# Radiocarbon Dating the Guadalupe Red Linear Style in the Guadalupe Mountains, New Mexico

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While radiocarbon dating Red Linear Style figures is difficult due to their small size, it is crucial to understand their temporal and geographical range. In the Guadalupe Mountains, five Red Linear Style paintings have been dated to 4400 to 1520 B.P. These dates provide chronological context for specific communal hunting strategies, including use of nets, atlatls, antler snares, and rabbit sticks. Regionally, these chronometric results strengthen parallels between the Red Linear Style of the Guadalupe Mountains of New Mexico and the Lower Pecos Canyonlands in Texas. However, there is only one direct radiocarbon date for a red oval at Cueva Quebrada in the Lower Pecos, highlighting the need for more chronometric studies on rock paintings in both regions.

t sites within Lincoln National Forest in New Mexico (Figure 1), we  ${f A}$  conducted fieldwork in 2009 and 2010 to collect paint samples for plasma oxidation and radiocarbon dating. Steelman's laboratory utilizes oxygen plasma to collect organic carbon from rock art paint samples (Steelman and Rowe 2012), a method that was developed specifically to radiocarbon date rock paintings (Russ et al. 1990). The main advantage is that the inorganic rock substrate does not decompose during plasma exposure. Plasma oxidation negates the use of extensive acid pretreatments because plasma temperatures (<150°C) are below the decomposition temperatures of carbonates and oxalate minerals and only organic material is removed for radiocarbon measurement (Chaffee et al. 1994; Russ et al. 1992). In addition, plasma oxidation is preferable for dating rock paintings because acid washes may not completely remove oxalate minerals, which are commonly associated with rock surfaces (Armitage et al. 2001). Plasma oxidation is ideal for samples in which only a trace amount of organic material remains because extensive acid pretreatments used in conjunction with combustion are avoided, minimizing the loss of organic material during wet chemical pretreatment steps. Thus, we are able to obtain direct radiocarbon results for rock paintings by dating the organic binders, vehicles, and other organic materials added to the paint by ancient artists.

The goal of this radiocarbon dating study is to provide a chronology for representational rock art with realistic hunting scenes in the Guadalupe Mountains, referred to as Representational Hunting-Gathering Art (Schaafsma 1980:55), Guadalupe Mountains Hunter-Gatherer Style (Bilbo and Bilbo 1991:57), Red Linear Style (Mark and Billo 2009), Pecos Red Miniature (Billo et al. 2011), or Guadalupe Red Linear Style (Dillingham and Berrier 2011). Previous researchers have recognized that the hunting and ceremonial scenes preserved in Guadalupe rock art appear to be Archaic (Bilbo and

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Bilbo 1991; Mark and Billo 2009). The radiocarbon results determined in this study for paintings at Lost Again Shelter (LA 162411) and Ambush Two Hands (LA 64908) do indeed confirm that the art was created during the Middle Archaic Avalon Phase (3000 B.C. to 1000 B.C.). In addition, we obtained one older age within the Early Archaic Hermit Cave Phase (4000 B.C. to 3000 B.C.) at Lost Again Shelter and one younger age in the Terminal Archaic (A.D. 1 to A.D. 500) at the Ambush Shelter (LA 158783). These results add detail about the use of nets and snares in rabbit and cervid hunting, use of curved fending or rabbit

sticks, and group ceremonies that are preserved in this upland setting.

# Guadalupe Mountains Study Area

The Guadalupe Mountains of southern New Mexico and far west Texas are an upland area within the overall Chihuahuan Desert ecoregion of the Trans-Pecos area (Figure 2). The mountains reach up to 8,700 feet within the Guadalupe Mountains National Park. The erosion of the limestone has formed deep, steep-sided canyons and well-known karst features such as Carlsbad Caverns. Because of limestone karst, water is rare on the surface and is only found underground in some places. Succulent plants are abundant, however, and provide a ready food source along with migrating game that may be concentrated in canyons. Evidence of prehistoric human activities includes rock-and-charcoal midden deposits, rockshelters, lithic and ceramic scatters, pit houses, and some minimal use of deep cave systems (Bilbo and Bilbo 1993; Katz 1978; Purcell and Greenwald 2004; Roney 1985). Archaeologically, there are some differences between the western and eastern Trans-Pecos areas. The Guadalupe Mountains are on the boundary but tend to be more eastern-oriented, based on projectile Greenwald 2004).

The majority of rock art sites in the Guadalupe Mountains are located near the bases of canyons in shallow rockshelters and cliff edges with just a few found within caves. Painted images consist of numerous finger-width lines and abstracts, some representational elements and panels, Apache dancers, historic period horse-and-rider petroglyphs, and a potential Spanish friar (see Dillingham 2003:sec E, pp. 8–9). The archaic rock art in this area includes three components including the Western Desert Abstract Tradition, Representational Hunting-Gathering, and Archaic Abstract Polychrome (Chihuahuan Polychrome).

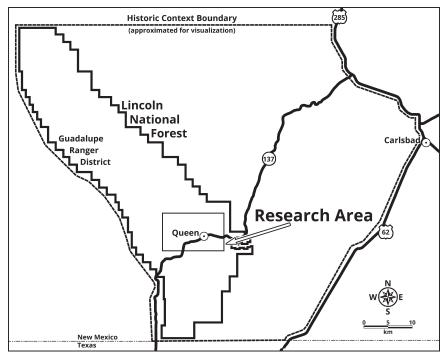


Figure 1. The research area is located on the eastern side of the Guadalupe Mountains of New Mexico about forty miles from Carlsbad.



point types and rock art (Purcell and Figure 2. Overview of the study area illustrating the terrain and vegetation. Photograph by Margaret Berrier.

