COLOR ANALYSIS OF ROCK ART VARNISH:

FAILING AT THE DATING GAME

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URARA CONFERENCE

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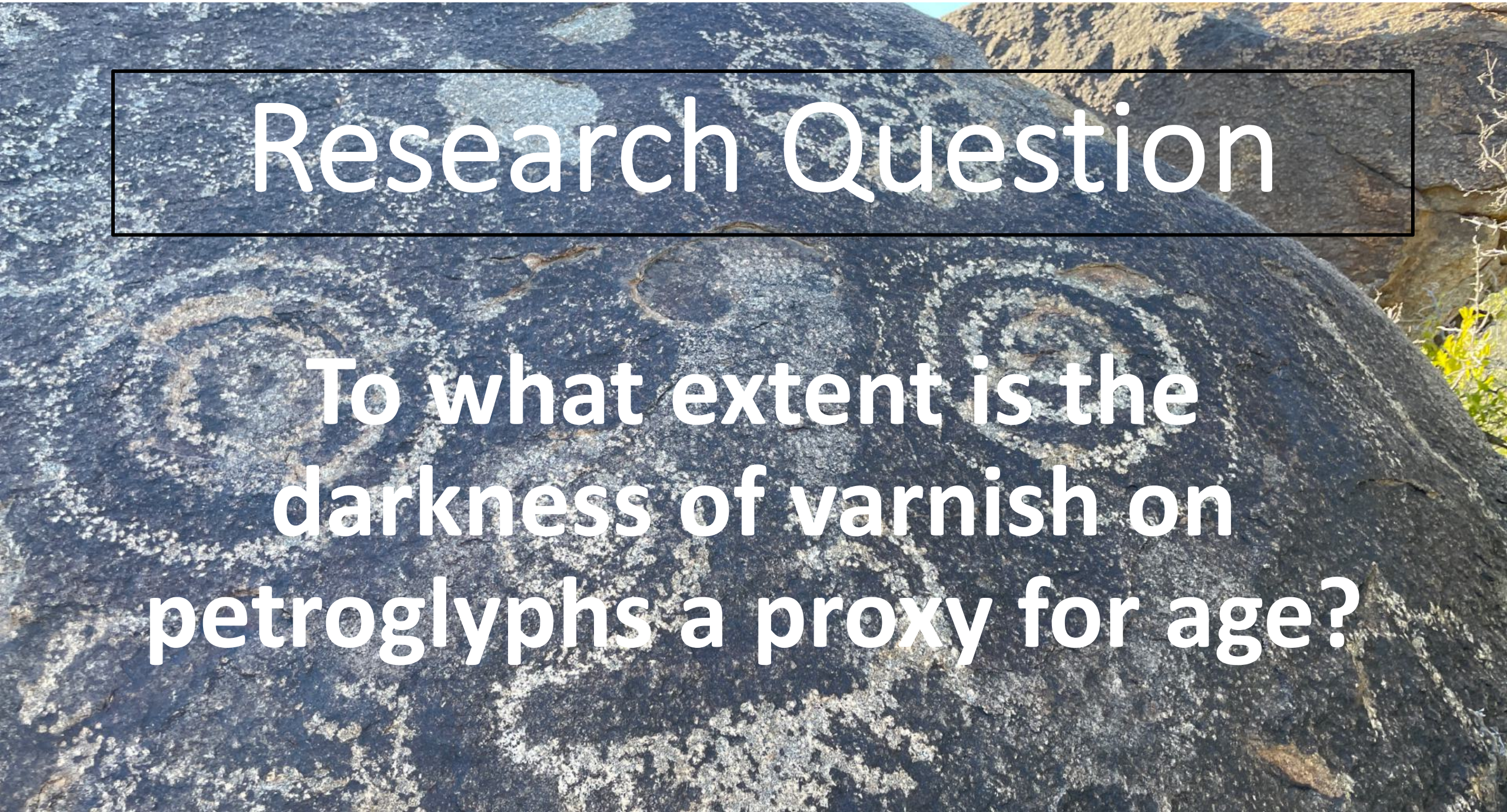
THE UNIVERSITY OF ARIZONA



Research Question

To what extent is the darkness of varnish on petroglyphs a proxy for age?

