Results of Pollen and Starch Analysis of Samples Taken from Chiflo Playa #1, Rio Grande Basin, Taos County, New Mexico

NMCRIS Activity Number: 142254
LA Number: 193273

Photo: Tim Viereck

Principle Investigators:
Dr. Tom Dillehay, Vanderbilt University, Dorothy Wells and Gary Grief of Taos Archaeological Society

Report compiled, prepared and edited by Gary Grief and Dorothy Wells of the Taos Archaeological Society, to be submitted to the Lab of Anthropology, Santa Fe, New Mexico 2019

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Report on Pollen and Starch Analysis of Samples from Playa Chiflo #1, Rio Grande Basin, New Mexico.

Tom D. Dillehay 2018

The stone-lined and stone-clustered cultural features in and around the edge of Chiflo playa basin were first brought to our attention in 2010 during a foot survey conducted by Gary Grief, Dorothy Wells and Marcel Kornfeld. The survey was of the unnamed playa now known as Chiflo Playa #1. Grief, Wells and Kornfeld returned to the playa and surveyed it with a total station (See Appendix A). In 2016, the features were shown to Tom Dillehay who thought they might have water management and agricultural functions similar to those he had observed in high altitude, seasonally dry basins in the Andes of Peru, Bolivia, Argentina and Chile (See appendix B-Dillehay 2016). In order to test this proposition, Dillehay, Grief, Wells, Tim Viereck, and Paul Reed carried out further field inspection and EM conductivity analysis of the features and any additional ones below surface. The conductivity study suggested additional stone features were buried as deep as 50-70 cm (See appendix B). The next step was to core selected features to obtain sediment samples for micro- and macro-plant study (e.g., pollen. Phytolith and starch grain), which was done in May, 2018, by Dillehay, Grief, Wells, Viereck and Harvey and Betty Hagenstad. Summarized below are the survey, coring and macro- and micro-plant analyses, the latter carried out by Dr. Linda Scott-Cummings at PaleoResearch, Inc. in Boulder, CO (See appendix C). Funding for the plant analyses was provided by the Taos Archaeological Society, Grief, Wells and Dillehay. As reported below, one radiocarbon date also was obtained on charcoal from an organic layer in Feature 2 at the ~25 cm level.

To summarize:

1. The rock features are cultural in nature and appear to date in the late Prehispanic to colonial and possibly early modern era. Several stone-lined and stone-clustered features were observed. Conductivity and coring was done at three Features, named Feature 1, Feature 2 and Feature 3, the first two being rock clusters and the latter stone-lined (See appendix D -Dillehay 2016).

Feature 2, a rectangular-shaped "rock-like garden" sampled on the far east end of the Chiflo playa (see appendix A), contained a medium grayish organic layer, most likely culturally produced, at the 0-35 cm level. A few charcoal specks were recovered from the ~25 cm level of a core sediment from this layer, which was sent for radiocarbon dating to Direct AMS. The resulting calibrated date was **1449+- 15 cal AD** years ago (Direct AMS: 028839), making it late prehispanic in age. This date agrees with the depth of dated sediments in playa basins sampled by Holiday et al. (Johnson Mesa) in northeastern New Mexico (Holiday and Meltzer, 2006). No diagnostic ceramics or point types were directly associated with the features, although point types of various cultural periods were recovered from near the playa. At the Chiflo Petroglyph site, Grief, Wells and Kornfeld have found diagnostic examples of a Cody complex point base (Turned into the state by BLM Archaeologist Paul Williams.). Bajada, San Jose, Armijo Stemmed, and a possible Jay point. The Chiflo petroglyph site is less than a mile from Chiflo Playa #1.

Dillehay and Grief also found a debitage of material of very fine thin volcanic andesite near dacite in composition just to the south of the playa. No diagnostic points were found at the site. Regardless of their age, the features are associated with local and regional indigenous cultures.

Furthermore, it is reasonable to presume that this type of water management and agricultural production in the playa basins occurred earlier than the radiocarbon date presented here as suggested by the deeper rock features (below ~30 cm encountered by both conductivity and coring.

2. The mico- and macro-plant study provided by PaleoResearch Inc. (See appendix C) revealed evidence for maize in levels well below the surface, indicating that corn was certainly part of the crop regime there in both prehispanic and colonial times. There also is the likelihood that chili peppers were grown, but as documented in the PaleoResearch Inc. report, these data are ambiguous.

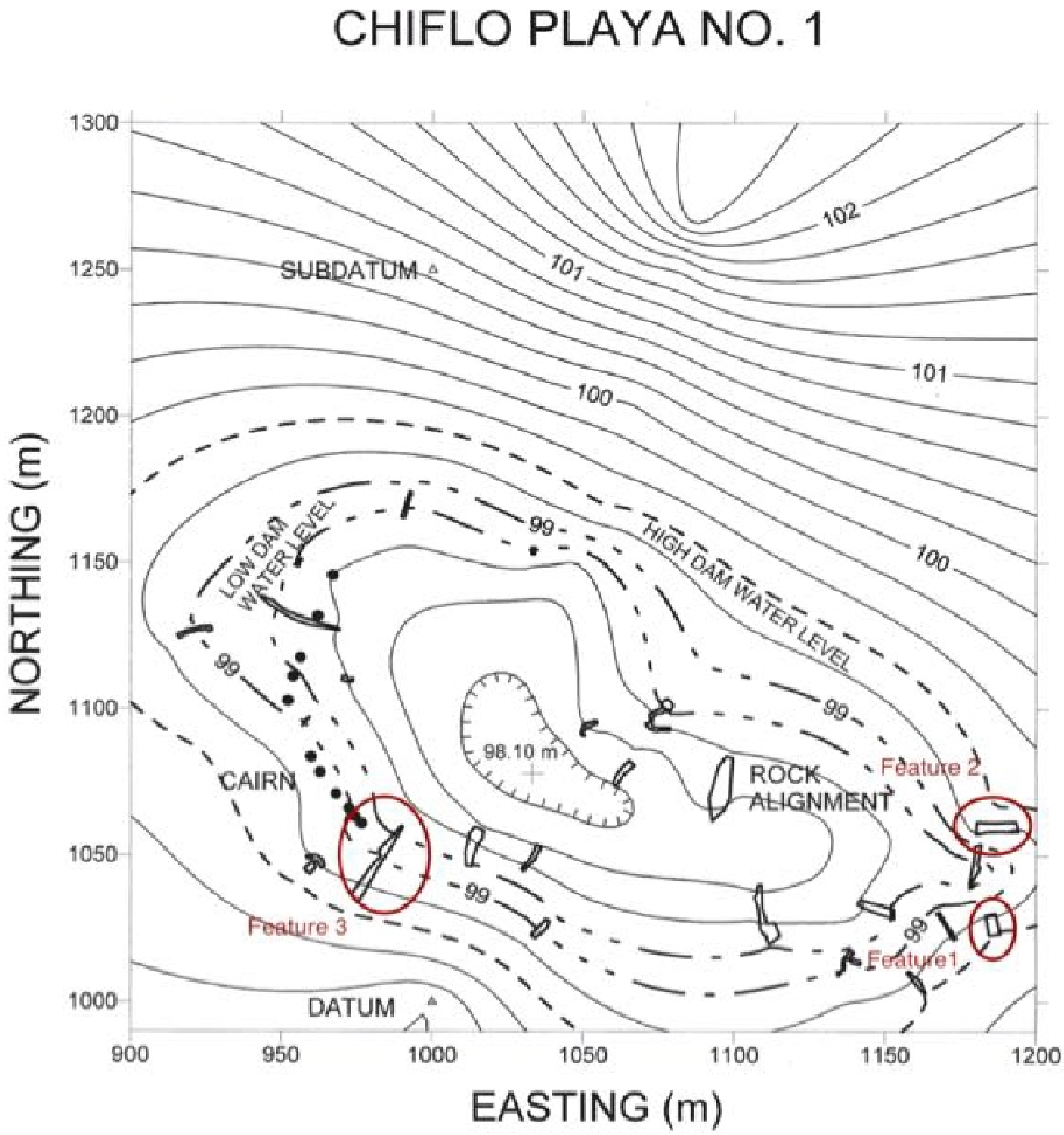
3. There also is a dung spore associated with grazing animals which could be elk, bison, horse, cattle, etc., yet in deeper (probably late prehispanic) levels (~20-35/40 cm), this would likely be elk and bison. In the upper levels (~5-10 cm) near the surface of the features the spores are probably associated with cattle, elk, and horse. It also should be noted that we deliberately cored narrow areas between surface rocks (~3-5 cm) in features to prevent any downward churning of sediments from animal hooves (elk, cattle, or horse), thus the stratigraphic spore contexts are solid, intact and most likely not from mixed or disturbed layers. This also holds for the pollen and starch grain context.

4. It should be kept in mind that nearly all of the rock linings and clusters at Chiflo had deeper rocks, perhaps suggestive of cultural features as deep as 50-70 cm. (Most of our cores ended by hitting deeper rocks at these levels). We suspect the deeper rocks are cultural features because some surface rocks are derived from fluvial deposits (i.e., rivers, creeks) that had to be imported. Others also likely came from the nearby mountainsides; the basins are not the sort of depositional environments that foster natural rock accumulation.

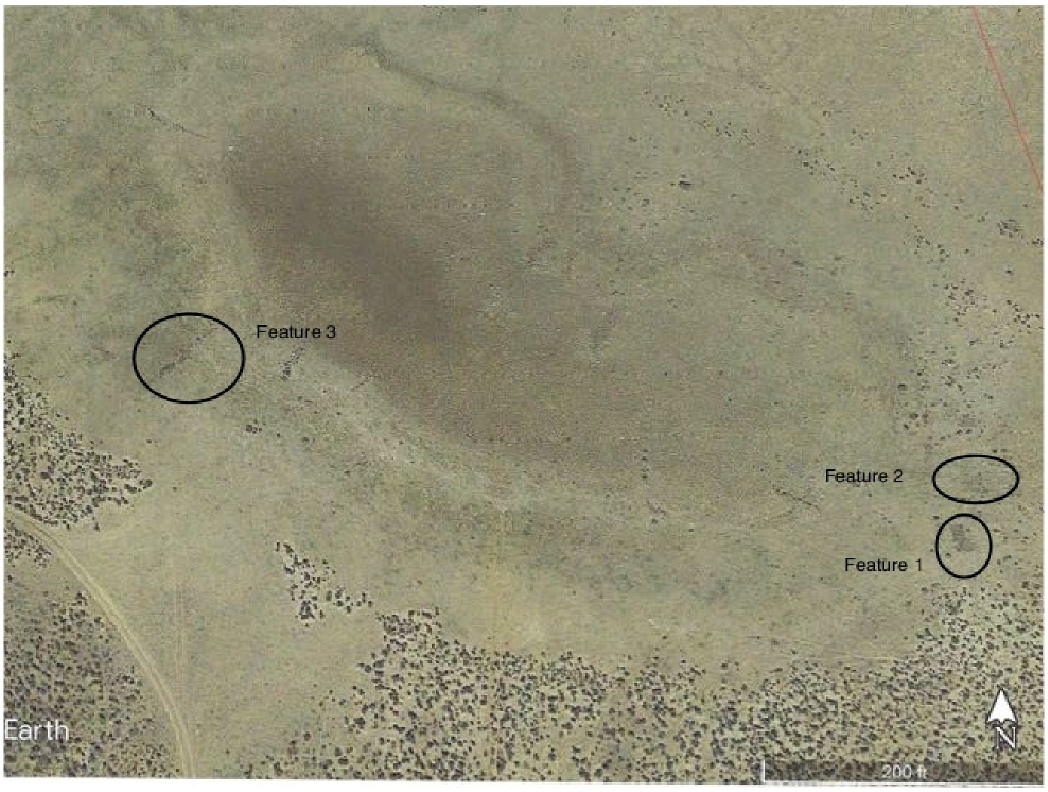
5. Located approximately 1 mile to the West of the Chiflo basin site, where Grief and Wells have been recording rock art in a narrow rock-ledged spring, are several other water management features (e.g., small canals, crop fields, holding basin, low dike), which are different from those documented at the playa basin. The features in the area of the rock art may date to the same time period as those in the basin and likely also related crop production. Grief and Wells have surveyed other playas in the area and have found similar features as seen in Chiflo Playa #1.

