Prediction of Acid-Producing Potentials for Coal Overburden and Waste by Static Geochemical Methods

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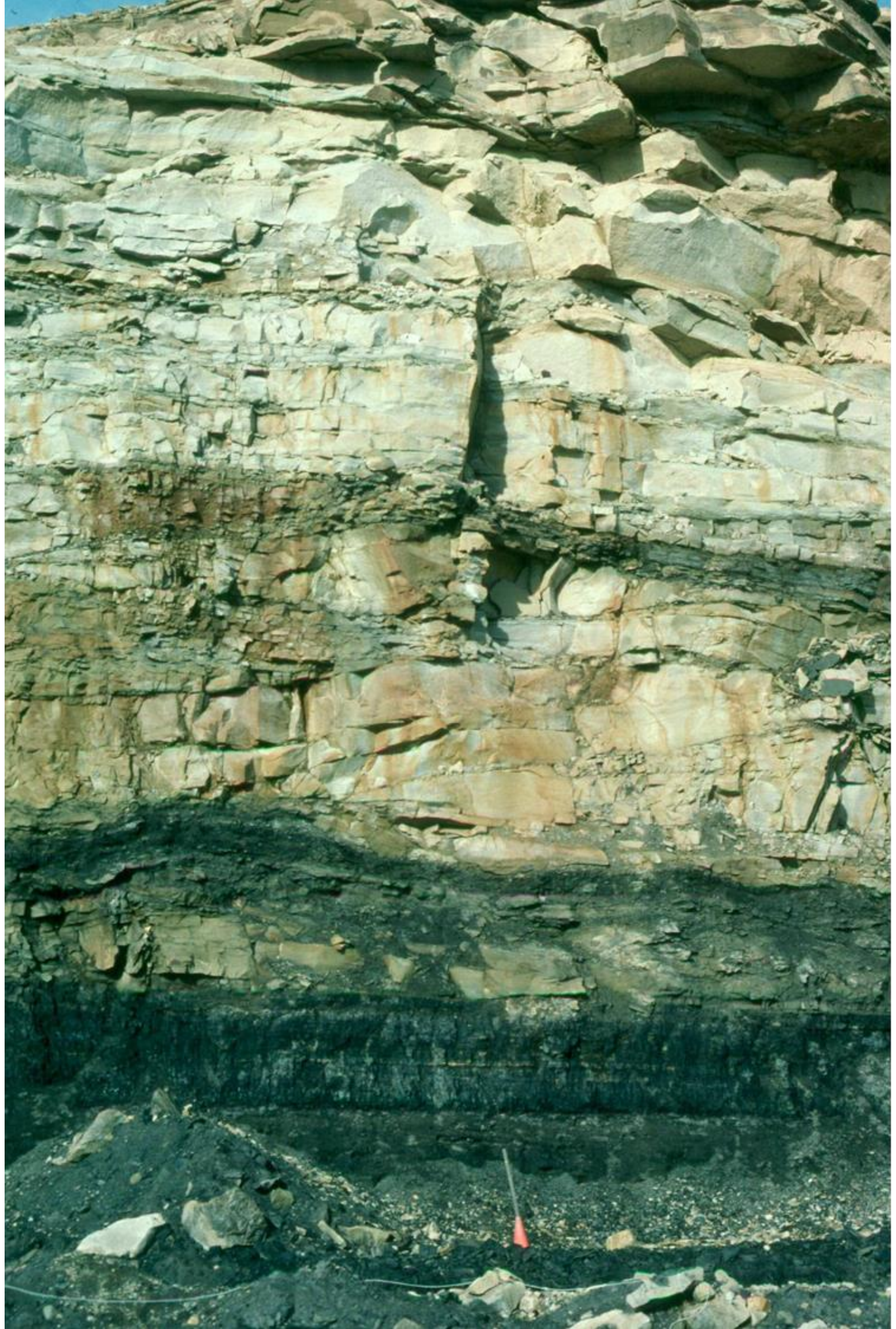


Sandstone

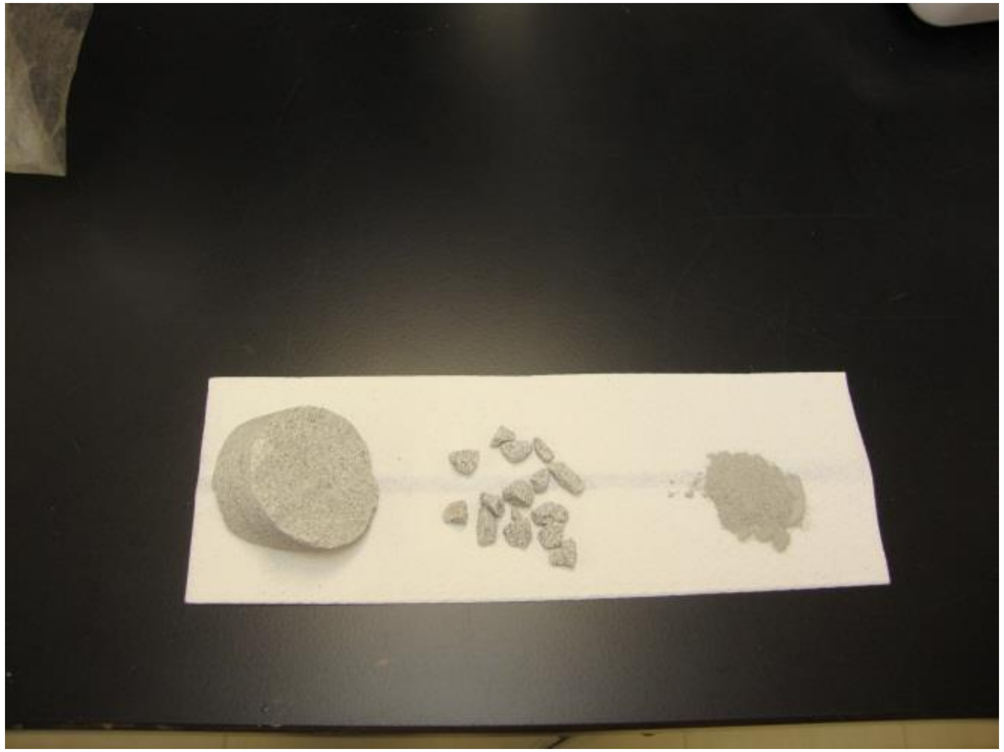
Fractured Sandstone

Shale

Black shale

Coal


COAL



Acid Base Accounting

- An operationally-defined, sample-subsampling based procedure.
- Attempts to quantify the inherent acid-producing and acid neutralizing capacity of each rock unit.
  - Especially acid-forming materials can be segregated
  - Add up (accounting) the rest

Acid Base Accounting (ABA)

