How do Iron Terraces Fit in the Periodic Table of Passive Treatment?

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First Encounters – Argo Tunnel 1988

My first encounter with an Iron Terrace was in 1988 when I entered the Argo Tunnel in Idaho Springs, CO as part of a rehabilitation project for the EPA and I was able to walk on top of 2 foot layer of iron oxyhydroxide for about 300 ft before it started to give way under my feet. We eventually cleaned it out along with some old mine cars with a tracked loader. I thought the accumulated iron was interesting but didn't give it much thought.

Tiff Hilton's Observations (2005)

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Top Vs. Bottom of Flume--Acidity and Iron Concentrations/Reductions

Site	Date	pH	Cal. Acidity	% Acidity Reduction	Fe	% Fe Reduction
Top of Flume	2/27/04	2.70	697	----------	163.00	----------
Bottom of Flume	2/27/04	2.90	375	46%	60.50	63%
Top of Flume	6/4/04	2.70	626	----------	116.00	----------
Bottom of Flume	6/4/04	2.80	400	36%	53.60	54%
Top of Flume	9/16/04	2.60	1,467	----------	404.00	----------
Bottom of Flume	9/16/04	2.70	944	36%	172.00	57%

Hilton, Tiff - Low pH---Iron Oxidation
(WV Task Force Symposium, April 20, 2005)

I encountered clues to this phenomenon at conferences. Early work at understanding the mechanisms in iron terraces **(aka terraced iron formations -TIFs)** in Eastern US coal mine ARD originated in West Virginia (appropriately by Tif Hilton) and at Penn State Bill Burgos

This site was more a flume than a terrace…

Tiff Hilton's Observations (2005)

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Bug Central

Hilton, Tiff - Low pH---Iron Oxidation (WV Task Force Symposium, April 20, 2005)

But the terrace structure is readily apparent in Tiff's photo of "Bug Central"

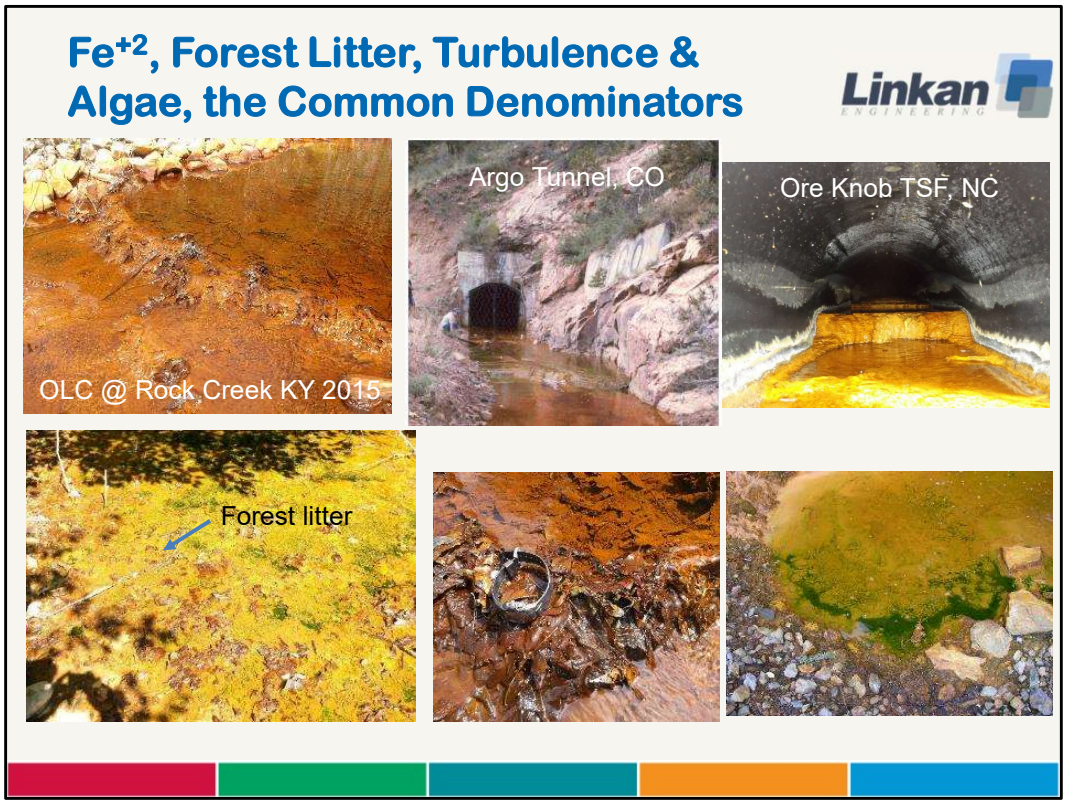
My “Aha!” Moment – Tiger Tunnel 2010

My “Aha!” moment was at the Tiger Tunnel in about 2010. I think Jason Willis of TU was there.

I spotted some iron precip coating some pine needles, whipped out my rock hammer to give them a poke.

Hard as a rock!

