

*Effect of Coatings on CCA Leaching in a
Soil Environment
(Raised Bed)*

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Coating CCA Wood -

- ▼ **Has shown promise in Reducing Leachable and Dislodgeable Arsenic**
- ▼ **Can be a remedial action which reduces As exposure**

EPA model –

Stochastic Human Exposure and Dose Simulation Model (SHEDS)

- ▼ **Draft of model predicts substantial decrease in As exposure, assuming 90% and 99.5% reduction in CCA residues on playsets by coatings.**
- ▼ **Lifetime Average Daily Dose (LADD)**
 - ▼ **Reduced by factor of**
 - ▼ **6-7 (90% reduction)**
 - ▼ **11-17 (99.5% reduction)**
- ▼ **99.5% may be too optimistic?**
- ▼ **50-90% reduction feasible?**

Coating CCA Wood

- ▼ **More work is needed to understand the characteristics of the coating variables.**
- ▼ **as well as the limitations of using coatings to form an As barrier between the wood and the environment.**

Coating Variables

- ▼ **Comparison of Coatings-**
 - ▼ **Formulation – water/oil based, acrylic, alkyds, polyurethane**
 - ▼ **Additives and Pigments- transparent, semi-trans, opaque, particle size (nano), iron?**
 - ▼ **market surveys – EPA sponsored study**

Coating Variables

- ▼ **Comparison of Coating environments –**
 - ▼ outdoors above ground
 - ▼ in soil
 - ▼ in water
 - ▼ simulated weathering.
- ▼ **Physical – durability and wearing (foot traffic)**
- ▼ **Surface preparation – old wood**

Test Methods to Evaluate Coatings –

-Surface Test Method

Apply Coatings -

Then wipe Surface –

▼ Measures –

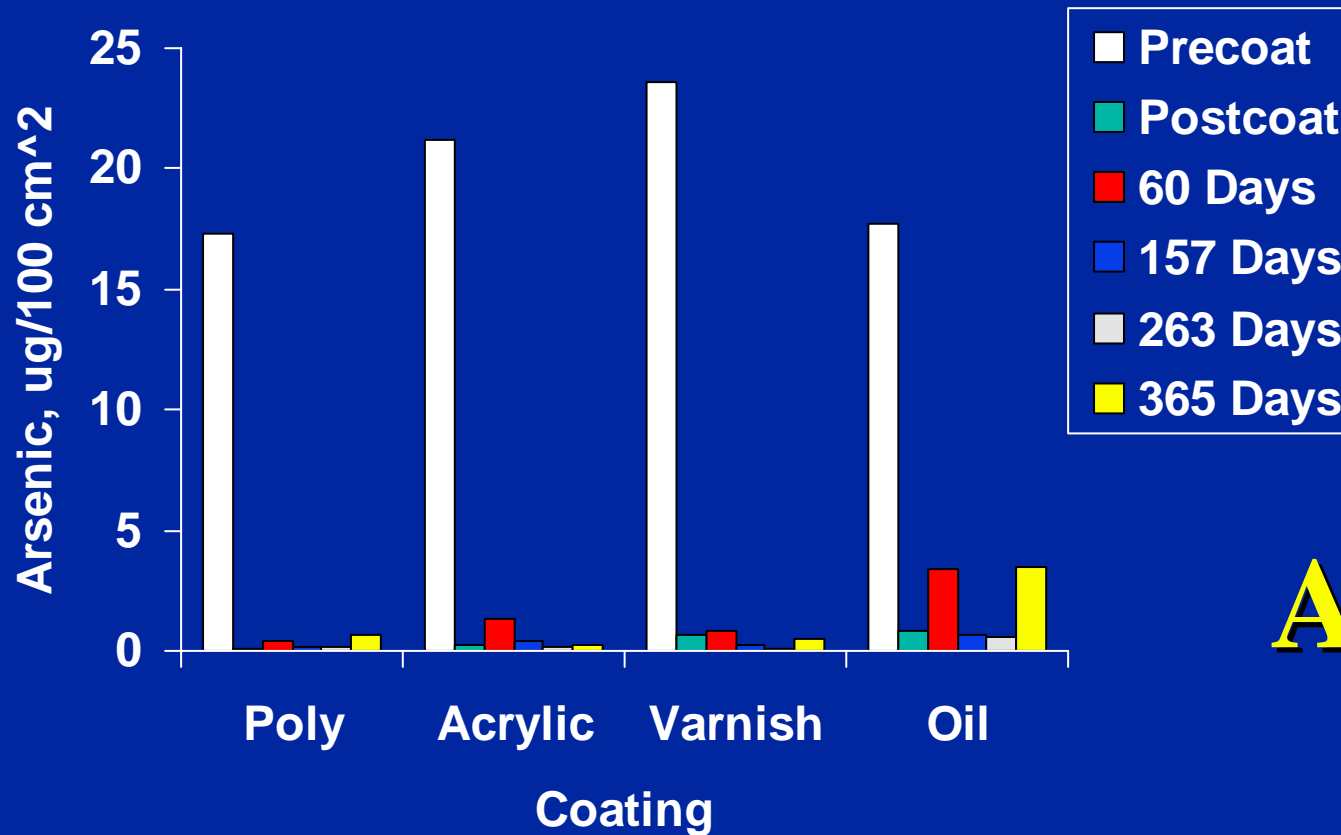
▼ Dislodgeable As

PREVIOUS WORK AT CAES – EFFECTS OF COATINGS ON ARSENIC DISLODGED FROM THE SURFACE

- ▼ Polyurethane
- ▼ Acrylic Latex
- ▼ Oil based
- ▼ Varnish (don't use)
- ▼ Placed outside and sampled 4x in 1 year



Average Arsenic Dislodged from Surface Before, After, and up to One Year After Coating



Arsenic

Spar Varnish – Durability Problem



Surface -Conclusions

- ▼ **Showed promise – (except for spar varnish)**
- ▼ **Did not account for physical wearing – foot traffic (horizontal) versus vertical**
- ▼ **Did not evaluate enough penetrating stains/sealants**
- ▼ **Did not determine what additives are important in forming barrier in these types of coatings**

Test Methods to Evaluate Coatings –

Leaching Test Methods

Apply Coating, collect rainwater-

Measures –Leachable Arsenic-

- ▼ Total – collect variable volumes over repeated rain events (resource intensive, Quantitative)
- ▼ Event – collect about 1x/month (snapshot)
- ▼ Immersion- place into container of water about 1x/month (limited resources, Qualitative)
- ▼ Soil Contact – Soil acts as As trap
(variation of total method)

