# CONTRASTING GEOLOGIC AND GEOARCHAEOLOGICAL VIEWS OF GRANTS RIDGE OBSIDIAN DEPOSITS, MOUNT TAYLOR VOLCANIC FIELD,NEW MEXICO

M. Steven Shackley and Fraser Goff

Known and documented sources of artifact quality obsidian in the North American Southwest


The Mount Taylor obsidian sources have been used to produce stone tools for over 13,000 years

# SHORT HISTORY OF GEOARCHAEOLOGICAL RESEARCH OF OBSIDIAN IN THE SOUTHWEST

• First scientific study: 1956 two UNM geology students used a refractive index analysis of Jemez Mtns obsidian and artifacts in northern NM (Boyer and Robinson 1956)

•In the 1980s, Shackley expanded the number of geoarchaeologically known Southwest sources from 6 to over 40 (59 today), working in John Holloway's lab at ASU (Shackley 1988, 1989, 2005 *ad nauseum*)

• In the 1990s Carmichael and Shackley with NSF funding secured a Philips 2400 WXRF for both geological and archaeological research at Berkeley until it went offline in the 2000s.

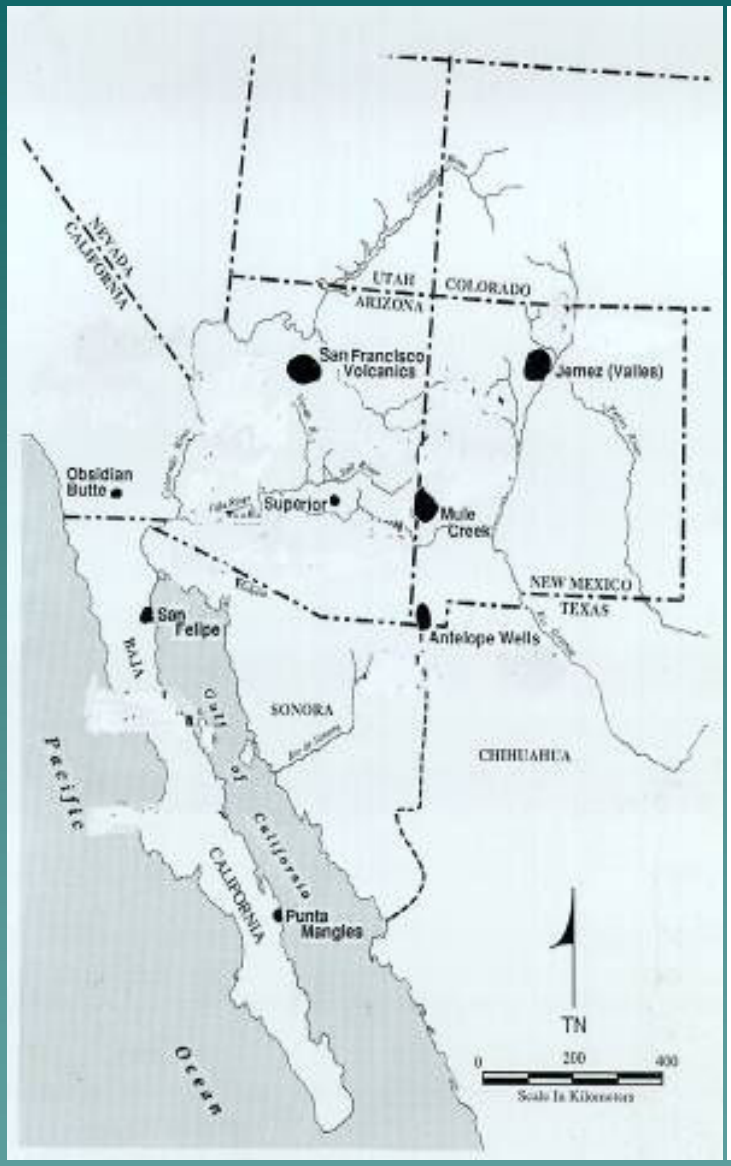
• In the 2000s, the Archaeological XRF Laboratory, mainly focused on North American obsidian studies using laboratory EDXRF, began processing thousands of samples annually teaching geology and archaeological students, the laboratory sponsored by NSF.

