Overburden Weathering Trials - 20 Years of Data: Stockton Coal Mine

Egypt Geochemical Trial Pads

Introduction

Objective:

- To understand long term changes in sulfate and acidity concentration data for the Brunner Coal Measures
- Understand inform mine closure studies
- To compare Egypt Trial Pad field data with the Gandy & Younger (2007) model for sulfate decay.

Shout out Phil Lindsay, Paul Weber, Liam Conner

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BRL, 2024


Legend
Public road
Cypress
Escarpment Extended
Mount Fred South
Stockton
Transport Corridor
State Highway 67
Stockton
Mount Fred South
Cypress
Escarpment Extended
Transport Corridor
016_12

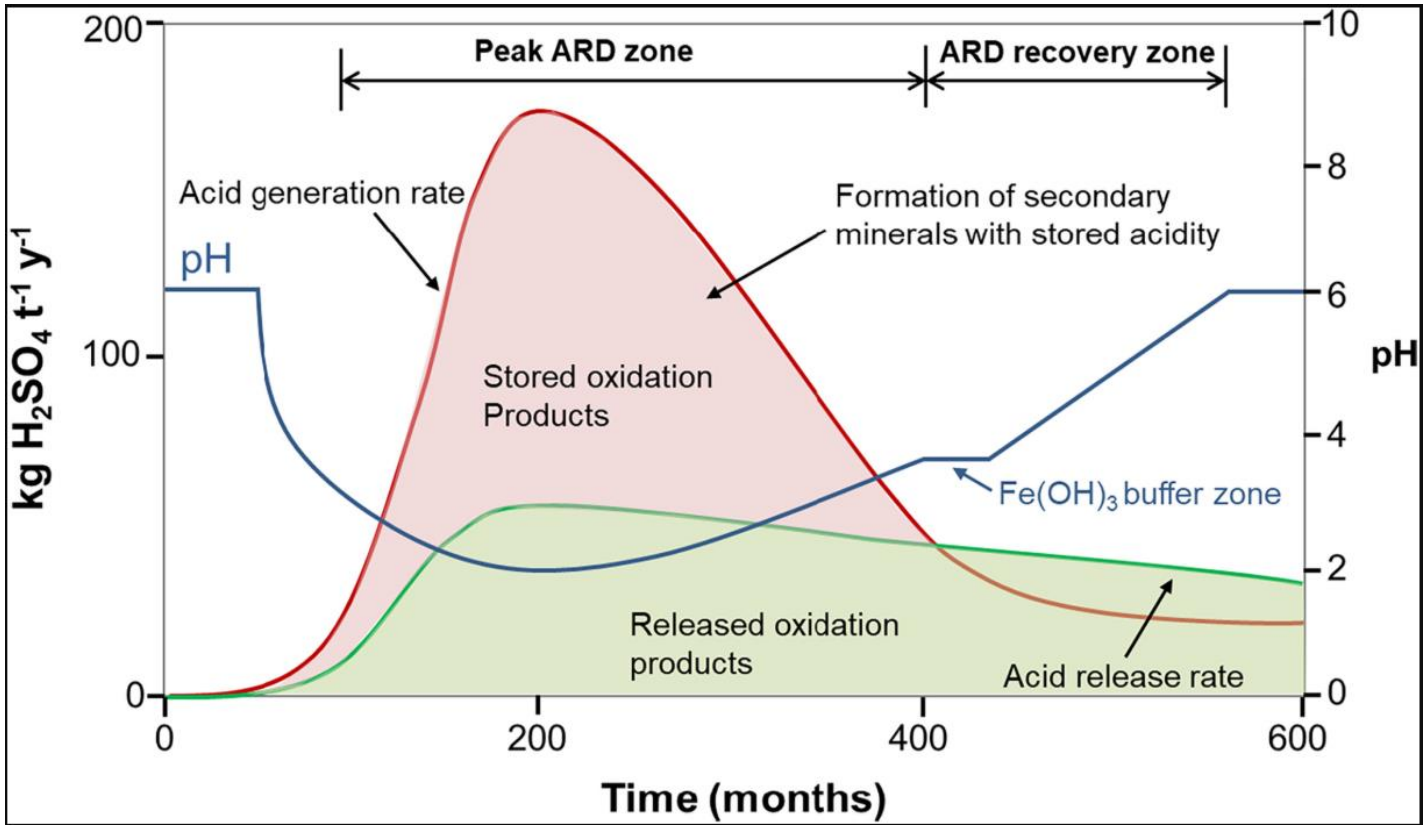

Buller River
Westport
Cape Foulwind

AMD Evolution Trends

In general:

- Following the exhaustion of carbonates that buffer acid generation there is a decrease in pH.
- However, there is a lack of carbonate minerals in the BCM so the pH decreases quickly coincident with significant acidity generation.
- Recovery can take a very long time.