Appendix A

Kornfeld Survey and Aerial View of Chiflo Playa #1 with Feature Locations



Aerial View of Chiflo Playa #1 with Feature Locations



Appendix B
Dillehay 2016

Preliminary 2016 Report on an EM Conductivity Study of Stone Features at Chiflo Playa No. 1, Northern New Mexico

Tom D. Dillehay

Introduction

On April 26, 2016, Gary Grief, Dorothy Wells, Tim Viereck, Paul Reed, and I carried out a brief conductivity survey of two areas at a playa basin, Chiflo Playa No. 1, north of Chiflo Mountain, which is located northwest of the town of Taos, New Mexico. I had visited the area before with Gary, Dorothy, and Mark Henderson and had seen the rock linings and other rock features on the surface around the edges of the plaza, believing that these might be indigenous water management features. In working specifically with Gary and Dorothy, we planned a preliminary conductivity survey of two 20 by 20 m blocks at the playa. The block survey was planned near present-day surface features at the playa that are straight lines of rocks or small boulders, while others are semi-rectangular "rock-like gardens" (?) or other stone features.

What initially called my attention to these features at the playa were similar ones I have seen at numerous places in the coastal desert plains and high desert regions of the Peruvian, Argentine, and Chilean Andes. In the Andes, water channel guides, sometimes called *patas de gallo*, are often built around the edges of the playa system to drain water into them from distant and/or higher areas (Fig. 1; Eling in Browman 1987), especially during the rainy seasons. These guides are usually a line of rocks or boulders that extend out from the shoreline of the playa basin to funnel water into certain areas. Sometimes these constructions can have reeds or small tree branches used to form an equilateral pyramid to slow or guide water higher than the rocks, thus the name *patas de gallo* (rooster feet).

Although corn and other crops are planted during the rainy season in places where the water is trapped from runoff (Fig. 2 shows a seasonal playa in the desert of Peru: Eling in Browman 1987), the moisture is soon lost. If the sediments are moist enough, then plants can complete their growth cycle. In Peru, these playa-like settings are sometimes called *melgas*. In Quechua, they are called *charka qocha*. More specifically, in areas where I have worked, such as the Jequetepeque and Chicama valleys on the north coast of Peru, these features were built since Formative times (~500 B.C.) and continue in use today (Figs. 3-4).

It must keep in mind that these types of features manage not only surface runoff water into the playa basins but also what hydrologists call "hydrostatic pressure", which is exerted when the seasonal or temporal flow of subsurface water percolates from slightly higher ground to lower elevated areas, resulting in the increased appearance of moisture below-ground, especially in, around, and underneath rocks.

This hydraulic condition persisted cyclically for thousands of years in the Andes, and the native Andeans of past and present knew and still know how to manage it with much skill and vision. This has permitted them to establish themselves on the borders of these basins and around the low knolls and hills surrounding them. This assertion is verified by archeological settlement pattern studies in various areas of the Andes that reveal adobe and/or stone constructions of household *pircas* where people lived nearby. In low-lying playa basins in the coastal deserts today, people continue to construct weirs and to manage water during the rainy season; these are usually run by local families and do not require a "centralized political authority".

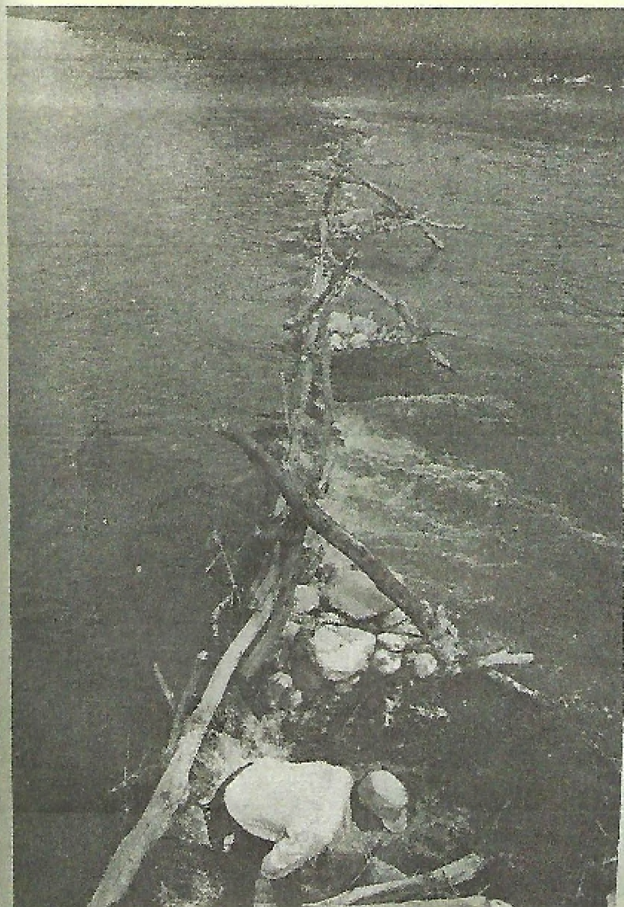


Fig. 7-4. Eling photograph of patas in Jequetepeque valley, 1977.

Figure 1. Photograph showing *pata de gallo* in small stream near the the Jequetepeque River. When the water is low during the dry season, the tree branches are not required (Browman 1987) and when the area is dry, the feature appears as a line of intermittent stones.

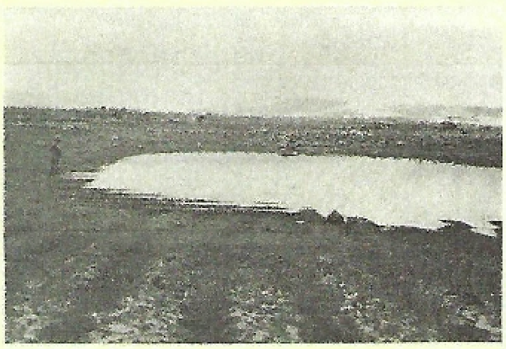


Fig. 12-4. Qocha in rainy season. Note 'yani' canal on far side.

Figure 2. Small, seasonal playa (*charka qocha*) in the desert of the Chicama Valley on the north coast of Peru. A rock-lined guide or *yani* canal is in the central background that drains water from higher areas into the basin. Corn, beans, and chili peppers are grown around these types of basins (Browman 1987).

Figure 3. Stone water-guideline associated with playa basin in foreground in the Atacama desert of north Chile. Probably dates between A.D. 1100-1400 based on its association with two diagnostic ceramic sherds (photo by Dillehay, TD).

Figure 4. Stone water-guideline heading into playa basin to left in desert of north Peru. Probably dates to late Formative period around 200 B.C. to A.D. 200 (photo by Dillehay, TD).

In returning to the Chiflo area, as a preliminary study, we selected two 20 by 20 m blocks to survey (Figs. 5-11). Each block was placed parallel to or over rock features. Each block mapped a 20 by 20 m space, each block had 20 parallel lines, each 20 m long, and each separated by 1 m, all marked by measuring tapes. A zig-zag pattern was walked up and down the lines with the conductivity instrument.

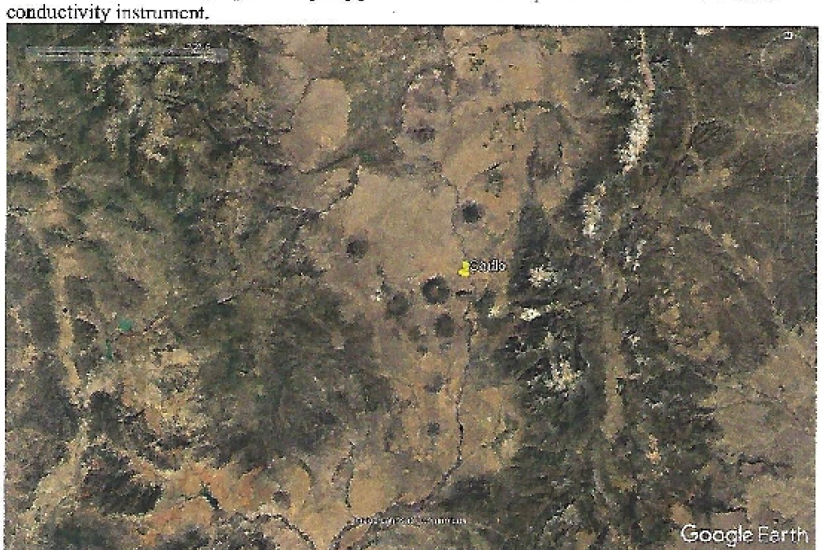


Figure 5. Location of Chiflo-1 playa basin north of Taos and west of the upper Rio Grande canyon.

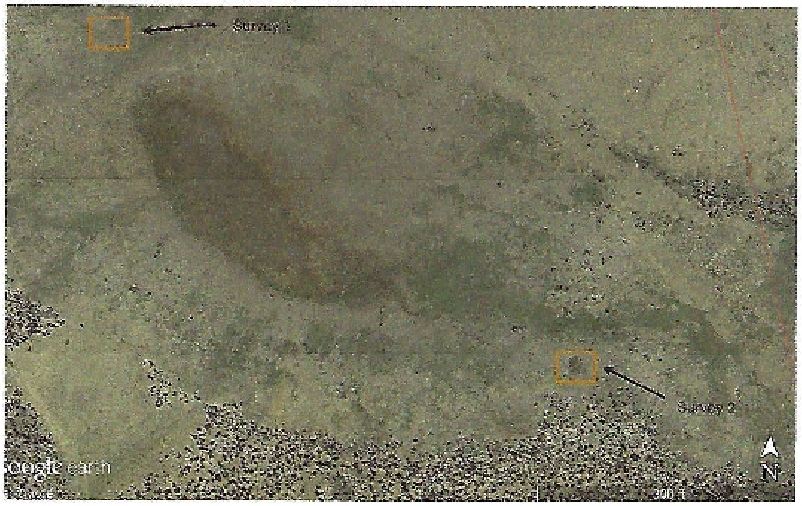


Figure 6. The two 20 by 20 m survey blocks are revealed on this Google Earth aerial. Note the present-day linear rock linings and other semi-rectangular rock features and the standing water in the left central part of the photograph.

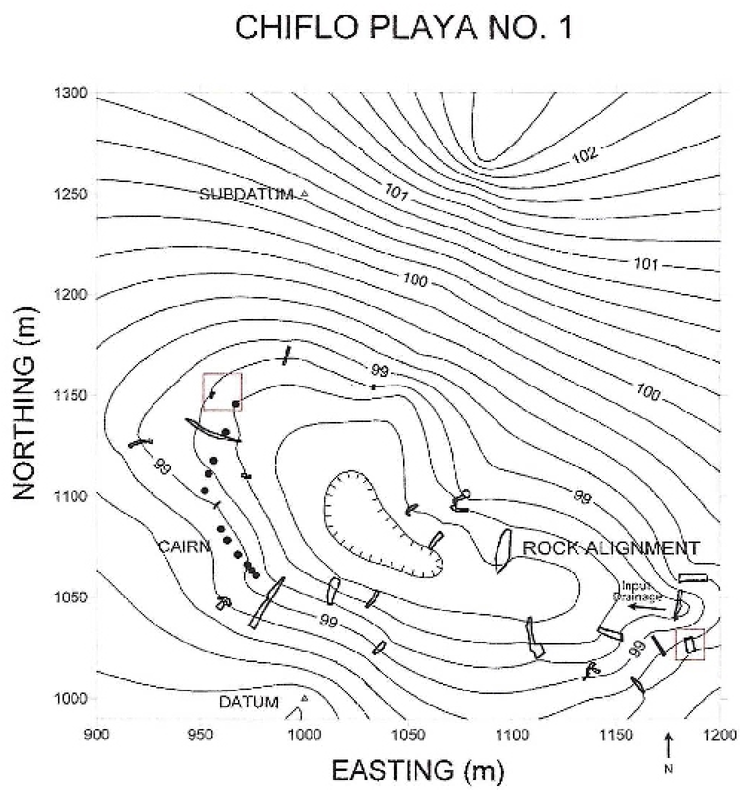


Figure 7. Topographic map of the Chiflo Playa No. 1 produced by Marcel Kornfeld, Gary Grief and Dorothy Wells, showing the location of the two survey blocks (in red) and rock features (modified from M. Kornfeld).