The Western Desert Abstract Tradition petroglyphs are generally non-figurative and heavily or totally repatinated. Some elements of this style include zigzags, wavy lines, dots, concentric circles, and complex designs with irregular curvilinear or rectilinear patterns (Bilbo and Bilbo 1991:44; Bilbo and Sutherland 1986; Schaafsma 1992:47). Bilbo and Sutherland suggest dates as early as 5000 B.C. (1986:23).

Archaic Abstract Polychrome pictographs use the same non-figurative elements of the Western Desert Abstract. They are painted in red, black, yellow, orange, and white mineral pigments although most of the individual designs use only one or two colors (Turpin 2001:381). Schaafsma describes Painted Grotto (LA 46313) in the Guadalupe Mountains as "by far the most exciting of these sites" (Schaafsma 1980:52). This shelter is different than the shelters dated in our study with its vibrant display of abstract style but does include a few figurative small animals and nets in red and fine line black.

Schaafsma describes "Representational Hunting-Gathering Art" as "an almost confusing array of representational rock art believed to be the work of late hunter-gatherers in the area." She goes on to mention examples in West Texas (Shumla Style), the Guadalupe Mountains, Northern Mexico (Candelaria Style), and the Rio Grande River corridor. She states, "there are, in addition, simple and crude paintings of human forms that resemble in general type those of the elaborate Western Archaic Pecos River Style Paintings to the southeast" (1980:55). Similar figures are found in the Guadalupe Mountains and have been given a substyle name of Guadalupe Mountains Hunter-Gatherer Style (Bilbo and Bilbo 1991:57).

Bilbo and Bilbo (1991) described the breadth of Guadalupe rock art and provided the first descriptions and drawings of pictograph sites discussed in this article. They compared Lost Again Shelter to the Texas Lower Pecos and Big Bend Styles, including representations of canids, plant forms, people-in-lines, turtles, and shamanic forms and additional comparisons to the Texas Red Linear Style and Red Monochrome Style (Bilbo and Bilbo 1991:Figures 12, 14, 15, and 16). Bilbo and Bilbo (1991:44) provided a regional hypothesis for a rock art chronology of the Guadalupe Mountains: Archaic (6000 B.C.-A.D. 300); Desert Mogollon (ca. A.D. 300–1350); Protohistoric (ca. A.D. 1350 –1538); and Historic (to present). However, this proposed chronology is based entirely on style with little to no independent evidence such as relative dating from spatially associated artifact types.

Work in the area by Mark and Billo (2009) documented two additional sites on the New Mexican side of the Guadalupe Mountains. Having both read Bilbo and Bilbo (1991) and studied the Lower Pecos rock art sites in Texas during site visits, Mark and Billo (2009) found similarities between these sites in New Mexico to sites 400 km to the southeast in Texas. Based on content and style, Hunters Shelter (NPS A232) in Carlsbad Caverns National Park and the White Oaks Pictographs site (LA 157206) are similar to multiple Red Linear Style sites in Val Verde County, Texas including 41VV75, VV612 and VV1000 (Billo et al. 2011:Figures 15 through 20; Mark and Billo 2009:208-209, Figures 13 and 14). Deer hunting, rabbit hunting, use of rabbit sticks, and lack of bow-and-arrow are notable comparisons, suggesting that the art was painted during the Archaic time period rather than the later Formative or more recent Apache time periods.

Previously, in the Guadalupe Mountains region, there was only one direct radiocarbon date on a red zigzag design painted at the Ruby Canyon site (LA148560) of 3140±60 years B.P., calibrated to 1540–1230 cal B.C. (Loendorf et al. 2016). These abstract paintings at Ruby Canyon fit the description of the Archaic Abstract Polychrome, previously called Chihuahuan Polychrome Abstract Style (Schaafsma 1992, 1997). However, Loendorf has tentatively assigned other paintings superimposed over the older zigzags at Ruby Canyon to the Formative Period (Loendorf et al. 2016). Until this current study, there have been no direct radiocarbon dates on the Guadalupe Red Linear Style rock art.

# Methods

Nine paint samples were collected at four sites including Lost Again, Ambush Two Hands, and Ambush shelters as well as in Last Chance Canyon, all within the Guadalupe Ranger District, Lincoln National Forest, Eddy County, New Mexico. In the field, photographs of sampling locations were taken before and after collection. Individual sterile surgical scalpels were used to collect each paint sample from a surface area on the order of 1 to  $4 \text{ cm}^2$  (Figure 3). Eight samples from adjacent unpainted rock were also collected. These were taken as close as possible to the collected paint samples to investigate the background levels of organic material in the rock substrate. All sites are limestone rockshelters or low overhangs at the basal edges of canyons. Lost Again Shelter and Ambush Two Hands Shelter are along the same main drainage while the Ambush Shelter is in a side drainage close to Ambush



Figure 3. Latex gloves, sterile scalpel blades, and 500°C pre-baked aluminum foil are used to collect samples for radiocarbon dating.

Two Hands, with all three sites within three kilometers of each other. The fourth collection area is within Last Chance Canyon approximately fifteen kilometers to the northeast of the other three sites.