NP = Neutralization Potential

\- MPA = Maximum Potential Acidity

NNP = Net Neutralization Potential

Acid-Base Accounting

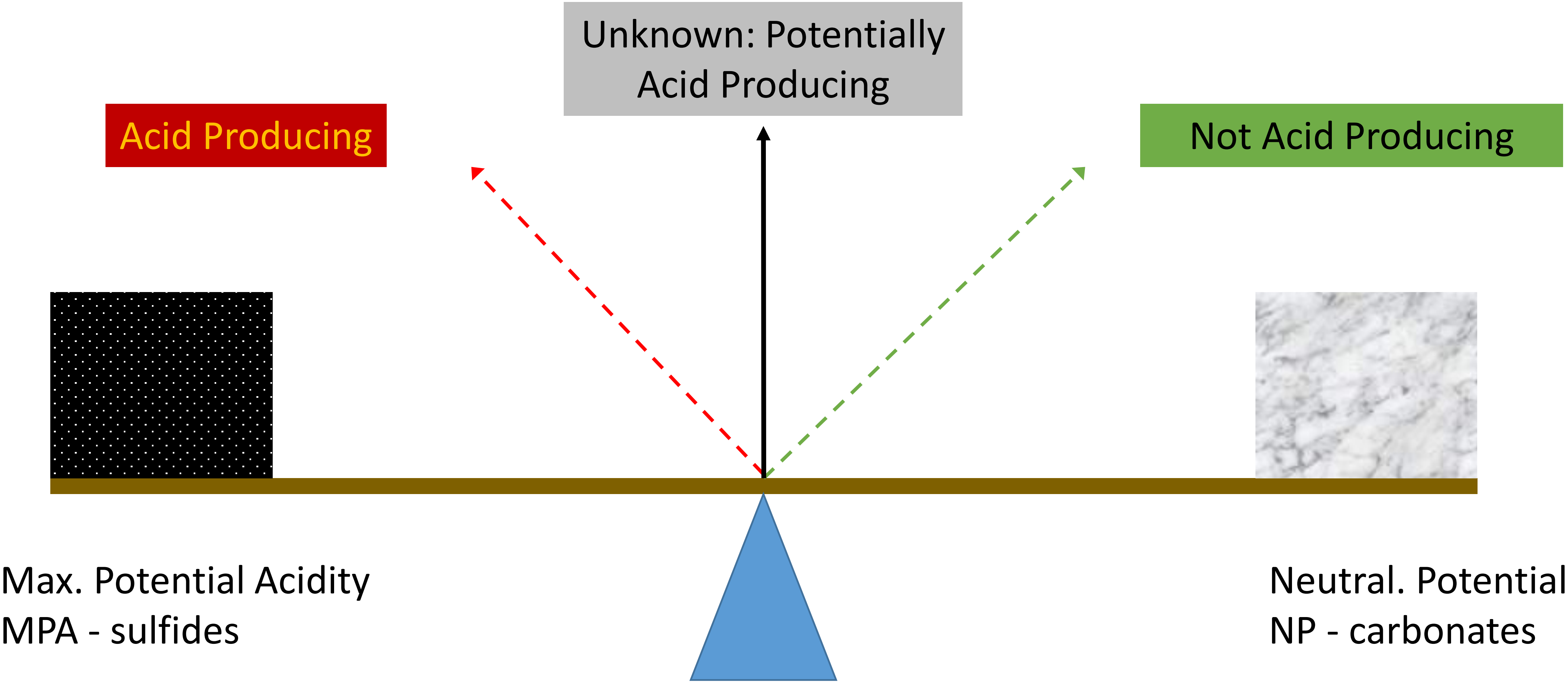
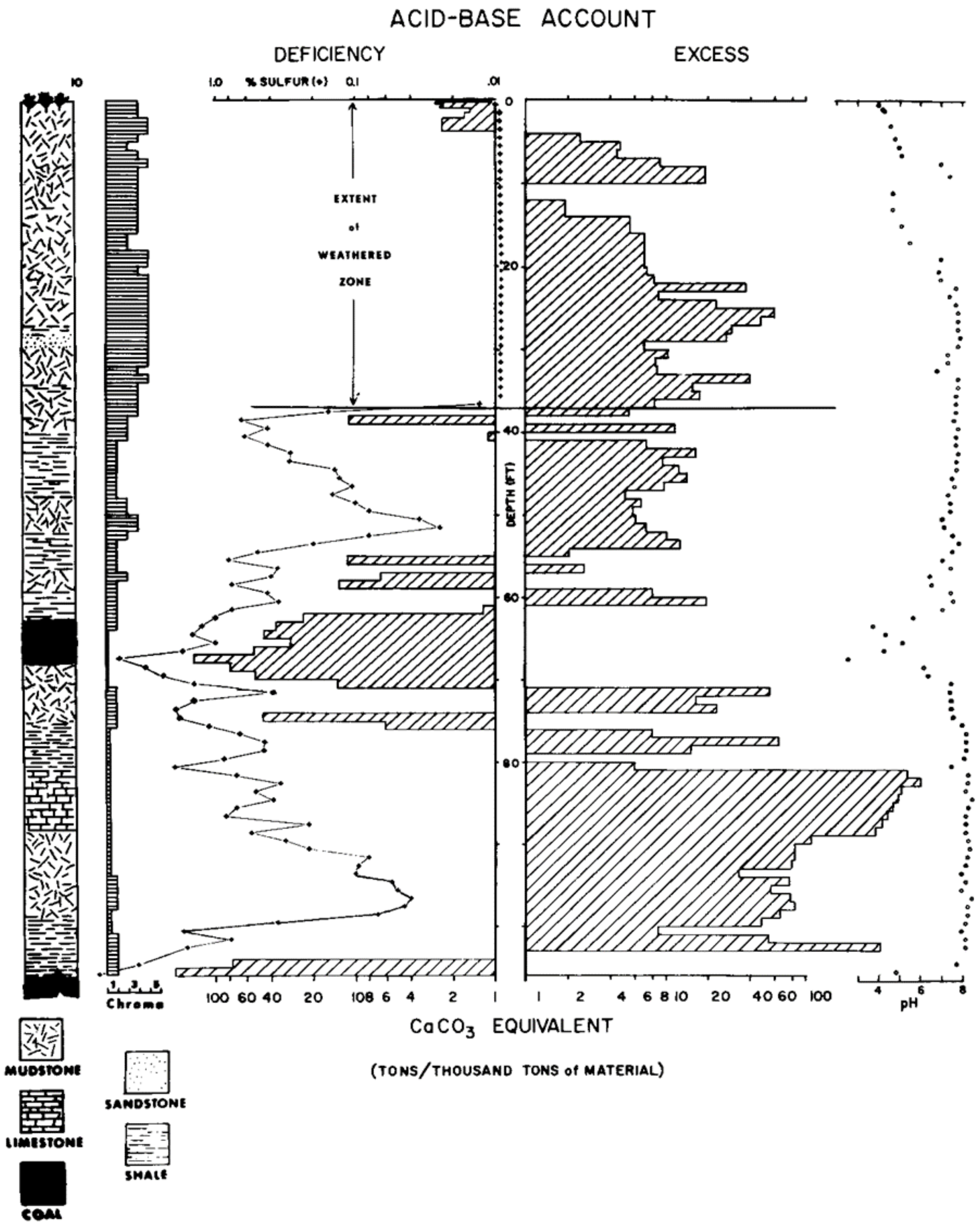