This Study – Leaching into a Soil Environment

- ▼ **Coatings Could Reduce leaching into soil**
- ▼ **Raised beds, landscape wood, posts-**
 - ▼ **above and below ground component.**
- ▼ **UV exposure above soil line**
- ▼ **Soil - More microorganisms**
- ▼ **Soil - More moisture (soil takes time to dry out)**

Coat wood boxes and fill with soil (2-3 cm from top)

- ▼ 10 boxes (27x28x14 cm)
- ▼ 8 CCA wood, 1 ACQ, 1 untreated
- ▼ CCA boards from 3 sets
 - ▼ (1 set CCA plus water repellent)
 - ▼ All 0.4 lbs/ft³ nominal
- ▼ Wood is above and below ground (simulates raised bed)

6 Coatings- 2 coats each

- ▼ **4 Oil based**
 - ▼ Semi transparent stain
 - ▼ Semi transparent stain with alkyds
 - ▼ Clear sealant
 - ▼ Opaque enamel with polyurethane
- ▼ **2 water based**
 - ▼ Sealant with alkyds and acrylics
 - ▼ Opaque latex acrylic

Behr Sealant – Water Based, Clear (Tone?), with Alkyd and Acrylics



New



14 months

Behr - Oil Based Stain - Grey, Semi,



New

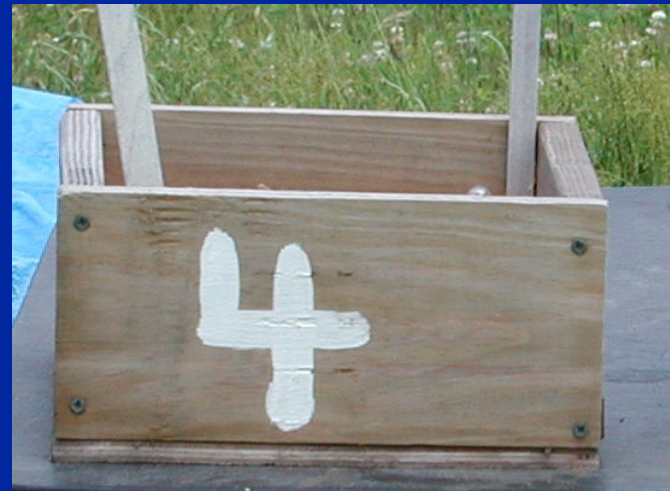


14 months

Box 4 – Thompson's WaterSeal

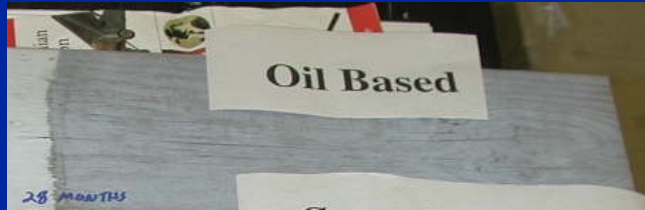


New



14 months

Olympic Stain- Oil Based with Alkyds, gray, semi



New



14 months

*Opaque –Latex Acrylic(#6),
Polyurethane Enamel (#7)*



New



14 months

*Control (untreated pine),
Uncoated CCA, Uncoated ACQ*



New



14 months

***The Soil -90% farm soil (sandy loam) +10%
Compost. Known to trap As***

pH	6.0 ± 0.3
CEC* (cmol/kg)	8 ± 1
P (mg/kg)	1040 ± 80
Fe (mg/kg)	9100 ± 1500
Sand (g/kg)	710 ± 20
Silt (g/kg)	110 ± 50
Clay (g/kg)	170 ± 70
Organic Matter (g/kg)	50 ± 4

***Cation Exchange Cap.**

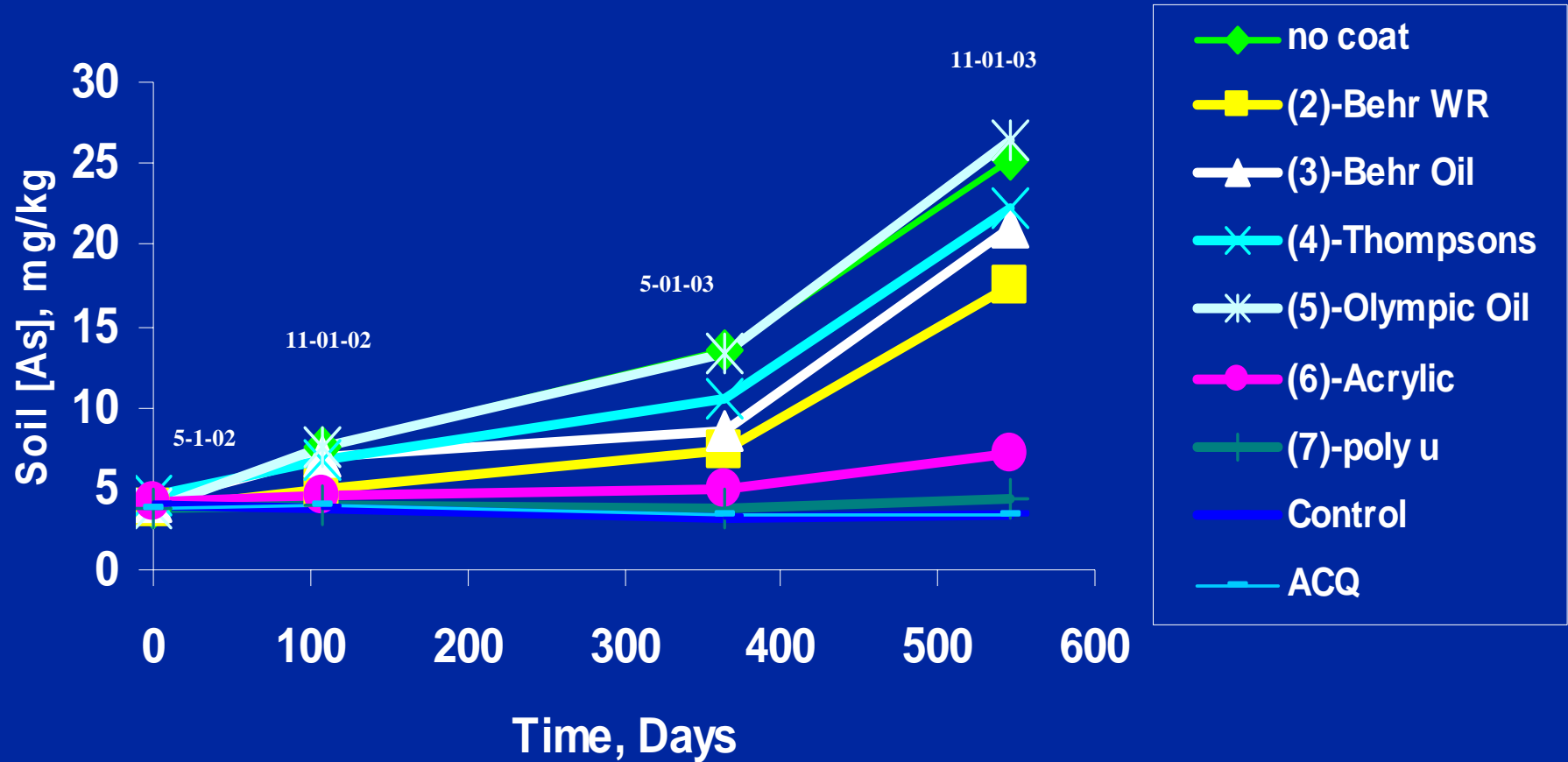
The Coated boxes day 1 – – Wood above and below ground