At Lost Again Shelter (LA 162411), described in Dillingham and Berrier (2011) and Rowe et al. (2011), four paint samples were collected for radiocarbon dating. Sample 1 is from the back portion of a zoomorph (Figure 4). The front portion had spalled away and, afterwards, seven vertical lines were painted in the spalled area. Sample 2 came from one of the vertical lines (Figure 4). Sample 2 is from the last figure in a row of dancers (Figure 5) and Sample 6 is from another anthropomorph (Figure 6) lower on the panel. At Ambush Two Hands (LA 64908), described in Dillingham and Berrier (2011), only Sample 4 of a red



Figure 4. Sample 1 from Lost Again Shelter was from a spalled zoomorph, radiocarbon dated to 3260±50 years B.P. Unfortunately, Sample 2 from the vertical lines painted afterwards in the spalled away section did not have sufficient carbon for dating. For scale, the width of the remaining zoomorph is ~3 cm.



Figure 5. Sample 3 from Lost Again Shelter, radiocarbon dated to 3600±150 years B.P., is from an anthropomorph in a line of over 20 with their arms raised above their heads. This scene has been interpreted as a line of dancers participating in a ceremony. The radiocarbon sample came from the far right anthropomorph.



Figure 6. Below the line of dancers at Lost Again Shelter, Sample 6 was collected from the ~3.5cm tall anthropomorph on the right. This sample was radiocarbon dated to 4440±80 years B.P.

cervid was collected for radiocarbon dating (Figure 7). At Ambush Shelter (LA 158783), only Sample 5 of a red cervid was collected for radiocarbon dating (Figure 8). At Last Chance Canyon (LA 159341), we collected samples from a red geometric (Sample 8) as well as two samples from a red and black footprint-like pictograph (Samples 9 and 10).

We utilized plasma oxidation and accelerator mass spectrometry (AMS) radiocarbon measurement to obtain direct ages for these rock art samples. Glow discharges are produced by radio frequency (RF) capacitive coupling with two external copper electrodes on either end of a glass sample chamber (Figure 9). An oxygen glow discharge or plasma converts organic matter to carbon dioxide and water, which we collect by freezing the Karen L. Steelman, Eric Dillingham, Margaret Berrier, Lennon N. Bates, Robert Mark, and Evelyn Billo



Figure 7. At Ambush Two Hands, Sample 4 was collected from a red cervid that was already badly spalling from natural deterioration. This sample was radiocarbon dated to 3285±40 years B.P. (a) panel of 9 cervids, (b) lower portion of panel, (c) sampled cervid.



Figure 8. At the Ambush Shelter, Sample 5 is from a cervid that is also badly spalling due to natural deterioration. This sample was radiocarbon dated to 1520±45 years B.P.

products with liquid nitrogen for AMS radiocarbon dating. See McDonald et al. (2014) for a detailed description of rock art dating methods employed by the Steelman laboratory.

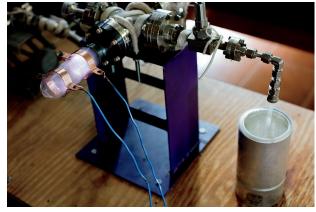
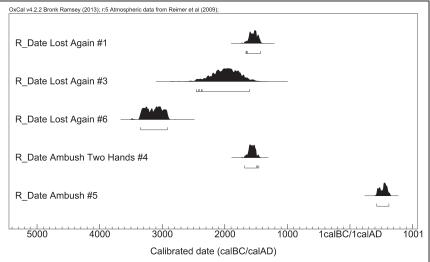


Figure 9. Plasma oxidation instrument at Shumla Archaeological Research & Education Center.

Lost Again Shelter and one younger age in the Terminal Archaic at the Ambush Shelter. Unfortunately, Sample 2 from Lost Again shelter and all three samples from Last Chance Canyon had insufficient carbon for dating (Table 2). Carbon levels in unpainted rock backgrounds

# **Results and Discussion**

We obtained five radiocarbon dates for these red figures within the Lincoln National Forest. Age results are shown in Figure 10 and Table 1. Calibration was performed using the OxCal computer program version 4.2.2 (Bronk Ramsey 2009, 2013) with IntCal09 curve data from Reimer et al. (2009). The radiocarbon ages of paintings at Lost Again Shelter and Ambush Two Hands are Middle Archaic. In addition, we obtained one older age within the Hermit Cave Phase at



within the Hermit Cave Phase at Figure 10. Two sigma calibrated age ranges for radiocarbon results obtained in this study.

Tube 1. Tube results.									
Site	Sample	Description	Sample Mass (mg)	μg Carbon	µg / mg	ID	CAMS	<sup>14</sup> C Age (years B.P.)	Calibrated Age (2σ, 95.4%)
Lost Again	1	red quadruped	32.2	120	4	B172	158671	3260±50	1670-1430 cal B.C.
LA 162411 AR-03-08-03-964	3	red dancers	29.8	30	1	B165	158665	3600±150	2500-1600 cal B.C.
	6	red anthropomorph	35.0	70	2	B170	158666	4440±80	3350-2910 cal B.C.
Two Hands LA 64908 AR-03-08-03-00845	4	red cervid	28.3	130	5	B171	158670	3285±40	1690-1450 cal B.C.
Ambush Site LA 158783 AR-03-08-03-00990	5	red cervid	80.2	110	1	B166	158669	1520±45	425-625 cal A.D.

Table 1. Paint sample results.

Table 2. Paint samples with insufficient carbon for dating.