• In the last few years, a collaboration between Fraser Goff and Shackley has resulted in a refined view of Jemez Lineament obsidian.

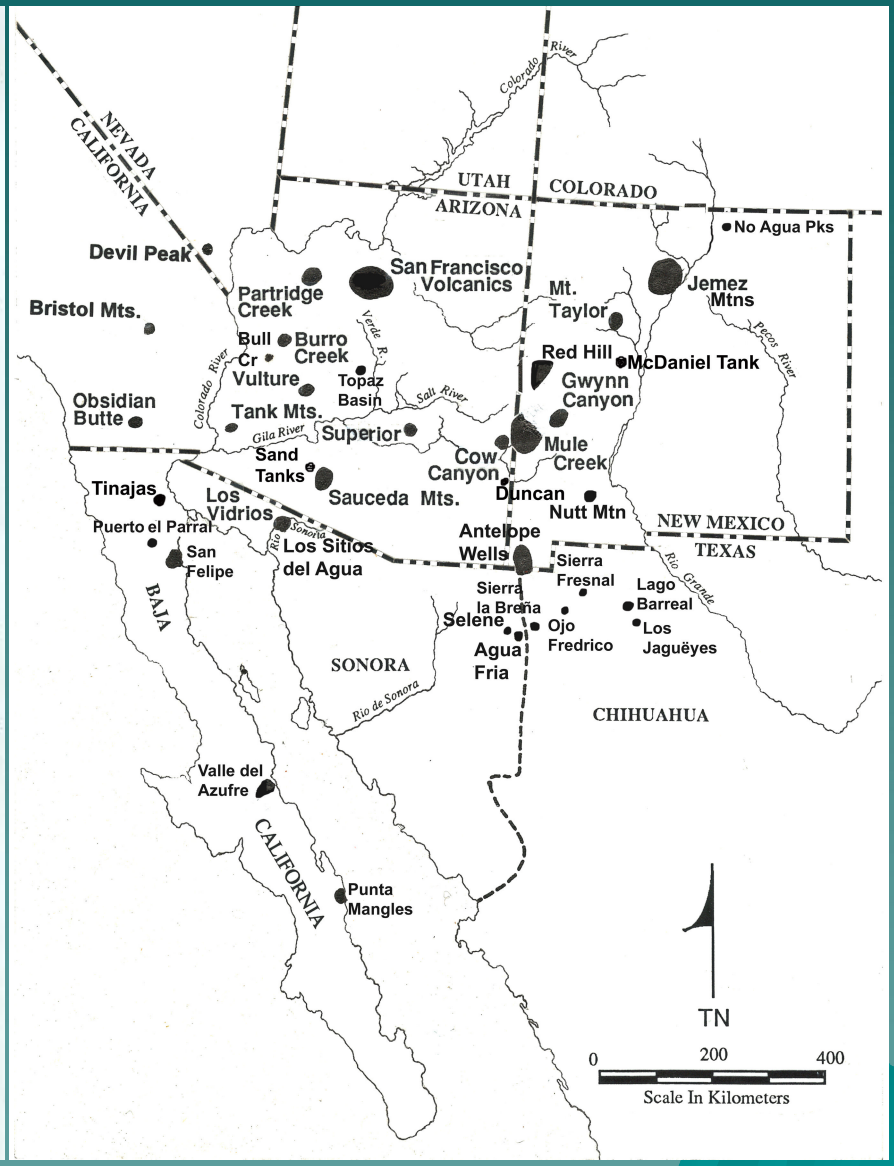
• The Rio Grande obsidian secondary deposit study (*Geoarchaeology* 2021)