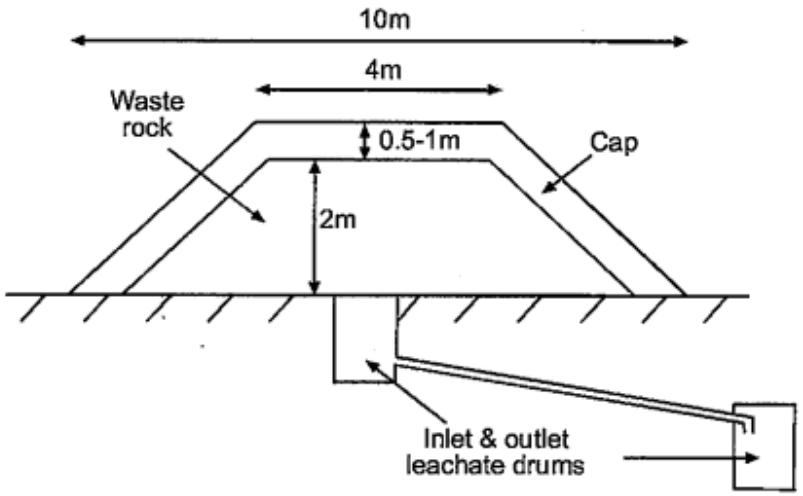
- Trials were undertaken to Stockton to understand these reactions.



Source: Fan et al. (2022)

Egypt Trial Pads

- 17 Trial Pads constructed in 2004.
- Goal of trial pad where to test different capping materials at reducing oxygenation



Source: Gandy & Younger (2007)