Site	Sample #	Description	Sample Mass (mg)	μg Carbon	µg/ mg
Lost Again LA 162411 AR-03-08-03-964	2	red line	14.2	10	0.7
Last Chance Canyon LA 71989	8 9 10	red geometric black triangle red triangle	23.0 9.1 78.5	6 9 7	0.3 1 0.08

were not negligible (Table 3); however, paint samples had significantly more carbon than the unpainted rock.

## **Contamination Issues**

Of interest, we calculated the amount of organic carbon extracted with the plasma per milligram of solid paint sample to normalize results. When determining how much organic contamination is in the unpainted rock substrate, normalized ratios should be compared instead of the raw microgram amounts of organic carbon as solid paint and background samples will not have the same mass. For example, a situation could occur in which a paint sample contains 100 micrograms of or-

Table 3.	Background	samples o	f un	painted	rock.

Site	Sample #	Sample Mass (mg)	μg Carbon	µg / mg		
Lost Again LA 162411 AR-03-08-03-964	1b 2b 3b 6b	46.7 7.5 19.4 35.9	20 10 20 20	0.4 1 1 0.6		
Ambush Two Hands LA 64908 AR-03-08-03-00845	4b	36.6	20	0.5		
Ambush Site LA 158783 AR-03-08-03-00990	5b	92.4	<1	0.01		
Last Chance Canyon LA 71989	8b 9/10b	42.9 44.0	10 10	0.2 0.2		

ganic carbon for dating, but a control or background sample of unpainted rock also has 100 micrograms of organic carbon. At first, it would appear as if the unpainted rock has the same amount of organic carbon as the paint sample and this could all be from contamination. However, if the solid paint sample is only 10 mg, but the control/background sample is 500 mg, then a normalized ratio in which you divide the micrograms of organic carbon by the mass of the solid sample is an appropriate measure for comparison. For the paint sample, 100 micrograms divided by 10 mg equals a ratio of 10; for the control or background, 100 micrograms divided by 500 mg equals a ratio of 0.2. Then, 0.2/10 X 100% = 2% contamination, for this example.

For this current Guadalupe study, all dated paint samples had a ratio greater than or equal to 1 (Table 1), whereas most unpainted rock samples had ratios less than 1 (Table 3). Looking at paint and background pairs, the dated paint samples had significantly more organic carbon than the unpainted rock—except for Samples 3 and 3b. From a laboratory perspective, paint Sample 3 is the least reliable age result with similar levels of organic carbon extracted from both the paint and background samples. In addition, Sample 3 has a large error due to its small size of only 30 µg C. Even so, the age of Sample 3 generally agrees with Samples 1 and 4, so it is reported here with great caution.

Background levels were greater than 10 micrograms of carbon in all unpainted rock samples except for Sample 5 at Ambush Shelter. However, levels were too low in the background samples for radiocarbon dating in order to correct for this contamination. Sample 5 is ideal as its background had negligible levels of contamination in the unpainted rock (0.01  $\mu$ g C / mg sample) and the paint sample had sufficient carbon (110  $\mu$ g C) for a reliable AMS measurement. Organic material extracted from the paint sample is most likely from the paint (organic pigment, binders, and/or vehicles) and not inherent in the rock substrate. Its age is much younger at 1520±45 years B.P. than the other results. Whether this is due to errors in the other measurements due to contamination in the rock substrate or actual differences in the age of the pictographs that might be discernable to archaeologists via stylistic differences is an interesting question to further explore. However, with 3600 years B.P. (Sample 3) as the contamination age and the known fraction of contamination from the micrograms of carbon in the associated backgrounds, mass balance calculations result in only a 40 years B.P. difference in the ages. It would require significant amounts of contamination, that is >10,000 years, to skew the ages significantly. We are cautiously confident in the ages reported here. However, multiple lines of evidence using both physical sciences and archaeological information are necessary when evaluating chronometric data.

## Guadalupe Mountain Chronology

These direct radiocarbon dates provide independent data for Guadalupe Mountains hunter-gatherer representational rock art, important for both internal and regional archaeological comparisons. The exceptionally rich content of the fine-line Guadalupe Red Linear Style rock art provides information on subsistence and hunting methods, seasonal rounds, and ritualism. As the majority of rock art sites lack associated archaeological deposits, the age of the rock art was hypothesized to be Middle Archaic based on content and is now confirmed by direct dating.

In the Guadalupe Mountains, specifically, Katz and Katz (1985) were instrumental in defining a local chronology (see Table 1 in Dillingham and Berrier 2011), including the Hermit Cave Phase (4,000–3,000 B.C.), the Middle Archaic Avalon Phase (3,000–1,000 B.C.), the Later Archaic McMillan Phase (1,000 B.C.-A.D. 1), and the Terminal Archaic Brantley or early Hueco Phase (A.D. 1–750). The Formative Period is quite similar to the preceding Archaic with the addition of somewhat more sedentary living when and where conditions allowed (near water), including very minimal corn-bean-squash agriculture, some pueblos (not in the Guadalupes), and technological advances including brownware and black-on-white pottery types. While this may be oversimplifying things a bit, the main point is that the Archaic culture persisted in the deserts and mountains; and, this Archaic tradition was only lightly touched by elements of Southwestern cultures.