# THE SOUTHWEST ARCHAEOLOGICAL OBSIDIAN PROJECT

n=6




1980s

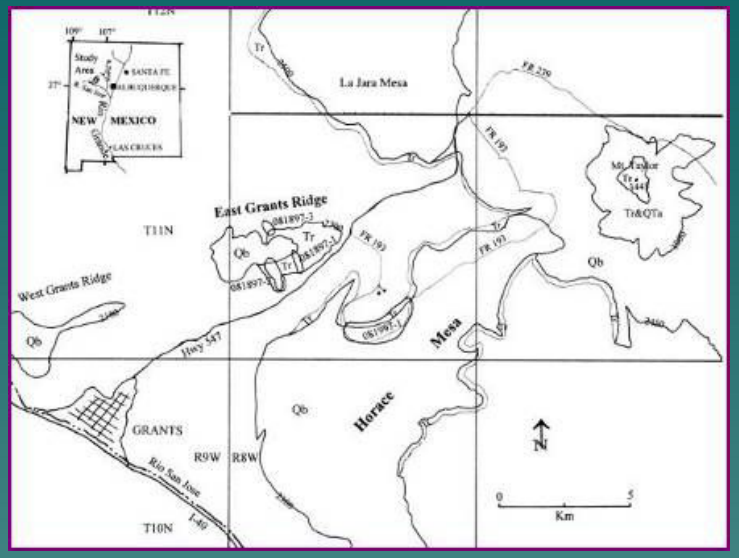



2022

n=59+

http://swxrflab.net/

# Obsidian in the Mount Taylor Volcanic Field

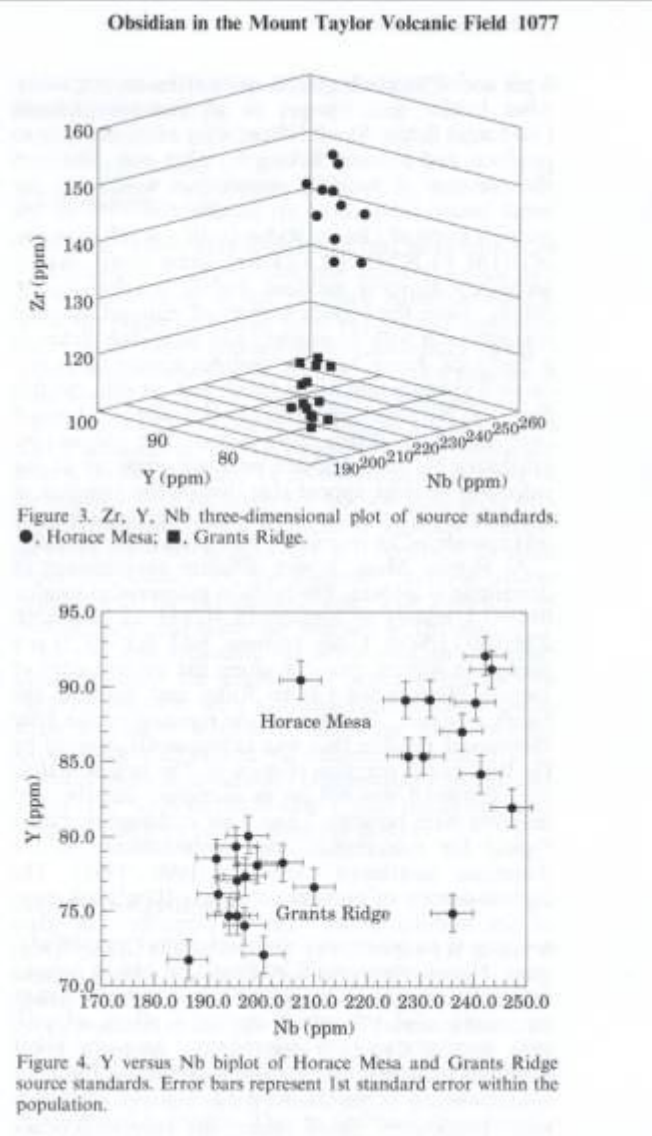



My original 1997 study of the Mount Taylor obsidian (map adapted from Dillinger (1990), Hunt (1938), Lipman et al. (1979).

It was becoming increasingly apparent in archaeological analyses that there were two compositionally distinctive chemical groups that were lumped into "Grants Ridge" obsidian I called "Grants Ridge" and "Horace Mesa" (Shackley 1998). This was long before the Goff study.

In 2009 during a Keck Foundation field camp, the extent of the deposit on Horace Mesa was considerably enlarged, and the La Jara Mesa obsidian was compositionally linked to Horace Mesa.