TABLE 6.2. Acid–Base Account for an Eastern U.S. Coal Mine[a]

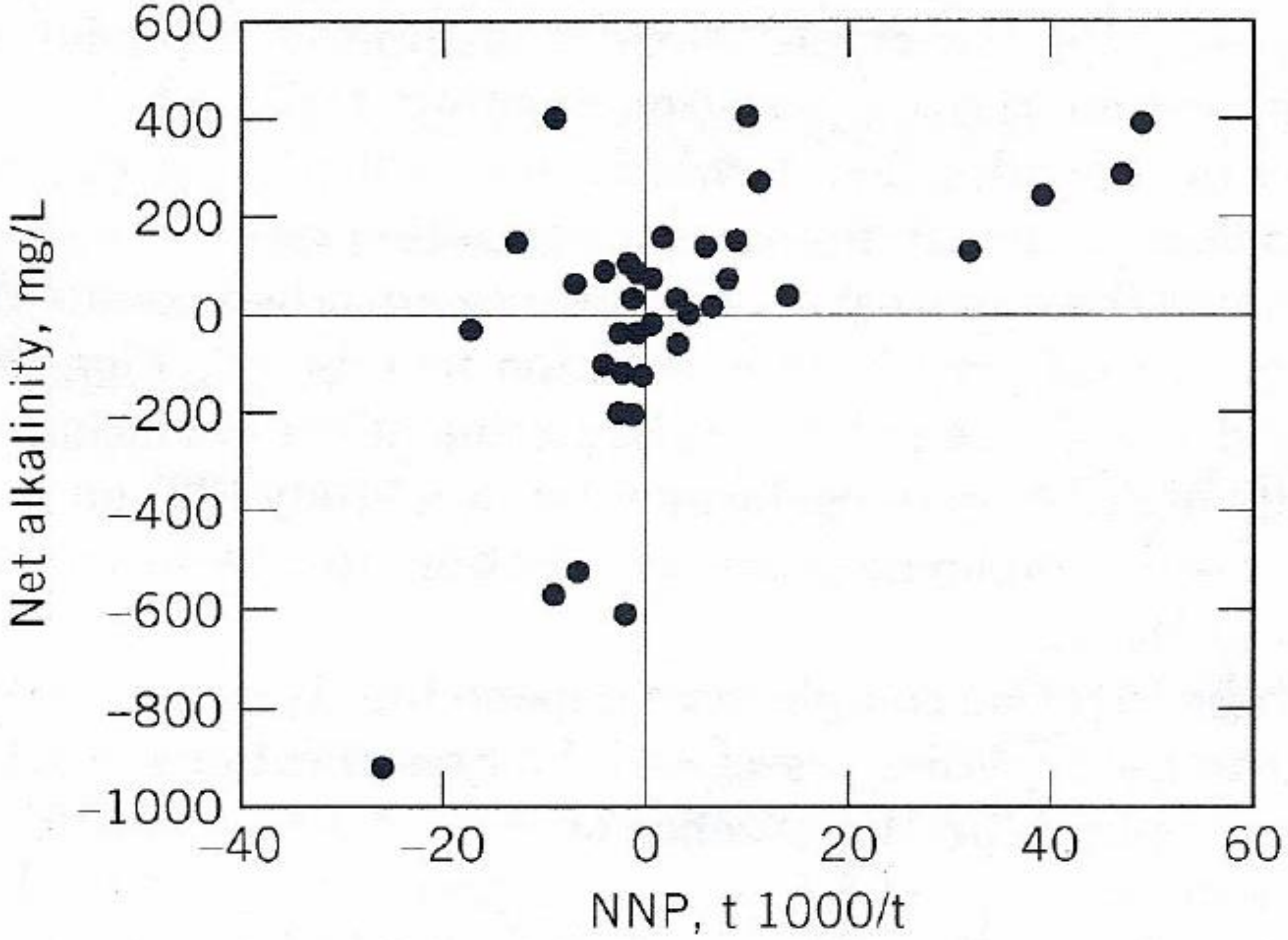
Sample No.	Thickness (ft)	Paste pH	Rock Type	Total Sulfur (%)	T in $CaCO_3$ Equivalent/1000 T Material: Maximum from Percent Total S* (Acid Potential)	Amount Present (Neutralization Potential)	Excess (+) or Deficiency (–)
1	18.0	6.1	Siltstone	<0.01		2.6	+2.6
2	23.4	7.7	Sandstone	<0.01		4.8	+4.8
3	8.6	6.2	Shale	0.09	2.8	5.7	+2.9
4	16.5	7.3	Shale	0.26	8.1	9.3	+1.2
5	6.5	7.3	Shale	0.36	11.2	23.2	+12.0
6	6.9	7.8	Sandstone	0.15	4.7	24.7	+20.0
7	10.0	8.1	Shale	0.03	1.0	22.0	+21.0
8	25.2	7.6	Shale	0.53	16.6	20.0	+3.4
9	5.8	7.4	Shale	1.90	59.4	58.0	–1.4
10	5.3	7.5	Claystone	0.95	29.8	7.8	–22.0

Source: Sobek et al., 1987.

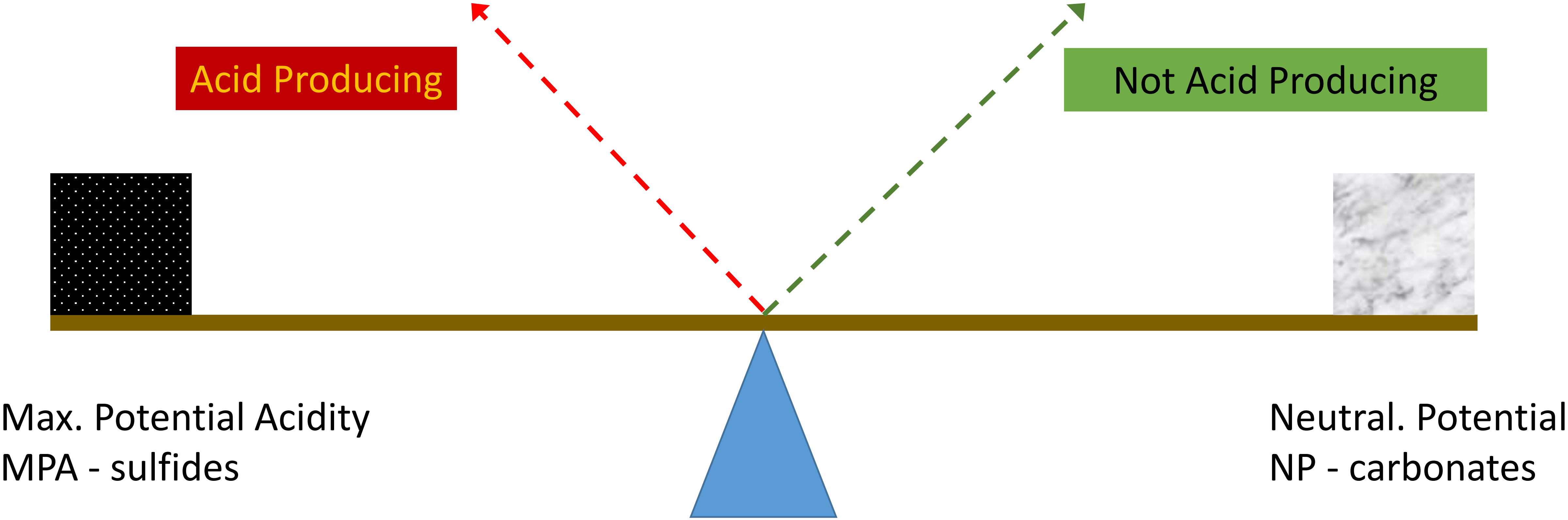
[a]Net for section = [(+713.14) + (–124.72)]/126 = +4.67 T $CaCO_3$ equivalent/1000 T material.