Measuring Color & Reflectance: 3 Techniques

Digital Photographs color-corrected to the IFRAO scale in PhotoShop

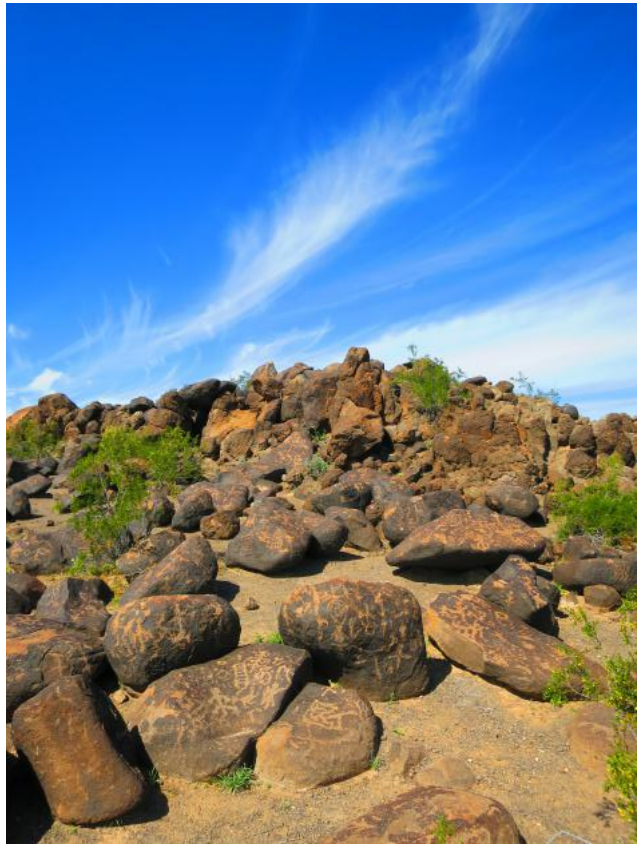
Portable Spectrophotometer

Digital Light Meter

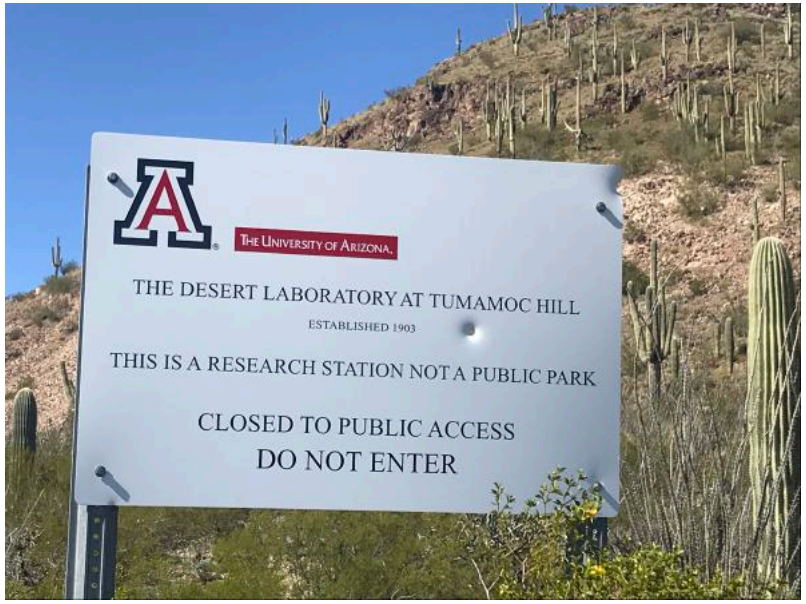
Research Hypotheses

If the darkness of rock varnish in the grooves of petroglyphs is a proxy for the age of the image, then…

- the amount of light reflected by the varnish (i.e., reflectance) ***as measured by a light meter*** will differ based on the petroglyph's antiquity.
- using the IFRAO color card as the standard, the mean RGB color of the varnish ***as analyzed in Photoshop*** will differ based on the the petroglyph's antiquity.
- historic rock inscriptions will be lighter and have a higher reflectance value ***as measured by a spectrophotometer*** than older, precolumbian petroglyphs which will be relatively darker.
- all three methods should result in ***similarly consistent measures*** on both dated and undated inscriptions.