In 1997 I found that the more vitrophyric obsidian of Grants Ridge and the aphyric Horace Mesa obsidian were, by geoarchaeological standards, easily discriminated with Mn, Rb, Y, Zr, and Nb




3-D and bivariate plots of three mid-Z elements of Grants Ridge and Horace Mesa from the 1997 study

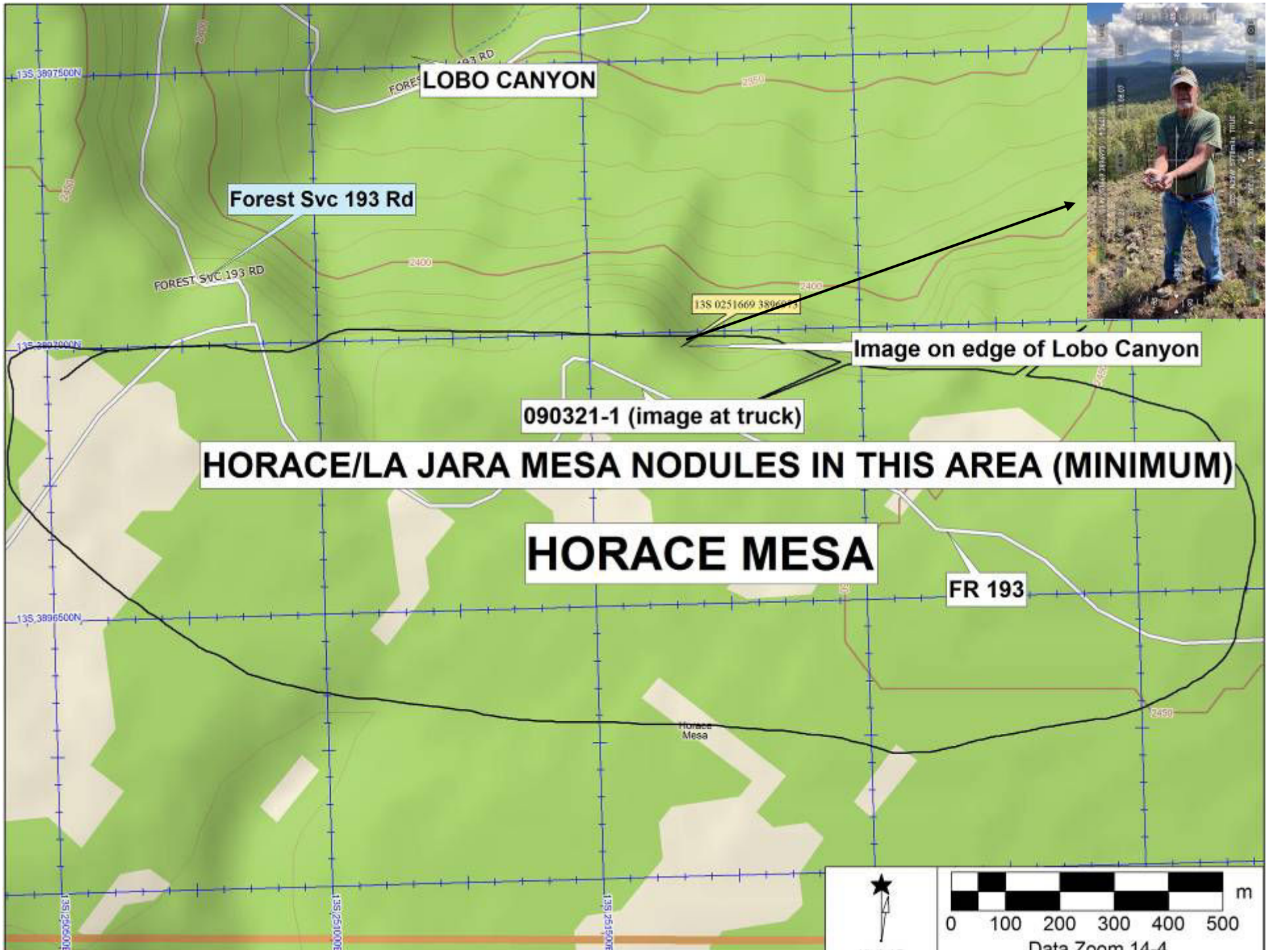
**Why is this important?** Geologically to (Goff et al. 2019) this is all "Grants Ridge rhyolite" and rightly so.