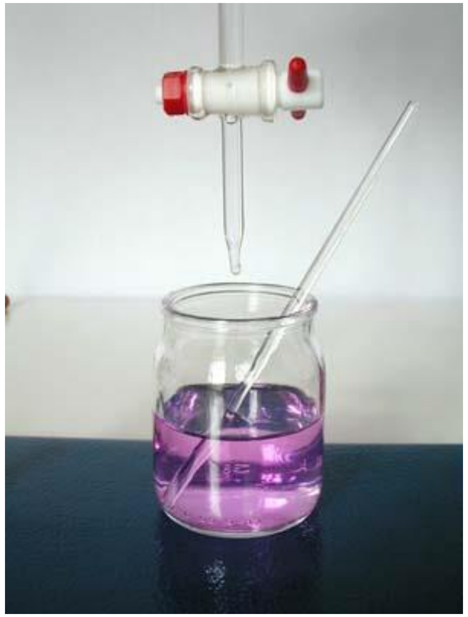
ACID-BASE ACCOUNT
DEFICIENCY
EXCESS
% SULFUR (+)
EXTENT of WEATHERED ZONE
DEPTH (FT)
Chroma
CaCO3 EQUIVALENT
(TONS/THOUSAND TONS of MATERIAL)
pH
MUDSTONE
LIMESTONE
COAL
SANDSTONE
SHALE

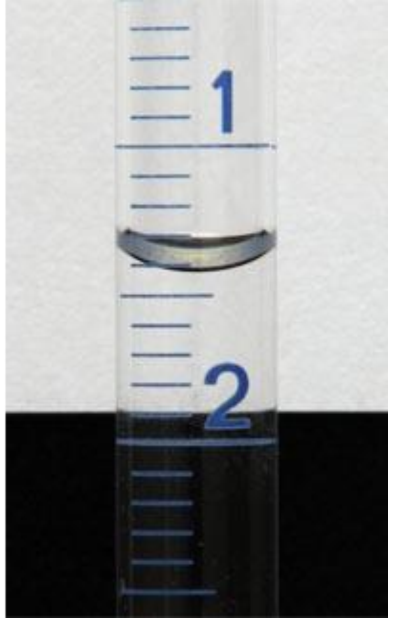

600
400
200
0
−200
−400
−600
−800
−1000
Net alkalinity, mg/L
−40
−20
0
20
40
60
NNP, t 1000/t

Acid-Base Accounting



ABA Method Improvements - Autotitration





ABA Method Improvements – Siderite ($FeCO_3$)

- Fe^{2+} → oxidation, hydrolysis =acid production
- CO_3^{2-} → acid neutralization

- Net effect = 0

- Solution = introduce another step (boil)

How to measure

Maximum Potential Acidity (MPA) → %S

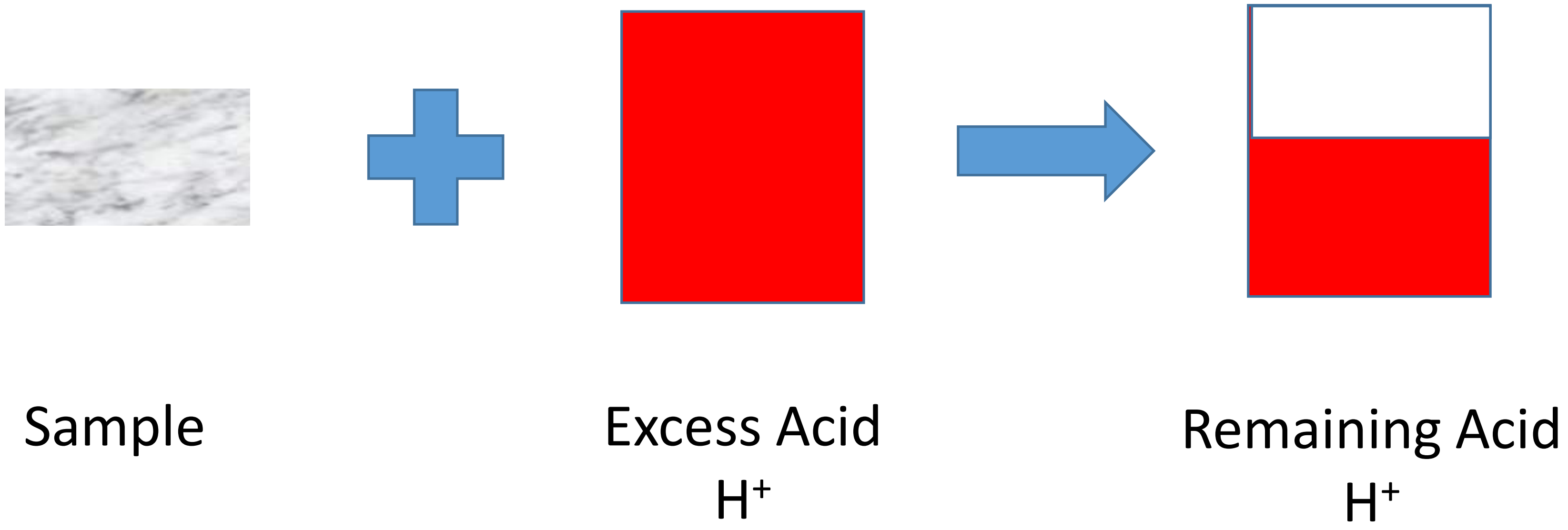
- %S x 31.25 = MPA (t/1000t)
- ASSUMPTION: All sulfur is pyritic
- Eastern Coal region ~ 0 – 2%
- Adequate Soil S for plant growth ~0.2% → none of which is pyritic!

