The Geologic and Archaeological Contexts for Lithic Resource Acquisition in Southeastern New Mexico

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Edited by

Scott H. Kremkau, Kate E. Zeigler, and Bradley J. Vierra

Submitted to

Bureau of Land Management
Carlsbad Field Office
620 E. Greene St.
Carlsbad, NM 88220

Contract No. L08PC90395
Delivery Order L12PD02007

Technical Report 13-39
Statistical Research, Inc.
Albuquerque, New Mexico

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with contributions by

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ABSTRACT

Between December 2012 and January 2013, archaeologists from Statistical Research, Inc. (SRI), conducted geologic and archaeological studies at 14 previously identified archaeological sites, 2 small survey parcels inspected for archaeological remains, and 3 locales visited solely for the geologic study, all located in Eddy, Lea, and Chaves Counties in southeastern New Mexico. The sites and survey areas occupy a range of geologic settings. All 19 areas were utilized prehistorically.

SRI conducted archaeological survey and site recording at 14 previously recorded sites and 2 survey areas. The survey and site recording were conducted using 15-by-15-m grid cells to allow for the implementation of National Register of Historic Places– (NRHP-) evaluation procedures and the development of eligibility recommendations for each archaeological resource in the project area. The grid-cells methodology required the creation of a custom program application that was used for collecting digital data each time a positive grid cell was encountered. Two primary aspects composed this data-collection method: the provenience designation system and the Field Information Digital Organizer system. A total of 4,717 grid cells were surveyed at the 14 sites and 2 survey areas, and 824 (17.4 percent) contained artifacts or features.

Of the 14 sites and 2 survey areas, 4 sites (LA 43423, LA 122842, LA 146857, and LA 155867) are recommended *eligible* for listing in the NRHP; the remaining 10 sites and 2 survey areas are recommended *not eligibl*e for listing in the NRHP. All sites dated to the prehistoric period. The prehistoric sites were primarily quarries and procurement sites; 1 campsite was also present.

MANAGEMENT SUMMARY

Project Title: The Geologic and Archaeological Contexts for Lithic Resource Acquisition in Southeastern New Mexico

Project Sponsor: New Mexico State Bureau of Land Management, Carlsbad Field Office

Contract Number: NAC080147

Task Order Number: 11

Statistical Research, Inc., Project No.: 12PB01

Project Description: The project consisted of two phases. The first was a geologic study of bedrock and gravel deposits in 19 locations, including 15 previously recorded archaeological sites and 4 survey areas. The second phase of the project recorded the archaeological remains at 14 of the previously recorded sites and 2 of the survey areas. The purpose of the study was to determine geologic and archaeological contexts for prehistoric lithic-resource acquisition across southeastern New Mexico.

Location: Across southeastern New Mexico, in Eddy, Lea, and Chaves Counties

Number of sites: 14

Dates of fieldwork: December 2012 to January 2013

Sites recommended *eligible*: 4 (LA 43423, LA 122842, LA 146857, and LA 155867)

Sites recommended *not eligible*: 10 (LA 29500, LA 119804, LA 121969, LA 130417, LA 144349, LA 149992, LA 150383, LA 161046, LA 163991, and LA 169668)

ACKNOWLEDGMENTS

The lithic source study was conducted in southeastern New Mexico and was undertaken by Statistical Research, Inc. (SRI), in conjunction with the Carlsbad Office of the New Mexico State Bureau of Land Management (BLM). Special gratitude is extended to Martin Stein (BLM archaeologist) for his guidance and thoughtful participation in these investigations. We would also like to thank Tim Jennings, Tom Jennings, Terry Michael, and Jay Powell for graciously allowing us access to sites and survey areas located on their properties.

This report would not be what it is without the talent and dedication of many people at SRI, especially the graphic artists and editors. Andrew Saiz and Jacqueline Dominguez prepared many of the figures for publication; KeAndra Begay, Beth Bishop, and Diane Holliday carefully edited and Jason Pitts and Linda Wooden meticulously laid out these chapters; Production Manager John Cafiero coordinated production of the report and was responsible for quality control; and Director of Publications Maria Molina supervised the production process. Yours is often a thankless job, and we cannot express enough our appreciation of your efforts. Stephen Norris and Adam Byrd provided maps and unending grid-cell and database assistance throughout the course of this project. Given the never-ending challenges of this project, that assistance has never been more appreciated. Lisa Atkinson—in addition to her many other contributions, big and small—tracked and verified all our varied and incomplete references. Terry Majewski and Robby Heckman provided logistical and personnel support. Bradley Vierra served as principal investigator on this project.

The project was successfully completed with the cooperation and dedication of the field and office personnel. The field investigations were led by Scott Kremkau and Monica Murrell, with the able assistance of Michael Dilley, Fabiola Silva, and Jennifer Frederick. Various analyses and tasks in the office and the laboratory were completed by Lisa Atkinson, Adam Byrd, Michael Dilley, Robby Heckman, Rebecca Kiracofe, Phillip Leckman, Stephen Norris, and Bradley Vierra.

CHAPTER 1

Introduction

Bradley J. Vierra and Scott H. Kremkau

This report presents the results of a multidisciplinary study of 19 lithic-raw-material sources located throughout southeastern New Mexico (Figure 1). Lithic raw materials were sampled from all 19 locations, and archaeological sites and survey parcels at 16 of the locations were recorded and tested. The 19 locations included 14 previously identified archaeological sites (LA 29500, LA 43423, LA 119804, LA 121969, LA 122842, LA 130417, LA 144349, LA 146857, LA 149992, LA 150383, LA 155867, LA 161046, LA 163991, and LA 169668), 2 small survey parcels inspected for archaeological remains (the Meadow Hill and Adobe Draw Survey Areas), and 3 locales visited solely for the geologic study (the Opalized Caliche Locality, the Pecos River Sample, and the Rocky Arroyo Sample). Either bedrock or gravel lithic-raw-material samples were collected from all 19 locations. Archaeological recording and test excavations were conducted at the 14 sites and the 2 survey parcels that also contained archaeological remains. All 14 archaeological sites and the 2 survey parcels were also evaluated for their eligibility for listing in the National Register of Historic Places (NRHP).

Eighteen study locations were situated on lands under the jurisdiction of the New Mexico State Bureau of Land Management (BLM) Carlsbad Field Office (CFO), in Eddy, Chavez, and Lea Counties. One study location was on State of New Mexico land, in Lea County.

This report is submitted by Statistical Research, Inc. (SRI), to the BLM-CFO in response to Task Order 11 of the Permian Basin Mitigation Program. The contract was awarded to SRI on September 25, 2012.

Project Background

The Statement of Work stated that "bedrock sources are available from the Sacramento Section east to the Pecos River and within the caprock of the Llano Estacado east of the river. Gravel deposits are present in the Pecos Valley and Mescalero Plain physiographic units. A review of excavation reports, [Laboratory of Anthropology] site records, and in-field visits to selected sites and localities shows there are no true quarries or prehistoric mines present within the study area, but rather stone was gathered from the surface by knappers. Likewise, there is no site known at present that can be singled out as significant or distinctive, and that the study of which would hold the key to a lithic distribution study. Instead there are a number of formations covering a large areal extent; the Dockum, Ogallala, San Andres, Seven Rivers, Tansil and Yates Formation that have exposures of knappable stone at different localities." The sample selected for the study was considered to be representative of the variability in exposed geologic deposits and lithic-procurement sites in the area.

The primary goal of the project is to develop a systematic approach for recording and evaluating the research potential of lithic-procurement locales in southeastern New Mexico. The project is an offshoot of BLM efforts to develop a cost-effective research strategy for maximizing information obtained from archaeological-research projects in the region. To that end, the BLM developed the Southeastern New Mexico Regional Research Design (SENMRRD) (Hogan 2006), which outlined several avenues for future research in the region. The SENMRRD, as well as the report *Synthesis of Excavation Data for the Permian Basin Mitigation Program* (Railey et al. 2009), stated that identifying the sources of lithic raw materials in the region and understanding the cultural behaviors associated with raw-material acquisition are important steps if we are to understand precontact lifeways in the region.

The by-products of stone-tool manufacturing are some of the most ubiquitous remains in the archaeological record. They represent a complex process involving the acquisition of raw materials, as well as tool production, tool use, and the subsequent discard of expended tools. Stone tools, therefore, offer a direct link to understanding how people coped with the uncertainties of living in the arid Southwest.

In order to study prehistoric stone-tool collections, archaeologists must first be able to address several basic research questions: *What possible geologic sources for lithic materials are present in the area? How did the variation in geologic structure affect the local availability of lithic materials, and did the use of these materials change through time?* These questions are often asked in southwestern archaeology, and they have important implications for understanding prehistoric procurement and exchange networks. How people procured stone raw materials and whether they obtained them from local or nonlocal sources are important for understanding the organization of past economic systems.

In order to address these questions, SRI conducted a multidisciplinary study of lithic-raw-material sources within the BLM-CFO area. The study is divided into two main components: a geologic study of the region that identified and characterized the different raw-material sources and an archaeological study that recorded and analyzed the distribution of archaeological materials at several sites and survey areas. These different lines of data will be used to compare how the available lithic raw materials were utilized by prehistoric groups.

Report Outline

Chapter 2 provides a regional geologic overview of southeastern New Mexico. It reviews the various geological zones within the study area, such as the ranges of the Sacramento Mountains to the west, the Pecos River area along the center, and the Llano Estacado and related areas to the east. It also presents the various geologic processes that have led to the distribution of different lithic resources in the study area. Chapter 3 provides specific geological contexts for the different sites and survey parcels within the study area, including those within the San Andres Formation cluster, the Upper and Lower Pecos gravels clusters, the Artesia Group cluster, the Opalized Caliche Group cluster, and two isolated sites. Chapters 4 and 5 discuss the lithic raw materials present at the different clusters and how the different raw materials were utilized. Chapter 6 discusses the field methods used during recording and excavations. Chapter 7 presents descriptions of all the cultural resources evaluated as part of the study, including 14 sites and 2 newly recorded resources. Chapter 8 discusses the stone-tool technologies utilized by prehistoric groups at the different sites and compares them to technologies of other sites in the region. Chapter 9 examines the spatial distribution of artifacts and features within the sites and survey areas and looks at how the locations were structured and utilized in the past. Chapter 10 presents the criteria for evaluating resources for listing in the NRHP as well as SRI's NRHP recommendation for each of the project sites and resources. Chapter 11 presents SRI's recommendations for further research.

CHAPTER 2

Regional Geology of Southeastern New Mexico

Kate E. Zeigler and Gregory Peacock

Introduction

Southeastern New Mexico includes a variety of geologic and geomorphic units and features that range in age from Early Permian to recent. The archaeological lithic-procurement locales examined for the Permian Basin lithic-resources study are located in southeastern New Mexico, in an area bounded on the west by the Sacramento and Guadalupe Mountains and on the east by the Llano Estacado. The area of study is effectively bisected from north to south by the Pecos River valley. The resources themselves are scattered across this landscape and occur in a wide variety of geologic units and/or on a wide variety of geomorphic surfaces (Figure 2). Here we discuss the regional geology and tectonic and depositional histories of southeastern New Mexico.