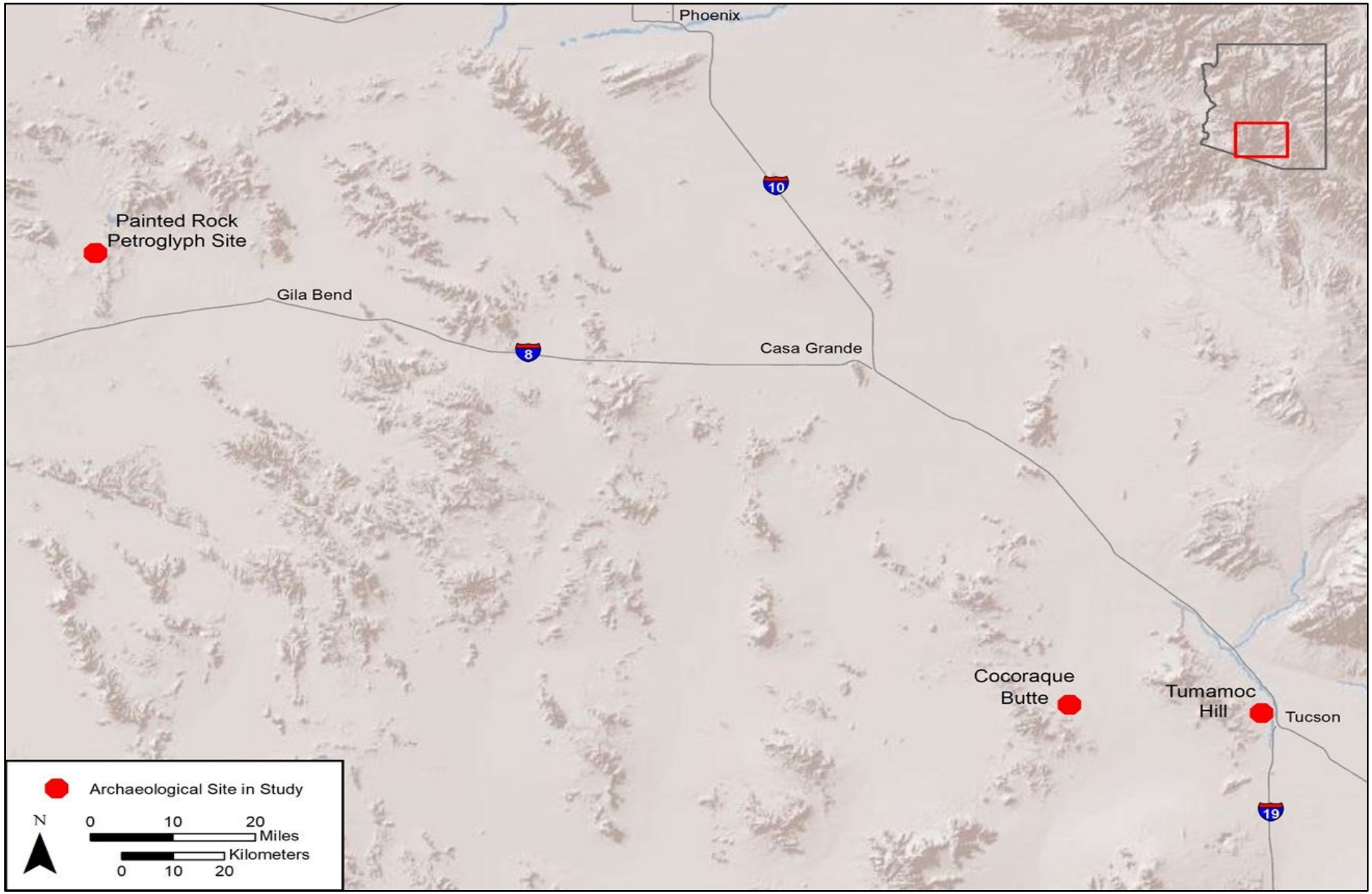
Painted Rocks



Tumamoc Hill

Cocoraque Butte

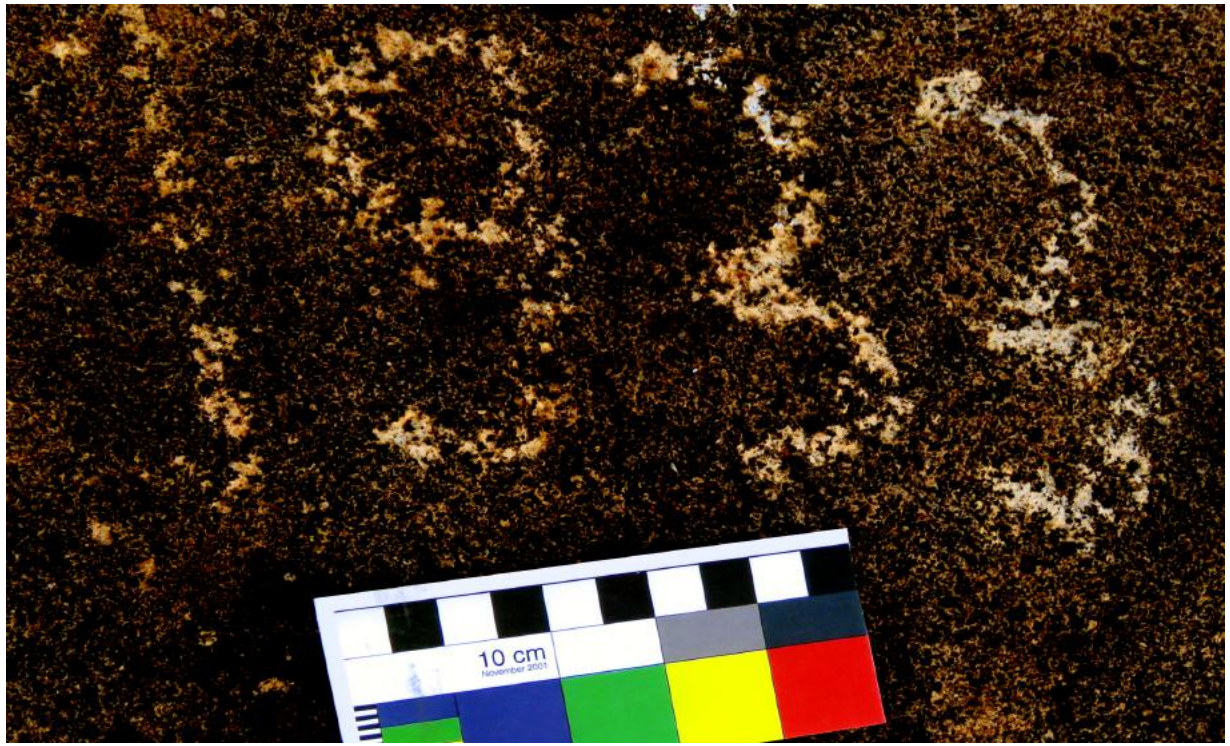
Three Sites in Arizona


Phoenix
10
Painted Rock
Petroglyph Site
Gila Bend
8
Casa Grande
Cocoraque
Butte
Tumamoc
Hill
Tucson
19
Archaeological Site in Study
N
0 10 20
Miles
Kilometers
0 10 20