Figure 8. Linear rock Feature-1 at Chiflo-1

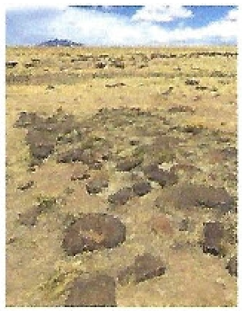


Figure 9. Rock Feature-2 at Chiflo-1

Figure 10. Linear rock Feature 3 at Chiflo-1

Conductivity Methods

In brief, the electromagnetic induction method is based on the measurement of the change in "mutual impedance" between a pair of coils in the instrument placed on or above the earth's surface. The coils are electrically connected and are separated by a fixed distance. The transmitter coil is used to generate an electromagnetic field at a specific frequency. This is known as the primary field. The primary field causes electrical currents to flow in conductive materials in the subsurface. The flow of currents in the subsurface, called eddy currents, generate a secondary magnetic field, which is sensed by the receiver coil. The magnitude of the secondary field sensed by the receiver depends upon the type and distribution of conductive material in the subsurface. Both the induced secondary field, along with the primary field, are detected at the receiver coil.

The magnitude of the secondary field is broken into two orthogonal components. These are the In-phase (real component) and the Quadrature component (imaginary component). Under certain operating conditions, the magnitude of the Quadrature component of the secondary field is linearly proportional to the apparent conductivity. In the absence of a highly conductive material (e.g., metal) in the subsurface, the magnitude of the in-phase component is dependent on the magnetic susceptibility of the subsurface.

There is no method to measure the precise depth from the data we produced, other than to note that it is almost certainly under 1.0 m as that is about the deepest the instrument will usually penetrate the ground, thus a depth of 40-60 cm is quite possible for some features, depending on the conductivity of the soil.

Once collected in the field, there were three primary computer-based steps used to make the data usable and to produce graphic results.

1. The database was divided into individual lines in order to make a formula (with help from James Zimmer-Dauphinee, a GPR expert, and Jacob Sauer, an archaeologist who regularly uses this same instrument with me) to search for data that was collected more than 10 seconds apart (i.e., pausing, turning around, and starting the next line took an average of about 30 seconds per line.) This produced 21 lines. We started at 0 and finished on 20, thus giving 21 lines.

2. Every other line was then flipped to take into account the zig-zag recording method. We wrote a formula whereby even numbered lines were the Y-coordinates, starting at 20 m and counting down every time a measurement was taken, and odd numbered lines were the X-coordinates, starting at 0 and counting up. When rendered as points, this approach puts the right measurements in the right places.

3. The instrument recorded data at a controllable pre-determined rate (more or less 8 readings/second), so the walker must keep a steady walking speed from line to line. If not, different numbers of measurements per line are produced.

The data were then imported into a QGIS program, and then IDW interpolations were performed with a 0.5 m cell size (the actual resolution is 1 m in the X direction and variable, depending on walking speed in the Y direction; the 0.5 m cell size gives it a smoother appearance), resulting in the following images whereby orange is higher in elevation and light green is lower in elevation for the Chiflo-1 block image in Figure 11 and black is higher and white is lower for the two Chiflo-2 block images in Figures 12a-b. (Because the database for Chiflo-1 was slightly distorted, we used a different software program (ARC-GIS) and graphic representation for it [Figure 7], thus the image is different and the anomalies or features appear as roughly shaped triangular symbols. Although the data were slightly distorted or damaged for Chiflo-1, the linear images they produced are still **real below-ground anomalies**. It is just that their graphic representation on the figure is irregularly or oddly expressed in triangular forms. We tried to smooth these out for roundness, but discovered that "playing" with the database just made them more triangular.)

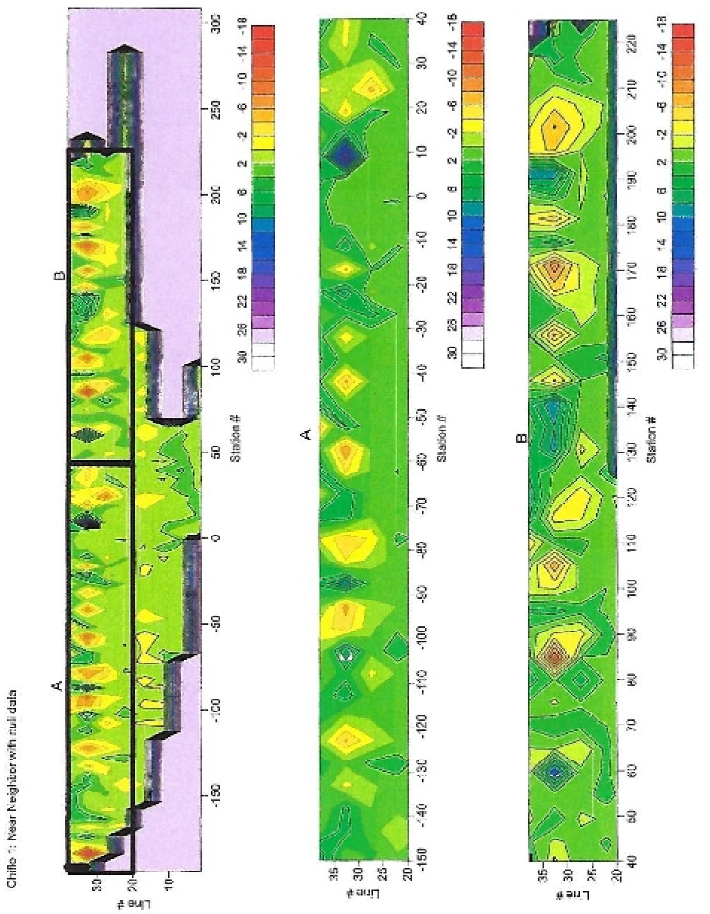
Lastly, it is relatively easy for electricity to pass through the ground. Highly conductive soils tend to be those that retain more water or are composed of more clay, which may be the result of either natural or anthropogenic processes. Less conductive soils, of course, are the opposite, better drained and/or composed of more sand, which could also result from natural or anthropogenic activity. The sandy playa basins in the study area generally are less conductive soils, although they drain water better than clayey and other soils.

Results

The instrument seems to have been slightly mis-calibrated for the Chiflo-1 survey grid, thus resulting in the less than perfect presentation, as noted above. The rows of amorphous-shaped objects or anomalies in the Chiflo-1 image are below-ground features that appear to be boulders or rock concentrations similar to those above-ground and shown in the previous photographs. However, sometimes areas retaining water in the sediments can produce similar anomalies but this is very unlikely, given the linear form of these anomalies, their sizes (between ~40-130 cm in diameter), and their position next to similar linear rock features on the surface of the playa basin today. It also is possible that the standard soil in the playa basin is not very conductive, as noted above. If so, we could certainly believe that the dark areas on the two images for the Chiflo-2 block in Figure 12a-b are not water management features but simply subsurface areas still retaining more water than surrounding areas, but again this is unlikely given their parallel and semi-rectangular forms. Both of the images for the Chiflo-2 block are actually of the same data for the survey grid. We were trying to offer a two different possible interpretations.

Chiflo-1

The line on the left (Figure 11a) represents the only linear feature recorded for the Chiflo-1 block. It suggests the presence of at least 15 single anomalies (e.g., single small boulders?) or separate clusters of small anomalies (e.g., piles of small rocks) in a south-to-north line oriented from higher ground down to the lower edges of the playa. The line is roughly 18 m long. The two enlarged lines to the right are close ups (Figures 11b-c) of the longer segment on the left. As for the depth of these anomalies, they seem to be roughly located at the same level below-ground surface. As noted above, it is difficult to estimate the depth below the ground surface based on data from the instrument, but the maximum depth recorded by this instrument usually is 0.8-1.0 m. These linear anomalies are probably 40-60 cm in depth.



a b c

Figure 11a-c. Chiflo-1 linear anomalies. North orientation is at the top of the figure to the left.

Chiflo-2

Figures 12a-b show the results for Chiflo-2. The dark regions outlined in red in Figure 12a are areas of high conductivity. The line to the lower right seems remarkably straight and seems to parallel the line forming the right side of the upper left anomaly. It would be surprising if the anomaly is fully the result of natural geology (though it is impossible to be certain, a single 20 x 20 m block doesn't provide a sufficiently large context and straight lines do appear sometimes in some natural environments). If the soil is naturally highly conductive, then the white to light gray areas (to the left) would indicate a well-drained, possibly highly compacted region, if the soil is naturally less conductive, then the black regions would indicate a deviation from the norm.

As for the two solid dark areas marked in red in Figure 12b and delineated by the dash-yellow lines in Figure 12a, these appear to not be linear rock alignments as those postulated for the single line in Chiflo-1 and observed on the surface of the playa today. They are possibly large semi-rectangular rock concentrations, of which we only partially mapped with the instrument, but at least we mapped part of the features below-ground. They also appear to be parallel and blocky-like. A rough guess is that they are rock gardens or something similar about 50-70 cm below-ground. These anomalies seem to be slightly off-north or northeast in direction, which would be similar to those observed on the surface of this same area today (see Figures 8-10).

Figure 12a. Amorphous and block=like features marked by yellow lines.

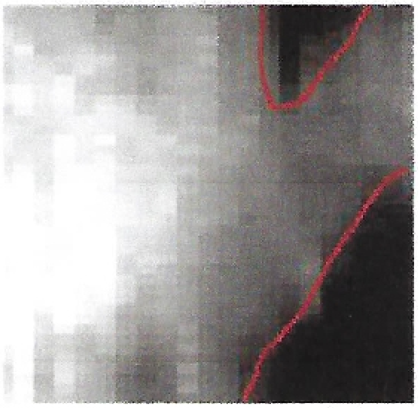


Figure 12b: Amorphous and block-like features demarcated by dark patches.

Discussion

Unfortunately, we do not know the depositional/sedimentation rates of this particular basin, but from the two publications (Holiday et al. 2006; Meltzer 2006) provided by Gary Grief and based on his rough estimates (as well as my own) drawn from these publications, I would guess that the Chiflo Playa No. 1 subsurface anomalies are either late pre-Hispanic or early to late Hispanic or Colonial in age. (Keep in mind that the depositional rates for northeastern New Mexico, where these two studies are based, are likely different from the geological setting and rates in the Chiflo area.) Without sub-surface testing and dating these anomalies, presuming they are culturally-related, we cannot obtain more absolute dates on them.

Based on these publications, we can roughly estimate that anything below 10-15 cm in depth is probably pre-European, but again this must be tested by below-ground data. This can be done by systematically coring these areas for any cultural materials and rock features (also as suggested by Merrill Ayers, personal communication, 2016) and/or by test pits. Both techniques might provide charcoal and also give sediment samples for starch grains, pollen, and phytolith analyses. The latter are particularly significant because if there is micro-evidence of cultigens or other non-local plant types associated with rock features around the edges of these playas, then they were probably placed there by human intervention.