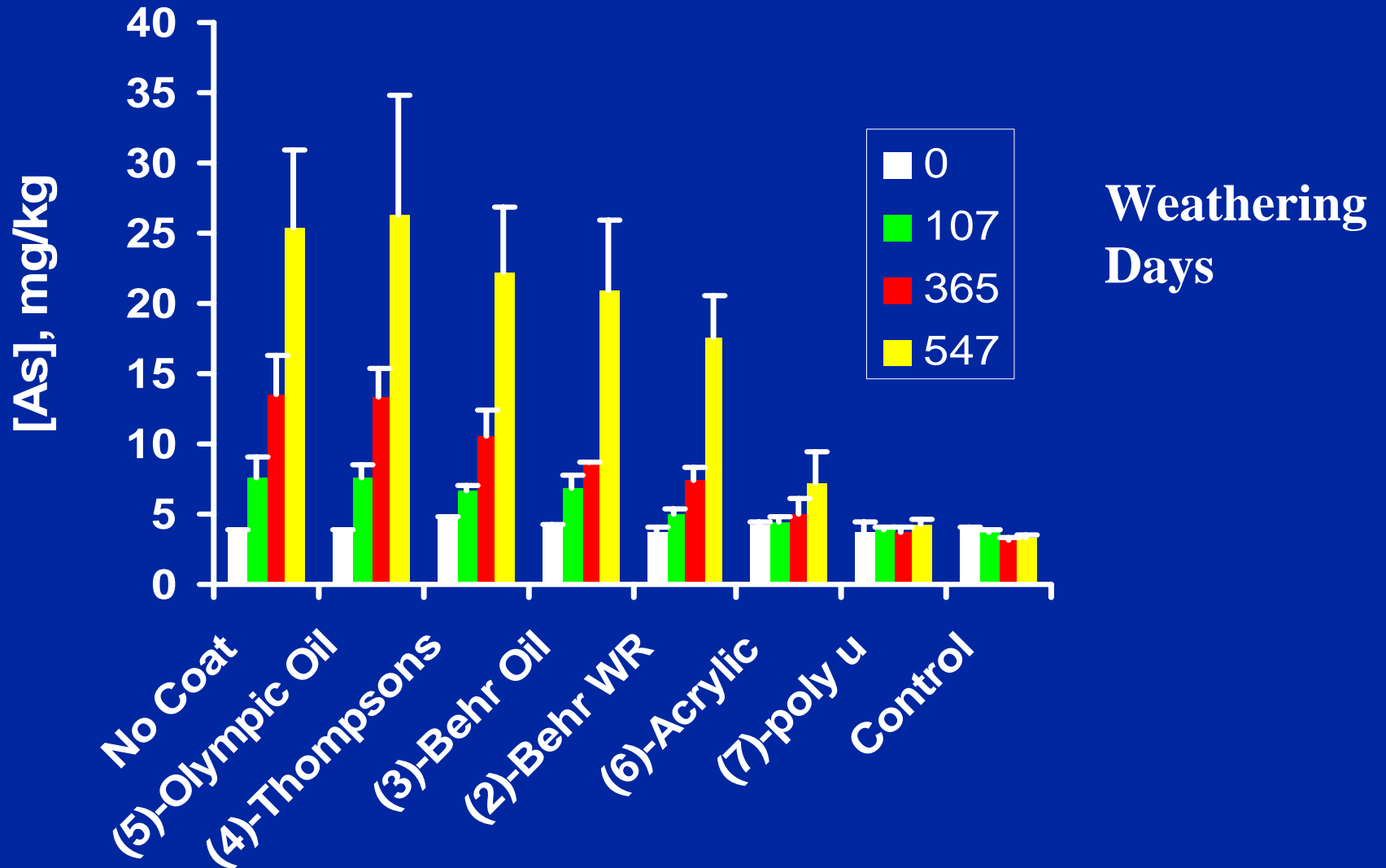
SOIL SAMPLING

- ▼ **Soil corer (2.2 cm dia.), soil adjacent to wood to box bottom, each side sampled (n=4 per sample event)**
- ▼ **Dry soil, digest in nitric acid**
- ▼ **Cu, Cr analyze by ICP.**
- ▼ **As -ICP or GFAA (GFAA if solution conc. <0.1 ppm).**