Sample	% Pyritic S
PO 2	4
PO 1	55
MKO 1	57
MKO 2	78
UFO	87
LKO	97

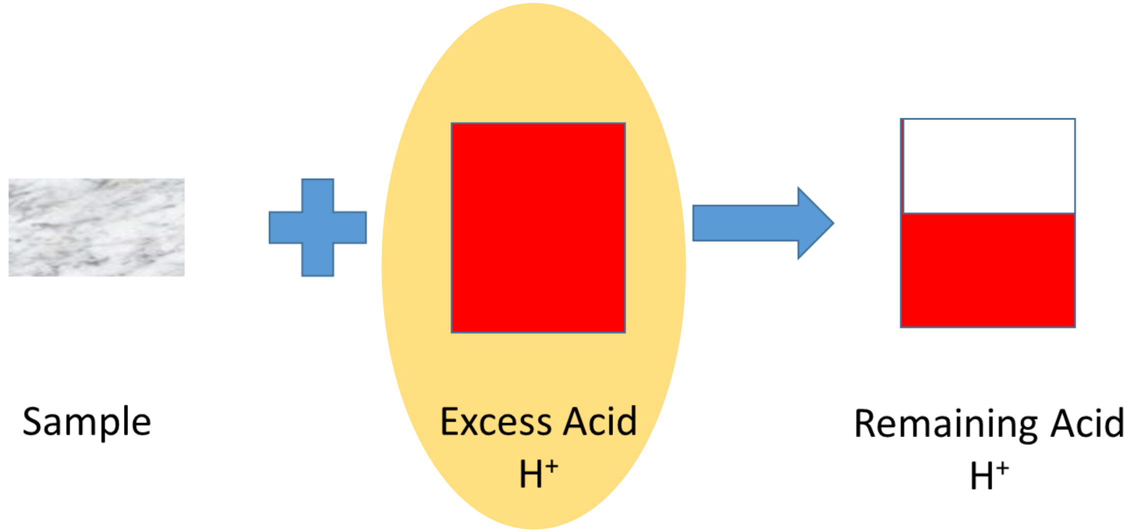
How to measure

Neutralization Potential (NP) → primarily carbonates

- One approach: titrate sample with acid until it stops dissolving
- Better approach: dissolve sample in excess strong acid, titrate with base whatever remains



But . . . .what is “excess” acid?



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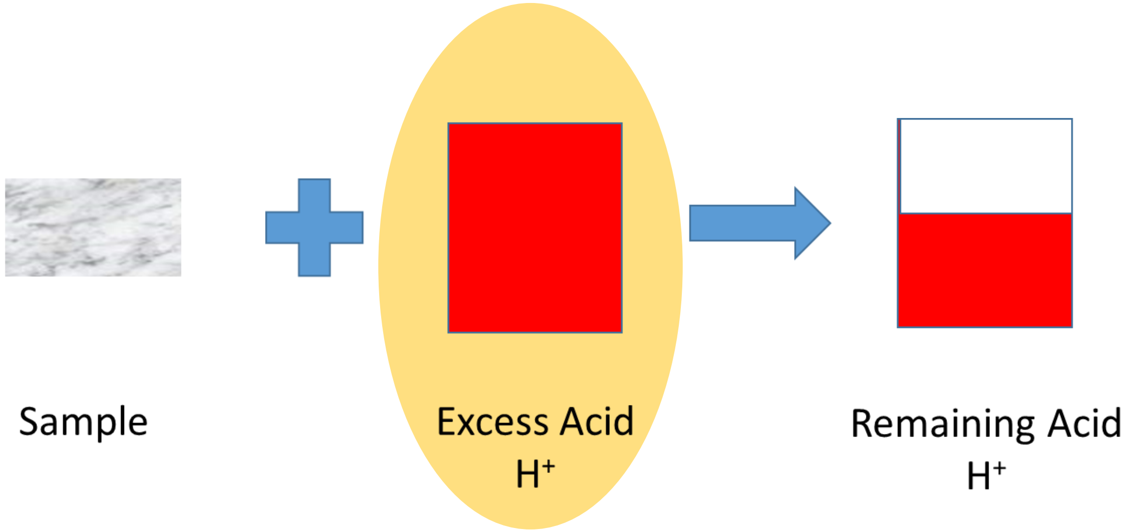
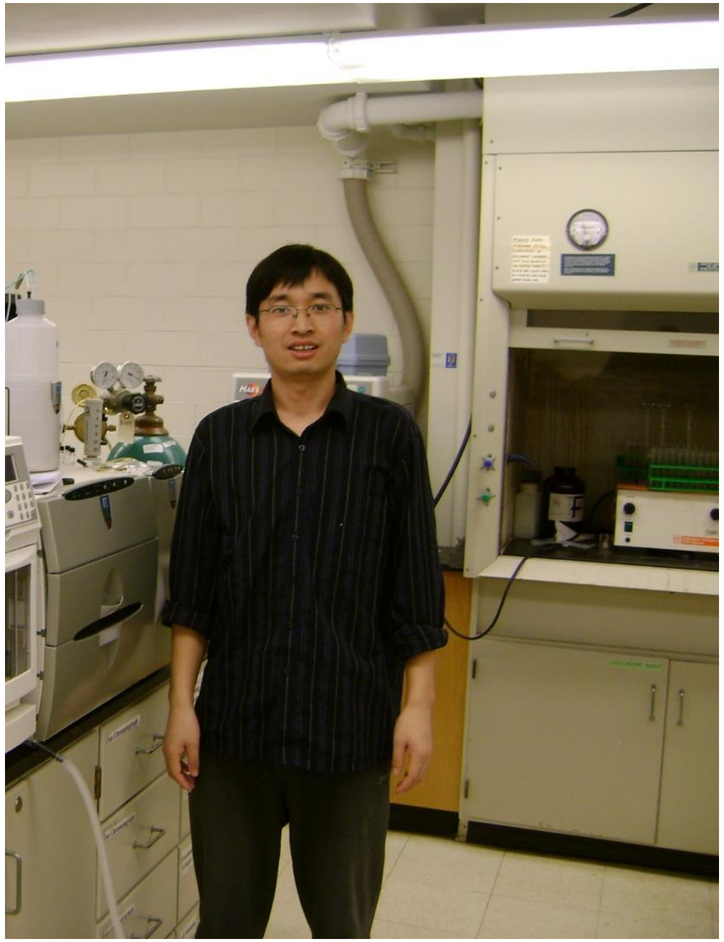