To archaeologists discrimination of these two groups allows us to target:

1) raw material selection – is one technologically preferred over the other?
2) possible social network/territoriality issues – i.e. did the Zuni claim Mt Taylor obsidian, and prefer one over the other
3) Volumetrically, has one eroded more into the Rio Grande basin than the other? (Shackley 2021).

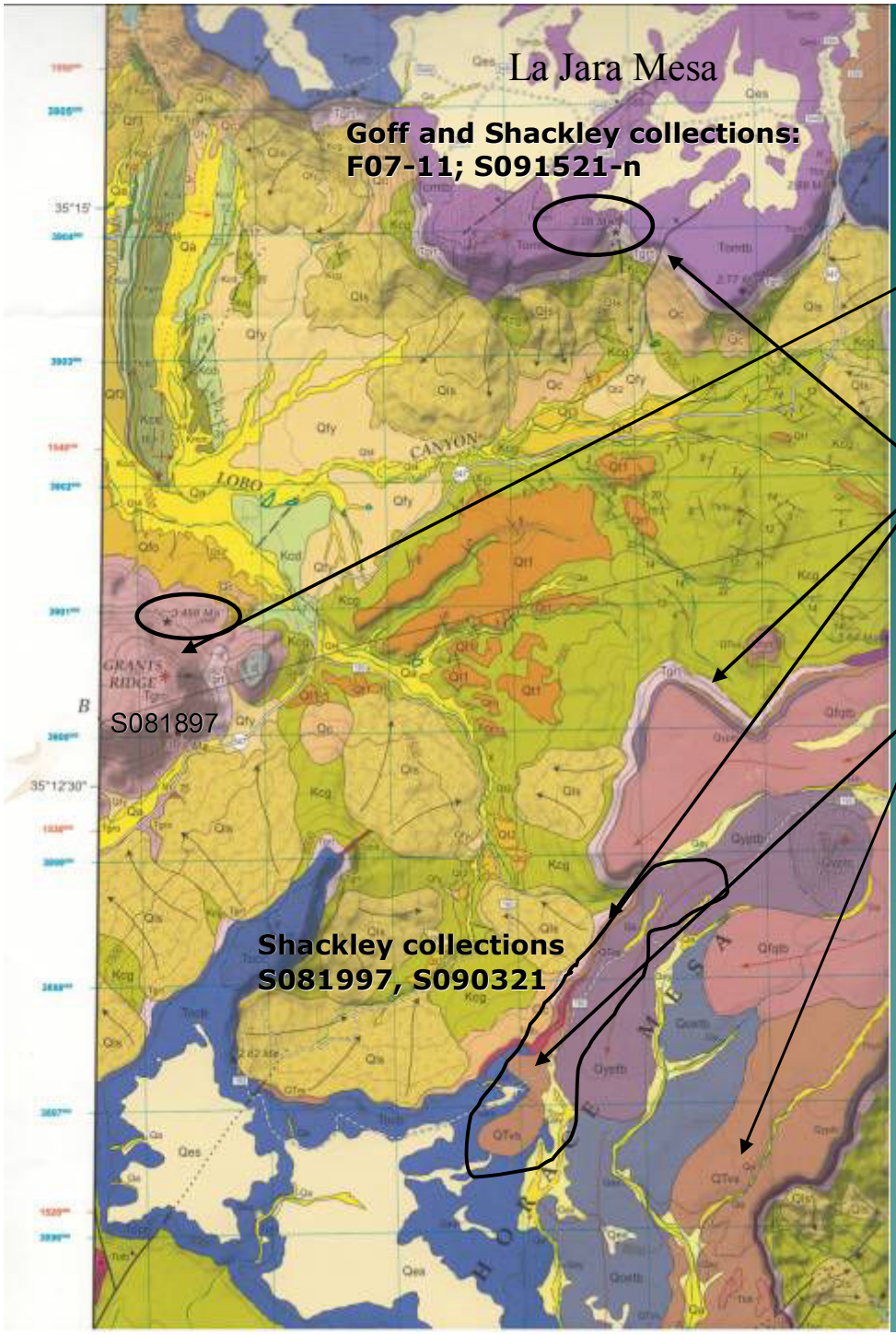

Horace Mesa
Grants Ridge
1CM
2CM


When told about the relatively high density of artifact quality obsidian on the surface of Horace Mesa, a certain geologist thought that it must have been deposited "by Indians" because it didn't fit the "scale of the analysis" and our understanding of the Grants Ridge rhyolite