Furthermore, based on what I have observed in the Andes and in the Coahuila area of northern Mexico, I would suspect that the Chiflo below-ground anomalies are indeed indigenous water management features, whether they be pre-Hispanic, Hispanic, Colonial, or early modern in age (i.e., pre- to early-1900). I have not seen similar features built by the Spanish in Spain or elsewhere in the Americas, except in those cases when the Spanish learned these techniques from local Native Americans, which means they could be Colonial in age but still based on an indigenous technology. More playa basins should be examined for similar features and ethnographic interviews should be conducted with Pueblo tribal elders regarding any knowledge they have of them. Lastly, I should note that my experience has been that these types of water-management features, whether above- or below-ground, are usually free of artifacts. Occasionally, a few lithics or sherds are found with them and rarely charcoal for dating.

To conclude, the purpose of water management features in arid lands like northern New Mexico is to enhance the carrying capacity of the land even if on a seasonal basis and to diversify production activities through specialized land use and settlement practices. The emphasis here is a historical perspective, that is, the need to understand not just the ambient conditions of today, but the long-term environmental variations and the consequent economic strategies evolved by local residents (indigenous or not) to survive and prosper in such situations. Theses historical features at Chiflo Playa No. 1 not only need to be preserved as cultural patrimony but studied as a technological investment of resources.

References

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Meltzer, D.

2006 *Folsom: New Archæological Investigations of a Classic Paleoindian Bison Kill.* University of California Press, Berkeley.

Appendix C

Pollen and Starch Analysis of Samples from Chiflo Playa #1, Rio Grande Basin, New Mexico

by Linda Scott Cummings, PaleoResearch Institute, Inc, Golden, Colorado

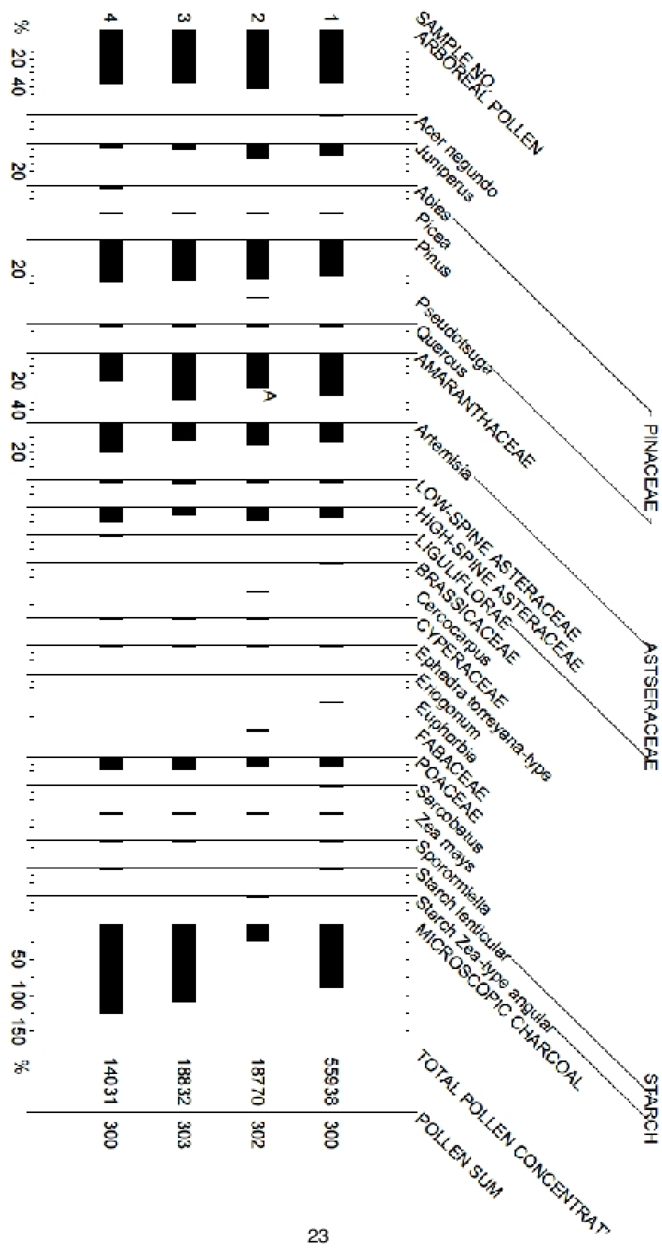


FIGURE 1. POLLEN DIAGRAM FOR CHIFLO PLAYA 1. NEW MEXICO.

Appendix D

Photos of Features, Dimensions and GPS Locations

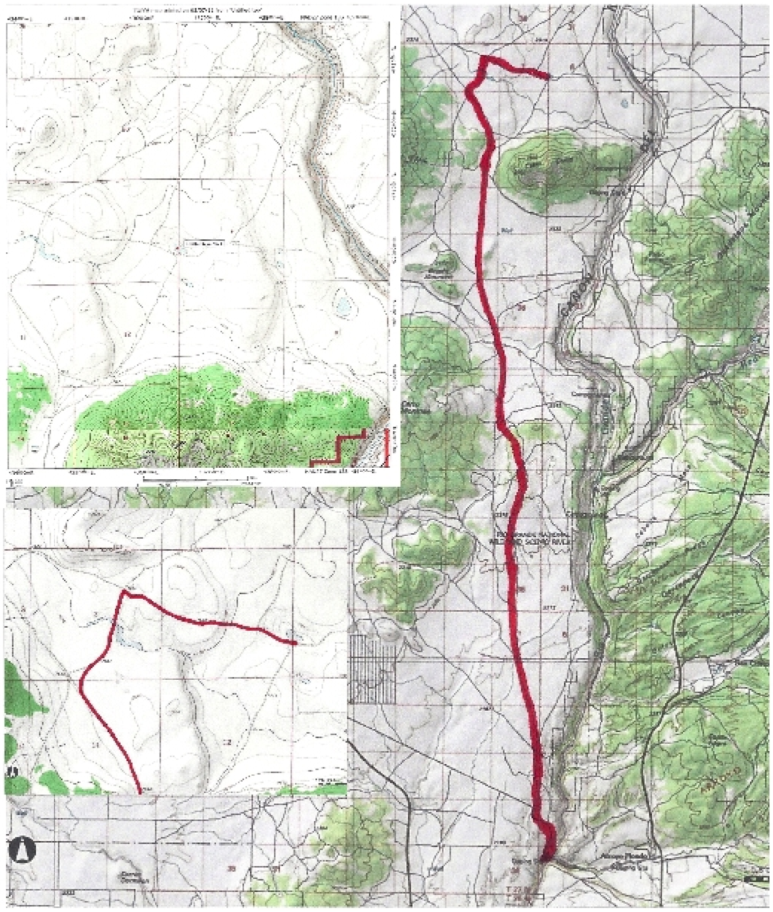
Feature 1
6.32m X 3.41m

Feature 2
17.11m X 4.28m

Feature 3
27.39m X .98m

Appendix F

Location and Directions to Chiflo Playa #1



Detail from the 7.5 degree quad of Sunshine, New Mexico
N3645-W10537.5/7.5, 1963, DMA 4857 SW - Series v881

Warning: Do not attempt this trip if it has been raining or if it is wet or damp.This route is 25 miles of dirt road and dirt 2 track.
Start in Taos, New Mexico and drive North on St. Hwy 522 until you get to the Village of Arroyo Hondo. Turn left on Taos County Road B006. Drive 3 miles to the John Dunn Bridge and proceed up the road on the West side of the Rio Grande Gorge. At the top of the gorge turn right at the directional signs to Cerro Chifo. Drive North on TP 130. This site is on private property.

Appendix F

NIAF Form 142254

NMCRIS No.: 142254

NMCRIS INVESTIGATION ABSTRACT FORM (NIAF)

1. NMCRIS Activity No.: 142254

2a. Lead Agency: US Bureau of Land Management Taos Resource Area

2b. Other Agency(ies):

3. Lead Agency Report No.:

4. Title of Report:

Results of Pollen and Starch Analysis of Samples taken from Chiflo Playa#1, Rio Grande Basin, Taos County, New Mexico

5. Type of Report

[ ] Negative

[x] Positive

Author(s)

T. Dillehay, Report Preparer Grief, Editor Wells

6. Investigation Type

[ ] Research Design [ ] Archaeological Survey/Inventory [ ] Architectural Survey/Inventory [ ] Test Excavation [ ] Excavation [ ] Collections/Non-Field Study [ ] Compliance Decision Based on Previous Inventory [ ] Overview/Lit Review [ ] Monitoring [ ] Ethnographic Study [ ] Site/Property Specific Visit [ ] Historic Structures Report [x] Other

7. Description of Undertaking (what does the project entail?):

On May 20, 2018 sample cores were taken from Feature 1 and 2 for Pollen and Starch Analysis to see if the rock alignments at the playa were used for Akchin Farming similar to what Dr. Dillehay had seen in South America.

[ ] Continuation

8. Dates of Investigation: from: 10-Jun-2010 to: 20 May 2018

9. Report Date: 07-Jan 2019

10. Performing Agency/Consultant: Taos Archaeological Society

Principal Investigator: Dr. Tom Dillehay, Gary Grief and Dorothy Wells

Field Supervisor: Gary Grief

Field Personnel Names: Tim Viereck, Harvey and Betty Hagenstad

Historian / Other: Gary Grief

11. Performing Agency/Consultant Report No.:

12. Applicable Cultural Resource Permit No(s):

NMCRIS No.: 142254

13. Client/Customer (project proponent):

US Bureau of Land Management Taos Field Office

Contact:

Address: **Phone:**

14. Client/Customer Project No.:

15. Land Ownership Status (must be indicated on project map):

Land Owner (By Agency)	Acres Surveyed	Acres In APE
Private Individual (see records for name)	14.00	14.00
TOTALS	14.00	14.00

16. Records Search(es):

Date(s) of HPD/ARMS File Review:	Name of Reviewer(s):	
Date(s) of Other Agency File Review:	Name of Reviewer(s):	Agency:

17. Survey Data:

a. Source Graphics [ ] NAD 27 [■] NAD 83 Note: NAD 83 is the NMCRIS standard.

■ USGS 7.5' (1:24,000) topo map ☐ Other topo map, Scale:

■ GPS Unit Accuracy ☐ <1.0m ■ 1-10m ☐ 10-100m ☐ >100m ☐ Aerial Photo(s)

Other Source Graphic(s): Total Station Survey done Dr. Marcel Kornfeld-2008

b. USGS 7.5' Topographic Map Name / USGS Quad Code

USGS 7.5' Topographic Map Name	USGS Quad Code

c. County(ies):

d. Nearest City or Town:

e. Legal Description:

Township (N/S)	Range (E/W)	Section

Projected legal description? [ ] Yes [ ] No [ ] Unplatted

f. Other Description (e.g. well pad footages, mile markers, plats, land grant name, etc.):

[ ] Continuation

18. Survey Field Methods:

Intensity: ■ 100% coverage ☐ <100% coverage

Configuration: ☐ block survey units ■ linear survey units (l x w):

NMCRIS No.: 142254

[x] other survey units (specify): Foot survey

Scope: [ ] non-selective (all sites/properties recorded) [ ] selective/thematic (selected sites/properties recorded)

Coverage Method: [x] systematic pedestrian coverage

[ ] other method (describe):

Survey Interval (m): 3 **Crew Size:** 6 **Fieldwork Dates:** from: 10-Jun-2010 to: 20-May-2018

Survey Person Hours: 12.00 **Recording Person Hours:** 5.00 **Total Hours:** 17.00

Additional Narrative:

[ ] Continuation

19. Environmental Setting (NRCS soil designation; vegetative community; elevation; etc.):

[ ] Continuation

20.a. Percent Ground Visibility: **b. Condition of Survey Area (grazed, bladed, undistributed, etc.):**

[ ] Continuation

21. CULTURAL RESOURCE FINDINGS [ ] **Yes, see next report section** [ ] **No, discuss why:**

[ ] Continuation

22. Attachments (check all appropriate boxes):

[ ] USGS 7.5 Topographic Map with sites, isolates, and survey area clearly drawn (required)

[ ] Copy of NMCRIS Map Check (required)

[ ] LA Site Forms - new sites (with sketch map & topographic map) if applicable

[ ] LA Site Forms (update) - previously recorded & un-relocated sites (first 2 pages minimum)

[ ] Historic Cultural Property Inventory Forms, if applicable

[ ] List and Description of Isolates, if applicable

[ ] List and Description of Collections, if applicable

23. Other Attachments:

[ ] Photographs and Log [ ] Other Attachments (Describe):

NMCRIS No.: 142254

24. I certify the information provided above is correct and accurate and meets all applicable agency standards.

Principal Investigator/Qualified Supervisor: Printed Name: Dr. Tom Dillehay, Gary Grief and Dorothy Wells

Signature: Date: Title:

25. Reviewing Agency

Reviewer's Name/Date:

Accepted [ ] Rejected [ ]

26. SHPO

Reviewer's Name/Date:

HPD Log #:

Date sent to ARMS:

CULTURAL RESOURCE FINDINGS

[fill in appropriate section(s)]

SURVEY RESULTS:

Archaeological Sites discovered and registered: 1

Archaeological Sites discovered and NOT registered: 1

Previously recorded archaeological sites revisited (site update form required):

Previously recorded archaeological sites not relocated (site update form required): 0

TOTAL ARCHAEOLOGICAL SITES (visited & recorded): 1

Total isolates recorded: 3

☐ Non-selective isolate recording?