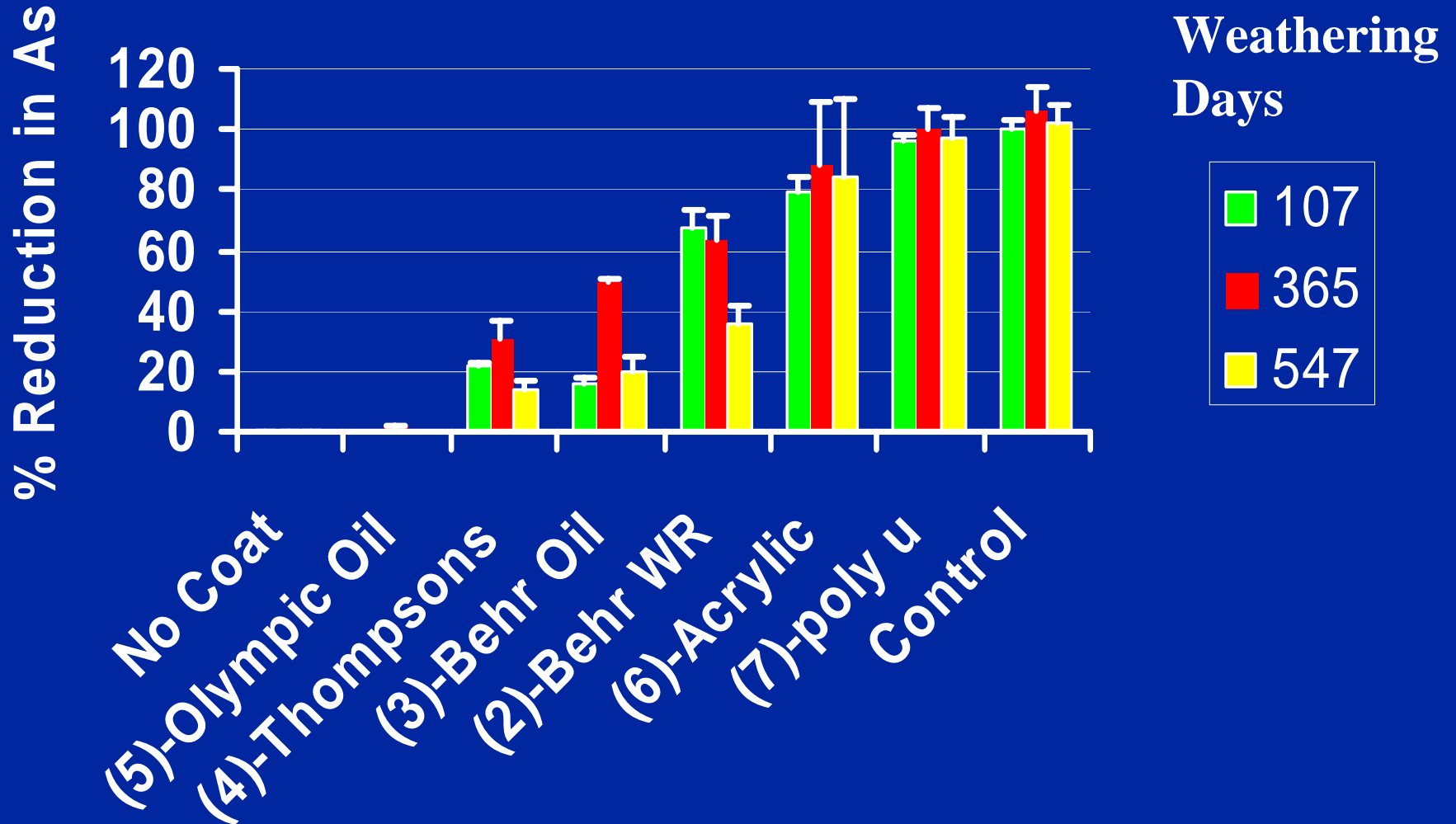
Soil As over time after using various coatings



Soil As



%Reduction in Soil As



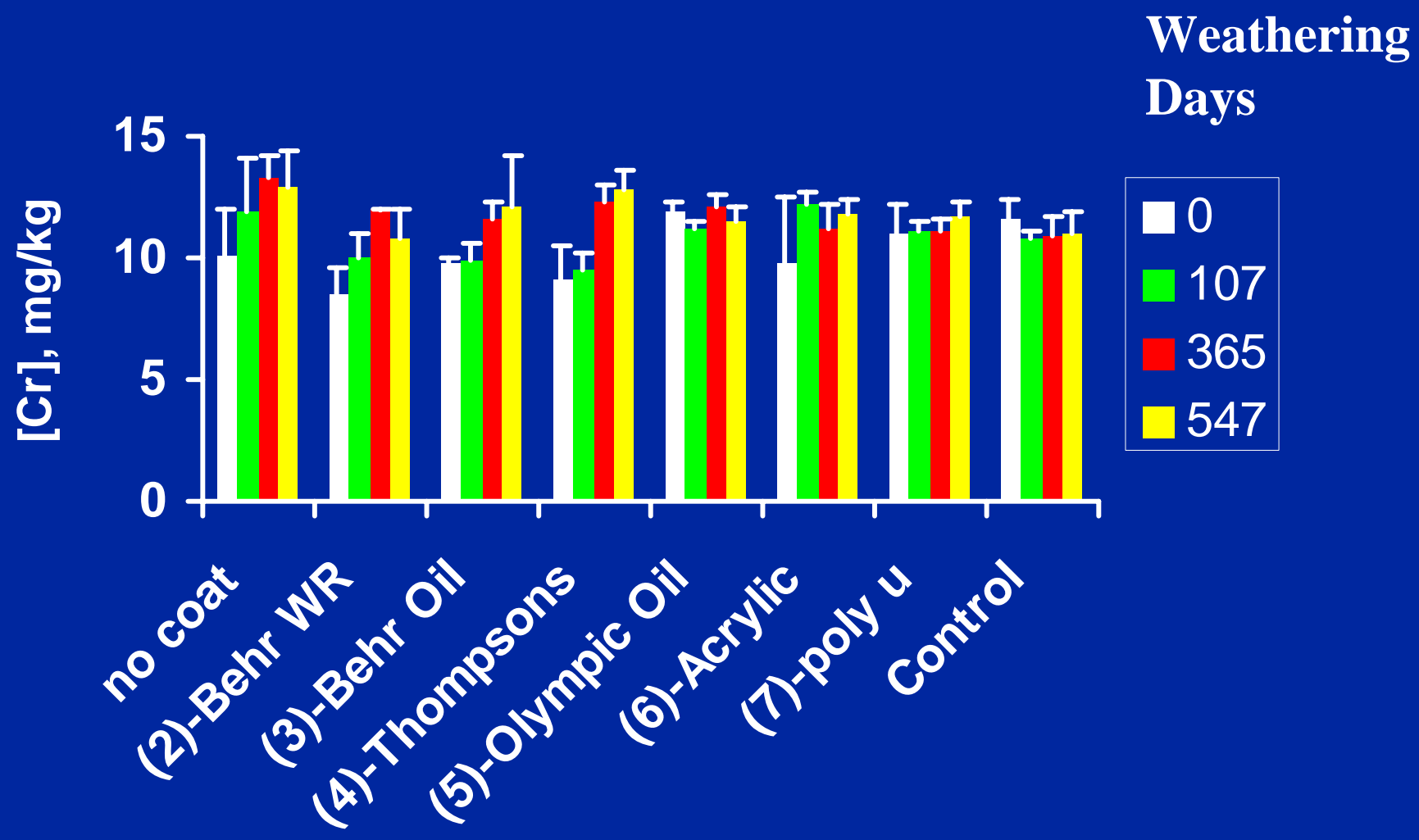
Soil As Data 1.5 year

Type/Base (#)	[As] mg/kg
Untreated	3.3 ± 0.2
PolyU/Oil/ Opaque (7)	4.3 ± 0.3
Acrylic/Water/ Opaque (6)	7 ± 2
Sealant w/Acrylics/Alkyd/ Water/Clear (2)	17 ± 3
Stain/Oil/semi (3)	21 ± 5
Sealant/Oil/clear (4)	22 ± 5
Stain w/Alkyd/oil/semi (5)	26 ± 8
Uncoated CCA	25 ± 6