Miller and Kenmotsu (2004:218) place the Archaic period of the Trans-Pecos, including the Guadalupe Mountains, from 6000 B.C. to A.D. 200. Pithouses, rockshelters, atlatl fragments, and dart points are characteristic. Early Archaic radiocarbon dates are uncommon but usually are on thermal features (Miller and Kenmotsu 2004:220). Archaic and Formative period use of the landscape is known through the radiocarbon dating of ring middens in the Guadalupe Mountains (Table 4). Ring middens are "created through multiple episodes of plant baking events that are further characterized as communal in nature" (Bureau of Land Management 2018). A 5,700-year old date on a ring midden places its use to the Early Archaic. Despite a drying trend, Middle Archaic populations and land use both increased in the Trans-Pecos, likely intensifying the need for seasonal movements across the landscape (Miller and Kenmotsu 2004:223). However, based solely on radiocarbon dates on carbonized vegetation remains found in ring middens, the use of the Guadalupe Mountains during the Middle Archaic time period may be under-represented. Most Archaic Guadalupe Mountain ring midden dates are Late and Terminal Archaic, which is similar to a trend across the western Trans-Pecos (Miller and Kenmotsu 2004:230, Figure 7.16).

Focusing instead on hunting rather than intensive vegetation gathering, information from the Archaic time period in the Guadalupe Mountains is still fairly minimal. Data includes archaeological material and radiocarbon dates from Little Pine Cave (LA 1771) and Hermit's Shelter (LA 4992). An atlatl fragment from Little Pine Cave is dated at 2540±40 years B.P. (Fields 2005). Archaic use of nets is documented from the Middle Archaic level at Hermit's Shelter (Ferndon 1946:17). The content of representational rock art in the Guadalupe Mountains shows Archaic-themed hunting scenes. Rock art sites located along the canyon bottoms, such as those that were dated, may be associated with hunting locations, as the canyons provided drinking water, food, and migration corridors for deer, elk, sheep, and perhaps pronghorn antelope. Given that the canyons are fairly narrow and steep-walled, the use of nets and antler snares in the areas at or close to the pictograph sites would be reasonable. Rock art sites located along cliff edges such as the Hunters Shelter may have other associations including possible lookout locations or storytelling sites.

The rock art of the Guadalupe Mountains, which includes the use of hunting nets, atlatls, fending sticks,

Site	Description	Lab Number	Years B.P.	Reference	Site	Description	Lab Number	Years B.P.	Reference
LA 73067	Ring Midden	WSU 3988	1060±90	Johnson 1990	LA 73096	Ring Midden	BETA 38399	790±50	Johnson 1990
LA 73067	Ring Midden	WSU 3989	1060±70	Johnson 1990	LA 28638	Ring Midden	BETA 38400	1840±110	Johnson 1990
LA 73067	Ring Midden	WSU 3990	1375±60	Johnson 1990	LA 28638	Ring Midden	BETA 38402	1070±70	Johnson 1990
LA 73067	Ring Midden	WSU 3991	900±90	Johnson 1990	LA 28638	Ring Midden	BETA 38403	900±90	Johnson 1990
LA 64669	Ring Midden	WSU 3992	510±80	Johnson 1990	AR-03-08-03- 405	Ring Midden	BETA 181918	230±50	Dillingham 2003
LA 64950	Ring Midden	WSU 3993	510±50	Johnson 1990	AR-03-08-03- 411	Ring Midden	BETA 181062	2080±50	Dillingham 2003
LA 73068	Ring Midden	WSU 3994	1130±140	Johnson 1990	AR-03-08-03- 642	Ring Midden	BETA 181063	400±60	Dillingham 2003
LA 73068	Ring Midden	WSU 3995	1170±70	Johnson 1990	41 CU 97	Ring Midden	TX2806	710±50	Katz and Katz 1978:87
LA 73075	Ring Midden	WSU 3996	1970±65	Johnson 1990	AR-03-08-03- 174	Ring Midden	BETA 247590	210±40	Dillingham and Powell 2008
LA 73075	Ring Midden	WSU 3997	1675±130	Johnson 1990	AR-03-08-03- 843	Ring Midden	BETA 247591	220±50	Dillingham and Powell 2008
LA 73075	Ring Midden	WSU 3998	1190±120	Johnson 1990	LA 1771 (Lincoln NF)	Little Pine Cave atlatl	Beta 173023	2540±40	Fields, R.C.D. 2005
LA 73075	Ring Midden	WSU 3999	1555±170	Johnson 1990	41CU196 (Pratt Cave,	cache (Kenmotsu	Tx 1021	1420±60	Miller and Kenmotsu 2004
LA 73076	Ring Midden	WSU 4000	410±110	Johnson 1990	Guadalupe Mountains NP)	- A.D. 530 date is Formative)			
LA 73076	Ring Midden	WSU 4001	1495±60	Johnson 1990	41CU196 (Pratt Cave, Guadalupe	basketry sample underneath cache	Tx 1022	1840±60	Miller and Kenmotsu 2004
LA 71925	Ring Midden	WSU 4002	1440±120	Johnson 1990	Mountains NP) 41CU196 (Pratt	bone apatite	Tx	2090±420	Miller and
LA 71931	Ring Midden	WSU 4003	MODERN	Johnson 1990	Cave, Guadalupe Mountains NP)	adjacent to cache			Kenmotsu 2004
LA 71931	Ring Midden	WSU 4004	1540±130	Johnson 1990	41CU196 (Pratt Cave,	bone apatite - level 2	Tx 2191A	2560±340	Miller and Kenmotsu 2004
LA 71933	Ring Midden	WSU 4005	1740±60	Johnson 1990	Guadalupe Mountains NP)	level z	2191A		Kennolsu 2004
LA 71935	Ring Midden	WSU 4006	1930±130	Johnson 1990	Cave,	bone collagen - level 2	Tx 2191B	2820±180	Miller and Kenmotsu 2004
LA 71935	Ring Midden	WSU 4007	5710±200	Johnson 1990	Guadalupe Mountains NP)				
LA 73096	Ring Midden	BETA 38396	1090±80	Johnson 1990	41CU196 (Pratt Cave, Guadalupe	cremated bone collagen - level 2		2100±60	Miller and Kenmotsu 2004
LA 73096	Ring Midden	BETA 38397	960±80	Johnson 1990	Mountains NP)	aromated base	Tv	2220+70	Millor and
LA 73096	Ring Midden	BETA 38398	900±50	Johnson 1990	41CU196 (Pratt Cave, Guadalupe Mountains NP)	cremated bone collagen - level 2	Tx 2192B	2320±70	Miller and Kenmotsu 2004