Regional Stratigraphy

In ascending age order, units exposed in the study area are the Middle Permian San Andres Formation, the Middle Permian Artesia Group, the Upper Permian Castile, the Salado and Rustler Formations, the Upper Triassic Chinle Group, the Pliocene Gatuña Formation, the Miocene-Pliocene Ogallala Formation, and Quaternary fluvial, alluvial, and aeolian deposits (Figure 3). The Pecos River valley has three major terraces associated with it, and the river carries a highly variable bed load; lithologies of the pebble and cobble fraction change downstream, with input from different tributary drainages. The Castile, Salado, and Rustler Formations do not outcrop near any of the lithic-procurement locales observed in this study but are important parts of the regional geology.

San Andres Formation

The San Andres Formation consists of three members: the lower Rio Bonito Member, the middle Bonney Canyon Member, and the upper Fourmile Draw Member (Kelley 1971; Pray 1961). The Rio Bonito Member is dominantly medium- to thick-bedded dark-gray micritic limestone. It can be medium to thin bedded and is locally fossiliferous. The lower third of this unit has been dolomitized (Kelley 1971; Pray 1961). The Bonney Canyon Member is characterized by thinner beds than the Rio Bonito Member, and the unit has been variably dolomitized throughout its thickness. The upper beds of the Bonney Canyon Member are marked by laterally variable horizons of chert that can vary in color from white to dark purple and is color banded in many localities, in a pattern referred to as "fingerprint" chert. The chert occurs as small (less-than-1-cm) to large (up-to-0.5-m) nodules along bedding planes. The Fourmile Draw Member includes beds of sandstone, dolostone, micrite, and gypsum. Much of the Fourmile Draw Member has eroded off the Pecos Slope (Kelley 1971). Total thicknesses of preserved San Andres Formation range between 115 and 215 m (Kelley 1971; Kues and Giles 2004; Pray 1961). Hayes (1964) considered the Fourmile Draw Member to be laterally equivalent to the Cherry Canyon sandstone to the south, whereas Kelley (1971) equated it to the Grayburg and Queen Formations of the younger Artesia Group.

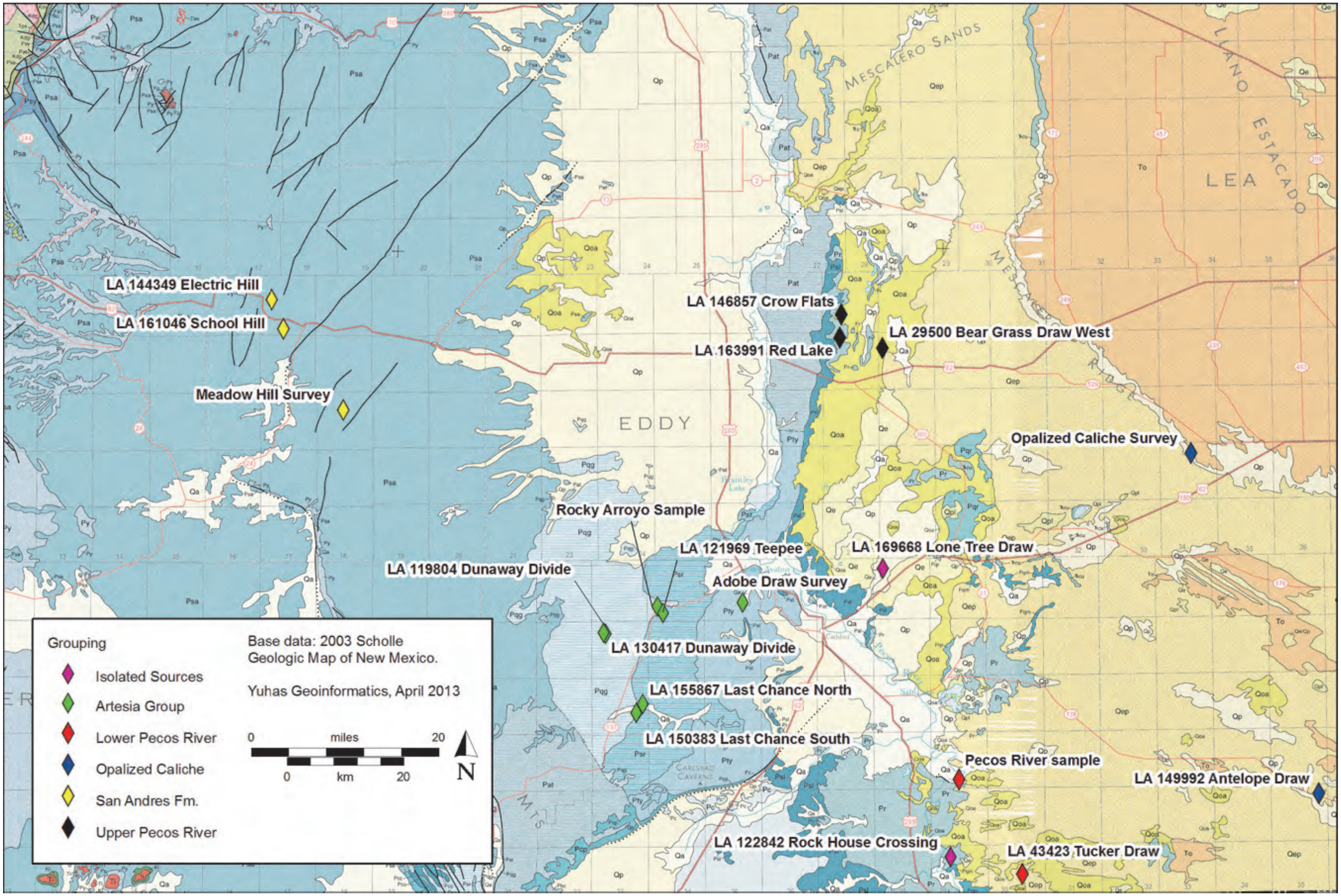

Figure 2a. Regional geology map of southeastern New Mexico showing sites and survey areas observed during this study (after Anderson and Jones 2003).

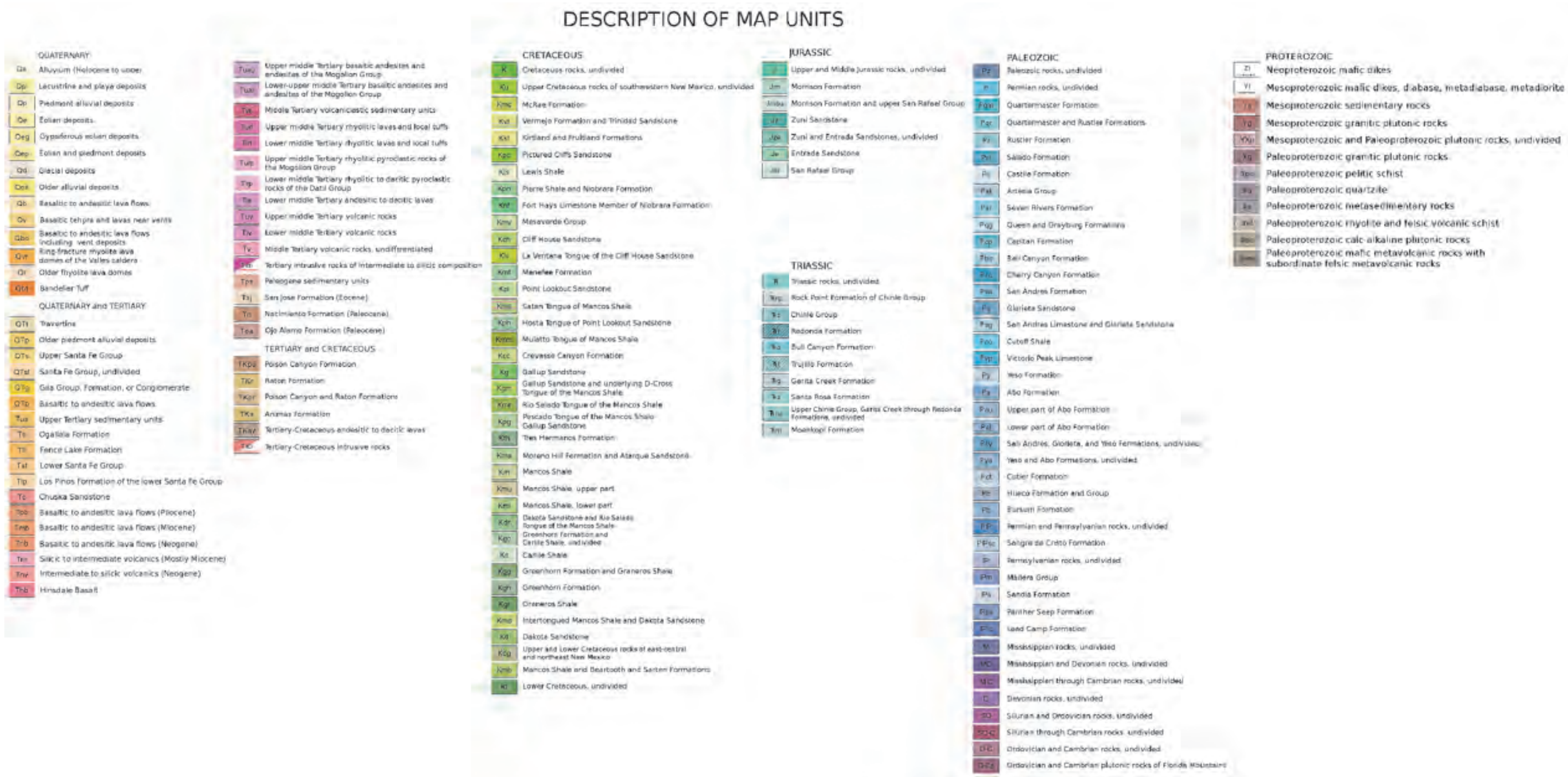

Figure 2b. Geologic-map legend (after Anderson and Jones 2003).