Conclusions Arsenic Data

- ▼ **Substantial increase in soil As next to uncoated boxes shows that this soil traps As – distance samples planned at 2 year.**
- ▼ **The large range between uncoated, best coating and untreated wood of about 20 ppm makes results more reliable and easier to interpret (see Cr, next)**
- ▼ **Opaque coatings work (80+% reduction)**
- ▼ **The others are <50% effective after 1.5 years, and the soil As is >10 ppm (State limit).**

Soil Cr



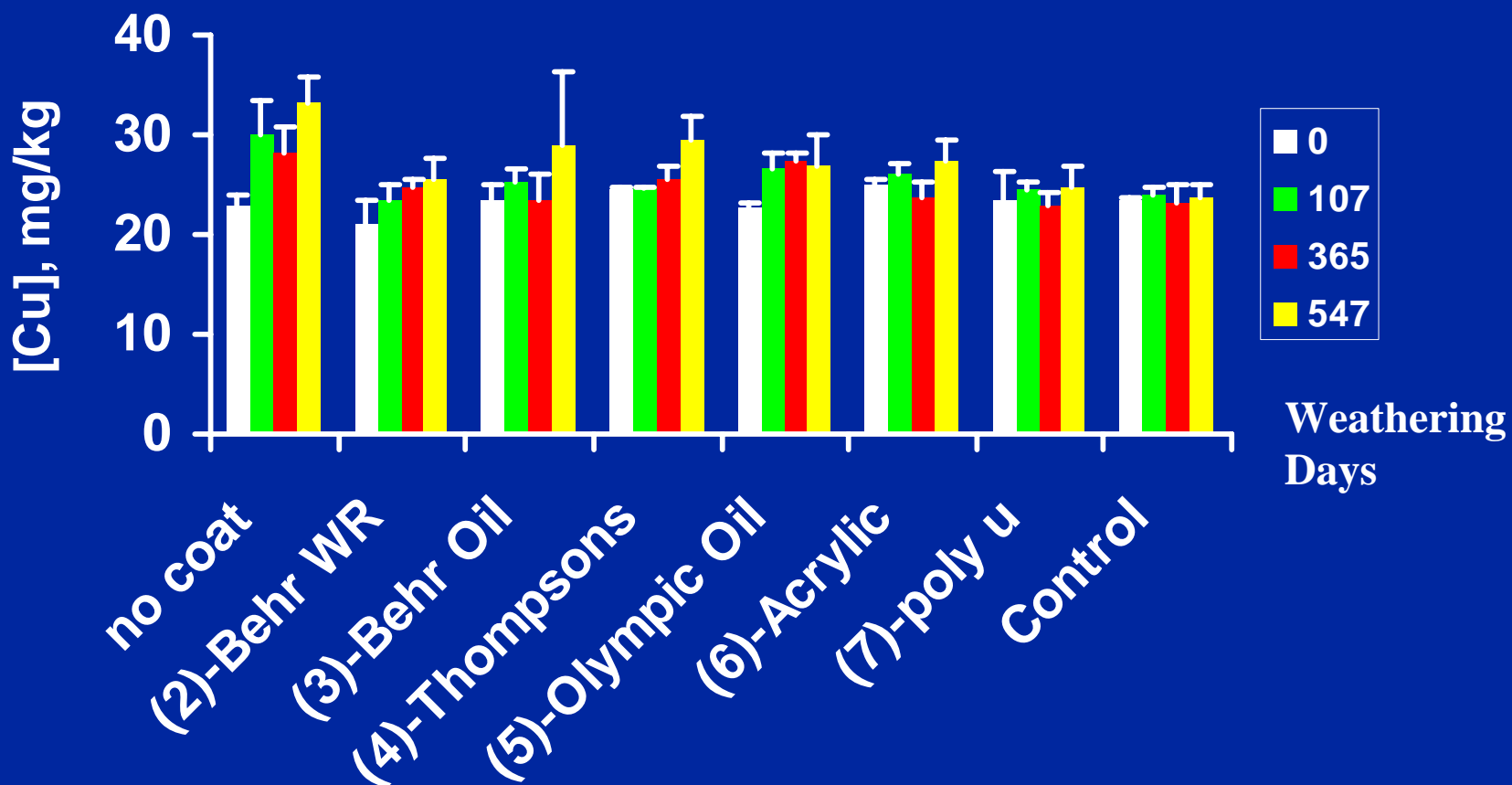
Soil Cr Data 1.5 year

Type/Base (#)	[Cr] mg/kg
Untreated	11.0 ± 0.9
PolyU/Oil/Opaque(7)	11.7 ± 0.7
Acrylic/Water/Opaque(6)	11.8 ± 0.5
Sealant w/Acrylics/Alkyd/ Water/Clear (2)	10.8 ± 1.2
Stain/Oil/semi (3)	12.1 ± 2.1
Sealant/Oil/clear (4)	12.8 ± 0.8
Stain w/Alkyd/oil/semi (5)	11.5 ± 0.7
Uncoated CCA	12.9 ± 1.5