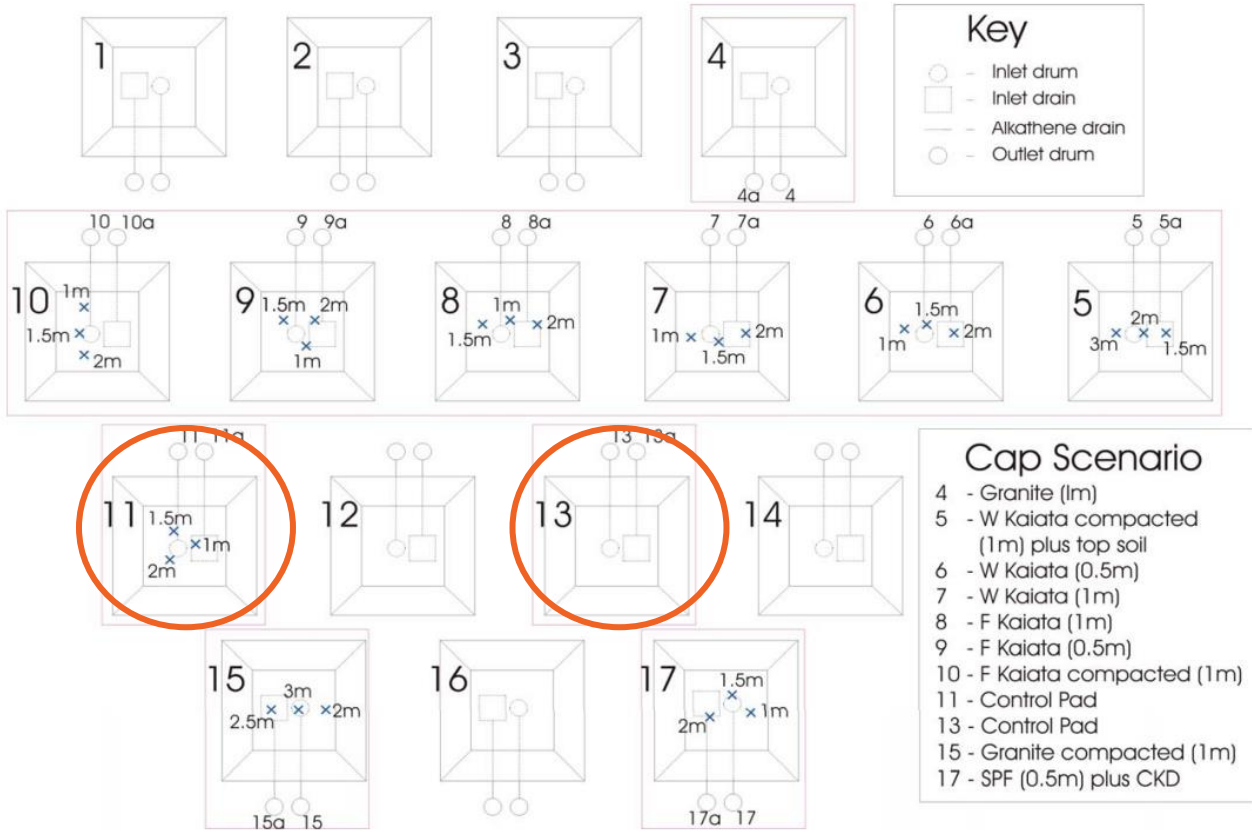
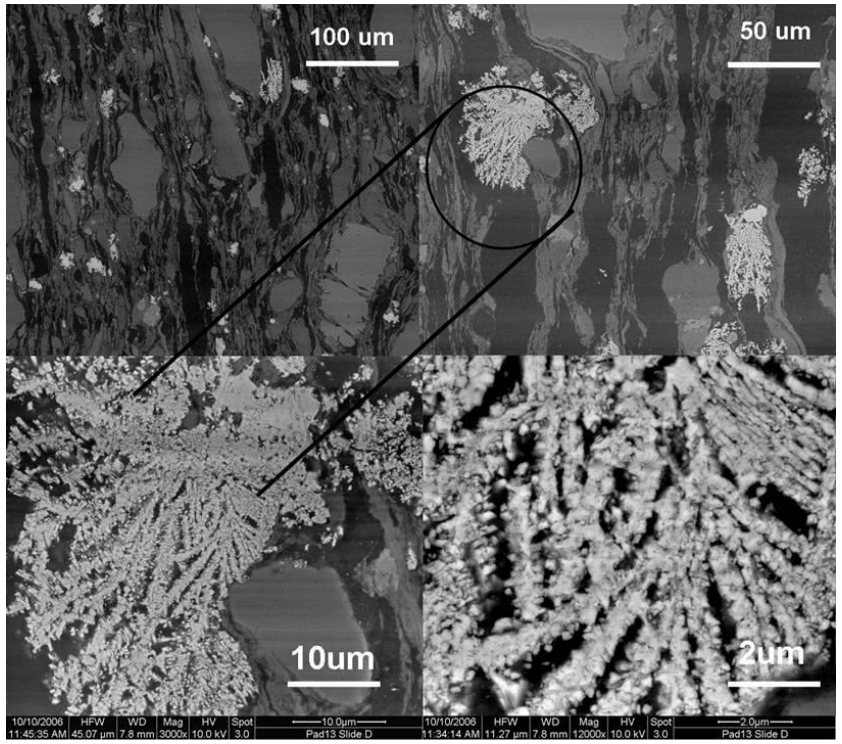


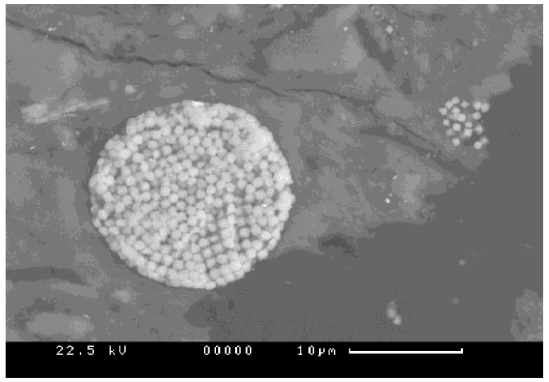
Figure 5-1. Plan view of capping field trial.