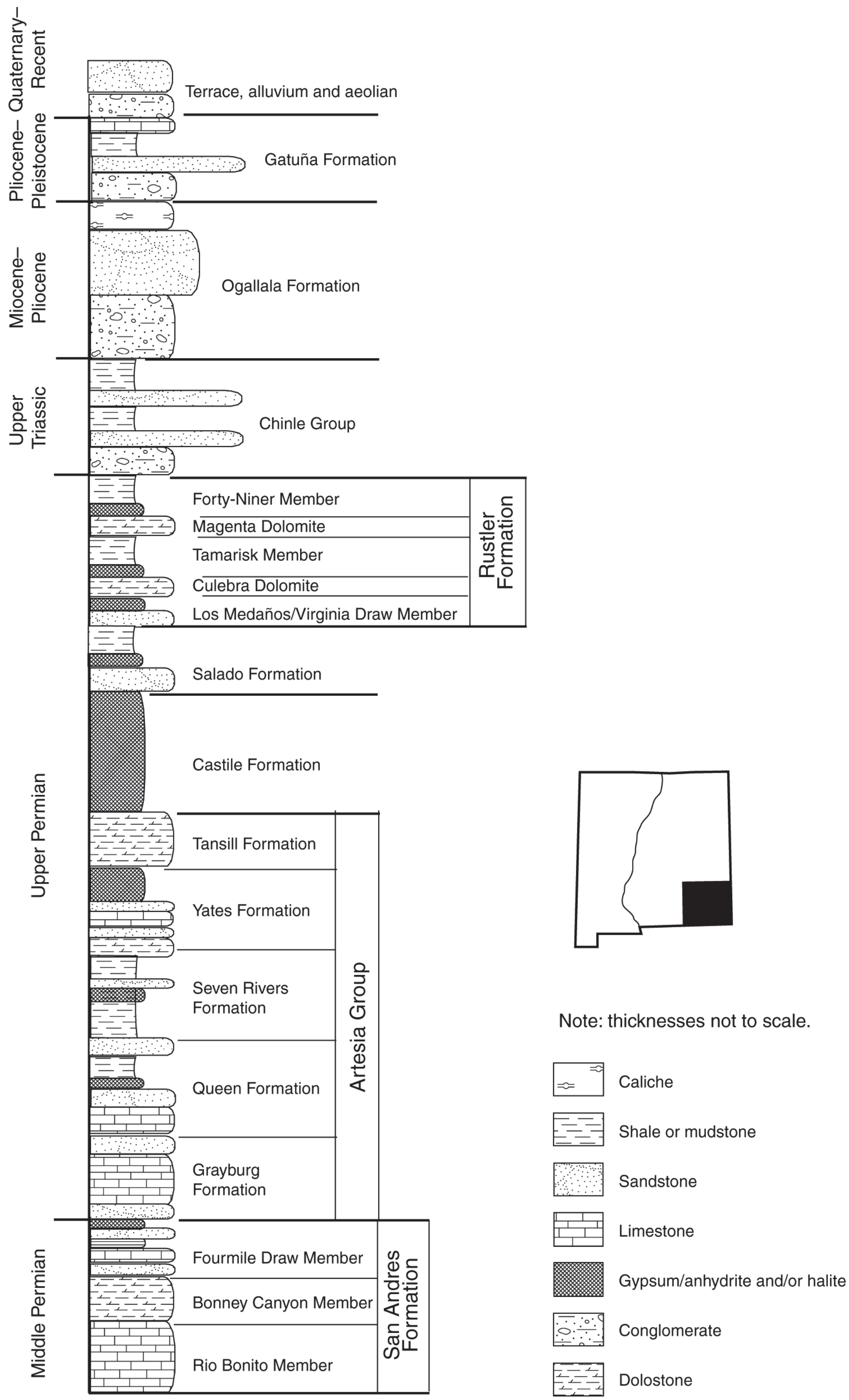

Figure 3. Regional stratigraphy of southeastern New Mexico for sites and survey areas observed during this study.

Artesia Group

The Artesia Group includes five formations (in ascending order): Grayburg, Queen, Seven Rivers, Yates, and Tansill. The Grayburg Formation is characterized by tan to brown medium- to fine-grained sandstone and ranges in thickness from 122 to 152 m (400–500 feet). Near the top of the unit, a cherty gray dolomite occurs (Kelley 1971). In the Guadalupe Mountains, the Grayburg Formation is dominated by lithographic and calcareous varieties of dolostone interbedded with sandstone. To the north, the sandstone beds are thinner, reddish in color, more friable, and interbedded with mudstone and, locally, gypsum (Kelley 1971). The Queen Formation, ranging between 61 and 122 m (200–400 feet) thick (Hayes 1964; Kelley 1971), is primarily composed of dolostone and sandstone in the southern part of the region and laterally grades to the north into gypsum, red mudstone, and dolostone (Kelley 1971). The Queen Formation has approximately twice the proportion of siliciclastic beds as the underlying Grayburg Formation and is generally somewhat darker in hue than the Grayburg and Seven Rivers Formations (Kelley 1971). The Grayburg and Queen Formations are laterally equivalent to the Goat Seep Dolomite in the Delaware Basin, to the southeast (Kues and Giles 2004).

The Seven Rivers Formation is predominantly thick beds of gypsum with thin, interbedded red or green mudstone and minor tan sandstone greater than 137 m (450 feet) thick (Hayes 1964; Hayes and Koogle 1958; Kelley 1971) that transitions to dolostone and siltstone to the south (Kelley 1971; Kues and Giles 2004). The lower part of the unit can include lithographic dolostone in exposures along the Pecos Slope and includes Azotea Tongue dolostone, which straddles the boundary between the Seven Rivers Formation and the overlying Yates Formation (Kelley 1971). Near Fort Sumner, the Seven Rivers Formation includes thick beds of alabaster (var. gypsum), and the famous Pecos "diamonds," double-terminated quartz crystals, occur near the top of the unit as well as in the lower Yates Formation (Kelley 1972). The Yates Formation has a lower carbonate unit and an upper evaporite unit. The lower carbonate unit includes the upper part of the Azotea Tongue of the underlying Seven Rivers Formation and is primarily composed of alternating carbonates, siltstone, fine-grained sandstone, and minor gypsiferous siltstone beds (Kelley 1971). North of Roswell, the Yates Formation is a distinctive olive-drab unit with fine-grained sandstone and siltstone (Kelley 1972). To the south, in the Guadalupe Mountains, the gypsum component pinches out, and the Yates Formation becomes primarily dolostone and sandstone approximately 61 m (200 feet) thick (Kues and Giles 2004). Thickness measurements for the Yates Formation vary considerably, from 122 m (400 feet) near Lake McMillan (Kelley 1971) to 100 m (328 feet) near North Rattlesnake Canyon (Hayes 1964) and to 92 m (300 feet) near Carlsbad (Motts 1962). Subsurface data from petroleum wells have indicated that the Yates Formation is generally about 31 m (100 feet) thicker in the subsurface than in outcrop exposures (Tait et al. 1962).

The uppermost unit of the Artesia Group, the Tansill Formation, is predominantly dolostone that formed in a reef-shelf-margin environment, and individual beds become thicker and massive as the unit grades upward into the Capitan Reef complex (Kelley 1971). The unit is approximately 31 m (100 feet) thick near the shelf edge but thickens to the southeast to over 99 m (325 feet) thick. To the north of Carlsbad, evaporite facies are more common, and salt deposits are more abundant to the east, in West Texas (Kelley 1971). To the north, near Fort Sumner, the unit includes sandstone and siltstone overlain by red and green mudstone with thin beds of dolostone (Kues and Giles 2004).

Castile Formation

The Castile Formation is a very thick sequence of massive to laminated anhydrite/gypsum with interbedded halite. Its maximum thickness is approximately 640 m in the central Delaware Basin, southeast of Carlsbad (Kelley 1971; Kues and Giles 2004). The halite units generally thicken to the north, and anhydrite units thicken to the east (Kues and Giles 2004). Both anhydrite and halite units include thousands of finely laminated beds that occur as couplets and may represent seasonal depositional patterns (Kues and Giles 2004). Limestone beds occur in the Castile Formation and in outcrops near the Yeso Hills, and locally, dikes and pipes of brecciated limestone have formed with collapse, flow, and replacement brecciation, as common features (Kelley 1971). The Castile Formation does not outcrop near any of the lithic-procurement locales observed in this study, but it is an important part of the regional geology.

Salado Formation

The Salado Formation overlies the Castile Formation and is up to 730 m thick (Kues and Giles 2004). It includes primarily halite with thin beds of anhydrite, sandstone, siltstone, and potash. Limestone and dolostone are very rare (Kues and Giles 2004). The Salado Formation is generally more colorful than the underlying Castile Formation, with pinkish hues in the siltstone and anhydrite beds. Outcrops often show chaotic fabrics that are collapse breccias reflecting salt-ablation processes in the shallow subsurface (Kelley 1971). Compared to the underlying Castile Formation, the Salado Formation has a smaller proportion of anhydrite (10–20 percent vs. 60–75 percent in the Castile Formation).

Rustler Formation

The Rustler Formation is Late Permian in age and up to 150 m in thickness (Kelley 1971; Kues and Giles 2004). The formation is divided into five members (in ascending order): the Los Medaños/Virginia Draw Member, Culebra Dolomite, the Tamarisk Member, Magenta Dolomite, and the Forty-Niner Member (Kelley 1971; Kues and Giles 2004; Powers et al. 2006). The lower 25–50 m of the Rustler Formation include reddish siltstone, dolostone, minor limestone, and gypsum, and invertebrate fossils represent normal marine fauna, as opposed to brackish-water or higher-salinity faunas (Kues and Giles 2004). The Culebra Dolomite includes both normal and marginal marine fossils. Above this unit, the remainder of the Rustler Formation includes gypsum/anhydrite, halite, and minor red siliciclastics.

Upper Triassic Dockum (Chinle) Group

Outcrops of the Chinle Group include the basal Santa Rosa Formation (named by Darton [1922]) and overlying shale-dominated units, all of which are referred to as the Dockum Group (Kelley 1971). Upper Triassic rocks are referred to as the Chinle Group for eastern New Mexico (Lucas 1991; Lucas and Anderson 1992, 1993, 1994; Lucas and Hunt 1987). The Santa Rosa Formation includes grayish to reddish sandstone and a basal conglomerate up to 15 m (50 feet) thick that includes round to subround pebbles of arkosic Permian sandstone but little or no chert or quartzite (Kelley 1971, 1972). Mudstone-dominated rocks exposed near Jal, New Mexico, are reddish brown to pale-green mudstone with lenses of micrite-granule conglomerate.

Ogallala Formation

The Ogallala Formation, which is Miocene to Pliocene in age, has been described as part of a complex fluvial system draining the eastern Rocky Mountains front range (see Gustavson and Winkler 1988) or as large aggradational-fan systems (Bretz and Horberg 1949; Frye and Leonard 1964; Reeves 1984; Sellards et al. 1932). The thickness of the Ogallala Formation is highly variable because of buried topography that the unit filled in as it prograded to the east (Gustavson and Winkler 1988). Thick paleovalley fill sequences occur adjacent to thin gravel deposits described as part of a pediment surface (Kelley 1971). Aeolian deposits are more prevalent in southeastern New Mexico in the Ogallala Formation (Hawley 1984; Hawley et al. 1976; Reeves 1972). The unit is a complex series of conglomerate, sandstone, siltstone, claystone, and caliche; it has such lateral and vertical variation that internal stratigraphic subdivisions of the unit in New Mexico have generally not been attempted (Bretz and Horberg 1949). The basal parts of the unit are generally coarser, and the pebble to cobble fractions of the conglomeratic beds include a wide variety of siliceous pebbles, including chert and quartzite as well as limestone, sandstone, basalt, and other rock types. Kelley (1971) described an Ogallala pediment-gravel "blanket" that covered most of southeastern New Mexico prior to the uplift of the Guadalupe Mountains. As uplift occurred in the Guadalupe Mountains area and the Delaware Basin subsided, this gravel surface was slowly let down onto the Pecos River floodplain. Alternatively, Ogallala gravels were exhumed during excavation of the modern Pecos River valley (Bretz and Horberg 1949) or are, in fact, entirely unrelated to the Ogallala Formation (such as quartzose cobbles in the Guadalupe Mountains that are probably attributable to erosion of Cretaceous conglomeratic sandstones [Hawley 1993]). According to Kelley (1971), either could explain the presence of abundant siliceous gravels on modern terrace surfaces and in near–Pecos River positions.

Opalized caliche, a unique feature of the Ogallala Formation, occurs near the bases of zones of calcrete and may result from a number of different opal-forming processes. Opalization can occur through biologic precipitation of opal from diatom shells, addition of opal to plant material that already contains silica, desilication of volcanic glass and precipitation of that silica in underlying rocks as cement, or desilication in conjunction with calcium-carbonate calcification just below a weathering surface (Franks and Swineford 1959). Reeves (1970) suggested this last process as the one most likely to have formed the opalized horizons in the Ogallala Formation. As soil carbonate weathers and is dissolved by infiltrating rainwater, it creates an alkaline solution that allows silica to go into solution at the expense of the calcium carbonate. Thus, silica is dissolved as carbonate is precipitated in the uppermost thickness of a developing calcrete horizon. Silica deposition occurs over a much longer time frame, because the deposition process has a much slower reaction time than for calcium carbonate. This reaction time, as well as the downward percolation of silica-saturated groundwater, would account for the silica's occurrence below the primary calcrete horizon (Reeves 1970).