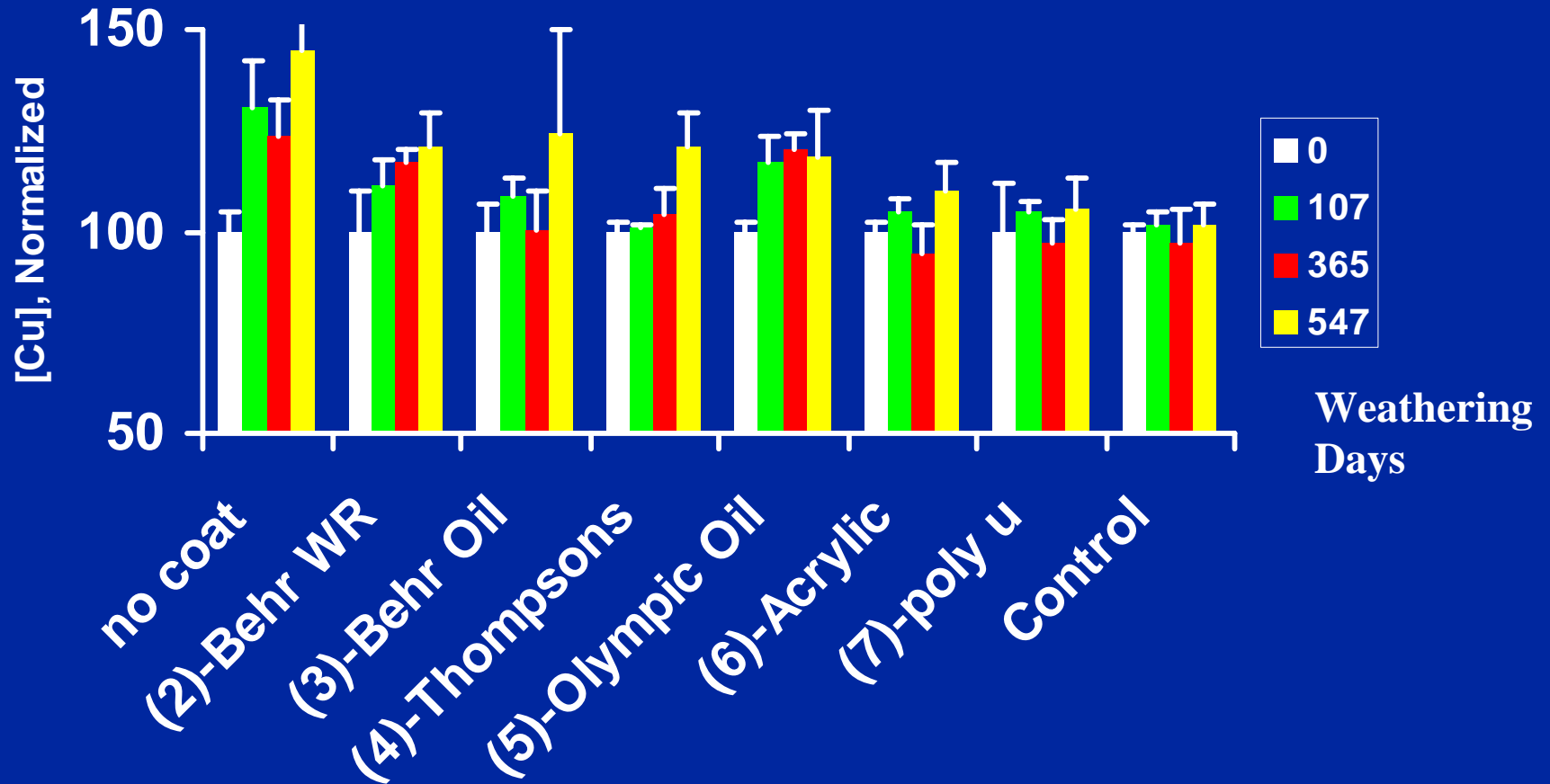
Conclusions/ Comments - Cr

- ▼ 2 ppm range in Cr 1.5 year data about equal to variation in baseline (day =0) Cr between boxes
- ▼ Baseline correction by normalizing data was used to spot trends, but results too uncertain to determine which coatings may work best for Cr.