HCPI properties discovered and registered:

HCPI properties discovered and NOT registered: 1

Previously recorded HCPI properties revisited: 1

Previously recorded HCPI properties not relocated: 0

TOTAL HCPI PROPERTIES (visited & recorded, including acequias): 1

MANAGEMENT SUMMARY:

[ ] Continuation

IF REPORT IS NEGATIVE, YOU ARE DONE AT THIS POINT.

SURVEY LA/HCPI NUMBER LOG

Sites/Properties Discovered:

LA/HCPI No.	Field/Agency No.	Eligible? (Y/N/U, applicable criteria)
LA193273		

NMCRIS No.: 142254

Previously recorded revisited sites/HCPI properties:

LA/HCPI No.	Field/Agency No.	Eligible? (Y/N/U, applicable criteria)
HCPI45973	185768	

MONITORING LA NUMBER LOG (site form required)

Sites Discovered (site form required):

LA No.	Field/Agency No.

Previously recorded sites (site update form required):

LA No.	Field/Agency No.

Areas outside known nearby site boundaries monitored? [ ] Yes [ ] No, Explain why:

TESTING & EXCAVATION LA NUMBER LOG (site form required)

Tested LA number(s)

Excavated LA number(s)

Appendix G
Site Record LA193273

1/23/2019 XtraExport

LABORATORY OF ANTHROPOLOGY SITE RECORD

1. IDENTIFICATION & OWNERSHIP

LA Number: **193273 (contact ARMS for site registration)** [X] **Site Update?** (complete at least Sections 1-4)

Site Name(s): ~~Cerro Chifle #1~~, Chiflo Playa #1

Other Site Number(s): (Agency Assigning Number)

Current Site Owner(s): ~~Robert R. ortega~~, Robert R. Ortega

Site Type: Archaeology/Features **Occupation Type:** Historic and Prehistoric

2. RECORDING INFORMATION

NMCRIS Activity No.: 142254 **Visit No.:** 1 **Field Site Number:**

Site Marker? [ ] (specify ID #):

Recorder(s):

Agency: Taos Archaeological Society

Recording Date: 07-Jan-2019

Site Accessibility (choose one): [X] accessible [ ] buried (sterile overburden) [ ] flooded [ ] urbanized [ ] not accessible [ ] not relocated [ ] destroyed

Surface Visibility (% visible; choose one): [ ] 0% [ ] 1-25% [ ] 26-50% [ ] 51-75% [ ] 76-99% [X] 100%

Remarks:

Recording Activities: [ ] sketch mapping [X] photography [X] instrument mapping (e.g. total station mapping) [ ] shovel or trowel tests; probes [ ] test excavation [ ] in-field artifact analysis [X] excavation (data recovery) [X] GPS mapping [ ] surface collection [X] other activities (specify): Cores for Pollen and Starch Analysis

Description of Analysis or Excavation Activities:

On May, 2018 cores were taken on 3 features for Pollen and Starch Analysis and sent to PaleoResearch Institute, Golden Colorado for analysis.

Photographic Documentation:

Photo 1 - Playa, Photo 2 Feature 1, Photo 3 - Feature 2 and Photo 4 - Feature 3

Surface Collections (choose one): [ ] no surface collection [ ] uncontrolled surface collection [ ] collections of specific items only [ ] controlled (sample: <100%) [ ] controlled (complete: 100%) [X] other method (describe): Coring

Records Inventory: [X] site location map [ ] excavation, collection, analysis records [ ] field journals, notes [ ] sketch map(s) [X] photos, slides, and associated records [X] NM HCPI form [X] instrument map(s) [ ] GPS mapping [X] other records: See Appendix

NMCRIS 2011 vers. 1/11

LA 193273

Repository for Original Records: State of NM, Taos BLM office, Land Owner and Taos Archaeological SocietyN/A
Repository for Collected Artifacts: N/A

3. CONDITION

Archaeological Status: [ ] surface collection [ ] test excavation [ ] partial excavation [ ] complete excavation
Disturbance Sources: [X] wind erosion [X] water erosion [X] bioturbation [ ] vandalism [ ] construct/land development [X] grazing [ ] other source (specify):
Vandalism: [ ] defaced glyphs [ ] damaged/defaced building [ ] surface disturbance [ ] manual excavation [ ] mechanical excavation [ ] other vandalism (specify): none at this time
Percentage of Site Intact (choose one): [ ] 0% [X] 1-25% [ ] 26-50% [ ] 51-75% [ ] 76-99% [ ] 100%
Observations on Site Condition:

This playa is used for watering of cattle when there is sufficient rainwater and runoff available. There is intense bioturbation by cattle noticed. The cores were taken within the clusters to offset the effect of bioturbation by cattle.

[ ] Continuation

ELIGIBILITY STATEMENTS (already in NMCRIS)

[ ] A [ ] B [ ] C [ ] D [ ] MPL NR Listed:
Statement By: State Reg. No.: Formal Determination:
Associated NMCRIS No.: HPD Log No.:

4. RECOMMENDATIONS (for Performer/Recorder use only)

use only if you cannot enter statements in NMCRIS

National Register Eligibility (choose one): [ ] Eligible [ ] Not Eligible [ ] Uncertain
Applicable Criteria: [ ] a [ ] b [ ] c [ ] d
Basis for Recommendation:

[ ] Continuation

Assessment of Project Impacts:

Treatment Recommendations:

5. SHPO CONSULTATIONS (for SHPO and Agency use only)

use only if you cannot enter statements in NMCRIS

Agency NR Determination: [ ] Eligible [ ] Not Eligible [ ] Not Evaluated
Applicable Criteria: [ ] a [ ] b [ ] c [ ] d
Agency Staff: **Date:**

NMCRIS 2014 ver. 2015

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Agency Remarks:

SHPO NR Concurrence: [ ] Eligible [ ] Not Eligible [ ] Not Evaluated

Applicable Criteria: [ ] a [ ] b [ ] c [ ] d

HPD Staff: Date: HPD Log No.:

Register Status: [ ] Listed on National Register [ ] Listed on State Register [ ] Formal determination of eligibility

State Register No.:

SHPO Remarks:

6. LOCATION

Source Graphics:

X USGS 7.5' (1:24,000) topo maps [ ] rectified aerial photos (describe):

X other topo maps (describe): Total Station mapping [ ] unrectified aerial photos (describe):

X GPS unit: GPS accuracy (choose one): [ ] < 1.0 m [ ] 1 - 10 m [ ] 10 - 100 m [ ] > 100 m

X other source (describe): Photos

Site Center UTM (NAD 83; from map service): E, N, Zone NOTE: GIS site center coordinates are proposed, not yet verified by ARMS

GPS Coordinates and Zone (NAD 83): 436584 E, 4370195 N, Zone 13

[ ] In highway R-O-W? Town (if in city limits): N/A

State: NM County:

USGS Quadrangle Name Date USGS Code

Cadastral (PLSS) Location (from NMCRIS Map Service, add additional to table)

Meridian		Unplatted	Township	Range	Section	1/4 Sections	Protracted?
New Mexico	[ ]	[ ]					
New Mexico	[ ]	[ ]					

7. PHYSICAL DESCRIPTION

Site Dimensions: 345 x 167 meters Basis for Dimensions (choose one): [ ] estimated [ ] measured

LA 193273

Site Area: 57615 sq m **Basis for Area (choose one):** [X] estimated [ ] measured **Elevation:** 7530 feet

Site Boundaries Complete? (choose one): [X] Yes

[ ] No (explain):

Basis for Site Boundaries: [ ] distribution of archaeological features, artifacts [ ] modern features, ground disturbance

[ ] property lines [XX] topographic features [ ] other (specify):

Depositional/Erosional Environment: [ ] alluvial [ ] aeolian [ ] colluvial [ ] residual [ ] no deposition (on bedrock)

[ ] other process (describe):

Stratigraphy & Depth of Archaeological Deposits (choose one): [ ] unknown / not determined

[ ] no subsurface deposits present [ ] subsurface deposits present [ ] stratified subsurface deposits present

Estimated Depth of Deposits: N/A

Basis for Depth Determinations: [ ] estimated [ ] shovel/trowel tests [X] core/auger tests [ ] excavations

[ ] road or arroyo cuts [ ] rodent burrows

[ ] other observations (describe):

Observations on Subsurface Archaeological Deposits:

When doing the coring in the rock alignments more rock alignments were contacted at about 28 in. This was consistent with all three features. Conductivity test indicated other rock alignments were under the surface rock alignments.

[ ] Continuation

Local Vegetation (list species in decreasing order of dominance):

Overstory:

Understory:

Vegetation Community (choose one or two):

[ ] forest [ ] woodland [XxX] grassland [ ] scrub [XxX] desert scrub [ ] marsh Other:

Topographic Location:

[ ] bench [ ] dune [ ] low rise [ ] ridge [ ] alluvial fan [ ] blowout [ ] flood plain [ ] mesa [ ] rockshelter [ ] arroyo [ ] canyon rim [ ] foothill [ ] mountain [ ] saddle [ ] badlands [ ] cave [ ] hill [ ] canyon [ ] talus slope [ ] cliff base [ ] cliff [ ] hill top [ ] plain [ ] terrace [ ] base of talus slope [ ] constricted canyon [ ] lava flow [XxX] playa Other:

Observations on Site Setting:

[ ] Continuation

LA 193273

8. ASSEMBLAGE DATA

Assemblage Content (all components):

Lithics:

[XxX] Lithic debitage
[ ] Chipped stone tools
[XxX] Diagnostic projectile points
[ ] Nonlocal lithics
[ ] Stone tool manufacturing
[ ] Ground stone tools
[ ] Other stone tools

Prehistoric Ceramics:

[ ] Prehistoric whole ceramics
[ ] Prehistoric diagnostic ceramics
[ ] Prehistoric other ceramics

Historic Artifacts:
[ ] Diagnostic glass artifacts
[ ] Other glass artifacts
[ ] Diagnostic metal artifacts
[ ] Other metal artifacts
[ ] Historic whole ceramics
[ ] Historic diagnostic ceramics
[ ] Historic other ceramics
[XxX] Historic other trash

Other Artifacts and Materials:

[ ] Bone tools
[ ] Faunal remains
[XxX] Botanical remains
[ ] Perishable artifacts
[ ] Ornaments
[ ] Figurines
[ ] Mineral specimens
[ ] Architectural stone
[ ] Burned adobe
[ ] Fire-cracked rock
[ ] Site furniture
[ ] Architectural debris