Gatuña Formation

The Gatuña Formation is an enigmatic unit in southeastern New Mexico, and the relationship of the Gatuña and Ogallala Formations is not always clear (Kelley 1971). Generally, the unit is predominantly sandstone with some mudstone, conglomerate, limestone, and rare gypsum. The conglomeratic beds include pebbles of yellow, brown, black, or white chert; red and brown Santa Rosa Formation sandstone; sparse rhyolite; and limestone (Kelley 1971). Fining-upward sequences are common, and facies vary both laterally and vertically, reflecting both a variety of depositional environments and syndepositional subsidence that occurred as underlying evaporite underwent dissolution (Powers and Holt 1993). Dating of the Lava Creek B ash (approximately 0.6 million years ago [Ma]) in the Gatuña Formation near Loving, New Mexico, and an ash in probable Gatuña Formation strata near Orla, Texas (approximately 13 Ma), constrained the age range of the unit to middle Miocene to Pleistocene (Powers and Holt 1993). Outcrops of the Gatuña Formation include caliche fragments probably derived from Ogallala outcrops, suggesting that at least some parts of the Gatuña Formation must be younger than the Ogallala Formation (Hawley 1993; Powers and Holt 1993). However, deeper deposits may be older, as was argued (in part) by Kelley (1971, 1980).

Quaternary Pediment Deposits

Kelley (1971) described geographically extensive pediment deposits in southeastern New Mexico that occur as part of a complex topography that includes long, irregular mesas and playa lakes on a broad surface about 92–122 m (300–400 feet) above the Pecos River. This surface dips gently to the west and has been termed the Mescalero plain. Gravels that cover the surface, interspersed with sand dunes, sand sheets, and caliche, have been interpreted as derived from the erosion of the Ogallala Formation of the Llano Estacado (Kelley 1971). Horberg (1949) identified a similar feature to the west of the Pecos River that he termed the "Diamond A Plain," which dips slightly to the east. Gravels of the Diamond A Plain are much coarser than those of the Mescalero plain.

Pecos River Terraces

Three major terraces have been identified that are related to the modern Pecos River drainage. The Lakewood terrace is the lowest and youngest of these geomorphic features and occurs as the modern alluvium along the bottomland of the river and tributaries (Kelley 1971). The Orchard Park terrace is 1.5–8 m (5–25 feet) above modern river level and often occurs as a thin veneer over older alluvium. It is typically composed of silt and sand with clay lenses and pebbly beds with poorly developed caliche horizons (Kelley 1971). Kelley (1971) considered this terrace to be a thin pediment gravel deposited on a surface that was eroded, across older, thicker gravel deposits. The thin pediment gravel includes abundant siliceous pebbles, especially quartz, chert, and quartzite, with minor granite, rhyolite, schist, and diorite. The Blackdom terrace is the oldest and highest of the terraces and occurs 12–30 m (40–100 feet) above the Orchard Park surface. It is similar in lithology to the Orchard Park terrace but is generally coarser grained and occurs as a pediment veneer over 6 m (20 feet) thick above the underlying gravels. Caliche zones in the Blackdom terrace are thicker and better developed.

Aeolian Deposits

Large tracts of southeastern New Mexico are covered by aeolian deposits of variable thickness (Kelley 1971). Deposits include reworked sheet sands, vegetated dune fields, and areas of active dune formation and mobilization that occur as a veneer across the Mescalero plain.

Tectonic History

Southeastern New Mexico has been the focus of a variety of different tectonic events, which are reflected not only by the different units discussed above but also by the modern topography as well as the vast oil and natural-gas reserves of the western Permian Basin. During the Early Permian, the Ancestral Rocky Mountains were uplifted as a series of north–south-trending uplifts separated by narrow and very deep basins. By the Middle Permian, the Delaware Basin of southeastern New Mexico saw maximum subsidence just prior to and during the deposition of the San Andres Formation, which took place during the Leonardian and early Guadalupian (Kues and Giles 2004). The San Andres Formation, dominated by normal marine limestone deposits, records complex facies changes laterally because of eustatic sea-level changes. Deposition took place on a low-relief carbonate shelf, such that slight changes in sea level altered deposition over a large geographic area (Kues and Giles 2004).

By the Guadalupian era, New Mexico was tectonically quiet, and marine environments regressed to the south. The Artesia Group records this overall regression but also smaller fluctuations in sea level that have a general cyclicity (Kues and Giles 2004). These units were deposited adjacent to the massive Capitan Reef complex that developed to the south. As sea level continued to drop through the Late Permian, the contact between normal marine and evaporite facies migrated closer to the reef complex to the south (Kues and Giles 2004). Units deposited during that time are dominated by dolostone to the south and grade to the north into evaporites and red siliciclastics.

During the Ochoan (Late Permian) era, the Castile, Salado, and Rustler Formations were deposited. Sea level was continuing to regress, and marine deposition was confined to the Delaware Basin, in the far southeastern corner of New Mexico (Kues and Giles 2004). Reef growth tapered off as sea level fell, and the Delaware Basin also stopped subsiding. Connections between the basin and the open ocean to the south became very restricted, turning the basin into a relatively isolated lagoon, thus causing the thick evaporite deposits of the Castile and Salado Formations (Kues and Giles 2004). By the onset of Rustler Formation deposition, an overall sea-level transgression had begun and five smaller transgressions were occurring. This rise in sea level brought normal marine deposition back to the region, although each smaller transgression was followed by development of sabkha and mudflat environments in the intervening regressions (Kues and Giles 2004). The final regression of this series was followed by deposition of the Dewey Lake Formation, which was entirely continental in origin.

Deposition of the Permian systems was followed by nearly 20 million years of erosion during the Early and Middle Triassic before deposition resumed in the Late Triassic with development of the Santa Rosa Formation and the rest of the Chinle Group (Kues and Giles 2004). The Santa Rosa Formation filled in this erosional surface, and the overlying units of the Chinle Group reflect deposition in a continental setting and include fluvial, lacustrine, and aggradational-fan depositional systems. In southeastern New Mexico, the Jurassic through Oligocene systems either were not deposited or were deposited and then subsequently eroded prior to the deposition of the Ogallala and Gatuña Formations. Small remnants of Jurassic and Cretaceous strata can be found scattered across southeastern New Mexico, and most preserved Cretaceous rocks outcrop near the Capitan Mountains to the northwest (Kelley 1971). Kelley (1971) observed that the Cretaceous Dakota sandstone steps down over Triassic strata, the Grayburg and San Andres Formations to the south, suggesting tilting and leveling of the landscape between the end of the Triassic and the onset of early Late Cretaceous deposition.

The Ogallala Formation filled in a highly eroded landscape, much as the Santa Rosa Formation did, and formed as either fluvial deposits from streams that were sourced in the newly risen Rocky Mountains (Gustavson and Winkler 1988) or as large aggradational-fan systems prograding off the mountain front (Bretz and Horberg 1949; Reeves 1984; Sellards et al. 1932). Ogallala Formation deposits were eventually cut off from their sources to the west as incision began (Bretz and Horberg 1949; Sellards et al. 1932). The Gatuña Formation was originally interpreted to be either predepositional to or syndepositional with the early Ogallala Formation (Kelley 1971), but radiometric dates and observations of cobbles of Ogallala caliche in some outcrops have indicated that the Gatuña Formation is syndepositional with or postdepositional to the Ogallala Formation (Hawley 1993).

Bretz and Horberg (1949) identified high-elevation gravel deposits to the west of the Pecos River as Ogallala Formation remnants that could be correlated to the Ogallala Formation of the Llano Estacado. They hypothesized that similar gravels on lower surfaces were either ancestral Pecos River gravels or Ogallala Formation gravels let down during uplift of the Guadalupe Mountains and erosion of Paleozoic evaporitic rocks. However, Hawley (1993) suggested that gravels found high in the Guadalupe Mountains are related to erosion of Cretaceous strata and are not Ogallala equivalents.

Development of the caliche caprock, a prevalent part of the Llano Estacado, took place from the end of the Pliocene until the onset of the first Pleistocene glaciations. Formation of caliche horizons requires a specific mix of precipitation, temperature, runoff, and relief (Reeves 1970). From the end of the Pliocene until the onset of glaciations, the High Plains were semiarid, and streams and lakes dried up and deflated, producing abundant loess deposits rich in calcium carbonate (Reeves 1970). Intermittent moist intervals and season variations during that time allowed for the development of early-stage caliche soils that developed over time into the thick calcrete sequence observable today.

The ancestral upper Pecos-Brazos River originally flowed southeast through Portales and across the Llano Estacado before the beginning of the Pleistocene (Fiedler and Nye 1933). In fact, this system was a major component of the construction of the northern Llano Estacado as it carried material from the Rocky Mountains eastward onto the High Plains. The current course of the river developed after the current Pecos River watershed extended its reach northward through headward erosion and eventually captured the ancestral upper Pecos-Brazos River sometime in the early Pleistocene (Fiedler and Nye 1933). The modern Pecos River has a relatively straight north–south course and lies within the Pecos Trough, an elongated series of solution and collapse features that include alluvial fill consisting of contorted Ogallala Formation (Bretz and Horberg 1949; Summers 1972). It is younger than the Llano Estacado, as evidenced by its inset position below the Llano Estacado's current surface (Fiedler and Nye 1933). The Pecos River–gravel deposits observed in the Roswell to Artesia area include abundant siliceous materials (quartzite, chert, and jasper) that have been reworked from the northern reaches of the Pecos River in the Sangre de Cristos and from nearby sources, including Permian and Triassic sedimentary rocks, Ogallala Formation gravels, and materials added via tributary drainages from the Capitan and Sierra Blanca Mountains. The southern Pecos River deposits near Carlsbad have higher proportions of dolostone and limestone as a result of increased input of these materials from the Sacramento and Guadalupe Mountains to the west.

CHAPTER 3

Site-Specific Geology of Lithic-Procurement Locales in the Permian Basin of Southeastern New Mexico

Kate E. Zeigler and Gregory Peacock

Introduction

In all, 19 locations were visited as part of the geologic study: 14 previously recorded archaeological sites, 2 archaeological survey areas, and 3 locales visited solely for geological study. The locations surveyed for this study have been grouped according to the bedrock or geomorphic unit on which each is located. The groups are designated as follows:

- San Andres Group: LA 144349, LA 161046, Meadow Hill Survey Area
- Artesia Group: LA 119804/LA 130417, LA 121969, LA 150383, LA 155867, Adobe Draw Survey Area, Rocky Arroyo Sample
- Opalized Caliche Group: LA 149992, Opalized Caliche Locality
- Lower Pecos River Group: LA 43423, Pecos River Sample
- Upper Pecos River Group: LA 146857, LA 163991, LA 29500
- Isolated Sites Group: LA 122842, LA 169668

Here we discuss the geology and/or geomorphology specific to each site or survey area within each group. The groups are presented in order of geologic age, starting with the San Andres Group locations because they are located on the oldest bedrock.