LOBO CANYON
Forest Svc 193 Rd
FOREST SVC 193 RD
13S 0251669 3806973
Image on edge of Lobo Canyon
090321-1 (image at truck)
HORACE/LA JARA MESA NODULES IN THIS AREA (MINIMUM)
HORACE MESA
FR 193
13S 3897500N
13S 3896500N
Horace Mesa
0 100 200 300 400 500 m
Data Zoom 14-4

So, this geological conundrum caused us to embark on a two day field investigation with a number of goals:

1) Is the deposit of "Grants Ridge obsidian" on Horace Mesa indeed geologically deposited?
2) Is Horace and La Jara Mesa obsidian compositionally similar?
3) Is the geochronology of Horace and La Jara Mesa obsidian contemporaneous?
4) I was interested in obtaining obsidian samples from the Goff et al (2019) previously dated contexts?
5) Finally, what geological conditions created the deposit of obsidian on Horace Mesa seemingly unexplained by then current understanding?



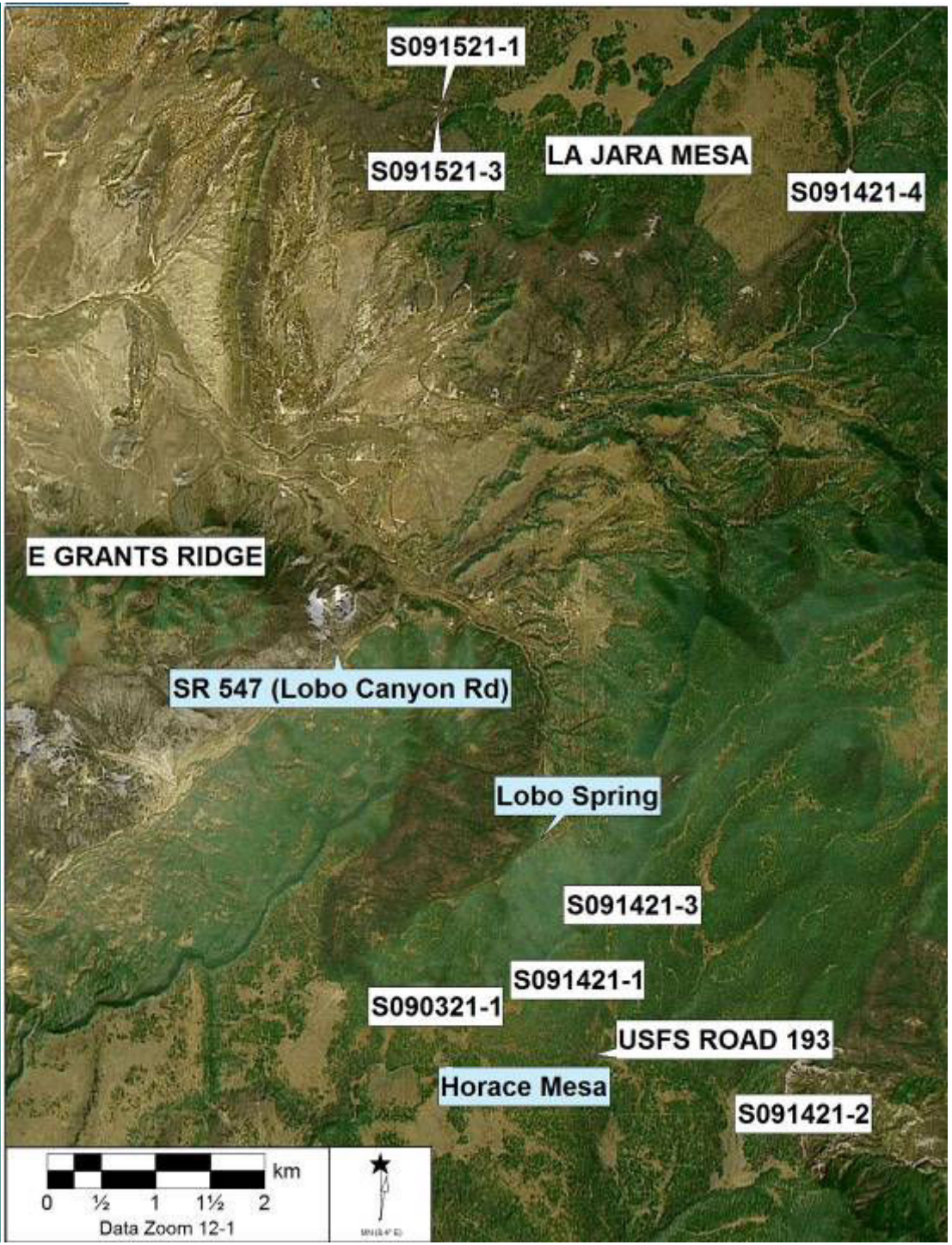

Portion of the Goff et al. 2019 Map

Relevant map units:

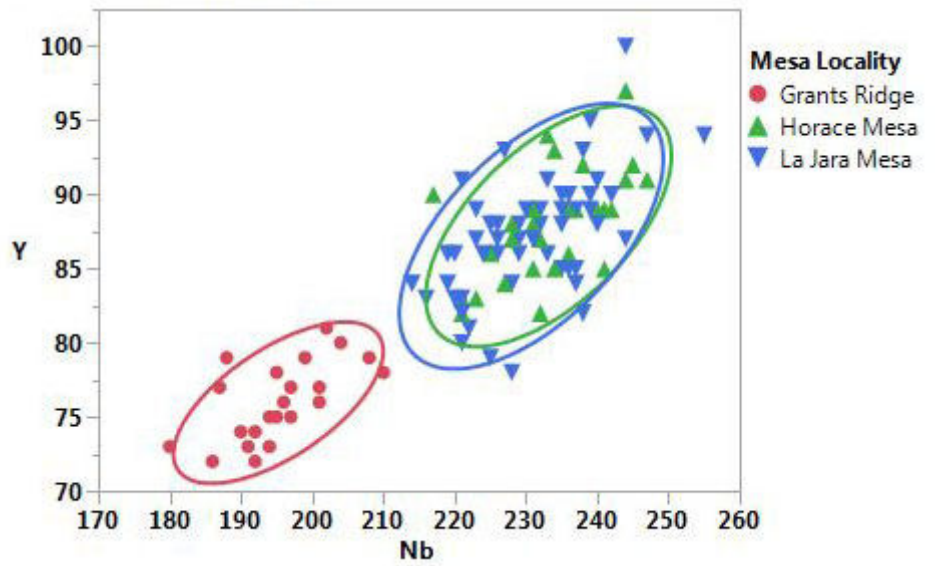
- Tgro: Grants Ridge Rhyolite center (Grants Ridge obsidian; 3.498±0.003 Ma - sanidine)
- Tgrt: Grants Ridge rhyolite tuff (Horace and La Jara Mesa obsidian; between 3.26±0.04 and 3.462±0.008 Ma - obsidian)
- QTvs: Volcaniclastic sedimentary rocks, including *debris flows and fluvial deposits*; "The basal contact is gradational with *older fluvial deposits (Tvss)*…Most deposits are Pliocene" (italics mine). Tvss is described as volcaniclastic sandstone… *may contain…rhyolite tuffs* (italics mine)

Ortho-photo of Grants Ridge and Horace and La Jara Mesas

Collection localities: S = Shackley followed by date and locality number.