Analyzing Varnish on Dated and Historic Graffiti

Analyzing Varnish Color & Reflectance

Color-Correction of Digital Photos to the IFRAO Scale Using Adobe PhotoShop

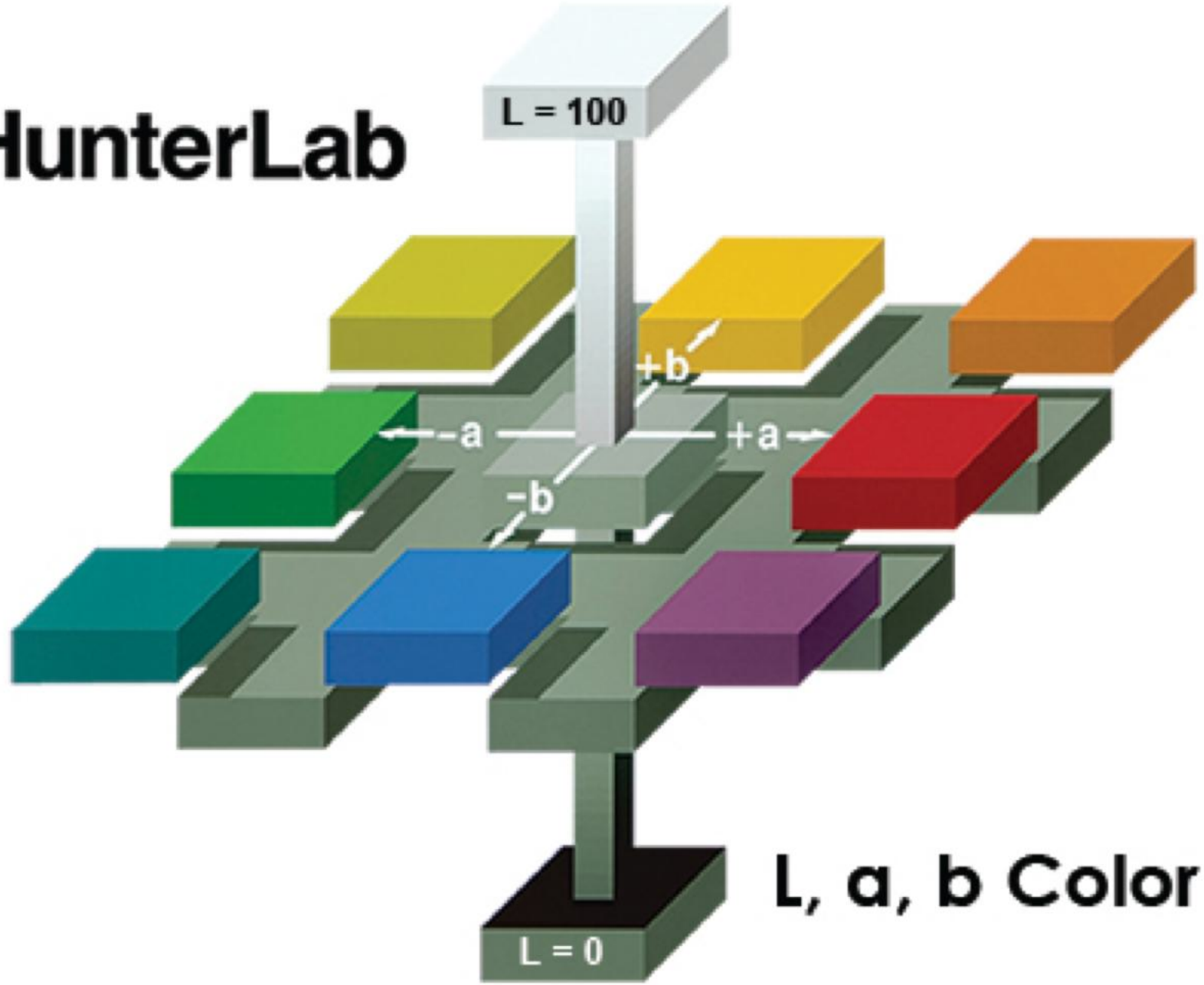


Hand-held Seconic Light Meter

Light Meter to Measure Illuminance (foot candles)
and Luminance (foot Lamberts)

Formula: Fc/FL = R

HunterLab



L, a, b Color Space

Spectrophotometer In the Field

Statistical Methods

- Purposive Sampling
- 79 petroglyphs analyzed
- Statistical Procedures

  <u>Dated Graffiti</u>
  - Correlation analysis
  - Regression analysis

  <u>Ancient and Dated Inscriptions</u>
  - t-test of means
  - Mann-Whitney test of medians

RESULTS

		Dated Inscriptions		Dated and Ancient Inscriptions	
	Statistical Method	**Correlation Analysis**	**Regression Analysis**	**t-test of means**	**Mann-Whitney of medians**
	RGB Mean			$p = 0.029$	
Cocoraque Butte	Reflectance				
	L* Value			$p = 0.001$	$p = 0.047$
	RGB				
Tumamoc Hill	Reflectance				
	L* Value				
	RGB			$p = 0.011$	$p = 0.009$
Painted Rock	Reflectance			$p = 0.004$	*$p = 0.009$*
	L* Value				