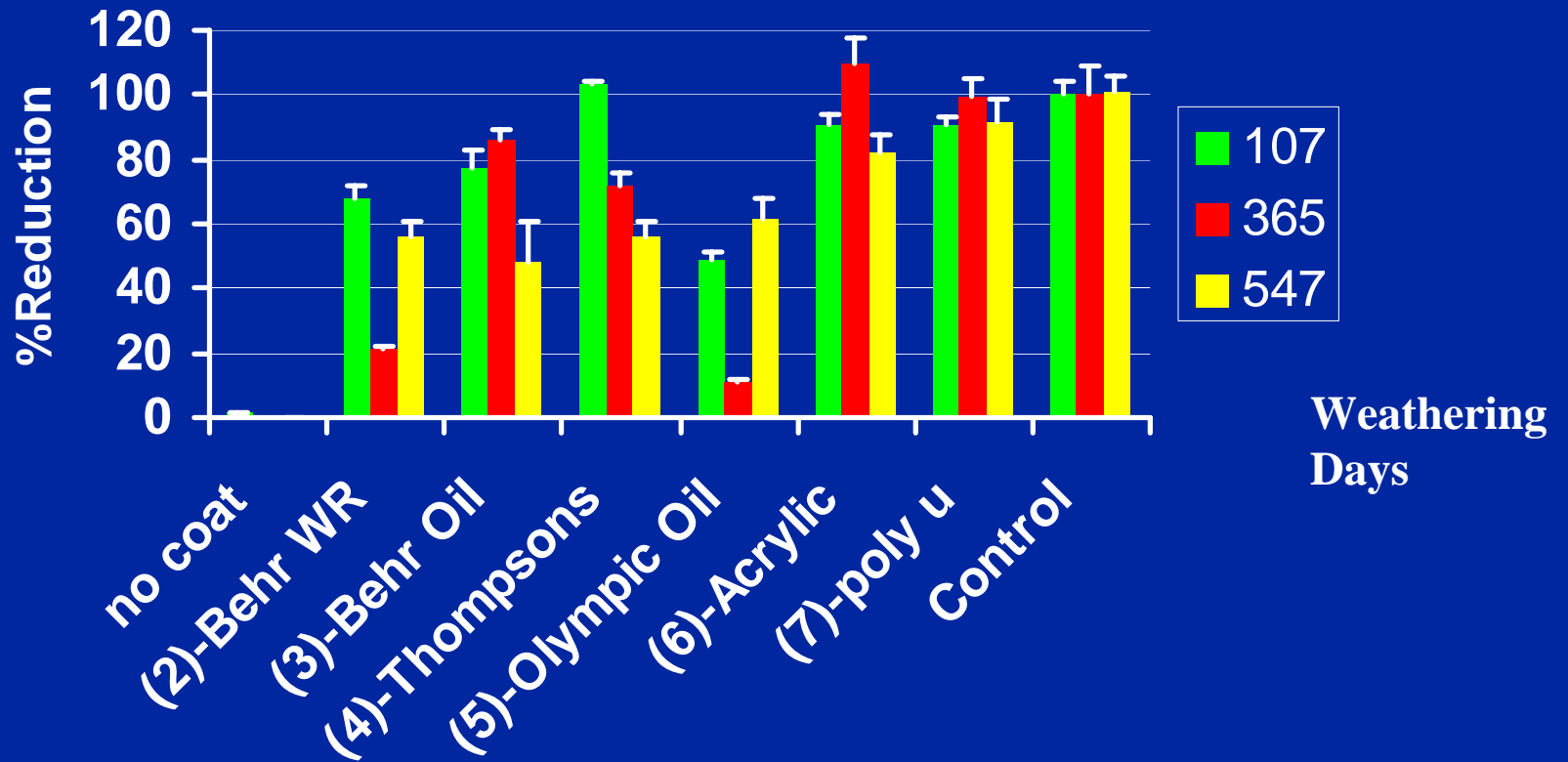
Soil Cu



Soil Cu – Normalized to initial amount=100



Approx. % Reduction in soil Cu*

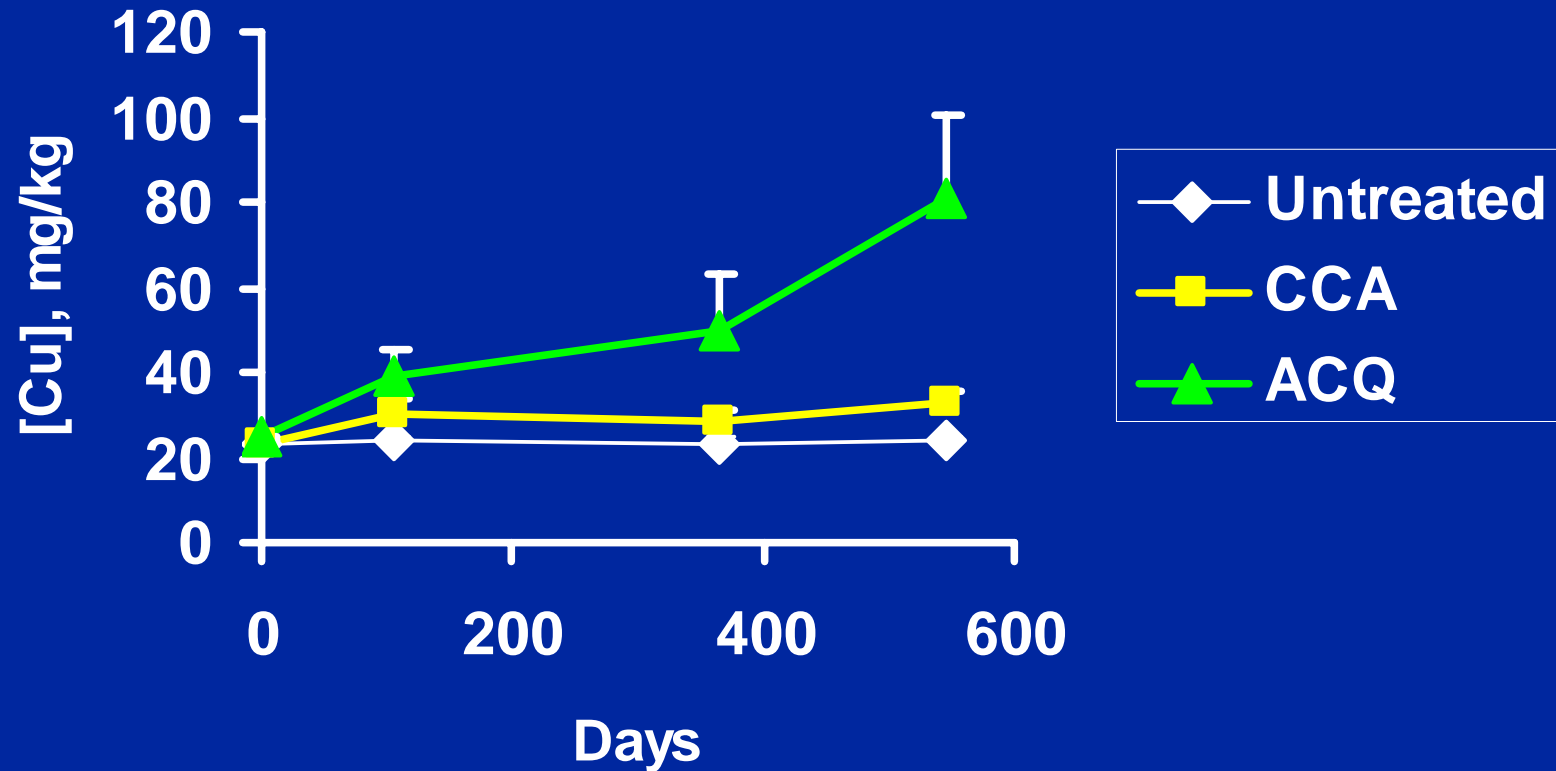


*Reduction compared to normalized difference in no coating and and control wood

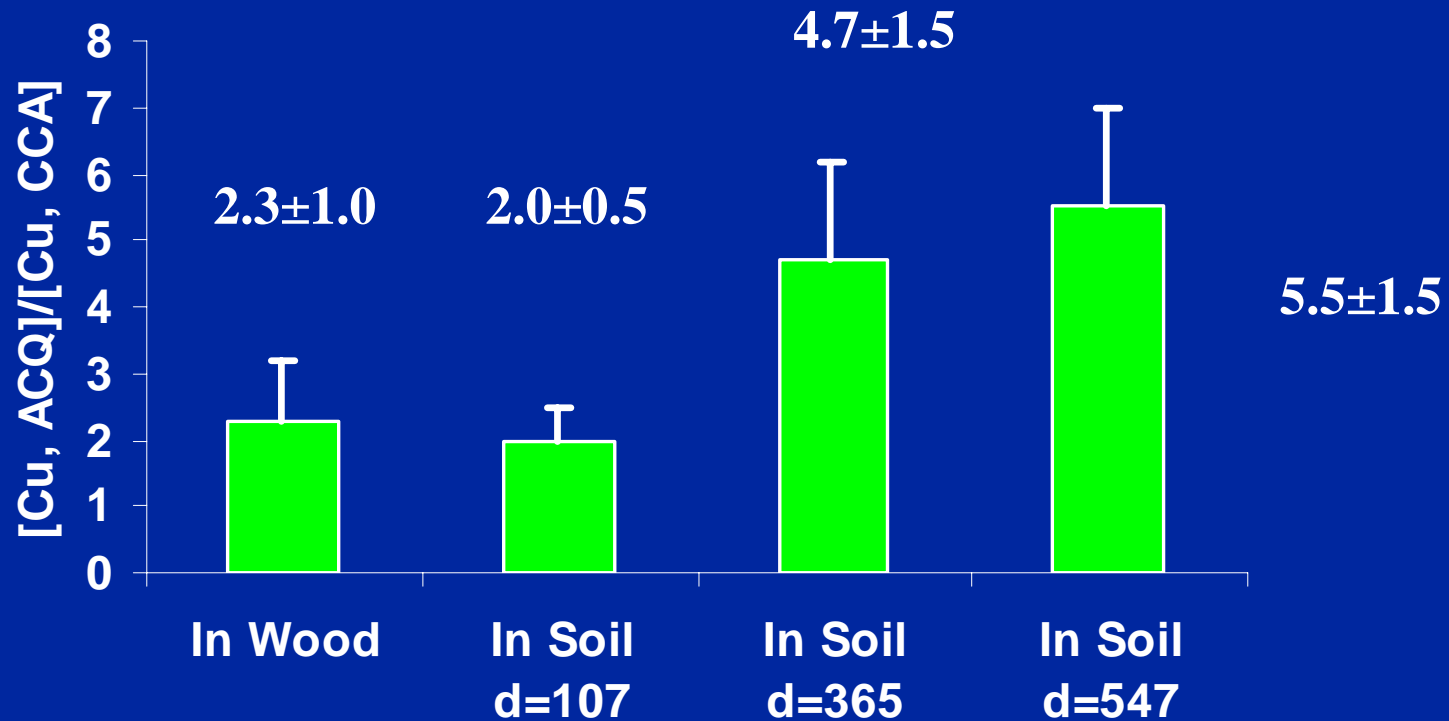
Soil Cu data 1.5 year

Type/Base (#)	[Cu] mg/kg
Untreated	24 ± 1
PolyU/Oil/Opaque(7)	25 ± 2
Acrylic/Water/Opaque(6)	27 ± 2
Sealant w/Acrylics/Alkyd/ Water/Clear (2)	26 ± 2
Stain/Oil/semi (3)	29 ± 7
Sealant/Oil/clear (4)	29 ± 2
Stain w/Alkyd/oil/semi (5)	27 ± 3
Uncoated CCA	33 ± 3
ACQ	81 ± 20

Soil Cu – ACQ vs.. CCA



*Ratio of Cu increase in soil - ACQ vs. CCA-
Suggests Leach Rate of Cu in ACQ > CCA*



Cu in CCA wood – 1050±310, 1263±54, 1773±16

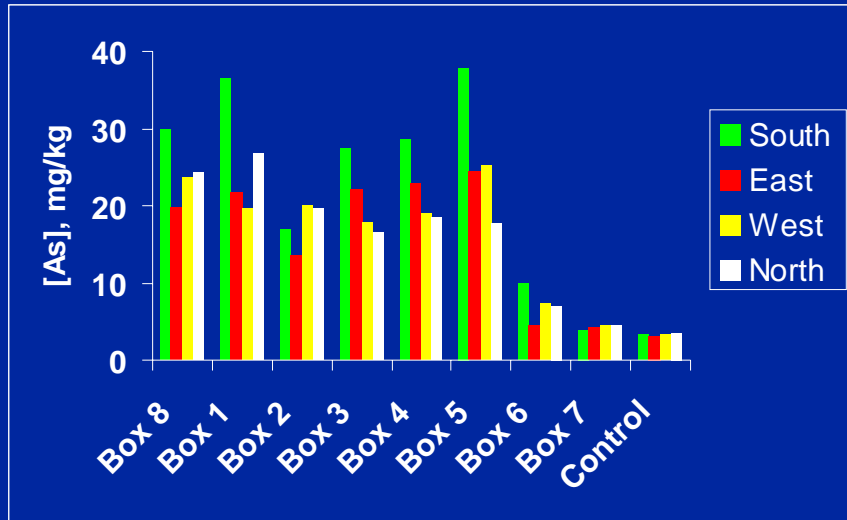
Cu in ACQ – 3073±60

Conclusions/ Comments - Cu

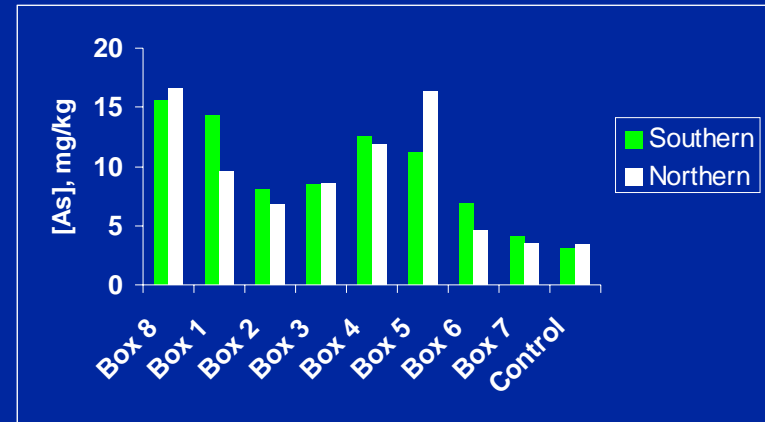
- ▼ 9 ppm range in Cu 1.5 year data greater than Cr (2ppm) but less than As (20ppm)
- ▼ Relative Cu increase (normalized data) still useful to spot differences