Table 4. Radiocarbon dates, central and southern Guadalupe Mountains, New Mexico and Texas.

and even two cervid butchering scenes (Billo et al. 2011:53–60; Mark and Billo 2009), provides insights into hunting technology in this region during the Archaic, which is lacking in the archaeological deposits. Additional imagery associated with hunting activities includes a quadruped, perhaps a deer, shown inside concentric circles, perhaps a corral, at LA 158785. Kominsky's Leaves-on-Floor Shelter (LA 152004) also includes rabbit sticks, possible canids, and a stick-figure

hunting several cervids (Dillingham et al. 2016:76). The White Oaks Shelter (LA157206) has a single wellpreserved panel with three hunting scenes of a cervid being butchered, a hunter driving cervids potentially toward a cliff (with one injured or dead animal), and a rabbit hunting scene with nets and rabbit sticks. Together, the Archaic representational rock art sites offer a rich pictorial history of the Archaic way of life, including subsistence methods, prehistoric technology, ceremonialism, social group construction, landscape use, chronologically overlapping rock art styles, and regional cultural traditions.

## Guadalupe Rock Art Dates

Pictographs at Lost Again Shelter (LA 162411) include canids, looped line nets and deer, as well as ceremonial scenes with much superimposition and subtle color differences (Dillingham and Berrier 2011:22-28). Previously, Rowe et al. (2011) conducted a portable x-ray fluorescence study at Lost Again Shelter in an effort to distinguish different painting episodes. At Lost Again, Sample 6 (4440±80 years B.P.) of a red anthropomorph is painted in the same shade as other figures with curved sticks. This older age from Sample 6 might correlate to figures at the Ambush Two Hands Shelter, which appear to be the earliest episode of painting at that site. Additional dates at Lost Again for Sample 1 (3260±50 years B.P.) of a red quadruped and Sample 3 (3600±150 years B.P.) of a red dancer are similar in age to Sample 4 (3285±40 years B.P.) of a red cervid from Ambush Two Hands.

At Ambush Shelter, there are multiple rock art components based on weathering, content, and superimpositioning. Both abstract and representational pictographs are present. Geometrics include zigzags, gridded dots, a one-pole ladder or rake, a solid-bodied circle with rays, a ladder, a star design (drawn with an ochre "crayon"), and a box design. There are at least eighteen positive and negative handprints at the site. A dot-grid superimposes a yellow, negative handprint. Representational pictographs include sub-rectangular solid-bodied cervids drawn either singly or as part of hunting scenes. Red stick-figure hunters surround cervids; other anthropomorphs painted below one of the cervids are drawn upside-down. Spears extend from the hunters' hands to the cervid (Figure 11). A serrated projectile point is clearly depicted in one instance at the end of a stick that pierces a deer (Figure 12). Serrated points are late Middle

Archaic to Jornada. This serrated projectile point resembles a Livermore or perhaps Guadalupe projectile point. Dates of the Trans-Pecos Livermore projectile point style range from 100 to 800 A.D., perhaps extending as late as 1100 A.D. (Justice 2002:231–237). Interestingly, we obtained a direct date of 1520±45 years B.P. (425–625 cal A.D.) on a painting of a red cervid (Sample 5) at this site.

At the Ambush Two Hands site (LA 6498), zoomorphs include possible pronghorn, bighorn sheep, deer, or elk. Some of the red painted cervid figures, including the one we dated, are markedly larger than the ones at other shelters such as White Oaks. Sample 4 from a red cervid is 3285±40 years B.P. Two anthropomorphs hold curved rabbit or fending sticks. One of these figures is holding possible implements similar to ones seen at Hunters Shelter (Mark and Billo 2009:208). These figures are the tiniest at the site and seem to be superimposed by the rest of the elements around them. A horned anthropomorph, stick figure hunters, two serrated projectile points (similar to the one at Ambush), and a net-like geometric design are painted in black. One of the serrated points touches a

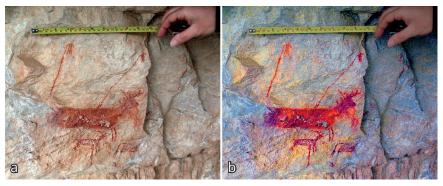


Figure 11. Ambush Shelter. (a) Photograph and (b) DStretch (LDS) enhancement of panel showing the anthropomorphs spearing a group of cervids. The larger cervid being speared is approximately 23 cm wide.



Figure 12. (a) Figure with serrated point from Ambush Shelter. From head to tail, the cervid is ~25 cm wide. (b) Close up of point with scale.

cervid which is painted in red. This cervid appears to be under the black paint and therefore older. If this figure were made in the same episode of painting as the red cervid we dated, then that would make the black figures younger and could possibly be dated "relatively" using the appearance of the Livermore or Guadalupe projectile point (Dillingham and Berrier 2011:29).