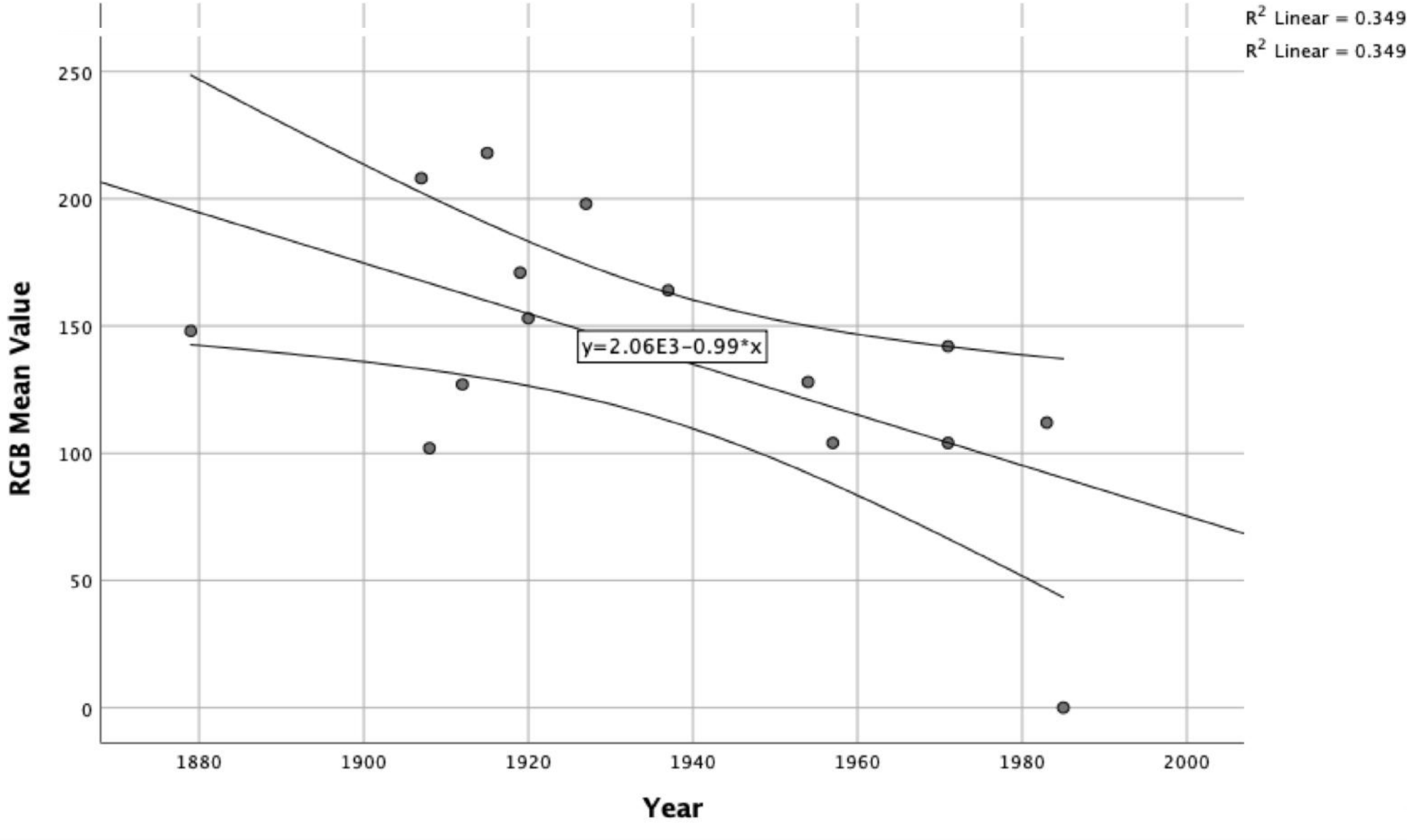
Discussion

- This study validates and supports previous research which indicates that **the older a petroglyph, the darker its varnish** is compared to more modern inscriptions.
- **However, data sets must be large enough** and **a variety of statistical methods** should be used to analyze these data sets. Random sampling of both types of images would improve analysis, but that is difficult with dated graffiti.
- The **digital light meter appears to be the most cost-effective tool** for analyzing rock varnish.
- Digital photographic analysis may be the only tool right now to analyze varnish formation on **very narrow inscriptions**.
- The **spectrophotometer offers many potentials** for use in rock varnish analysis.