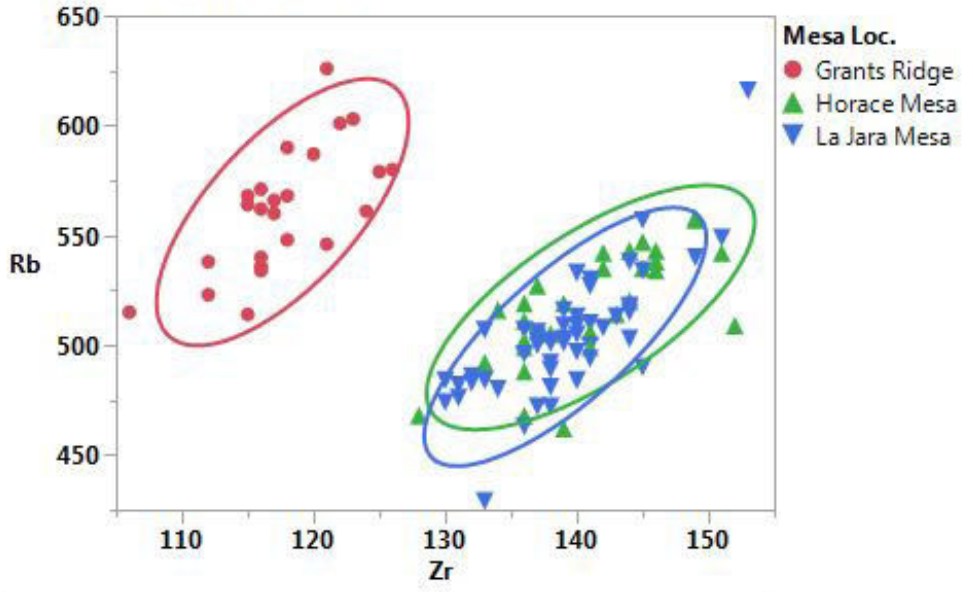
So, is the composition of Grants Ridge, Horace Mesa, and La Jara Mesa obsidian similar? With these new data are the compositional patterns the same as in the 1998 study?




Using non-destructive EDXRF Grants Ridge certainly has a different composition on four mid-Z elements, and Horace and La Jara Mesa cannot be statistically discriminated.

So we can use this discrimination to address archaeological issues.

Confidence ellipses at 90%



There is an indication that there is a relationship between the eruptive timing (Grants Ridge rhyolite center - earlier, and Grants Ridge (Horace and La Jara Mesa) rhyolite tuffs – later, and the elemental composition. Perhaps simple evolution within the magma chamber and differences in the eruptive events – lava (Grants Ridge) versus ash flow tuffs (Horace and La Jara Mesas)

Back to our research questions:

1) Is the deposit of "Grants Ridge obsidian" on Horace Mesa indeed geologically deposited?
   Yes, and likely a result of fluvial action above Tgrt.

2) Is Horace and La Jara Mesa obsidian compositionally similar?
   Yes, based on the non-destructive EDXRF analysis of trace elements

3) Is the geochronology of Horace and La Jara Mesa obsidian contemporaneous
   Yes, it appears so with recent $^{40}Ar/^{39}Ar$ dates

4) Finally, what geological conditions created the deposit of obsidian on Horace Mesa seemingly unexplained by previous understanding.
   Yes, back to question 1: The volcaniclastic sedimentary unit QTvs has included the Tgrt Grants Ridge tuff with embedded obsidian marekanites

So, it's a matter of scale. The concentration of the geoarchaeological research focused on the location of obsidian in space and the discrimination of the obsidian sources re-focuses the geological explanation for the Grants Ridge rhyolite in space and time.

We propose that in present day Lobo Canyon ≥215m of volcanic and sedimentary rock was carved out of Lobo Canyon in the last 2.64 Ma. This supports the presence of large quantities of Grants Ridge and Horace Mesa obsidian in Rio San Jose, Rio Puerco and Rio Grande Quaternary alluvium all the way to Chihuahua (Shackley 2021)

Often in my own research I move from the lens of the geological to the lens of the archaeological. In our research at Mount Taylor, both disciplines are working in tandem to provide a level of clarity not necessarily possible looking through only one lens.

Funding:

1) our own pockets
2) National Science Foundation Grants to Shackley: BCS 0905411; BCS 0810448; BCS 0716333; DBS 9205506
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