Pyrite Oxidation

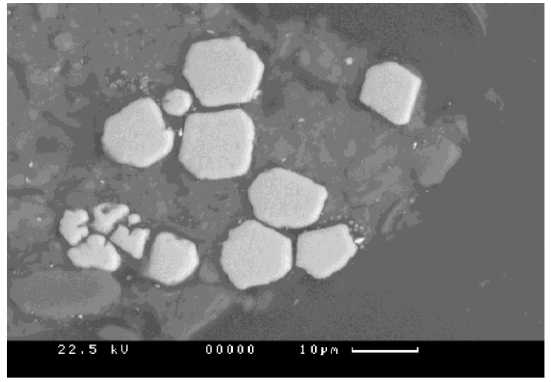


At Stockton Coal Mine 80% of pyrite is framboidal. Fpy is more reactive due to higher surface area.

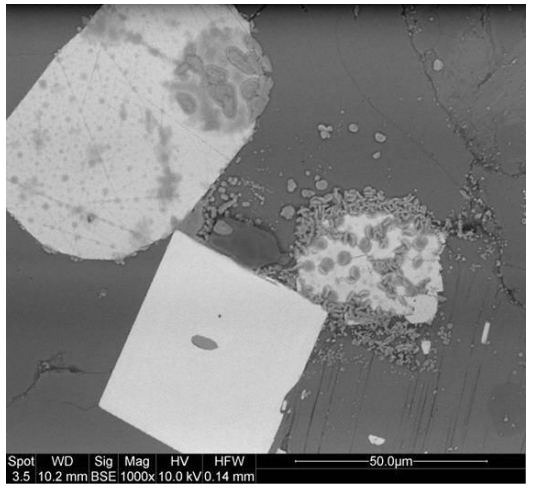
RSA = reactive surface area

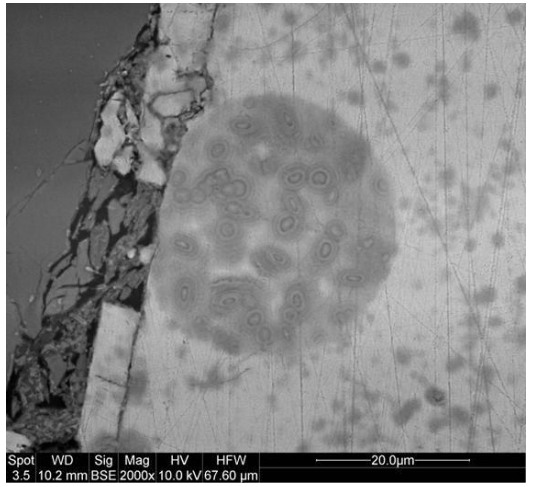


Fast nucleation / formation kinetics



Slow nucleation / formation kinetics

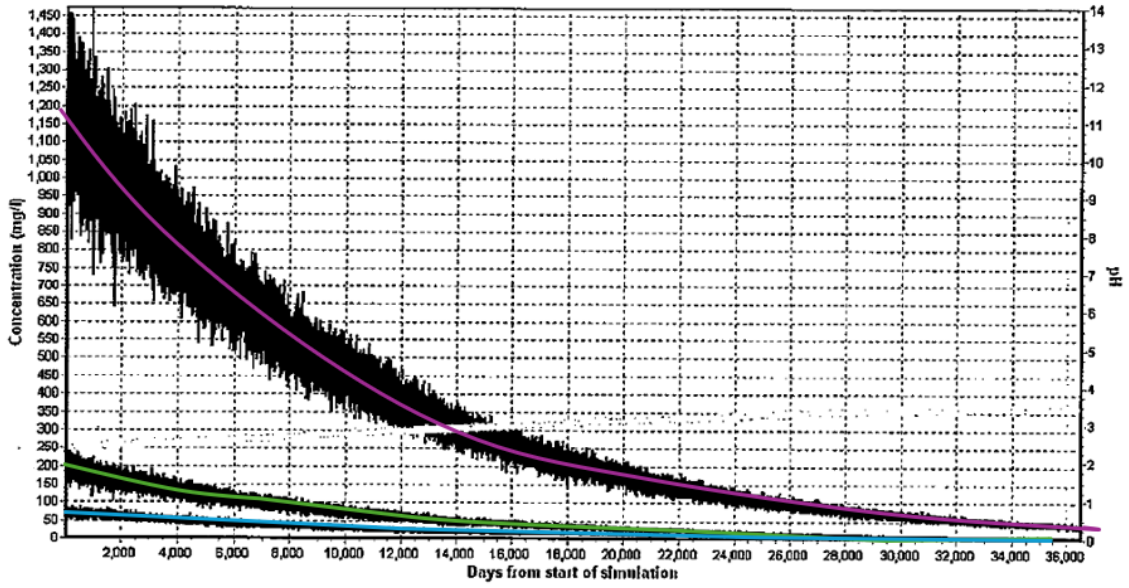




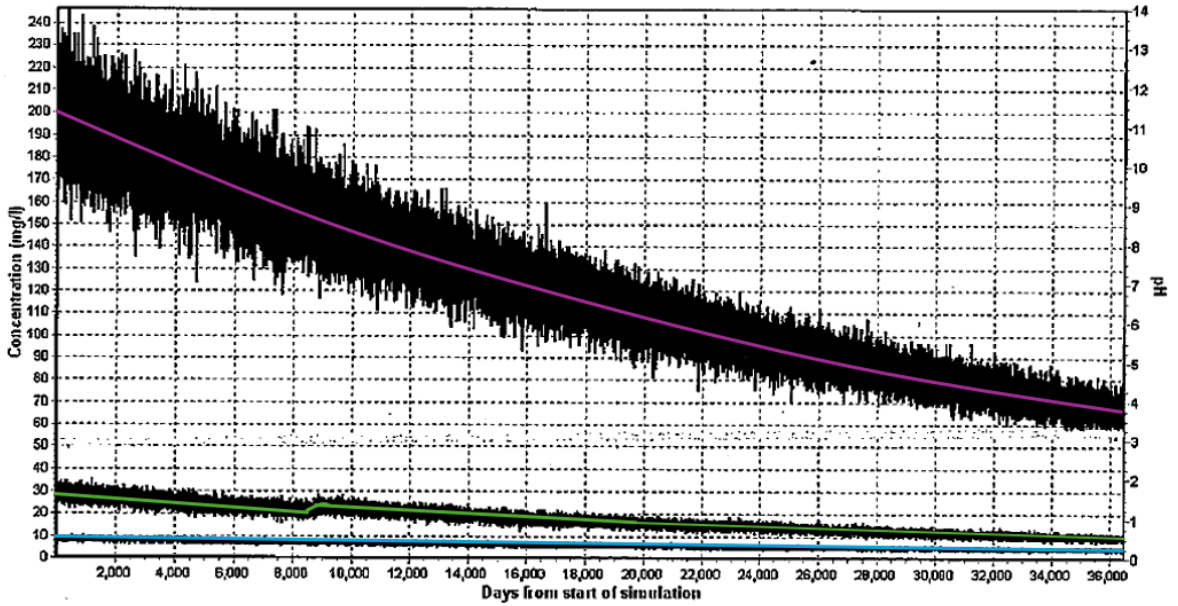
Source: Weisener and Weber (2010)

Reactive- high surface area sulfide forms will generate elevated acidity and sulfate very quickly

POTOMAC Model – Gandy and Younger (2007)



Gandy & Younger. (2007) Scenario 1



Gandy & Younger. (2007) Scenario 2

Trend lines were created manually as part of this study as the model data was not available where:

- Purple lines represents sulfate concentrations.
- Green lines indicates iron concentrations.
- Blue corresponds to aluminium concentrations.

Pyrite Morphology and Oxidation

PARAMETER	SCENARIO 1	SCENARIO 2
Density of pyrite (kg/m3)*	5000	5000
Average diameter of pyrite (µm)*	15	50
Pyrite diameter (m)	**1.50E-05**	**5.00E-05**
pyrite content (%)	0.71	0.71
pyrite content	0.0071	0.0071
Specific Surface Area (m2/kg)	80	24
Mass Concentration (kg/m3)	35.5	35.5
Total Surface Area(m2/m3)	2840	852

* = sourced from Gandy & Younger. (2007)

Importance of Morphology: Oxidation Rates

Impact on Models: Models can overestimate long term sulfate concentrations if they do not consider the effects of pyrite morphology.