Assemblage Size (all components):

artifact class	0	1s	10s	100s	1000s	>10,000	*counts (if<100)
lithic artifacts-include debitage (choose one):	[ ]	[ ]	[X]	[ ]	[ ]	[ ]	
prehistoric ceramics (choose one):	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	
historic artifacts (choose one):	[ ]	[ ]	[X]	[ ]	[ ]	[ ]	
total assemblage size (choose one):	[ ]	[ ]	[X]	[ ]	[ ]	[ ]	

(estimated frequency)

Dating Potential: [X] radiocarbon [ ] dendrochronology [ ] archeomagnetism [ ] obsidian hydration
[ ] relative techniques (e.g. seriation, diagnostics, etc.) [ ] historic records [ ] informant
[ ] other methods (specify):

Assemblage Remarks:

[ ] Continuation

9. CULTURAL/TEMPORAL AFFILIATIONS

TOTAL NUMBER OF COMPONENTS DEFINED: 1

COMPONENT #1 (EARLIEST)

Cultural Affiliation: Unknown

Basis for Temporal Affiliations (choose one): [ ] not applicable [ ] based on associated chronometric data or historic records
[ ] associated diagnostic artifact or feature types [ ] based on analytically derived assemblage data or archeological experience

*Period of Occupation: (*see NMCRIS Guidelines for valid periods, default occupation dates, and phase/complex names)

	Period Name	Begin Date	End Date
Earliest Period:	Unspecific / Other Prehistoric		

NMCRIS form vers. info

LA 193273

Latest Period (if any): Unspecific / Other Historic 9500 BC 9999 AD

Dating Status: [X] radiocarbon [ ] dendrochronology [ ] archaeomagnetism [ ] obsidian hydration
[ ] relative techniques (e.g. seriation, diagnostics, etc.) [ ] historic records [ ] informant
[ ] other methods (specify):

Basis for Cultural/Temporal Affiliation:

Component Type: NA

Remarks:

No diagnostic material was found in the playa basin

***Associated Phase/Complex Name(s):**

10. FEATURES

additional features not in NMCRIS - see Users Guide for feature types

Feature Type	Reliable ID ?	√ Observed	Assoc. Comp. #s	Feature ID	Notes

11. REFERENCES

Written Sources of Information:

Additional Sources of Information:

12. NARRATIVE DESCRIPTION

[ ] Continuation

13. SITE RECORD ATTACHMENTS

NMCRIS 2019 vers. 1/01

LA 193273

[ ]site location map (USGS 7.5' topo: required) [ ]sketch map or site plan (required)
[ ]continuation forms?
[ ]other materials (itemize):

Appendix H

Pollen and Starch Analysis of Samples from Chiflo Playa #1, Rio Grande Basin, New Mexico

POLLEN AND STARCH ANALYSIS OF SAMPLES FROM CHIFLO PLAYA 1, RIO GRANDE BASIN, NEW MEXICO

By

Linda Scott Cummings

With assistance from
R. A. Varney

PaleoResearch Institute, Inc.
Golden, Colorado

PaleoResearch Institute Technical Report 2018-061

Prepared for

Vanderbilt University
Nashville, Tennessee
September 2018

INTRODUCTION

The Chiflo Playa 1 site is situated in the Rio Grande Basin in northern New Mexico approximately 7,000 feet above sea level. The site contains surface rock gardens that the indigenous Pueblo peoples believe were used to grow crops and date to the Prehispanic or Colonial era. Four sediment samples were collected beneath the surface rock gardens for pollen and starch analysis.

METHODS

Pollen

Sediments often present unique challenges for pollen preservation and recovery, meaning that larger samples are required for land sediments than for pollen recovery from lake sediments or peat bogs. A chemical extraction technique based on flotation is the standard preparation technique used in this laboratory for recovering pollen grains from sediments. This particular process was developed for extracting pollen from soils where the ratio of pollen to inorganic material is relatively low. It is important to recognize that it is not the repetition of specific and individual steps in the laboratory, but rather mastery of the concepts of extraction and how the desired result is best achieved, given different sediment matrices, that results in successful recovery of pollen for analysis.

Hydrochloric acid (10%) was used to remove calcium carbonates present in the sediment samples, after which, they were screened through 250-micron mesh. Multiple water rinses until neutral employ Stoke's Law for settling time. After settling the supernatant was poured off. A small quantity of sodium hexametaphosphate was mixed into each sample to suspend clay-sized particles prior to filling the beakers with water. Again, multiple rinses employing Stoke's Law and decanting facilitated clay removal. Treatment with sodium hexametaphosphate was repeated, as necessary, to remove clay. This process was repeated with ethylenediaminetetraacetic acid (EDTA), which removes clay, soluble organics, and iron. Finally, the samples were freeze-dried under vacuum.

Once dry, the samples were mixed with sodium polytungstate (SPT), at a density of 1.8 g/ml, and centrifuged to separate the organic material including pollen and starch, which floats, from the inorganic remains and silica, which do not float. The supernatant containing pollen and organic remains was decanted and retained. The sodium polytungstate process was repeated to recover all of the organics. Once the organics were recovered, the accumulated supernatant was centrifuged at 1,500 rpm for 10 minutes to allow small-sized silica to be separated from the organics. This supernatant was decanted into a 50-ml conical tube and diluted with reverse osmosis deionized (RODI) water and centrifuged at 3,000 rpm to concentrate the organic fraction in the bottom of the tube. This pollen-rich organic fraction was rinsed, then all samples received a short (25 minute) treatment in hot hydrofluoric acid to remove remaining inorganic particles. The samples were acetylated three times for 10 minutes each to remove extraneous organic matter. The samples were rinsed with RODI water to neutral. Following this a few drops of potassium hydroxide (KOH) were added to each sample which was then stained lightly with safranin.

A light microscope was used to count pollen at a magnification of 500x. Pollen preservation in these samples varied from good to poor. An extensive comparative reference housed at PaleoResearch Institute aided pollen identification to the family, genus, and species level, where possible.

Pollen aggregates were recorded during pollen identification. Aggregates are clumps of a single type of pollen and may be interpreted to represent either pollen dispersal over short distances or the introduction of portions of the plant represented into an archaeological setting. The aggregates were included in the pollen counts as single grains, as is customary. An "A" next to the pollen frequency on the percentage pollen diagram notes the presence of aggregates. The percentage pollen diagram was produced using Tilia 2.0 and TGView 2.0.2. Total pollen concentrations were calculated in Tilia using the quantity of sample processed in cubic centimeters (cc), the quantity of exotics (spores) added to the sample, the quantity of exotics counted, and the total pollen counted and expressed as pollen per cc of sediment.

Pollen extraction retains starch granules. Since starch analysis was requested for these samples, not only were starches recorded as part of the pollen count, an additional search for starches was conducted. Starch granules are a plant's mechanism for storing carbohydrates. Starches are found in numerous seeds, as well as in starchy roots and tubers. The primary categories of starches include the following: with or without visible hila, hilum centric or eccentric, hila patterns (dot, cracked, elongated), and shape of starch (angular, ellipse, circular, or lenticular). Some of these starch categories are typical of specific plants, while others are more common and tend to occur in many different types of plants.

ETHNOBOTANIC REVIEW

Archaeological studies reference ethnographically documented plant uses as indicators of possible, or even probable, plant uses in pre-Columbian times. Ethnobotany, the study of the relationship "between people of primitive societies and their environment" (Schultes 1962 in Chandra and Rawat 2015:124), provides evidence for both broad and specific historic exploitation of numerous plants. Multiple ethnographic sources evidencing a plant's exploitation suggest its widespread historic use and an increased likelihood of the same or a similar plant's use in the past. We consulted a broad range of ethnographic sources both inside and outside the study area to permit a more exhaustive review of potential plant uses. Ethnographic sources document historic use of some plants enduring from the past. Most likely medicinal plant use persisting into the historic period originated in pre-Columbian times. An estimated 17.1% of the world's flora comprise medicinally important plants (Chandra and Rawat 2015:124). Unfortunately, due to changes in subsistence practices and European food introduction, a loss of plant knowledge likely occurred. The ethnobotanic literature serves only as a guide for potential uses in pre-Columbian times, not as conclusive proof of those uses. When compared with the material culture (artifacts and features) recovered by the archaeologists, pollen, phytoliths, starch, and macrofloral remains can become use indicators. We provide the following ethnobotanic background to discuss plants identified during pollen and starch analyses.

Native Plants

Amaranthaceae (Amaranth Family)

Recent revision to botanical taxonomy, using gene-based APG (The Angiosperm Phylogeny Group 1998) and APG II (The Angiosperm Phylogeny Group 2003) systems, subsumes Chenopodiaceae under Amaranthaceae and places *Sarcobatus* as the single genus in its own family (Sarcobataceae). Cheno-am is a term derived from pollen analysis, although we have replaced it with Amaranthaceae according to the revised botanical taxonomy. Amaranthaceae refers to a group that includes the genus *Amaranthus* (amaranth, pigweed) and members of the former Chenopodiaceae (goosefoot family) such as *Atriplex* (saltbush), *Chenopodium* (goosefoot), *Monolepis* (povertyweed), and *Suaeda* (seepweed). Other members of the original Amaranthaceae have pollen distinct from that of *Amaranthus*, so are identified to genus. Weedy annuals or perennials, species of *Amaranthus* (amaranth, pigweed) and *Chenopodium* (goosefoot), grow in ecologically disturbed habitats such as cultivated fields and the vicinity of habitation sites, ditch banks, river bottoms, and disturbed areas. Other members of the former Amaranthaceae have pollen distinct from *Amaranthus*, so are reported by genus when they occur (Curtin 1984:47-48; Kearney and Peebles 1960:265; Kirk 1975:57-63).

Sometimes eaten raw, the nutritious seeds often were parched, ground into meal, and made into mushes cakes, and beverages (Harrington 1967:55-62, 69-71; Kirk 1975:57-63). Although *Chenopodium* seeds contain calories roughly equivalent to corn, they provide significantly more protein and fat (Asch 1978:307 in Kindscher 1987:82). The leaves, which are most tender as young, spring growth, were eaten fresh or cooked throughout the growing season (Harrington 1967:55-62, 69-71; Kirk 1975:57-63). Older *Amaranthus* leaves provide iron and vitamin C, whereas young *Amaranthus* leaves contain significant amounts of protein, calcium, phosphorus, potassium, vitamin A, and vitamin C (Watt and Merrill 1963:6 in Kindscher 1987:22). Amaranthaceae were gathered from early spring through fall (Harrington 1967:55-62, 69-71; Kirk 1975:57-63).

Amaranthus poultices were used to reduce swellings and to soothe aching teeth. Leaf tea was used to stop bleeding, as well as to treat dysentery, ulcers, diarrhea, mouth sores, mild heart, lung, and liver disorders, sore throats, and hoarseness. *Chenopodium* leaves, rich in vitamin C, were eaten to treat stomach aches, intestinal infections, and to prevent scurvy. Leaf poultices were applied to burns as well. Furthermore, Amaranth contains abundant iron and is given to those lacking iron in their diet (Angier 1978:33-35; Foster and Duke 1990:216; Harris 1972:58; Krochmal and Krochmal 1973:35, 66-67; Moore 1990:12). Native groups used *A. retroflexus* leaves to make soap for washing bandage and linens used to treat illnesses (Angier 1978:35).

Poaceae (Grass Family)

Poaceae (grass family), one of the largest and most economically important families of plants, grow in all climates, though local conditions determine their abundance. Cereals, grown worldwide, have been a staple in diets for thousands of years. Cereals and all grass seeds contain an incomplete protein complex and often are eaten with legumes to provide a complete protein complex that contains all the essential amino acids (Couplan 1998:464).