The Last Chance Canyon archaeological site (LA 159341) includes a large deep rock midden, likely heavily mixed charcoal deposits, brownware pottery fragments, an overhang with low rock walls, a small rockshelter with pictographs, and a long limestone bluff with pictograph panels (Dillingham and Powell 2008). We collected samples from a red geometric (Sample 8) as well as two samples (Samples 9 and 10) from a red and black footprint-like pictograph shown in Figure 13. Bilbo and Bilbo (1991:49, 55–57) label this figure as proto-historic, suggesting possible links to Apache, Comanche, or even Jumano. We would have expected that this element would have had a younger date, but were unable to obtain any results due to insufficient carbon.



Figure 13. Samples 9 and 10 were collected from both the red and black portions of this ~15 cm wide image at Last Chance Canyon.

# Comparisons to the Lower Pecos Canyonlands of Texas

While the purpose of this study is to radiocarbon date a set of rock art sites to support a study of local rock art chronology of the Guadalupe Mountains, there was a secondary goal of verifying regional comparative ties to the Lower Pecos Canyonlands of southwest Texas. In the Lower Pecos Canyonlands, the sole radiocarbon result for the Red Linear Style is from a red oval at 41VV162a, Cueva Quebrada (Ilger et al. 1994). In the literature (Hyman and Rowe 1997; Rowe 2003), a second radiocarbon result from a charcoal deer at 41VV75 was published and assigned to the Red Linear Style. However, Boyd et al. (2013, 2014) has reassessed the stylistic assignment of the dated figure at 41VV75, with a correct photograph and description, as an unclassified drawing style and not Red Linear. These two radiocarbon results have often been cited as two Red Linear Style dates and have perpetuated a misunderstanding of the age of the Red Linear Style. We also caution against the use of any one radiocarbon date to place a style of painting in time. This is simply one radiocarbon date for one painting.

In addition, the one radiocarbon result from 41VV162a is from an oval (Figure 14) and not a diagnostic figure of the Red Linear Style. Cueva Quebrada is a small cleft in the rock with black walls that obscure Pecos River Style pictographs and Red Linear scenes. The panel consists of seventeen red ovals, four with legs that have been described as bison (Turpin 1984). An additional Red Linear scene with 10 to 14 small phallic anthropomorphs is also in close proximity in the shelter. An entire oval ( $3.5 \times 1.7 \text{ cm}$ ) was removed for plasma oxidation radiocarbon dating and an AMS date of  $1280\pm45$  years B.P. was determined. An adjacent unpainted rock sample similar in size to the paint



Figure 14. At Cueva Quebrada, an entire red oval (3.5cm X 1.7 cm) was collected for radiocarbon dating with an age of 1280±150 years B.P. There are seventeen red ovals, four with legs.

sample contained 80  $\mu$ g organic contamination, but was not dated for a correction calculation. With nine percent contamination, the reported error was increased to ±150 years (Hyman and Rowe 1997; Ilger et al. 1995).

The age of Red Linear Style paintings in the Lower Pecos Canyonlands is presently not well known. However, Turpin doubts that the bulk of Red Linear Style paintings are as young as the radiocarbon result at 41VV162a and stated that it is more likely that the age range is 3100 to 2500 B.P. (Turpin 2005:316). Boyd et al. (2013) recently completed an analysis of 444 Red Linear figures from 12 sites in the region. Using a Dino-Lite digital microscope in the field, they identified 38 Red Linear figures overlain by Pecos River Style art and no converse examples, thus inverting the accepted relative chronologies for the two styles. For the Pecos River Style, there are 30 published radiocarbon dates incliding 27 accepted dates ranging from 4200 to 1465 years B.P. (Bates et al. 2015; Hyman and Rowe 1997; Rowe 2004; 2005). Thus, the superimposition of Pecos River Style images over Red Linear images highlights the need for further dating research.

# Comparison with Other Representational Archaic Hunter-Gatherer Rock Art in West Texas and Northern Mexico

Some researchers suggest that the Candelaria Style and Shumla Style may have been a single tradition with varied expression, comparing both to the Red Linear Style of the Lower Pecos Canyonlands (Bilbo and Sutherland 1986:16; Schaafsma 1980:55–56). Most miniature figures in the Guadalupes appear to be deer or elk while the majority of Candelaria and Shumla Style are bighorn sheep (Bilbo and Bilbo 1991; Billo et al 2011; Davis 1974; Mark and Billo 2009; Schaafsma 1980). Many of these figures are remarkably similar to some of the hunting scenes in the Guadalupe Mountains.

With the Candelaria Style, Green (1966) reported tiny atlatl pictographs in Sierra de Kilo, Mexico. Later, Davis characterized the Candelaria Style as wildly animated life forms (human, bighorn sheep, and deer). Many of the humans have long spear-like devices which are usually disproportionately long (Davis 1974; Turpin 2002:3). Schaafsma (1980:56–60) discusses the Candelaria Style in more detail and describes them as vivacious. Bilbo and Sutherland (1986:23) provide relative dates for this style as Late Archaic (500 B.C. to 200 A.D.). Their location is limited to a small area of northern Chihuahua, Mexico (Wright and Schaafsma 2016:7), approximately 260 km southwest from our study area in the Guadalupe Mountains. Many of the elements found in Mexico are similar to those in the Guadalupe Mountains, including fending sticks, cervids speared with atlatls, and figures with what appear to be hair hanging down from the back of their necks (Figure 15). These figures are painted in red, black, and sometimes yellow, but are predominantly red.