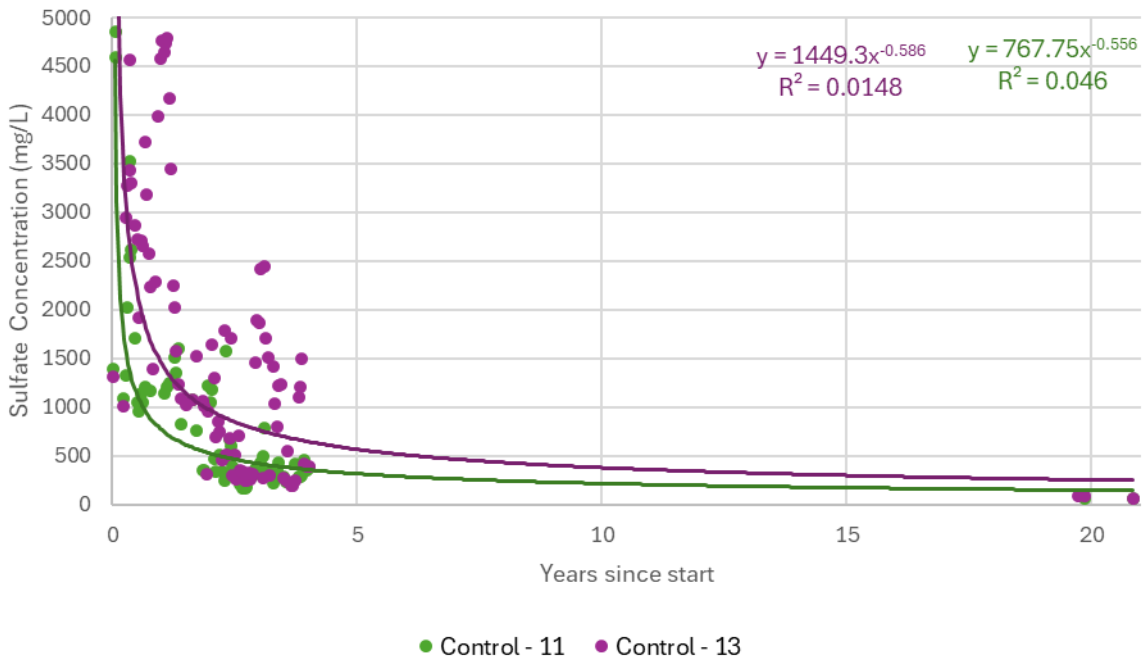
Framboidal Pyrite: Small particles with high surface area, which oxidize rapidly, contributing to rapid sulfate release.

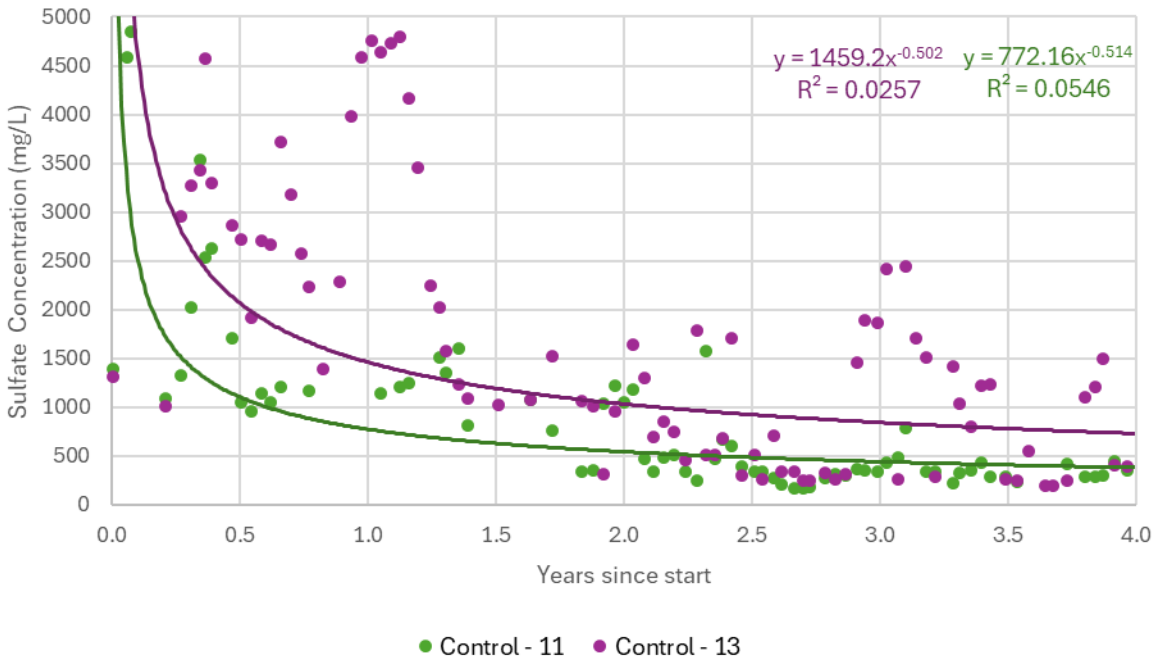
Euhedral Pyrite: Larger crystals with less surface area, oxidizing at a slower rate, leading to longer term sulfate release.