“How old is this channel?” (Less than a year…) Hmmm



These four conditions seem to be a common denominator for iron terraces –

Volunteer Fe Terrace (Elizabeth Mine, VT)

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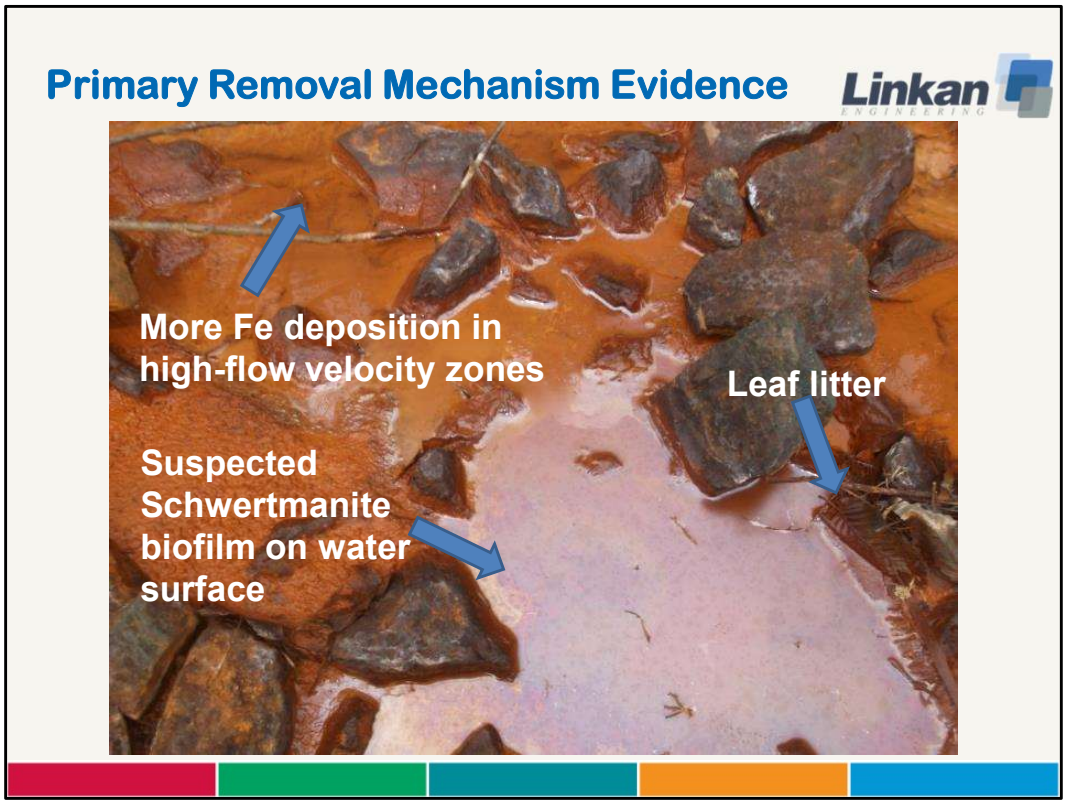
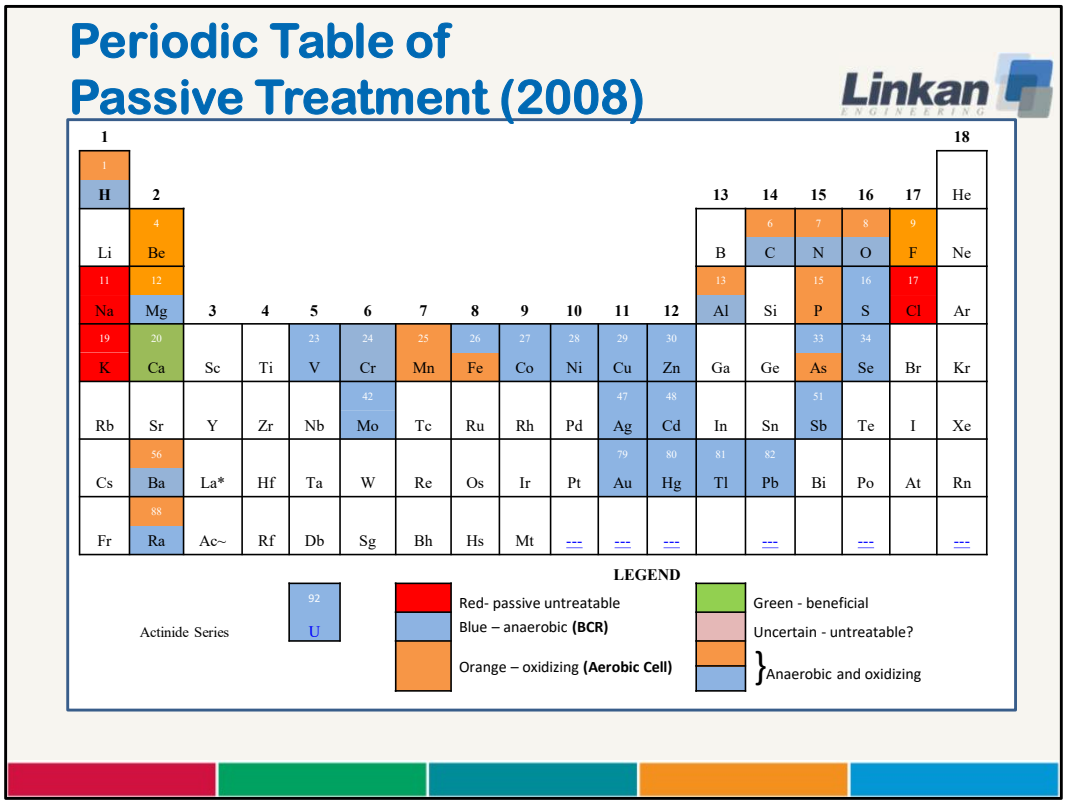
Pre-mining ferricrete in Copperas Brook