The Shumla Style, previously known as the Diablo Dam Style, has many hunting-related elements as described by Schaafsma (1980:56-60). The majority of these elements are pecked petroglyphs, but there are several miniature pictographs painted in red, black, and yellow. Much of the area where these paintings are found is on private property so they are not well documented. Recent research shows that this style is found along the Rio Grande River as far east as Big Bend, Texas (Wright and Schaafsma 2016:7). Additional places with representational Archaic hunter-gatherer rock art includes Centipede Cave (Figure 16) as well as at other west Texas sites such as Upper Centipede Cave (no trinomial assigned); Tigua Canyon (no trinomial assigned); Los Vientos (41HZ609) (Turpin 2002:20–22); sites on the Wilkey Ranch (Miller et al. 1988); the Delaware Mountains (Broughton 1999); in the Baylor Mountains (Clark 1974:110); and in a shelter at the Fort Hancock Site



Figure 15. DStretch photos from Candelaria Style sites. (a) Bighorn (~25 cm wide) surrounded by tiny hunters with spears with net (LRE); (b) Figure (~10 cm tall) with fending sticks (FLT-AC-YRE-CB) and (c) DStretch (CRGB\_CB) bighorn sheep (~35 cm wide) and hunters. Photos from John Davis taken in mid 1970s.

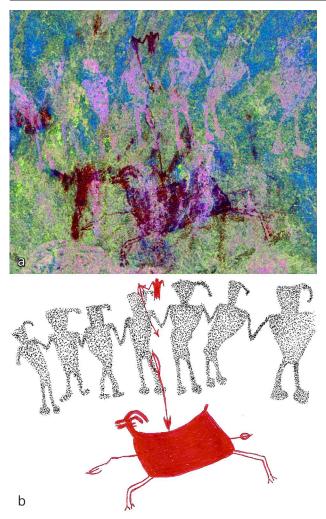


Figure 16. Centipede Cave. (a) DStretch photograph (CRGB\_CB) of 10 cm tall hunter and (b) tracing from the photograph by Margaret Berrier.

(41-EL375) (Sutherland and Steed 1974). In one panel at Tigua Canyon (Figure 17), tiny hunters surround a cervid similar to a composition at Ambush (Figure 11). These Shumla Style sites are ~215 km southwest of our study area in the Guadalupe Mountains.

The map in Figure 18 shows our study area in relationship to some of the locations of Archaic huntergatherer representational rock art in West Texas and Northern Chihuahua. Most of this area is extremely remote and much of it is private property so there may be additional sites. Other authors suggest this style continues along the Rio Grande drainage to Big Bend (Bilbo and Bilbo 1991). We recognize that style is about more than subject matter and that additional research for all associated rock art styles, including the Guadalupe Red Linear Style and the Lower Pecos Red Linear Style, needs to be conducted.



Figure 17. DStretch photograph (YRE\_CB) of hunters from Tigua Canyon, Texas. The deer is approximately 30 cm tall.

## Conclusions

With direct radiocarbon dates on the rock art, this current study places the Guadalupe Red Linear Style in the Guadalupe Mountains of New Mexico within the Middle Archaic, as well as one date within the Hermit Cave Phase and another younger age in the Terminal Archaic. Most importantly, these rock art dates provide chronological context for hunting methods within the Guadalupe Mountains. From midden dates (Table 4), it is of note that there are limited data for the Archaic time period in the local and regional chronology of the region, highlighting the importance of obtaining direct ages for rock art. Most Archaic sites in the Guadalupes are the result of intensive gathering of lechuguilla, agave, and sotol, which are then roasted in ring middens. This activity is not shown or recognized well in the rock art record.

After Bilbo and Bilbo (1991), the rock art of the Guadalupe Mountains was largely understudied and under-published until recently. Mark and Billo's (2009) article on Hunters Shelter and White Oaks Shelter brought renewed attention. With many of the shelters having an array of faded, superimposed, and fragmentary images, as well as remote and difficult terrain, the research is challenging. More direct radiocarbon dates for the Guadalupe Red Linear Style are crucial to understanding the chronology of the area. Using the insights of previous researchers (Schaafsma, Turpin, Mark and Billo, Bilbo and Bilbo, Dillingham and Berrier) and doing more careful comparisons of other representational hunter-gatherer styles will provide more data. New technologies to determine superimposition—such as the Dino-Lite digital microscope and portable X-ray fluorescence (pXRF) spectroscopy-

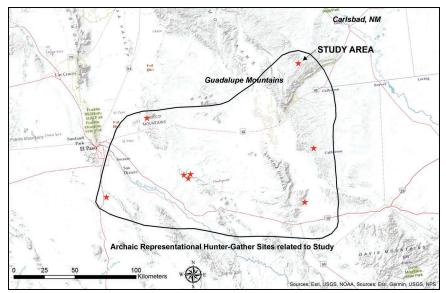


Figure 18. Map showing relationship between our Guadalupe Mountains study area and far west Texas and northern Chihuahua Archaic hunter-gatherer representational sites.

could be useful tools in this process. Radiocarbon dating should be coupled with these tools as well as other best recording practices such as those documentation processes being done now with Shumla's Alexandria Project in the Lower Pecos Canyonlands (see Koenig et al. 2019) and research like Sacred Sites and Versar (Loendorf et al. 2013, 2014, 2015, 2016).

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