Methods

We observed bedrock exposures and/or geomorphic surfaces at and immediately adjacent to each site or survey parcel and described the local geology and geomorphology in detail. Each was plotted on the 1:1,000,000-scale geologic map of New Mexico, and the geology that we observed was then compared with the geology described on the state geologic map and in the literature. We also observed the lithologies of the pebble-to-cobble component at each location, regardless of whether the materials had been used for manufacturing lithic tools. We did not attempt to quantify proportions of different materials numerically.

San Andres Group

Sites and survey parcels on bedrock outcrops of the San Andres Formation are located to the west of Artesia and are found on the medial member of the San Andres Formation (Figures 4 and 5). These locations include abundant chert in dolostone.

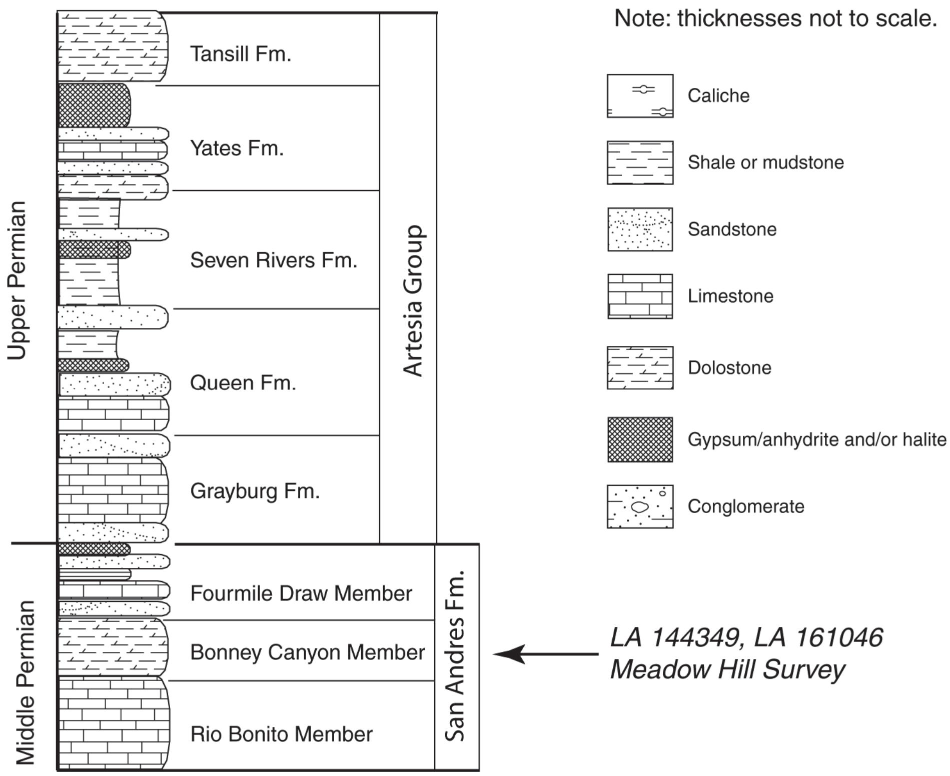

Figure 5. Regional stratigraphy for the San Andres Group.

LA 144349 ("Electric Hill")

LA 144349 is located on a hillside above a tributary canyon to the Rio Peñasco just west of Dunken Elementary School. The lower 100 m (ca. 328 feet) of the slope are the Rio Bonito Member of the San Andres Formation and the upper 33 m (ca. 108 feet) are the Bonney Canyon Member of the San Andres Formation. There are discrete large nodules and discontinuous bands of chert that are parallel to bedding at different horizons within tan dolostone and variably dolomitized limestone of the Bonney Canyon Member, approximately 13–20 m (ca. 43–66 feet) above the contact. Here, the chert is banded dark gray and very light gray or yellow and is termed "fingerprint" chert for its distinctive swirled banding. Chert is abundant in certain beds in the Bonney Canyon Formation and is also common along the canyon floor as weathered nodules.

LA 161046 ("School Hill")

LA 161046 is located southeast of LA 144349 and also is located in the Bonney Canyon Member. Less of the underlying Rio Bonito Member is exposed here and the chert-bearing horizons at LA 161046 are found topographically lower than at LA 144349 because the San Andres Formation is dipping to the east and a large monoclinal fold brings both units down, with the Rio Bonito almost entirely in the subsurface to the east. The chert, also fingerprint chert, is found as large nodules and discontinuous bands about 20 m (ca. 66 feet) above the contact, in a tan dolostone or variably dolomitized limestone as at LA 144349. Nodules are abundant in situ and are common as weathered debris on the slopes of the hills and in the valley floors.

Meadow Hill Survey Area

The Meadow Hill Survey Area is located southeast of LA 144349 and LA 161046 on the top of the Meadow Hill anticline, a broad antiformal feature northwest of the YO Buckle, a large strike-slip fault that cuts across the Pecos Slope. The rocks exposed here are entirely Bonney Canyon Member and include pale gray dolostone and dolomitized wackestone. Small chert nodules are common, although they are generally smaller in size and only rarely exhibit the fingerprint pattern observed at the previous locations. Colors include grayish brown, white, yellow and pale gray with a brownish orange cortex. Many of the chert nodules are fossiliferous and include fossils of foraminifera tests and shell fragments.

Artesia Group

These sites and survey areas are located on or near bedrock outcrops of various formations of the Artesia Group, including the Queen, Seven Rivers and Yates Formation (Figures 6 and 7). These locations include abundant dolostone cobbles with lesser chert.

Rocky Arroyo Sample

The Rocky Arroyo Sample is located in Rocky Arroyo where the drainage enters a narrow east–west-trending canyon with exposures of the Seven Rivers Formation of the Artesia Group to the northeast and southeast. It is on the northern bank of the arroyo and consists predominantly of reworked very pale-gray dolostone cobbles from the underlying Queen Formation and possibly dolostones from the Seven Rivers Formation weathered from the Seven Rivers Hills to the north and Mesa Azotea to the south. There are very rare pebbles of chert and these are dark brownish gray and mottled bluish white and gray with a reddish brown cortex.

LA 119804/130417 ("Dunnaway Divide")

LA 119804/130417 extends across a large geographic area of low rolling hills of Queen Formation dolostone and conglomeratic dolostone. Outcrops of conglomeratic dolostone include abundant cobbles of rounded dolostone and occasional pebbles of chert encased in a limestone matrix. This unit is probably a collapse-breccia feature associated with dissolution of underlying evaporitic or carbonate units. Chert pebbles are primarily grayish brown with a reddish brown cortex; less common are gray, pale gray, orange, brown and black striped, and mottled yellowish gray. Both chert pebbles and dolostone cobbles have weathered free of the conglomerate and are found in abundance on the surface.

LA 121969 ("Teepee")

LA 121969 is on the northern rim of Mesa Azotea, overlooking Rocky Arroyo, on the upper Seven Rivers Formation. The site, as described in the site form, is within an area of severe ground disturbance immediately adjacent to a well pad. Outcrop exposed during clearing of the well pad includes two dolostone beds, approximately 1.5 m (ca. 5 feet) thick, separated by a pale green mudstone bed. The dolostone beds are overlain by a gypsiferous mudstone, which is capped by a tan to pinkish dolostone, approximately 1–1.5 m (ca. 3–5 feet) thick. Small lenses of dark orange fine-grained lithic arenite occur along the outcrop belt. Cobble- and pebble-sized materials on the upper surface of the outcrop are predominantly tan dolostone with very rare pebbles of chert that are pale brown in color.

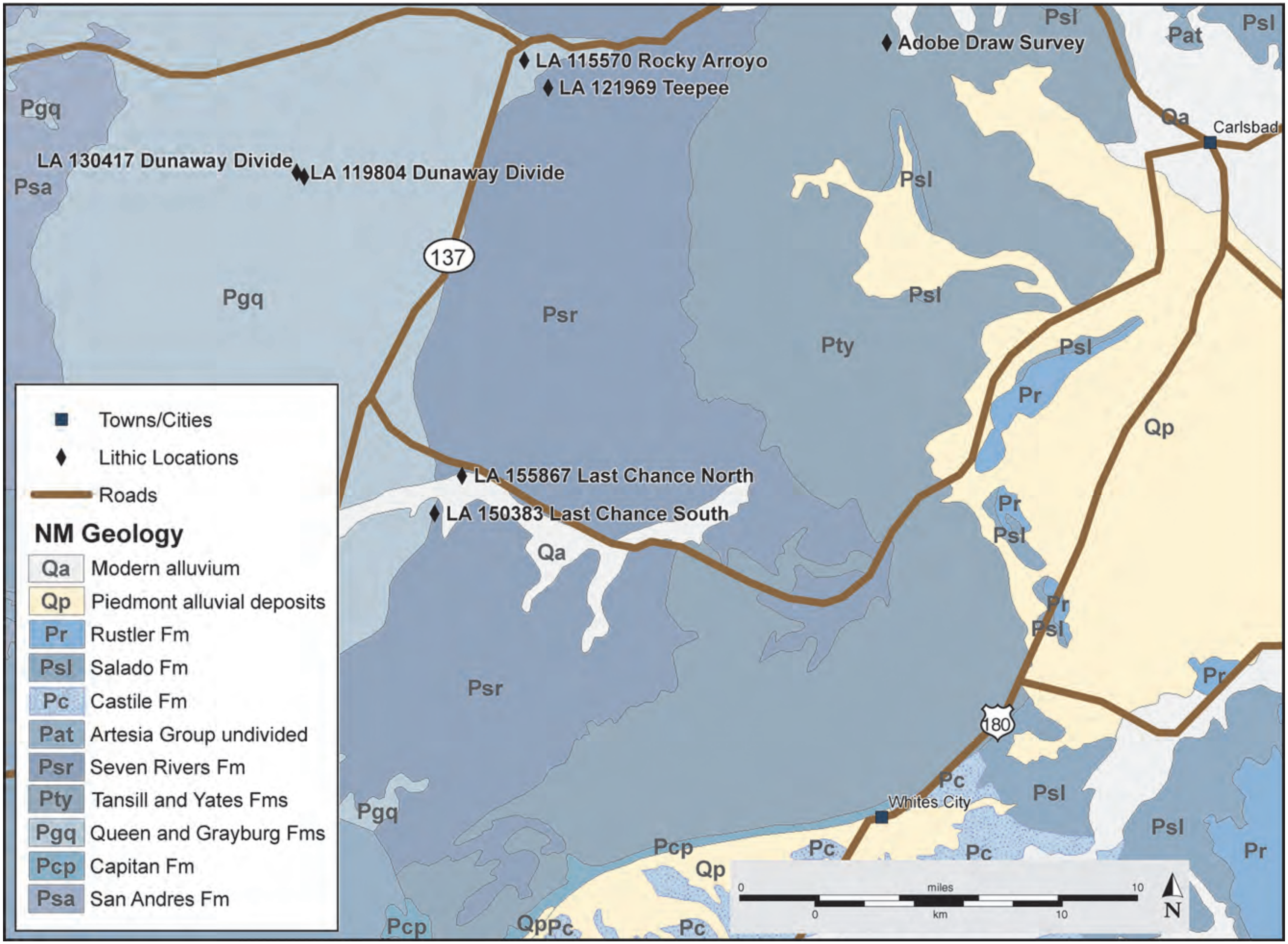

Figure 6. Regional geology of the Artesia Group.