Fizz Rating Description

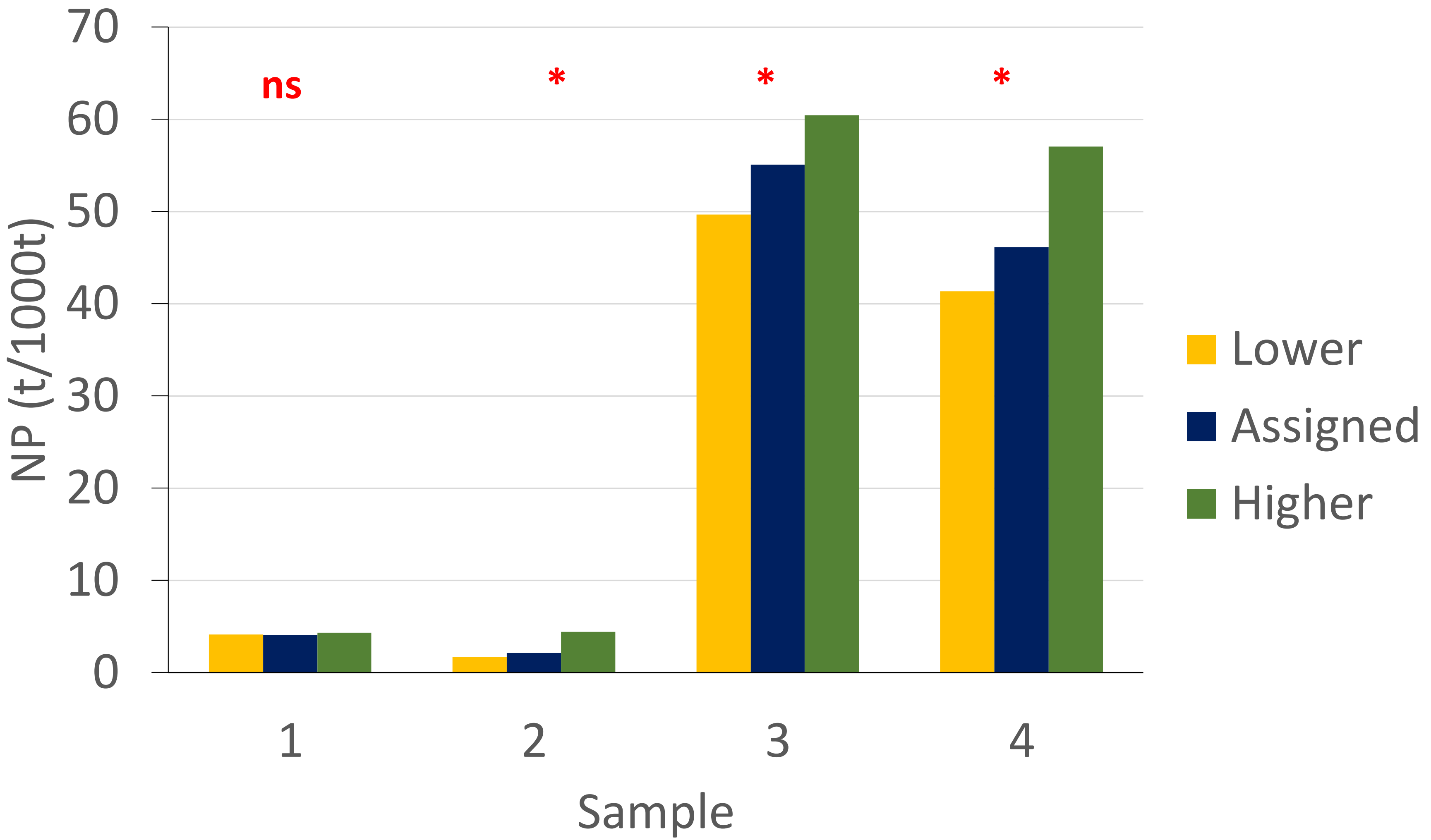
Fizz Rating	Description	Acid Amount (mL)	Acid Volume (M)
0	No reaction	20	0.1
1	Minimal reaction; a few to many fine bubbles	40	0.1
2	Active bubbling with only a small amount of splashing	40	0.5
3	Very active bubbling that includes substantial splashing	80	0.5

Approach

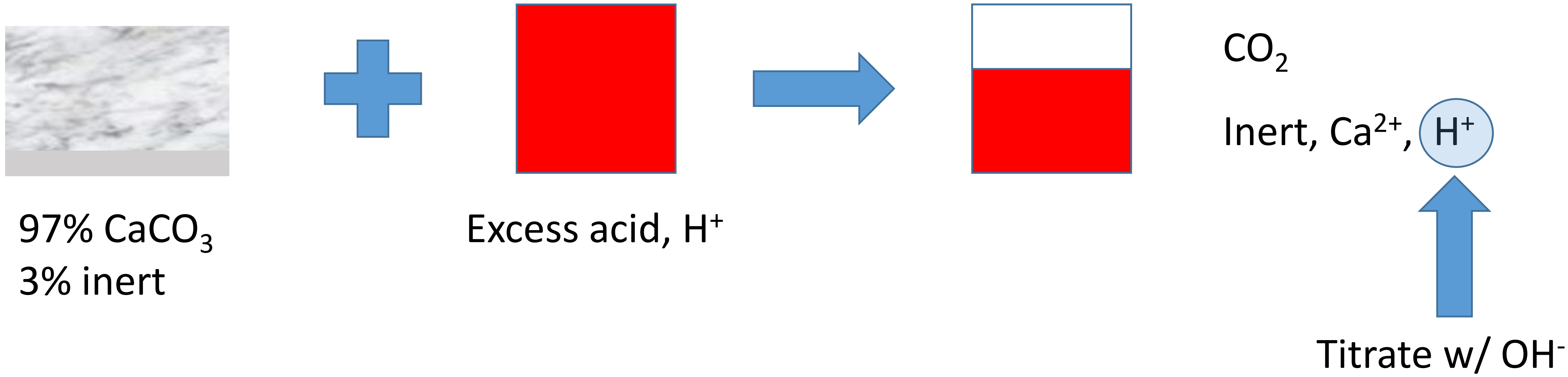


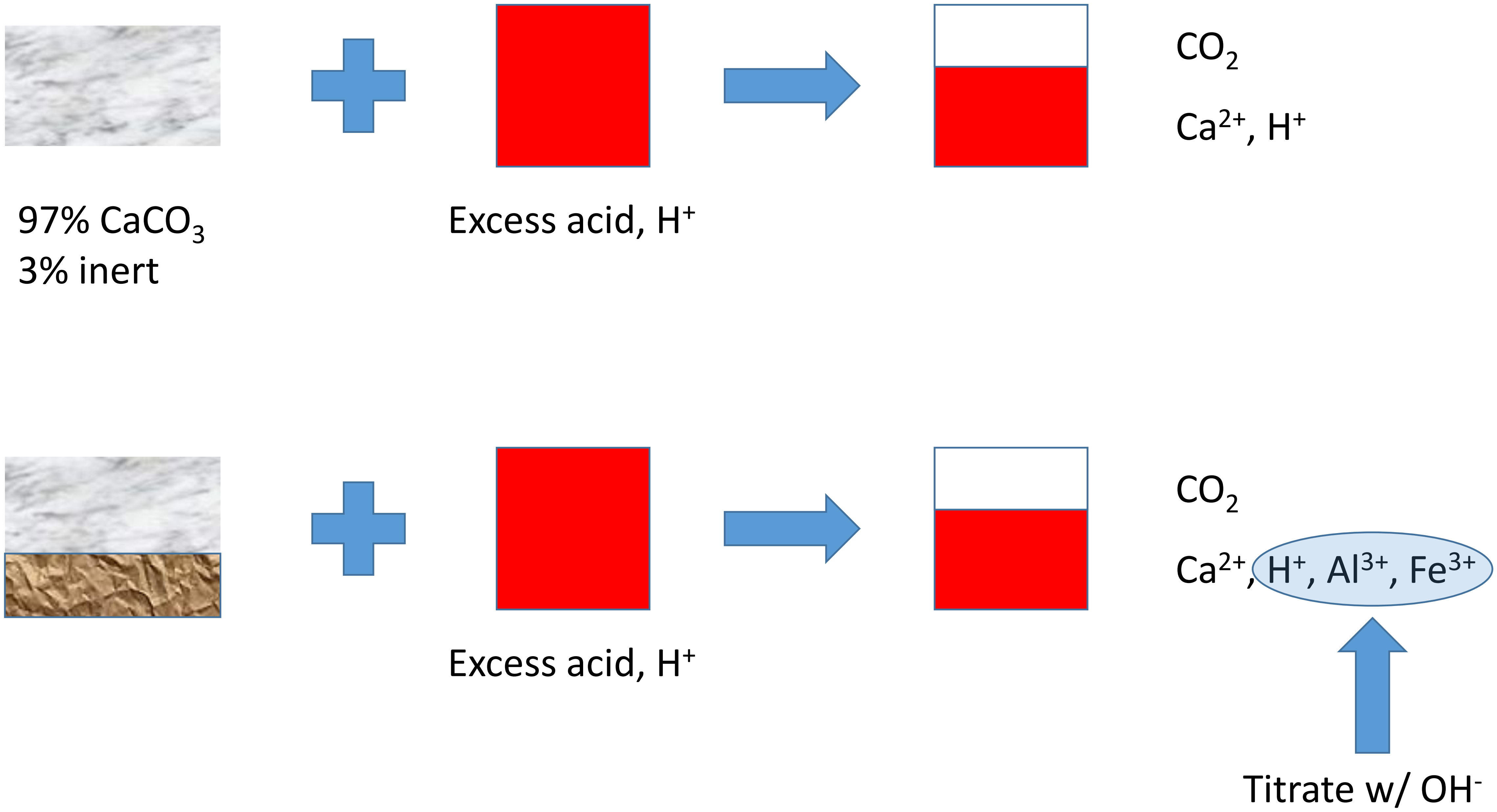
- Overburden and refuse samples from US and China
- Assigned Fizz Rating → determine NP
- Determined NP for next lower and next higher Fizz Rating
- If Assigned Fizz Rating = 1, then
  - Lower = 0
  - Higher = 2
- Determined pH & cation concentrations for each