Native Americans typically used a seed beater and burden basket when collecting caryopsis (seeds) (Ebeling 1986:183, 195; Grant 1978:517). When present, grass awns (hairs) were singed off by exposing the seeds to flame. Depending on species, grass seeds ripen from spring to fall (Kirk 1975:189; Pohl 1954:131-132), providing a long-term available food source. Grains were parched and ground into meal for making mush, bread, flour, and cake (Ebeling 1986:195-198; Kirk 1975:177-189).

Lenticular starch grains are observed in large-seeded grasses such as wheatgrass, ryegrass, and barleygrass, all of which are members of the festucoid or cool season grass group.

Grass leaves and stems were used for building, weaving, and making cordage. Bedding, baskets, mats, clothing, screens, nets, twine, thatch, brushes, brooms, hairbrushes clothing, and sandals were made from grasses. Grasses also were used for floor and roof coverings and tinder (Ebeling 1986:195-197; Kelly 1978:417; Moerman 1998:127).

Cultigens

Capsicum (Pepper)

Capsicum (bell pepper, cayenne pepper, chili pepper, etc.) are cultigens introduced from tropical America, originally brought under domestication in Mexico. This group has many different varieties, including chilies, cayenne pepper, and pimentos. Fruits ripen to a yellow, red, or black color. *C. annuum* is the most widely cultivated species of pepper, and its varieties include bell peppers, jalapeños, pimentos, chili peppers, and cayenne peppers (Elmore 1944:73; Foster and Cordell 1992)(Hedrick 1972:135; Kearney and Peebles 1960:755-756). Lenticular starches are documented in chili pepper (*Capsicum* spp. L.) flesh (Perry et al. 2007). While Perry et al. (2007) discuss the lenticular starch in chili pepper as "a genus-specific starch morphotype that provides a means to identify chili peppers from archaeological contexts" they do not compare or contrast the lenticular starches of chili peppers with the lenticular starches produced in wheat, barley, oats, rye, and their wild relatives (*Agropyron* (western wheatgrass), *Hordeum pusillum* (little barleygrass), and *Elymus* (wild rye)).

Chili peppers are noted to have been the most common spice used by Native Americans in the Southwest. Sweet peppers are mild in flavor and include the varieties commonly called pimientos and bell peppers, whereas the hot pepper group includes varieties with a stronger hot, spicy flavor. Peppers are often canned, dried, or pickled (Brenzel 2001:512) (Hedrick 1972:135). Peppers are the most commonly used condiment in the world, and they are easily cultivated by many of their consumers in regions with long, warm growing seasons. The fruits are a source of Vitamins A and C, iron, and magnesium (Andrews 2000).

Zuni groups are reported to have seasoned *Cleome* (beeweed) and *Zea mays* (maize) with chili pepper (Stevenson 1915:69). *C. annuum* (cayenne pepper) can be used medicinally to stop bleeding or to treat sore throats, colds, chicken pox, backaches, and a number of other ailments (Hedrick 1972:135; Heinerman 1983:23-26; Kearney and Peebles 1960:755-756).

Zea mays (Maize, corn)

Zea mays (corn, maize) is a New World cultigen in the Poaceae (grass) family. Endosperm composition allows identification of five different maize types. Flour corn, often used by Native Americans, is starchy with little protein. Popcorn and flint corn have hard starch and more protein than other varieties. Dent corn has a waxy starch, and sweet corn contains little starch and is mostly sugar (Heiser 1990:95; McGee 1984:241). Experimental processing reveals maize pollen on husks, silks, in shelled maize, and in ground maize flour (Scott Cummings, personal communication, 1983).

Zea mays evolved in the southern highlands of Mexico from the annual grass, teosinte. Maize is a staple of many groups around the world and is the second most cultivated crop in the world (Cushing 1920:267; Kiple and Ornelas 2000:99-100; Mangelsdorf 1974:122-125; McGee 1984:240). Maize demonstrates great variability in kernel color, size, and shape; in ear size and shape; and in maturation time. Maize kernel colors include white, yellow, blue, red, and black, and combinations of these (Heiser 1990:95; Huckell and Toll 2004:45; Kiple and Ornelas 2000:99-100; Whiting 1939:67-70).

Maize is known to have been cultivated in the southwestern United States since approximately 1500 BC, but is believed to have reached this area by 2000 BC. *Zea* had been well established in the Fremont area 2000 years ago (Madsen 1989:7). Maize reached the northeastern United States by at least AD 200, and likely earlier. Cultivated maize is noted in east Florida around AD 750(Milanich 1998:45). The Great Plains acted as a gene flow barrier, resulting in eastern maize species that are enzymatically different than their southwestern counterparts. Northeastern introduction began with minor crops that were grown in small quantities for hundreds of years. However, by the Late Woodland period, maize had become the principal food crop and was the focus of many northeastern tribes' activities (Heiser 1990:89).

By AD 250, corn was cultivated at the Middle Woodland Trowbridge site in Kansas, and it appears at sites in eastern Texas and western Arkansas around 800 BC. Most likely maize was adopted after the cultivation of domesticated squash began and before the appearance of beans (Adair 1988:114; Perttula 2008).

At European contact, "maize was the most widely grown plant in the Americas, extending from southern Canada to southern South America, growing at sea level in some places and at elevations higher than eleven thousand feet in others" (Heiser 1990:89).

Often, maize was husked immediately upon harvesting. Ears were dried on the roofs of homes, and ristras of maize were hung inside from the roof. Whole ears or shelled kernels were stored for future use. Shelled maize was stored in bark containers, large baskets, and underground storage pits (Hurt 1987:40; Robbins et al. 1916:83-93; Stevenson 1915:73-76; Vestal 1952:18-19; Whiting 1939:67-70).

Early-ripening corn was picked while still green and roasted on the cob, while late-ripening corn was made into bread (Hurt 1987:40). Corn silks were dried and ground with parched corn to add sweetness. Because pollen is retained on the silks, this practice is one method of adding corn pollen to food and the archaeological record. Corn is frequently husked immediately upon harvesting (Cushing 1920:264-267; Kiple and Ornelas 2000:107; Moerman 1998:610-612), reducing the quantity of corn pollen introduced into archaeological proveniences, although pollen that is retained on the silks often is included with the kernels, as it is difficult to remove all of the silks.

An infusion of corn silks (collected before pollination) was used for many urinary tract disorders such as incontinence, infection, and kidney stones (Rogers 1980:42). Corn was used ceremonially by many tribes, and as well as for making toys, containers, thatch, cigarette paper, ribbons, arrowheads, and ceremonial items. Often, cornmeal was colored with *Atriplex* (saltbush) ashes. Black corn was made into dye for basketry, textiles, and body paint. Clean husks were saved for smoking and other uses, such as wrapping food. Corn pollen was widely used in various rituals and ceremonies (Robbins, et al. 1916:83-93; Stevenson 1915:73-76; Vestal 1952:18-19; Whiting 1939:67-70).

Although men sometimes helped clear the land for fields, usually women were responsible for planting, weeding, and harvesting maize crops. Seeds were planted in hills, not rows, and often were planted alongside beans, which replaced nitrogen that corn plants removed from the soil. Corn stalks, in return, provided a vertical surface for beans to climb. Also squash was planted as a groundcover that prevented weeds. Watchtowers and platforms were erected so women and children could guard crops against birds, especially crows. Snares and deadfalls were used to trap pests such as raccoons, woodchucks, and deer. The abundance of game (generally deer and rabbits) in fields offered the opportunity for "garden hunting". Often, two crops of maize were planted in a single season. Maize is by far the most common remain in Anasazi coprolitic material from Basketmaker III through Pueblo times (Clary 1983; Cummings 1994:134-150; Minnis 1989; Moore 1978; Scott 1979; Stiger 1977; Williams-Dean 1986; Williams-Dean and Vaughn M. Bryant 1975).

Green corn was eaten fresh, and mature ears were roasted or wrapped in corn husks and boiled. Dried kernels were ground into a multipurpose flour. Corn was eaten boiled, baked, popped, parched, wet or dry ground into meal, or dried for later use. It was made into mushes, pinole, a variety of breads and cakes, dumplings, porridge, and hominy. It served to feed both humans and livestock. Ripe corn kernels were dried, parched and ground into meal, hulled with lye from ashes to make hominy, or prepared in various other ways (Gilmore 1977:15). Hominy is made by soaking corn kernels in lye water created with ashes, which removes the outer skin of the kernels (Gilmore 1977:15). Dried maize was boiled, often with meat and dried pumpkin or squash, or ground into meal that was used to make bread, mush, or dumplings (Hurt 1987:40; Moerman 1998:612). Parched corn was frequently served as a beverage similar to coffee (Moerman 1998:611). The corn smut fungus *Ustilago* was also used for food. The fungi were gathered when the spores were firm and ripe, and boiled (Rogers 1980:42).

Easily transportable, both ground maize flour and a thin bread made from it provided a useful travel food (Elmore 1944:28; Stevenson 1915:73-74). Dried maize was boiled, often with meat and dried pumpkin or squash, or ground into meal that was used to make bread, mush, or dumplings (Hurt 1987:40; Moerman 1998:612). Parched corn was frequently served as a beverage similar to coffee (Moerman 1998:611). The corn smut fungus *Ustilago* was also used for food. The fungi was gathered when the spores were firm and ripe, and boiled (Rogers 1980:42).

Whole ears were also boiled and eaten. Corn silks were dried and ground with parched corn to add sweetness. This practice would add corn pollen to the food and archaeological record. Corn is frequently husked immediately upon harvesting, limiting the quantity of corn pollen introduced into archaeological proveniences, although pollen is regained on the silks (Cushing 1920:264-267; Kiple and Ornelas 2000:107; Moerman 1998:610-612).

Chapalote and Reventador

Chapalote popcorn, or pinole-popcorn, is an ancient type of maize thought to have arrived in the American southwest more than 4,100 years ago (Nabhan 2008:84). The variety has been deemed among the first land races of maize in Mexico. Producing small ears and tan- to coffee-colored kernels, this maize usually has 12–14 rows of kernels, some of which are flinty, while others more resemble popcorn. Toasted kernels may be ground into a sweet meal and used to make a variety of foods such as polenta, cornbread, pinole, atole, and tortillas. Discussing the uniqueness of chapalote, Nabhan (2012) remarks that "three corn experts associated with Harvard and the Rockefeller Foundation singled it out for further study:

> "Chapalote is one of the most distinctive races of maize in Mexico. It is primitive in being not only a popcorn but also a week pod corn. One of the most distinctive characteristics of chapalote is its brown pericarp [kernel] color." (Citation not attributed in publication).

Chapalote has been found to "perform well even during relatively dry years because it was early maturing and needed little supplemental irrigation if planted with the first monsoon storms of the summer season" (Nabhan 2012:71). Mexican ethnobotanist Efrain Hernandez-Xolocotzli believed that chapalote exhibits traits that indicate cross-pollination with teosinte, and he classified this type of maize as a bridge between the wild ancestors of corn, and the more recent popcorn and flint corn, speculating on possible trade routes through western Mexico (Nabhan 2012:71).

Reventador, known locally as "*maiz reventador*" which means, quite literally, "exploder corn," or popcorn, is "small-grained, flinty and undented," with white kernels (Anderson 1944:301). It is noted to have been grown in western Mexico in the Colonial period. Similar maize was recovered from archaeological sites including Paso Real and Culiaćan, Sinaloa, excavated by Dr. Isabel Kelly. *Maiz chapalote* is reported to look similar to *maiz reventador* except that those ears look even more primitive and exhibit a dark tan pericarp. *Maiz reventador* also has a longer growing season than *maiz chapalote*. *Maiz reventador* is also similar to a maize grown by the Akimel O'odham and Tohono O'odham groups in Arizona in plant color, and in "having narrow cobs, tessellated seeds, well-developed tillers, and prominent husk striations" (Anderson 1944:307).