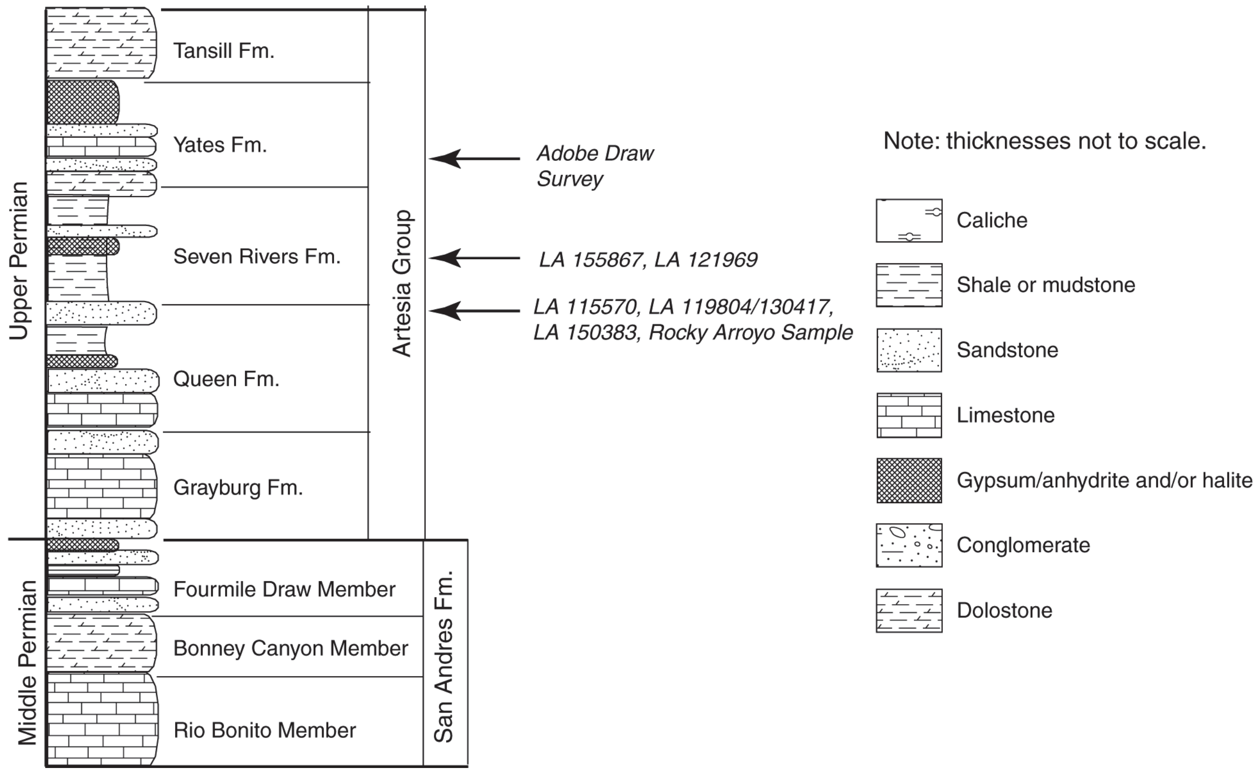

Figure 7. Regional stratigraphy for the Artesia Group.

LA 150383 ("Last Chance South")

LA 150383 is located on the south side of Last Chance Canyon where it enters Azotea Mesa. The site is located on a terrace surface above the main channel. The surface is a reddish brown silty sand that is locally deflated, with pebbles and cobbles in an uneven distribution across the surface. The top of the terrace itself is dominated by pebbles and cobbles of dolostone with rare very small nodules of brown chert with a reddish brown cortex. In a low depression between two ridges and to the west of the top terrace surface, a large deflationary area includes abundant pebbles and some cobbles of chert. Colors include gray, white, reddish brown, white and gray mottled, tan and very pale gray, as well as a distinctive fossiliferous chert with abundant, very large fusulinids (up to 1 cm in length). Very isolated outcrops are found along a two-track south of the site and are of the conglomeratic dolostone of the Queen Formation observed at LA 119804/130417.

LA 155867 ("Last Chance North")

LA 155867 is north of Last Chance Canyon and northeast of LA 150383. The site observed is located on a lower, younger terrace surface near the main channel. North of the site is an older, higher terrace developed on an outcrop of Seven Rivers Formation. This terrace is at approximately the same elevation as the terrace on which LA 150383 is located. At the site itself, cobbles are pale gray oolitic dolostone; very pale gray massive dolostone; very fine-grained, hematite-cemented limey quartz arenite with rare fossils; gray slate; dark gray micrite; and chert. Chert colors include grayish brown, white, brown, very pale brown and very pale yellow, gray, dark brown, yellowish brown, dark grayish red, brown and white mottled, and fossiliferous chert with fusulinids. On the older, higher terrace, cobbles and boulders of dolostone, limestone, yellow limey quartz arenite, and chert are abundant.

At LA 155867, the bedload gravels in the dry creek bed adjacent to the site were identical in composition to materials found at LA 155867 but were not identical to materials observed on the terrace above and about 100 yards north of the site, on the Seven Rivers Formation. The dry creek immediately below the terrace was overgrown enough with vegetation that we are hesitant to commit to the degree of similarity between bedload and adjacent deposits.

Adobe Draw Survey Area

The Adobe Draw Survey Area is located on a dip slope of lower Yates Formation dolostone that is buff to pinkish gray in color. Chert nodules and stringers are weathering out of the surface of the dip slope and are up to 30 cm (ca. 1 foot) in maximum dimension. The chert is uniformly a very pale blue-gray with a reddish orange cortex. Abundant loose, very small siderite and goethite nodules occur throughout the area. To the east, low hills of pale green and pinkish gray siltstone and mudstone crop out.

Opalized Caliche Group

Sites and survey areas in the Opalized Caliche Group are related to a zone of variable silicification that occurs a few meters below the well-developed calcrete horizon that is the caliche caprock of the Llano Estacado (Figures 8 and 9).

LA 149992 (“Antelope Draw”)

LA 149992 is located northwest of a small topographic feature locally known as “Custer Mountain.” Low bluffs along the northern boundary of the site consist of Upper Triassic Chinle Group reddish brown mudstones overlain by pinkish orange coarse-grain lithic wackes of the Ogallala Formation that are variably cemented with silica cement and highly bioturbated. Silicification varies between moderately well-cemented sandstone and very well-indurated material that can include chalcedony in vugs and fractures. This unit is overlain by a poorly developed laminar calcrete, the “caprock” of the Ogallala Formation. Pebbles on deflationary surfaces along the foot of the bluff include goethite concretions, black or black-and-white banded chert, and slate. Cobbles, which are much rarer, include gneiss, gray quartzite, caliche nodules, and banded quartzite.

Opalized Caliche Locality

The Opalized Caliche Locality is at the base of the Llano Estacado escarpment west of Hobbs, New Mexico. The opalized caliche is a zone of variably silicified sandstone about 6 m (ca. 20 feet) below the top of the escarpment. The silica cement is found very sporadically along a horizon about 1 m (ca. 3 feet) thick. Locally, silica is concentrated in lenses and small nodules of opal.

Lower Pecos River Group

Lower Pecos River Group sites and survey parcels are near or on the lower Pecos River and reflect not only Pecos River terrace deposits but also additions of different geologic materials from major tributaries to the west that carry predominantly limestone and dolostone as well as associated chert from the Guadalupe and Sacramento Mountains (Figures 10 and 11).

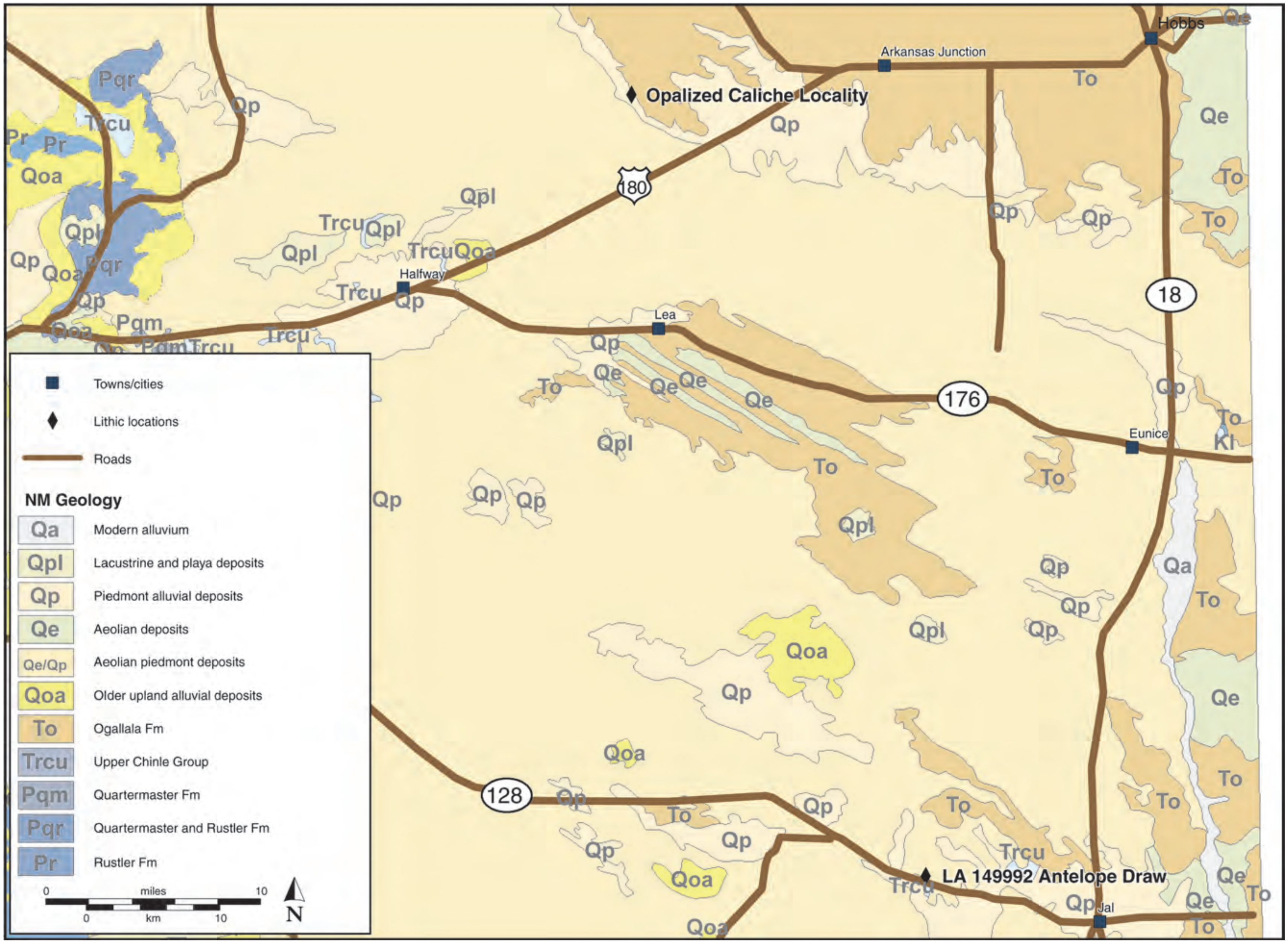

Figure 8. Regional geology of the Opalized Caliche Group.