Effect of Fizz Rating Assignment on NP



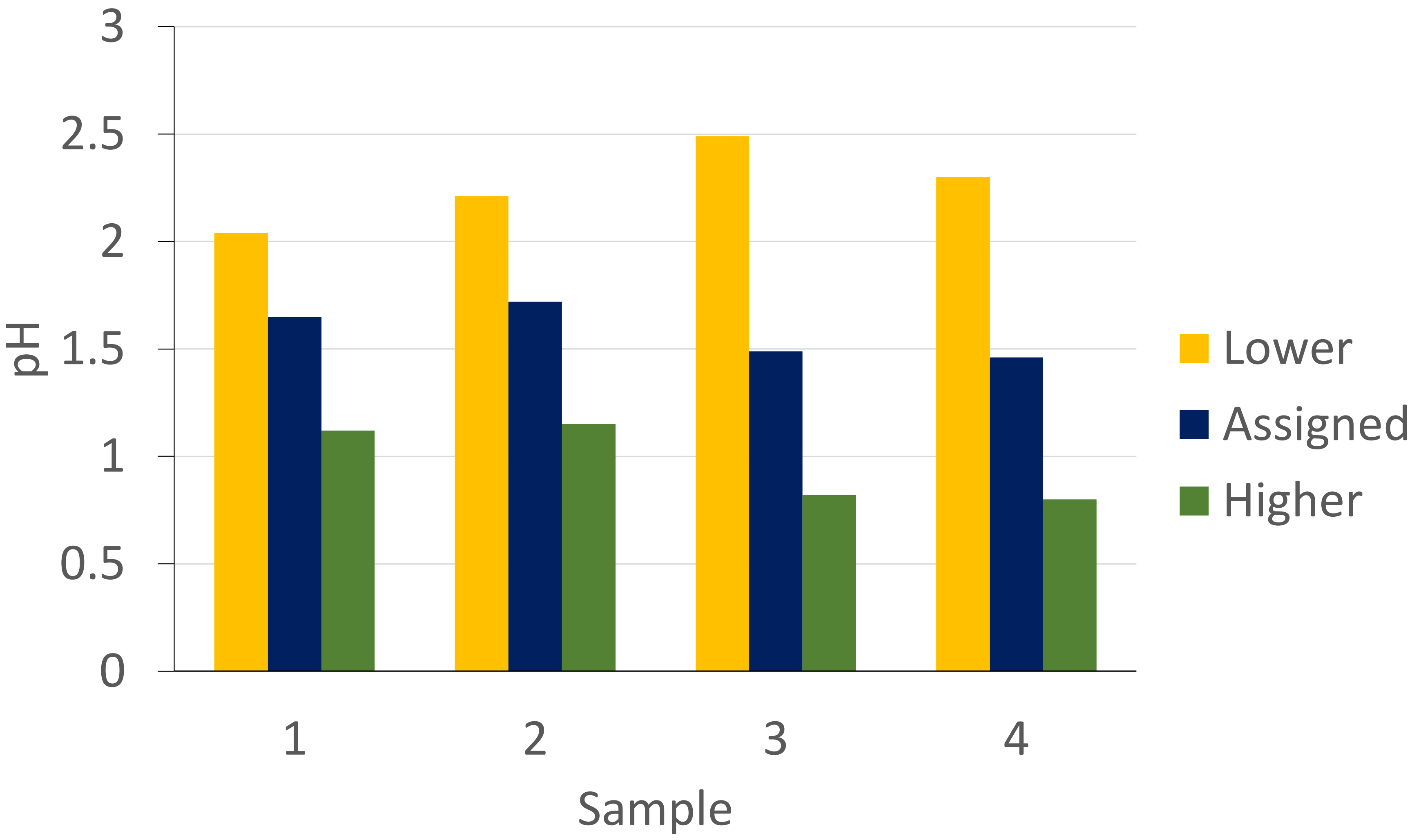
Why?