- ▼ More reliable than Cr, distance samples planned at 2 year.
- ▼ Opaque coatings consistent reduction >80%
- ▼ ACQ wood more suited for coating study of Cu
- ▼ Cu in ACQ may leach at a relatively higher rate than Cu in CCA

Soil As by Exposure – Emerging Trend

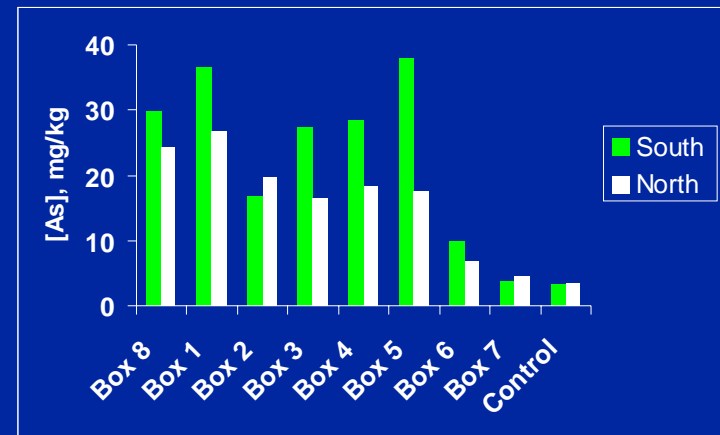
$S > N$ after 1.5 years but not after 1 year



1.5 years



1 Year



Conclusions

- ▼ Opaque Polyurethane and Acrylic coatings worked best – In agreement with dislodgeable As results
- ▼ Good to Excellent reduction over 1.5 years-about 80% with latex acrylic and 95% with polyurethane enamel.
- ▼ Oil Based Finishes – appear to be breaking down – no more than 40% effective after 1.5 years.
- ▼ Peeling and Chipping problem associated with solid finishes on horizontal surfaces may not be an issue for this application
- ▼ Above and below ground component in leaching not determined.

*I would like to Thank the
Florida Center for their
Support,
and
Thank You for Your Time –
Questions?*