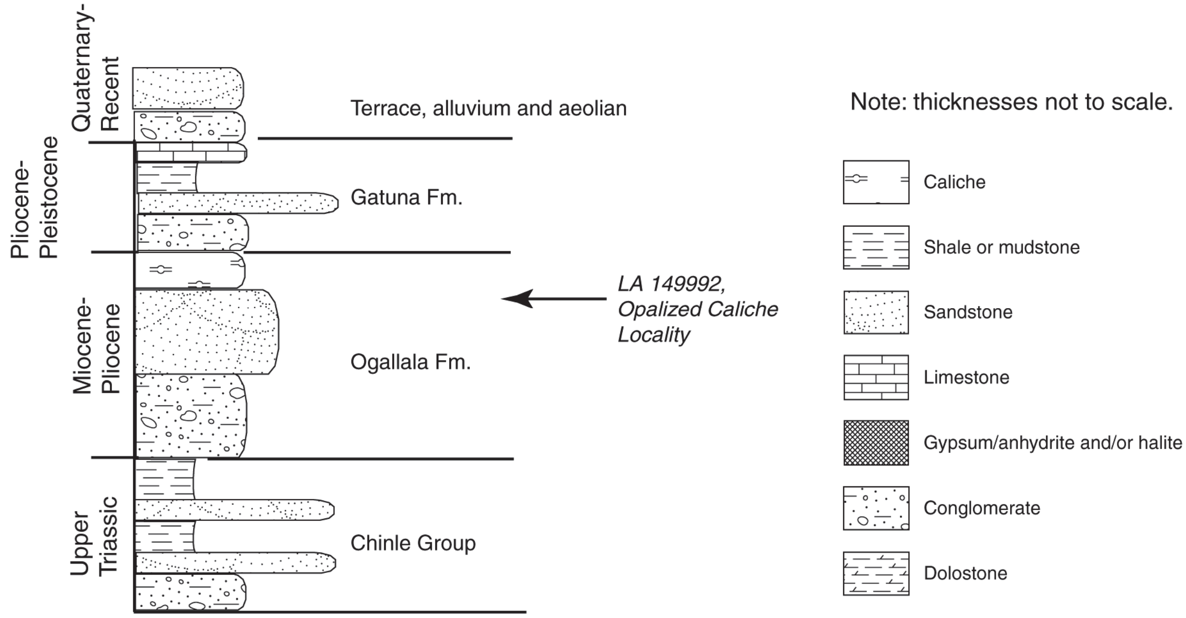

Figure 9. Regional stratigraphy for the Opalized Caliche Group.

LA 43423 ("Tucker Draw")

LA 43423 lies on low rolling hills of reddish orange, reworked aeolian sheet deposits with gravel-lag deposits capping low rises. Pebbles and cobbles in the lag deposits include quartzite (dark purple, gray, pale red, pale orange, grayish brown, white, black, gray and yellowish brown), chert (mottled red, pale grayish red, brown, orange-white, bluish white, mottled brown and white, white, gray, reddish orange, and very rare fingerprint chert), dark gray micrite, rare white chalcedony, rare dark brown slate, rare grayish orange dolostone, brown porphyritic andesite with phenocrysts of feldspar and pyroxene, and pale brown fine-grained lithic arenite.

Pecos River Sample

The Pecos River Sample location was originally chosen at the foot of an escarpment of the Permian Rustler Formation capped by a cobble-to-boulder conglomerate of the Ogallala Formation. The sampling area was moved away from the foot of the escarpment to minimize contamination of the Pecos River gravels with material weathering from overlying outcrops of Ogallala Formation conglomerate. At the second location selected, cobbles and pebbles found on a point bar of the river included very pale yellow lithic wacke of the Ogallala Formation, gray to dark gray micrite to wackestone, calcrete nodules (also Ogallala Formation), chert (mottled brown and yellow, black, brownish red, pale greenish yellow), yellow-brown fine-grained lithic arenite, quartzite (reddish orange, white, yellow, and brownish red), and pumice.

Upper Pecos River Group

Upper Pecos River Group sites and survey areas are located on older pediment surfaces to the east of Artesia, and the easternmost site (LA 29500) most likely includes components of Ogallala Formation gravels left by the eastward retreat of the Llano Estacado (Figure 12; see Figure 11).

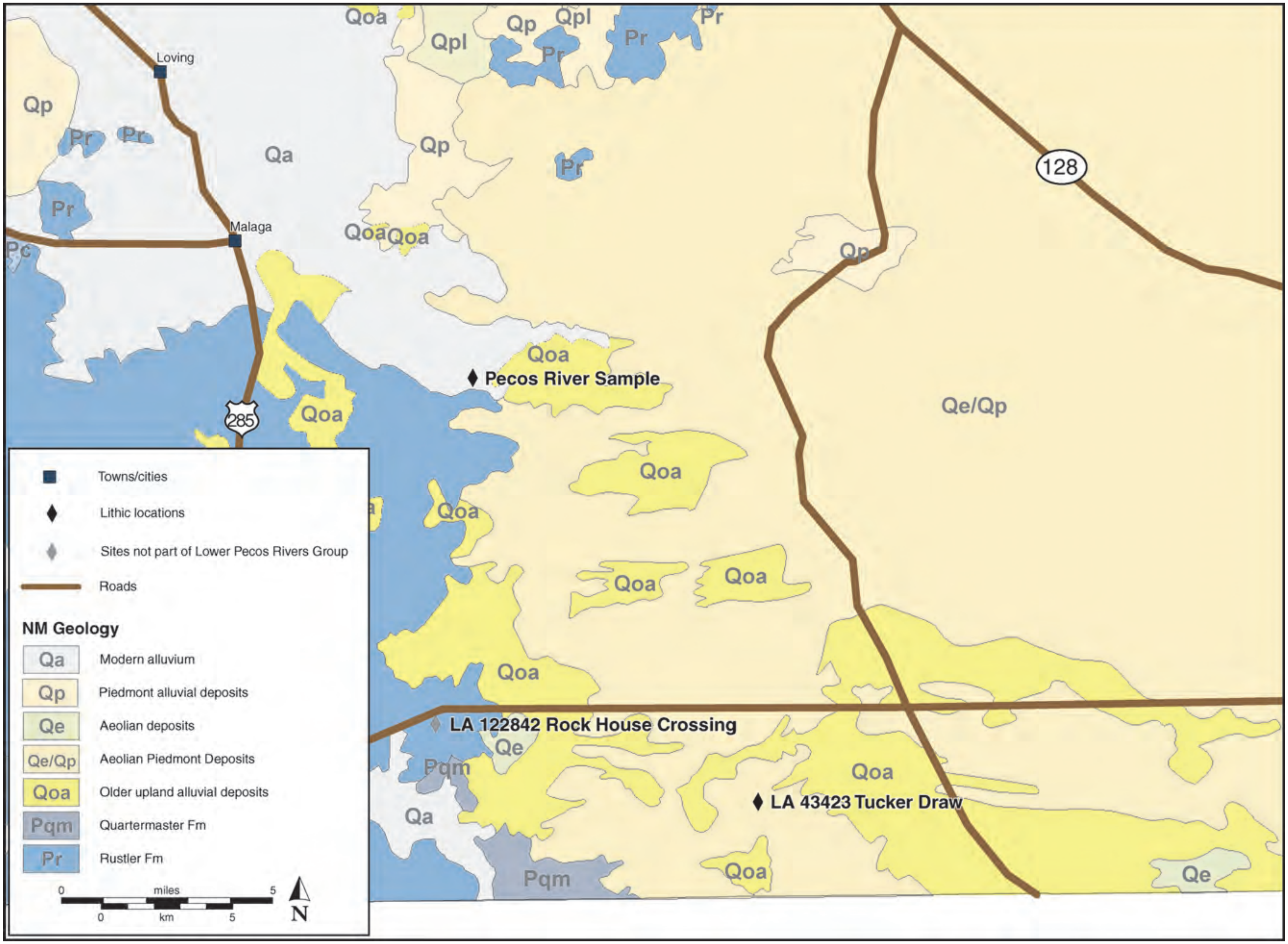

Figure 10. Regional geology of the Lower Pecos River Group.

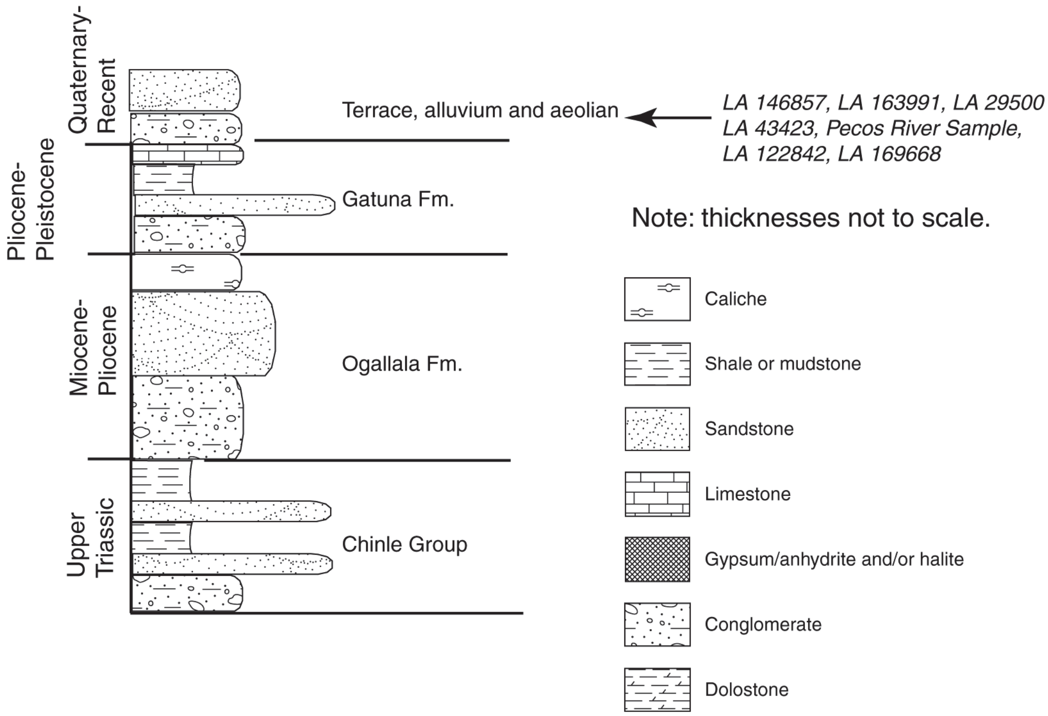

Figure 11. Regional stratigraphy for the Lower and Upper Pecos River Groups and the Isolated Sites Group.

LA 146857 ("Crow Flats")

LA 146857 is located east of the Pecos River and northwest of Red Lake on very low hills capped with rounded cobbles and pebbles interspersed with broad deflationary surfaces. This surface is covered by a thin cover of reworked aeolian sheet deposits and is probably a pediment surface. Cobbles and pebbles include quartzite (pale purple, dark gray, very pale gray, pale red, dark purple, yellowish white, pale yellow, and mottled red and white), chert (black, yellow, white, mottled red and white, brown, red, and green), pale pink and pale gray andesite, and red sandy fossiliferous limestone. The abundance of cobbles and pebbles is much less than at LA 163991 to the south.

LA 163991 ("Red Lake")

LA 163991 is located south of LA 146857 and just west of Red Lake on low rolling hills capped with abundant rounded cobbles and pebbles, probably a pediment surface that has since been incised. Low mounds of laminar travertine occur to the north of the site. The lithology of the pebble-to-cobble-sized assemblage varies widely and includes quartzite (orange, white, yellowish white, pale greenish yellow, dark gray, purple, red, and pale bluish gray); chert (black, gray, reddish brown, white, reddish orange, black, bluish gray); petrified wood; travertine; coarse-grained reddish orange lithic arenite that can be bioturbated and include clay rip-up clasts; pale yellow or gray rhyolite that can be porphyritic with plagioclase phenocrysts; brownish yellow, medium-grained quartz arenite; pale gray micrite; pale red gneiss; purple welded tuff; pale yellow-green to pale green slate; pinkish gray porphyritic andesite; dark yellow-brown chalcedony; white vein quartz; and rhyolite with distinctive pink phenocrysts (possibly Thunderbird rhyolite).