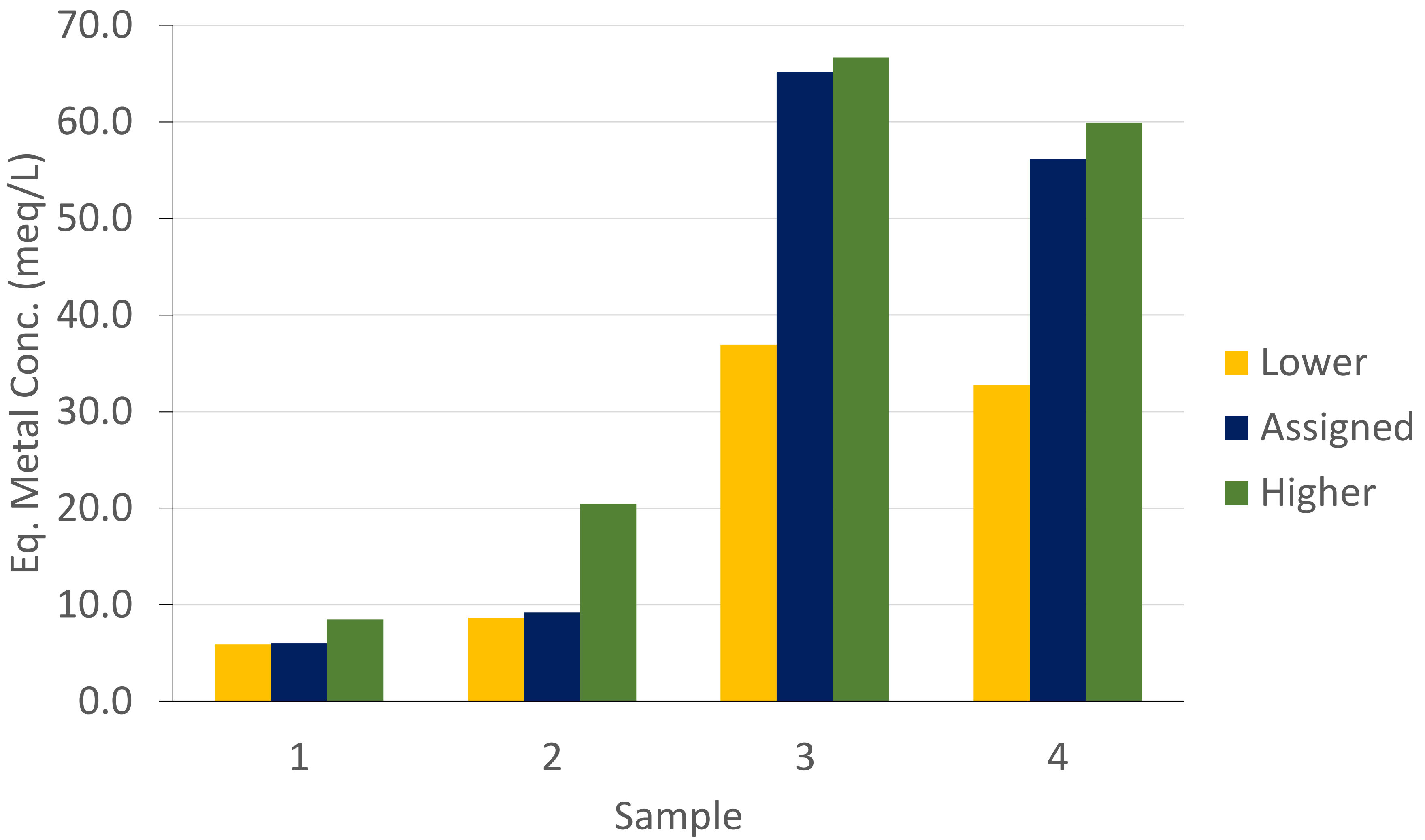


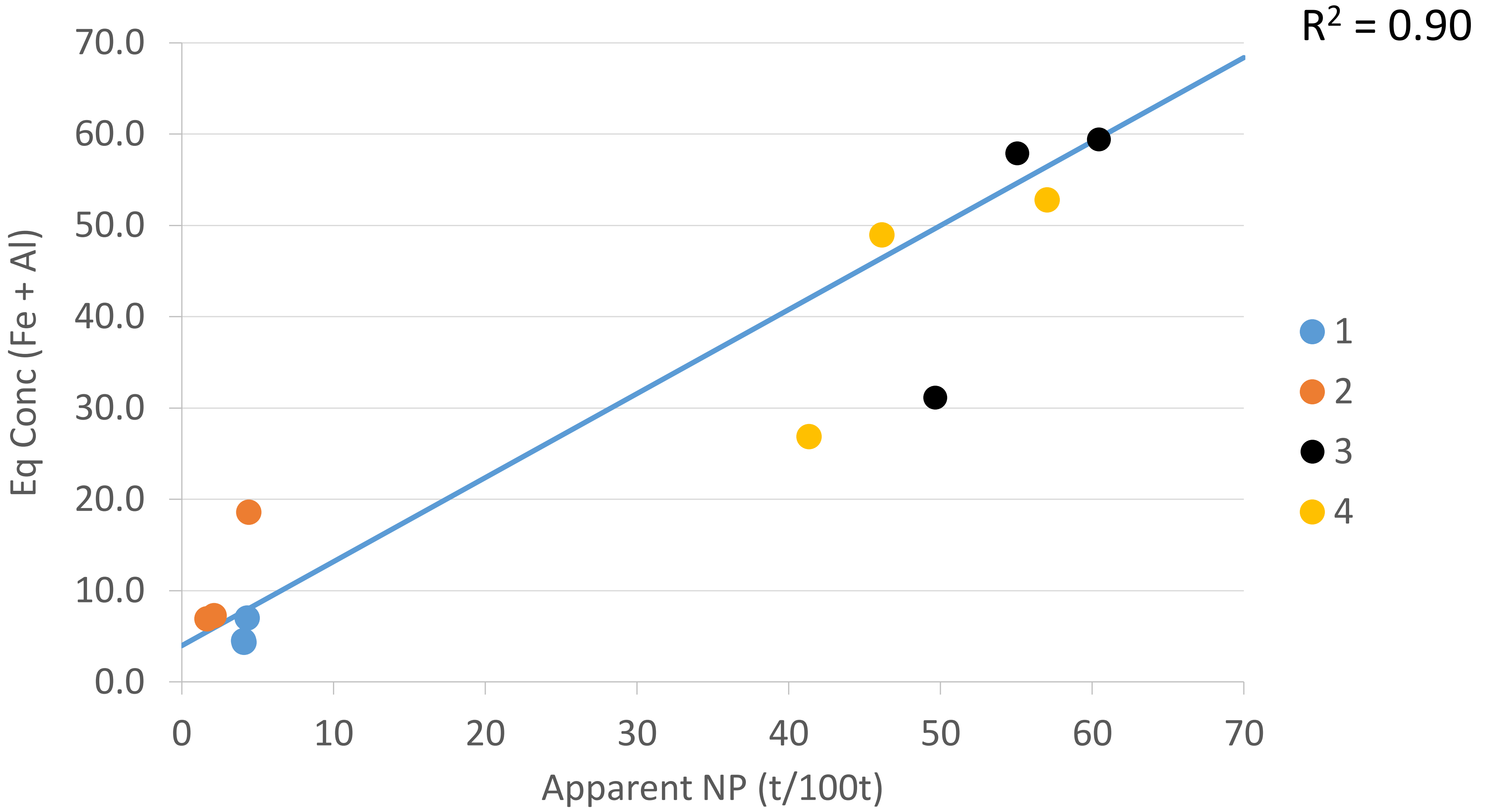
CO$_2$
Ca^{2+}, H$^+$
97% CaCO$_3$
3% inert
Excess acid, H$^+$
CO$_2$
Ca^{2+}, H$^+$, Al^{3+}, Fe^{3+}
Excess acid, H$^+$
Titrate w/ OH$^-$

Effect of Fizz Rating Assignment on pH



Effect of Fizz Rating Assignment on Fe + Al




R² = 0.90
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Eq Conc (Fe + Al)
0
10
20
30
40
50
60
70
Apparent NP (t/100t)
1
2
3
4

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