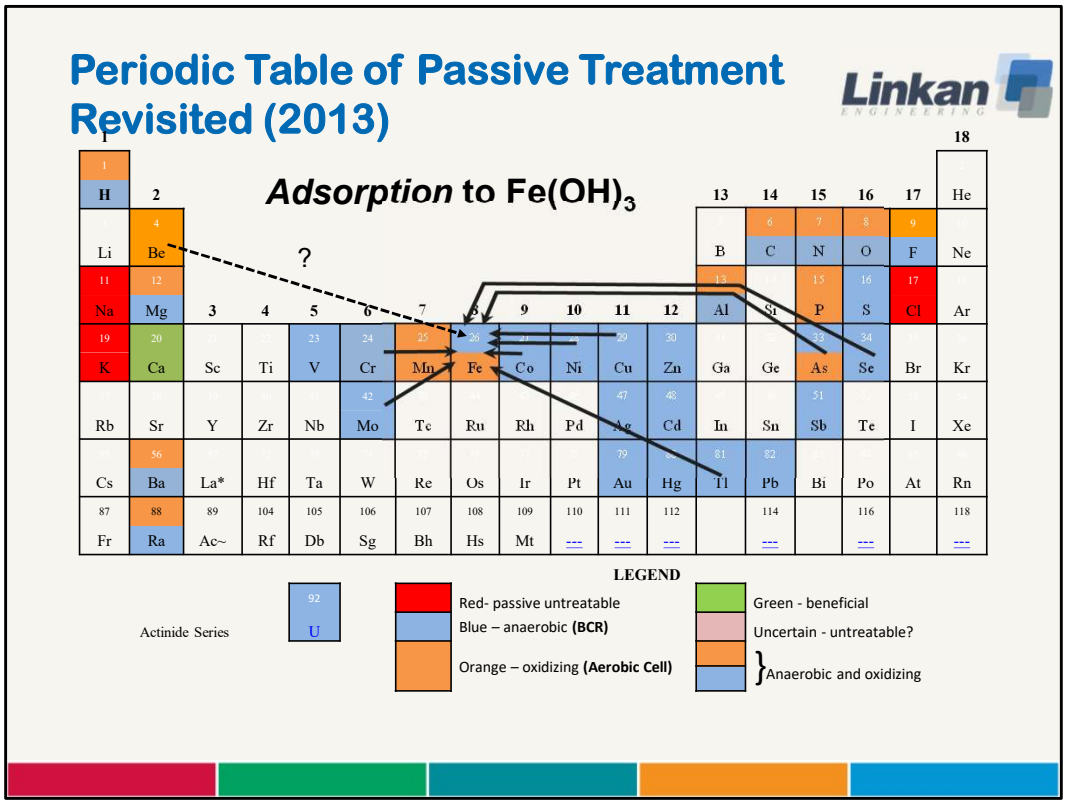
Here’s another example at the Elizabeth Mine Superfund Site in Vermont – in my first visit there in about 15 years, I found a "volunteer" TIF at the toe of a capped TSF and evidence that the process wasn’t new at this site (ancient ferricrete)



Three things visually stood out: **high flow, leaf litter, and biofilms** seemed to correlate with iron deposition. There was no ferrous iron.



So how does this process fit in the periodic table of passive treatment which has processes characterized by relative oxidation reduction potential. Blue elements are removed anaerobically and orange cells aerobically



Information in the published literature suggests that all these metals will adsorb to iron oxide coatings. My personal observation at a biochemical reactor site suggests that beryllium might also adsorb to iron oxyhydroxide but I have no proof.

This facet of passive treatment has been around for quite some time – I first observed this with an arsenic bearing MIW being treated in an aerobic cell at the Wheal Jane Mine in Cornwall passive treatment system in 1995. If you can get iron oxyhydroxide to form, common sense suggests that you can pull these other parameters with it. What's uncertain is the ratio of iron to the other parameters.

When COVID restrictions descended, Linkan redeveloped an old screening tool – Proof of Concept or "Proof Passive" static testing. We're kind of scratching our heads as to how we can test the iron terrace process statically or with as little effort as possible. Leaf litter? Turbulence? Algae? Iron Oxyhydroxide "seed" material? It can get tricky. Any audience input?