In addition to having kernels a similar dark brown to those of teosinte, chapalote exhibits:

> "large knobs on every chromosome except No. 10. It would seem as if these western Mexican varieties represent a maximum introgression of teosinte. If so, this must have occurred at some time in the past. While teosinte is not unknown in western Mexico, it is now a rarity in the fields where we have studied *maiz reventador*" (Anderson 1944:307).

The topic of crosses with *maiz reventador* is explored, noting that within the resulting X1 population, some of the maize will more closely resemble *maiz reventador*, while others are less similar. This same phenomenon is visible within the morphometric data for modern Hopi cobs, suggesting that they are the result of crossing. Thus far the probable races of maize for this cross have not been identified (Anderson 1944:307).

Evidence for growth of *maiz reventador* farther northward is noted in a "manuscript copy of the 1776 *Relación of (San Miguel de) Sahuaripa*," where it is located on a map of Sonora. The entry indicates that *maiz "rebentador*" has small white grains and that it was used to make a form of pinole that was commonly eaten in the area. Generally, reventador was used for popcorn and pinole, although it was not the only maize used to make pinole. Often, popped reventador was mixed with crude brown sugar syrup and made into balls (Anderson 1944).

DISCUSSION

The Chiflo Playa 1 Site is located in the Rio Grande Basin of northern New Mexico. The site is situated at an elevation of approximately 7,000 feet within a high desert environment where vegetation is dominated by sagebrush. Artificial rock formations that are laid out as alignments or in roughly rectangular areas are associated with sediments that are 15–20 inches deep around the dry playa basin. Samples were collected from depths between 12–14 and 22 inches below the surface in the rock gardens. Local traditions of the Puebloan people indicate these rock gardens probably were used to grow crops during Prehispanic or Colonial times. A few non-diagnostic ceramic sherds and lithics were recovered.

Four sediment samples from the Chiflo Playa 1 Site were collected from 12–14 or 22 inches beneath the surface rock gardens for pollen and starch analysis (Table 1). The pollen record from all four samples exhibits many similarities. The consistency and the signatures suggest a relatively tight targeted time range. The arboreal portion of the record includes small to moderate quantities of *Juniperus*, *Abies*, *Picea*, *Pinus*, and *Quercus* pollen (Table 2, Figure 1), representing Juniper, fir, spruce, pine, and oak trees, in all of the samples and small quantities of *Acer negundo* or *Pseudotsuga*, representing box elder and Douglas fir, in Samples 1 and 2, respectively. Quantities of Amaranthaceae pollen, representing plants in the goosefoot family, varied in these samples, with Sample 2 yielding Amaranthaceae aggregates and Samples 1 and 3 yielding the largest quantities of Amaranthaceae pollen. Amaranthaceae pollen might represent either native plants such as salt bush, or weedy plants such as goosefoot that might have been tolerated or even encouraged as economically valuable native plants. Quantities of *Artemisia* pollen, representing sagebrush, were relatively stable, with Sample 4 yielding the largest amount of *Artemisia* pollen. Small quantities of Low-spine Asteraceae and High-spine Asteraceae pollen reflect local growth of various plants in the sunflower family, including ragweed or marshelder (Low-spine Asteraceae) and probably rabbit brush or sunflower, or related plants. A small quantity of Liguliflorae pollen was observed only in Sample 4, indicating local growth of plants in the chicory tribe of the sunflower family, such as dandelion. Brassicaceae pollen was observed only in one sample (1), suggesting that weedy plants in the mustard family and economically valuable plants in the mustard family were not grown in these rock gardens.

Cercocarpus pollen, reflecting mountain mahogany shrubs, was only observed in Sample 2. Cyperaceae pollen was observed in Samples 2, 3, and 4, suggesting that these linear rock clusters help to retain sufficient soil moisture to support members of the sedge family. *Ephedra torreyana*-type pollen was observed in all samples, indicating local growth of ephedra or Mormon tea of the variety that reflects summer-dominant precipitation. *Ephedra* pollen is divided into two types: *torreyana* and *nevadensis* types, which are differentiated by furrows, ridges, and hyaline lines (Martin 1970:51). *Torreyana*-type includes *E. trifurca*, *E. antisyphilitica*, and *E. torreyana*, while *nevadensis*-type includes *E. clokeyi*, *E. coryi*, *E. funera*, *E. viridis*, *E. californica*, *E. aspera*, and *E. nevadensis*. Within their range, *torreyana*-type ephedra is dominant along the Mexican border in southern Arizona, New Mexico, northern Mexico, and west Texas with 90–100% frequency. There is a sharp demarcation between dominance, and *nevadensis*-type plants are dominant in the Four Corners area, Great Basin, and Mojave Desert. This distribution mirrors the distinction between summer-dominant and winter-dominant precipitation, with *Ephedra nevadensis*-type growing in areas of winter-dominant precipitation and *Ephedra torreyana*-type occupying areas of summer-dominant precipitation (Martin 1970:51-52). Modern distribution along precipitation lines indicate that prehistoric distribution should be an indicator of summer- or winter-dominant precipitation and that changes in frequencies of these two types of *Ephedra* pollen relative to one another act as indicators of changes in precipitation patterns (Martin 1970:51-52).

Eriogonum pollen, reflecting wild buckwheat, was observed in three samples (1, 2, and 4), while *Euphorbia* pollen, representing spurge, was only observed in Sample 1. These weedy plants form part of the background pollen signature. Fabaceae pollen, indicating a member of the legume family, was observed only in Sample 2. This pollen was not similar to that produced by cultivated beans. Poaceae pollen was present in moderately small frequencies in all samples, documenting local growth of grasses, some of which might have been harvested either for making baskets or because their seeds are edible. *Sarcobatus* pollen was observed in Samples 1 and 2, reflecting local growth of a small quantity of greasewood.

The most interesting recovery is the presence of *Zea mays* pollen, reflecting maize, in all four samples examined. This is strong evidence that maize was grown in these gardens delineated by or associated with these linear rock clusters. Recovery of *Sporormiella* dung fungal spores in three samples (1, 3, and 4) was a little surprising and may suggest a Colonial age use of the upper level agricultural features because *Sporormiella* dung fungal spores colonize feces of grazers such as horses, although they are not limited to large grazers, and elk could easily account for this presence to, or a combination of these grazers.

Sporormiella, an ascomycete fungus, grows only on herbivore dung in sub-boreal and temperate regions. Produced from ascomata on the surface of drying dung, *Sporormiella* spores spread passively to nearby vegetation, then are ingested inadvertently by grazing herbivores (Davis and Shafer 2006), especially elk herds. Many coprophilous fungi, such as *Sporormiella*, rely on a cyclic process involving herbivore ingestion of spores with foliage, germination of spores following passage through the gut, mycelial growth within, and eventual sporulation on the surface of drying dung (Wicklow et al. 1980). Ascomata, the fruiting bodies on dung, contain millions of individual spores, contributing to the environmental record in areas where dense herbivore populations exist (Aptroot and Geel 2006). Depending on a sample's context, *Sporormiella* recovery in archaeological samples can be an indicator of herbivore presence, and/or possibly use of their byproducts. Interpretations range from the presence of dung on the landscape, to burning dung for fuel, to the consumption of intestinal material for cooking and subsistence.

Following the historic introduction of grazing animals, *Sporormiella* becomes more abundant in Historic Period sediments. Numerous palynological studies document this increased occurrence in historic samples (Davis 1987). *Sporormiella* fungal spores are recoverable not only from introduced herbivores such as horses and cows, but also bison, moose, wild sheep, deer, elk, caribou, and rabbit dung. Increased recovery of *Sporormiella* spores in historic sediments may relate to changing land use patterns, as well as the increased time length that herds occupy any given area.

Scanning each of the samples for starches yielded three lenticular starch grains. Lenticular starches have traditionally been attributed to large grass seeds from festucoid or cool season grasses. However, Perry et al. (2007) published description and photographs of lenticular starches from chili pepper (*Capsicum*) fruits. They did not discuss the similarities or differences between lenticular starches produced in grass seeds and those produced in chili pepper fruits. Lenticular starches were observed in Sample 1 and a single lenticular starch in Sample 4. These starches suggest either local growth of a grass such as western wheatgrass or little barley grass or growing chili peppers in areas bounded by rock alignments. It should be noted that other seasonal grass species associated with wheatgrass and barley grass are not present, perhaps suggesting chili peppers or a combination of all of these. An angular starch typical of *Zea mays* was noted in Sample 2, adding to evidence for growth of maize in the area represented by this sample.

Microscopic charcoal was moderately abundant in Samples 1, 3, and 4, and far less abundant in Sample 2. Total pollen concentration was high, varying from slightly more than 14,000 to nearly 56,000 pollen per cubic centimeter (cc) of sediment.

SUMMARY AND CONCLUSIONS

Pollen and starch analysis indicates that these linear rock clusters do, indeed, represent agricultural features in this dry playa basin. Maize was grown, probably benefitting from increased moisture due to the presence of these linear rock alignments. Recovery of pollen from agricultural crops is common from rock alignments, as these alignments also serve to slow water transport of sediments and debris across the landscape. Maize starch was recovered in Sample 2, further supporting growth of maize. Lenticular starch recovered in Samples 1 and 4 suggests either growth of chili peppers or growth of cool season grasses that produce large seeds such as western wheatgrass or little barley grass.

TABLE 1
PROVENIENCE DATA FOR SAMPLES FROM CHIFLO PLAYA 1, RIO GRANDE BASIN, NEW MEXICO

Sample No.	Core	Depth (cmbs)	Provenience/ Description	Analysis
1	1	35–37.5	Sediment from linear rock cluster	Pollen Starch
2	2	25–27.5	Sediment from linear rock cluster	Pollen Starch
3	1	35–45.5	Sediment rock cluster	Pollen Starch
4	2	35–22.5	Sediment from rock concentration	Pollen Starch

TABLE 2
POLLEN TYPES OBSERVED IN SAMPLES FROM CHIFLO PLAYA 1,
RIO GRANDE BASIN, NEW MEXICO

Scientific Name	Common Name
ARBOREAL POLLEN:	
Acer negundo	Boxelder
Juniperus	Juniper
Pinaceae:	Pine family
Abies	Fir
Picea	Spruce
Pinus	Pine
Pinus ponderosa	Ponderosa pine
Pseudotsuga	Douglas-fir
Quercus	Oak
NON-ARBOREAL POLLEN:	
Amaranthaceae	Amaranth family (now includes Chenopodiaceae, these two families were combined based on genetic testing and the pollen category "Cheno-ams")
Asteraceae	Sunflower family
Low-spine	Includes Ragweed, Cocklebur, Sumpweed
High-spine	Includes Aster, Rabbitbrush, Snakeweed, Sunflower, etc.
Liguliflorae	Chicory tribe, includes Dandelion and Chicory
Brassicaceae	Mustard or Cabbage family
Cercocarpus	Mountain mahogany
Cyperaceae	Sedge family
Ephedra torreyana-type (includes *E. torreyana*, *E. trifurca*, and *E. antisyphilitica*)	Ephedra, Jointfir, Mormon tea
Eriogonum	Wild buckwheat
Euphorbia	Spurge
Fabaceae	Bean or Legume family
Poaceae	Grass family
Sarcobatus	Greasewood
CULTIGENS:	
Zea mays	Maize, corn
STARCHES:	
Lenticular starch	Typical of starches produced by grass seeds such as those from wheat grass (*Agropyron*), ryegrass

TABLE 2 (Continued)

Scientific Name	Common Name
	(*Elymus*), or barley grass (*Hordeum*)
Zea-type Starch	Typical of starches produced by maize
FUNGAL SPORES:	
Sporormiella	Dung fungus
OTHER:	
Microscopic charcoal	Microscopic charcoal fragments
Total pollen concentration	Quantity of pollen per cubic centimeter (cc) of sediment

FIGURE 1. POLLEN DIAGRAM FOR CHIFLO PLAYA 1, NEW MEXICO.

See Appendix C

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