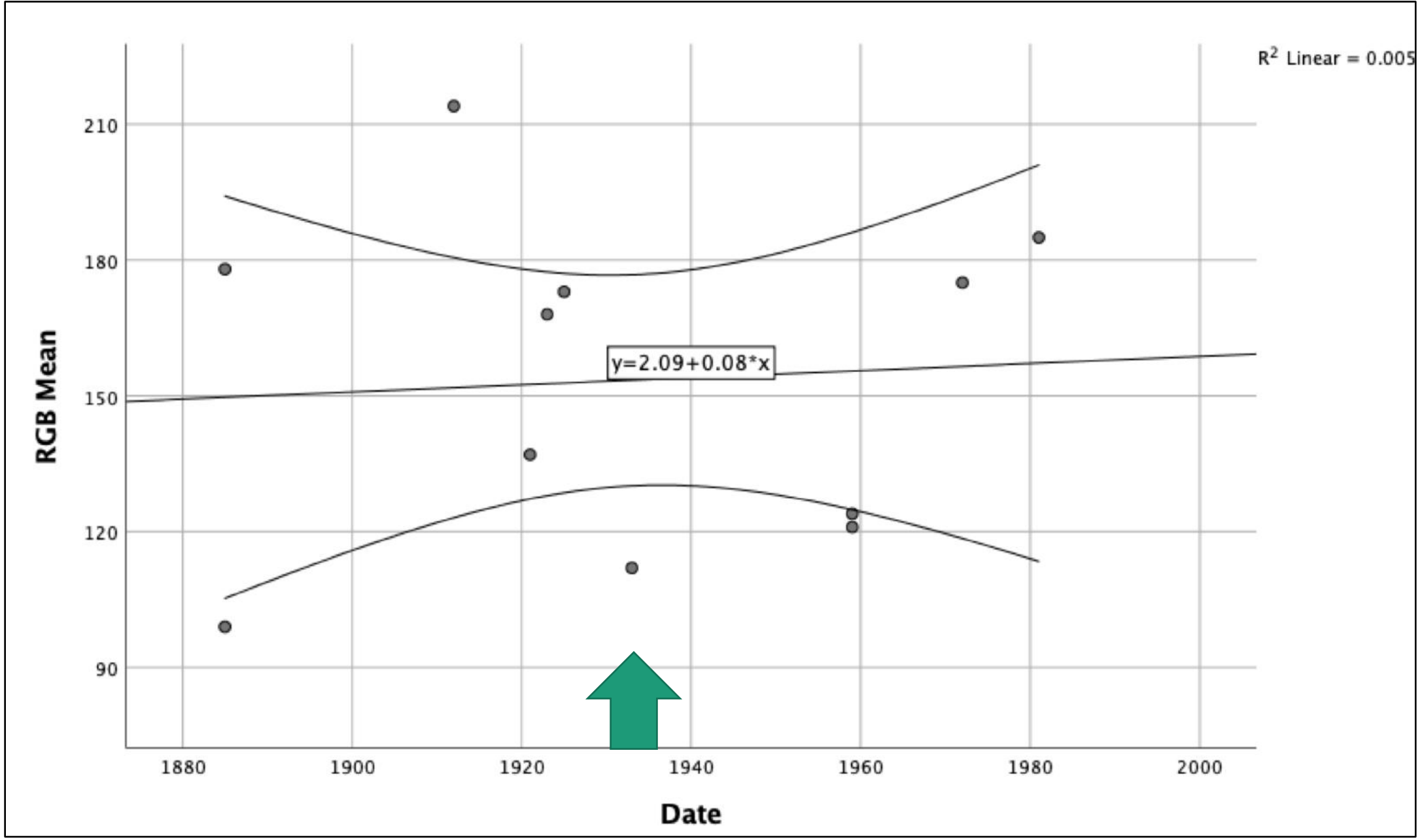
Problems with the IFRAO Card

- **Glossy coating** which reflects sunlight and can wash out
- **Small size of color squares** for color correction in software programs
- Inadequate **number of gray scales** for comparison. Colorimetry research recommends several gray scales for color correction.
- Photoshop may not be the best **software program** for doing color analysis. Lightroom or others may be better choices.
- The **IFRAO card fades quickly** over time rendering them useless except as a measurement scale.