Mineral Morphology Type Cluster Size Range (~40 x 75 µm^2)	SSA (um-1)	PAD 13 (~wt%)	PAD 11 (~wt%)
100 nm^2 - 5 µm^2 Individuals	2.68	40%	0%
5 – 10 µm^2 Individuals	1.68	12%	2%
10 – 25 µm^2 Individuals	1.06	14%	27%
Isolated Coarse Grains (30-75 µm^2)	0.62	34%	71%
Assumed Pyrite Density (g/cm3)		5	5
Pyrite content (%)		**45%**	**55%**
Pyrite content		**0.45**	**0.55**
Mass Concentration (kg/m3)		**2250**	**2750**
Total Surface Area(um-1)		**1.63**	**0.76**

Source: Hughes et al. (2007) with MWM Calcs

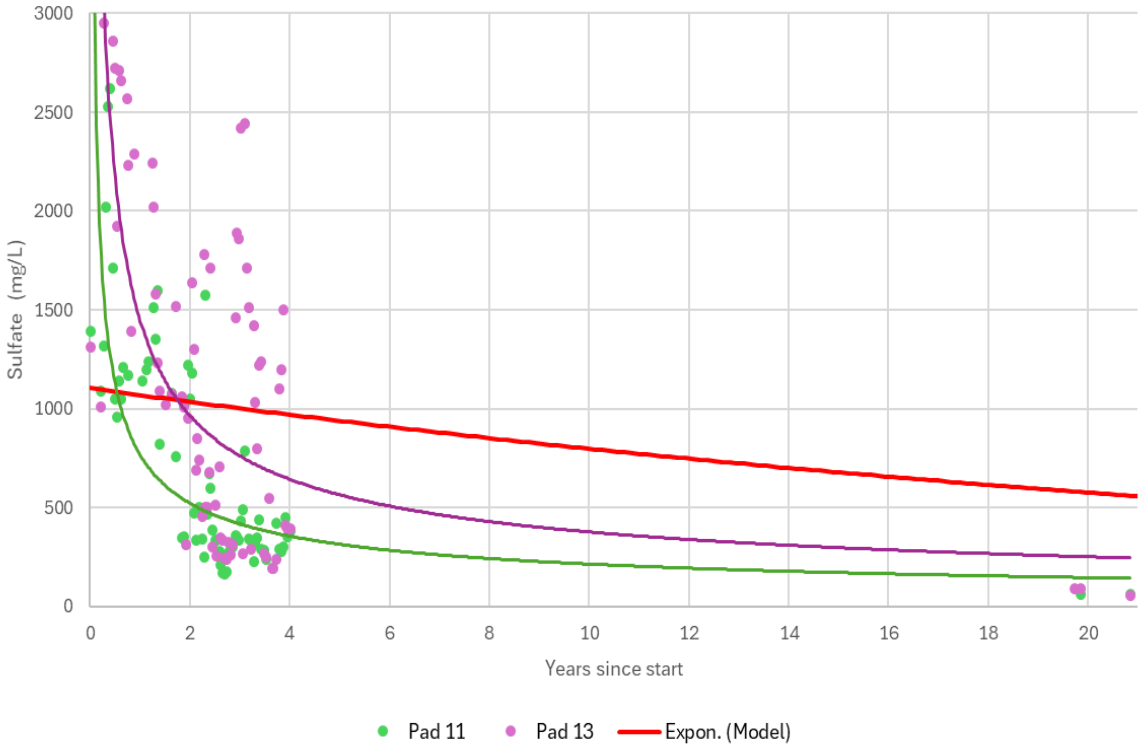
Sulfate Concentration

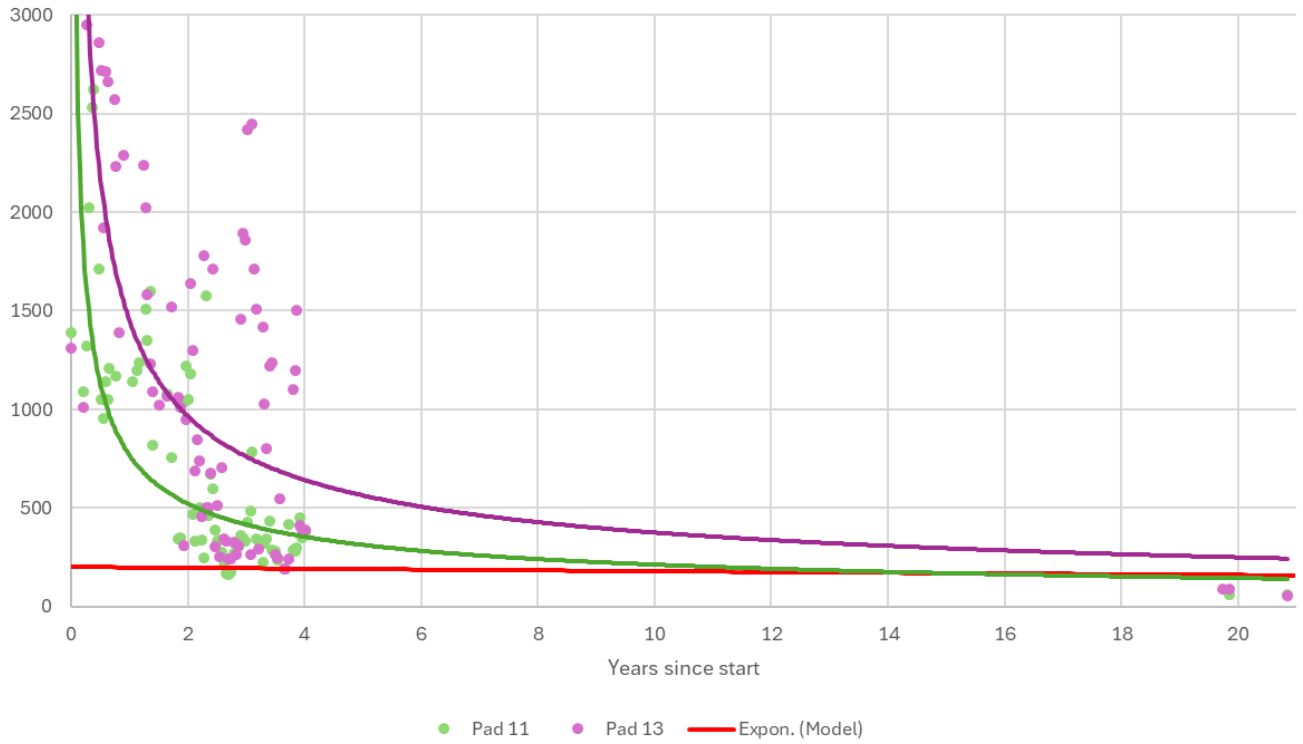




Note: The relationship exponential function was fitted to the data.

Sulfate Decay Comparison: Field vs Model





Note: The exponential model is the manual best fit line from the Gandy and Younger (2007) Model.
Left Model = Scenario 1. **Right** Model = Scenario 2

Conclusions

- High-surface area pyrite morphologies can oxidise quickly and contribute to elevated sulfate concentrations in the short term. These are higher than forecast by the model.
- In the longer term the model overestimates sulfate concentrations assuming higher levels for longer rather than sulfate exhaustion

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