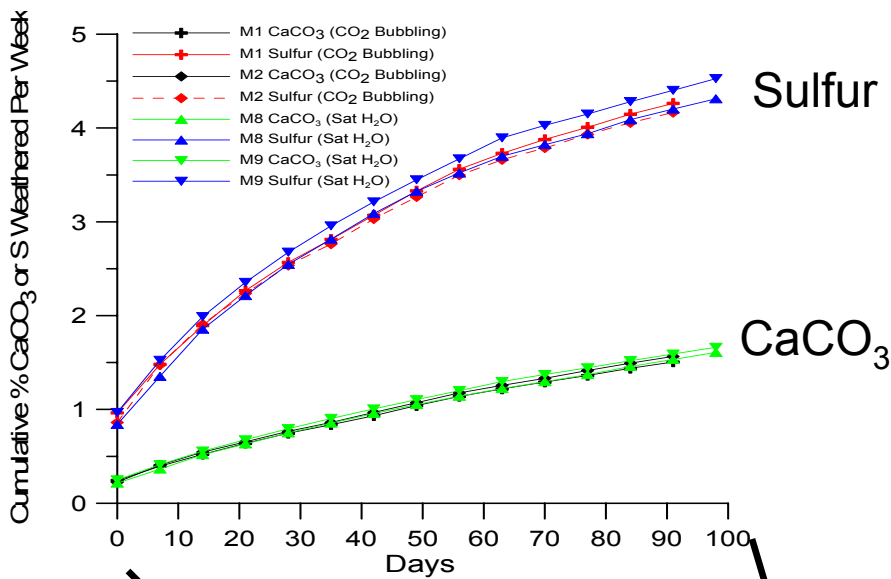
Gypsum Oversaturated

Determine Saturation Indices

Brush Creek Pyrite Oxidation
Diffusion Reaction

$$N_S \;\; = \;\; K\,t^{1/2} + F$$

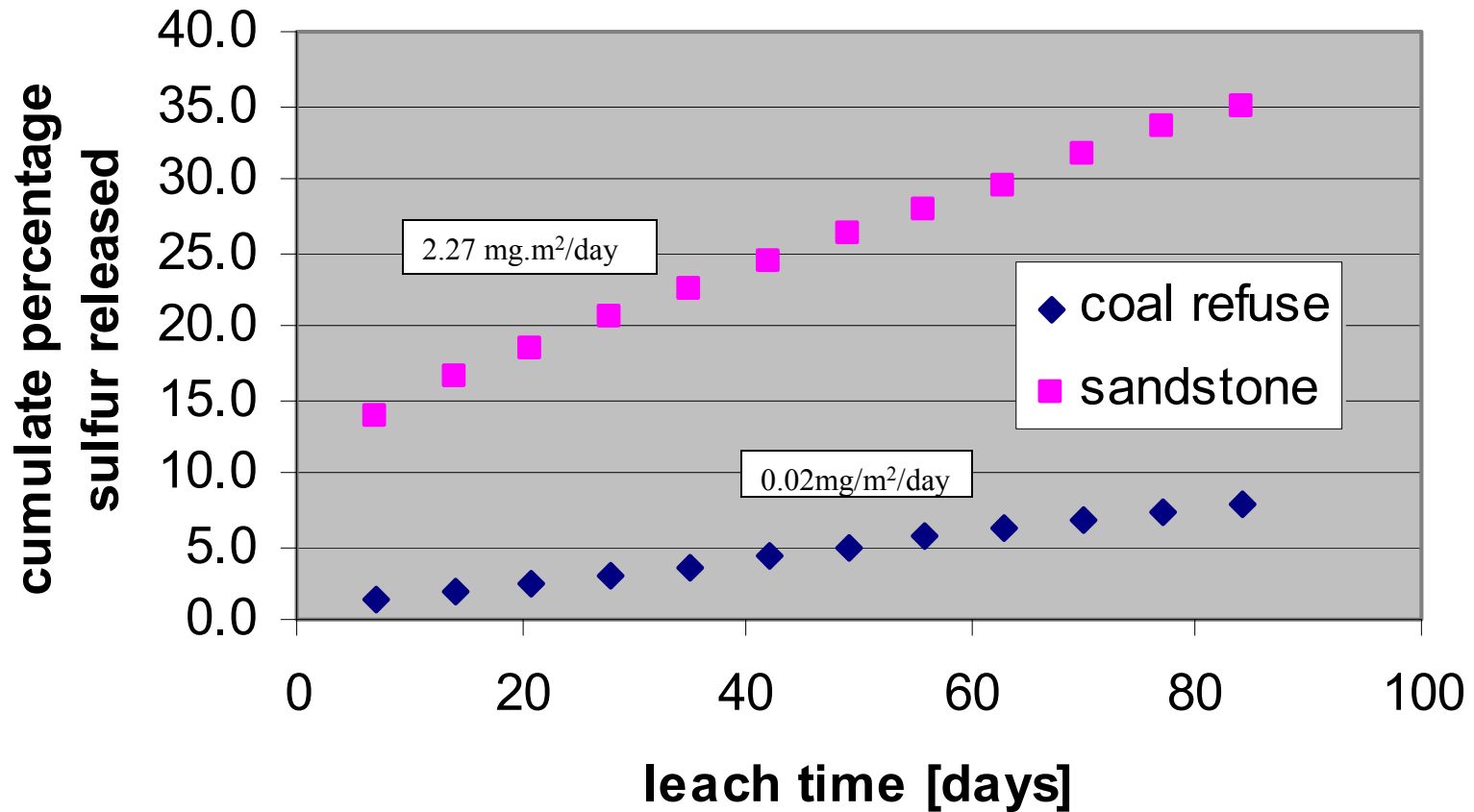Brush Creek Shale
Predicting Water
Chemistry into
the Future

Hydrothermal
Pyrite

Pyrite Veins

Weathering Rates of Coal Refuse & Hydrothermal Pyrite

2.27 mg.m²/day

coal refuse

sandstone

0.02mg/m²/day

cumulate percentage sulfur released

leach time [days]

Findings

1. The ADTI-WP2 method produces concentrations of acidity, alkalinity, sulfates and metals comparable to mine environment.

2. The laboratory performance show good repeatability for duplicate samples in columns.

3. It is important to normalize the leaching data. Steps include: standardized particle size distribution; surface areas measurements, and surface area to volume ratios.

Findings, continued

4. %S leached through time for the different rocks indicate differences in leaching processes. The Brush Creek shale exhibits a square root of time dependence, which suggests a diffusion-controlled process. The coal refuse and the Bald Eagle sandstone conform to a simple linear weathering process.

5. To interpret leaching data solubility controls must be considered.

Any Questions?