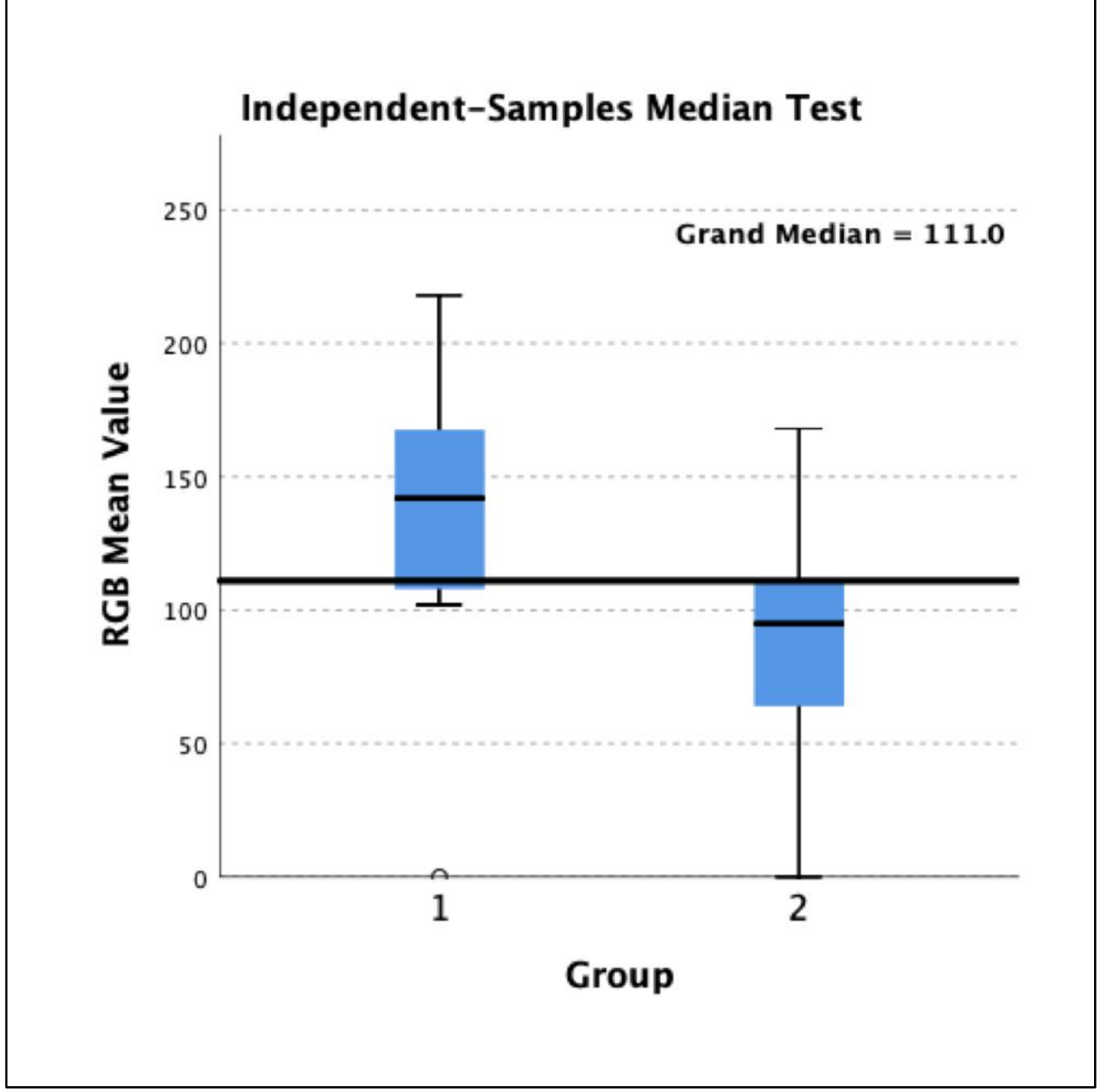

10 cm
November 2001



RGB means for dated inscriptions, Painted Rock Petroglyph Site (p = 0.099).

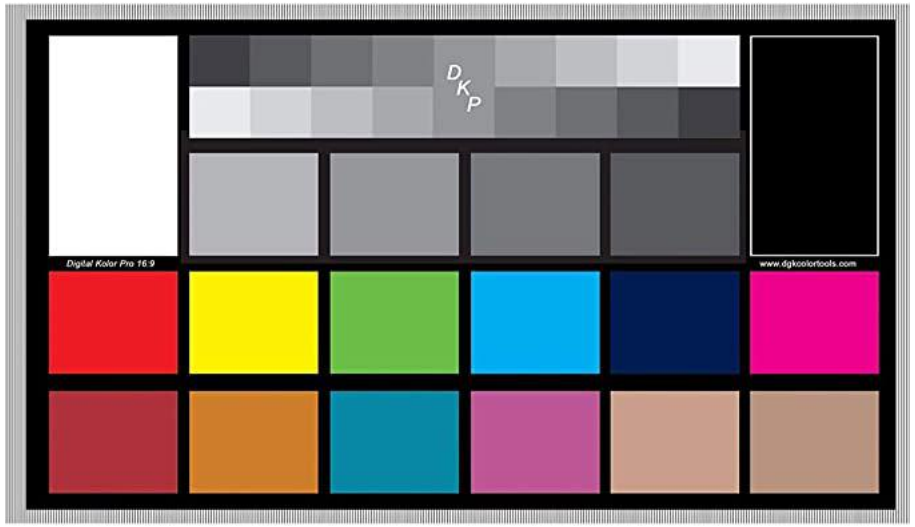


Cocoraque Butte—Regression Analysis for RGB

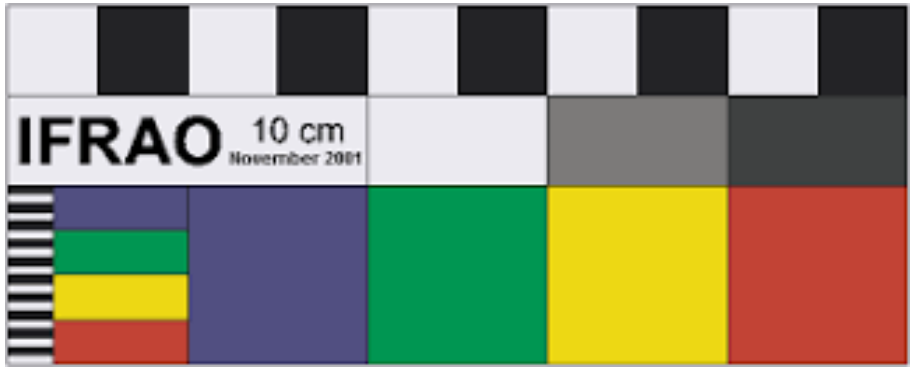


Box and whisker plot of RGB medians for dated (group 1) and ancient (group 2) inscriptions at Painted Rock Petroglyph Site.

X-Rite Color Checker Passport



DGK Color Card



IFRAO Color Card

Considerations in Petroglyph Research

- **Varnish formation** is still not well-understood
- **Groove depth and width** are potential influencers to varnish formation
- **Cardinal direction** may also influence varnish formation—north, south, east, west
- **Orientation** may also affect varnish formation—vertical, horizontal, under alcoves

Future Directions for Dating

- Use of other color cards for digital photographs in the field.
- Use of other software programs for analysis of digital photographs.
- Continued use of digital light meters to measure varnish reflectance.
- Continued use of spectrophotometers to measure color of rock varnish, particularly the ”Y” measure.
- Study differences in rock varnish both from aspect (compass orientation) and spatial placement on rocks (horizontal, vertical, overhangs).
- Groove depth and width should be studied in relationship to varnish formation.

Thank You!
Questions?

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