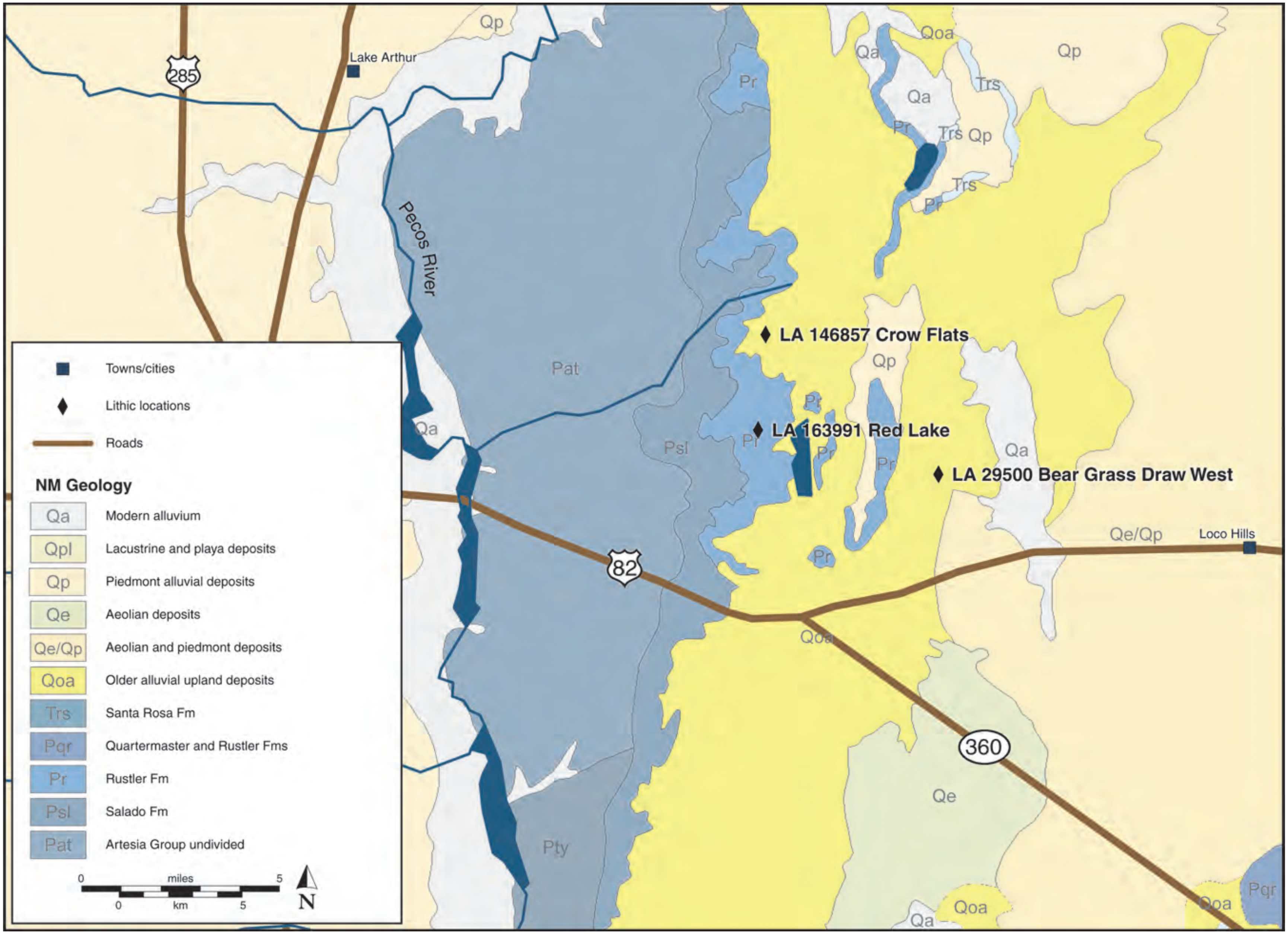

Figure 12. Regional geology of the Upper Pecos River Group.

LA 29500 ("Bear Grass Draw West")

LA 29500 is located to the east of LA 163991 on low hills capped with rounded cobbles and pebbles of varying lithologies and fragments of caliche. The surface is covered by a thin deposit of reworked aeolian sheet sand that is locally deflated. Pebbles and cobbles include quartzite (dark purple, yellow, brown, white, medium gray, pale red, pale purple, and rare pale green); chert (red, mottled red and white, brownish yellow, black, greenish gray, reddish orange, and multicolored); pale gray andesite with megacrysts of plagioclase and pyroxene; pale red rhyolite with large plagioclase and round, very clear quartz phenocrysts; petrified wood, and caliche nodules.

Isolated Sites Group

The Isolated Sites Group consists of sites that are not located near a well-defined geologic or geomorphic unit that would have been a potential source for knappable materials (Figure 13, see Figure 11).

LA 122842 ("Rock House Crossing")

LA 122842 is located on an incised and locally deflated older Quaternary surface at the base of an isolated outcrop of Ogallala Formation conglomerate. Cobbles observed at the site included dark gray micrite or packstone, reddish brown quartzite, and yellow-brown slate. Pebbles include quartzite (yellow, red, gray, black, and pale purple) and chert (black, pale gray, pale yellowish gray, mottled red, white, bluish gray, and brown). This distinct sorting of lithology by size reflects sorting in the adjacent outcrop of Ogallala Formation, which is composed of a conglomerate dominated by cobbles of rounded limestone. The site itself sits on what is most likely a pediment surface and includes cobbles weathered from the Ogallala Formation outcrop.

LA 169668 ("Lone Tree Draw")

LA 169668 is in a broad, shallow drainage with abundant deflationary features between two long, low hills. Small, low-density gravel lags occur sporadically along the drainage as well as isolated outcrops of gypsiferous soil. Pebbles and cobbles include quartzite (dark purple, pale yellowish green, white, pale purple, pink, pale yellow), chert (red, dark gray, reddish orange, mottled red and white, brown, pale gray, mottled brown and white, yellow brown, and black), gray micrite, medium-gray andesite with feldspar phenocrysts, tan andesite with pyroxene and plagioclase phenocrysts, and dark gray rhyolite with pink feldspar and large round, clear quartz phenocrysts (possibly Thunderbird rhyolite).

Discussion

The cobble-sized materials observed in this study were primarily and directly related to the immediate bedrock geology or geomorphic surface of each site or survey area. We did not observe any unaltered materials from a primary source outside the study area, with the exception of the Thunderbird rhyolite. For the San Andres Group, the Bonney Canyon Member is well known as a chert-bearing unit, and the fingerprint chert has been well documented (Kelley 1971; Pray 1961; Zeigler 2008, 2009). Outcrops of chert nodules and lenses are common throughout the eastern Sacramento Mountains, and often chert densities are such that flat surfaces are almost entirely covered with weathered nodules of chert.

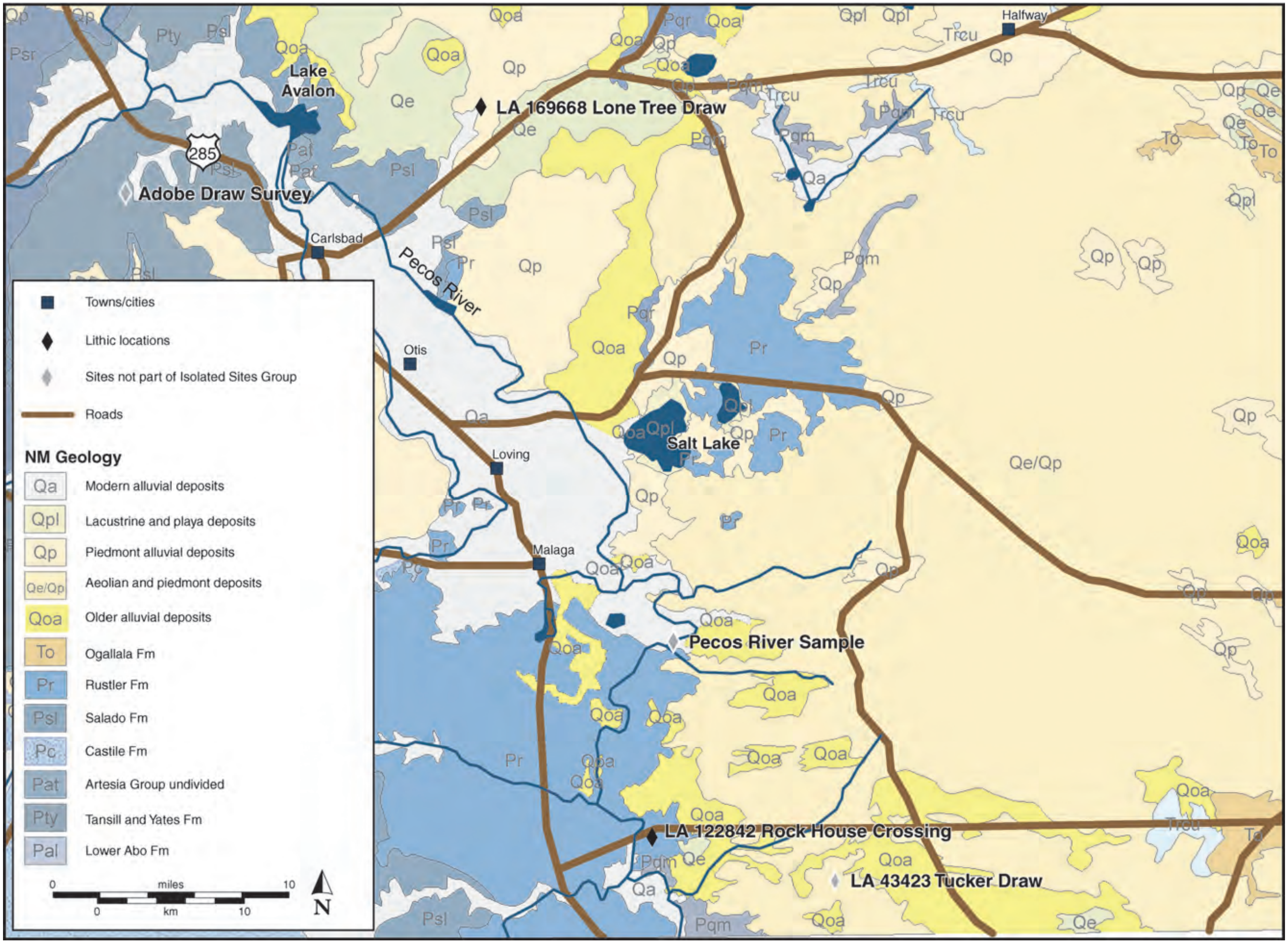

Figure 13. Regional geology of the Isolated Sites Group.

The sites and survey parcels included in the Artesia Group also reflect the bedrock geology and/or nearby geomorphic surfaces. Those located on bedrock exposures of the Queen and Seven Rivers Formations (LA 119804/LA 130417, LA 121969, and Rocky Arroyo Sample) are dominated by cobbles of dolostone, which is the most durable lithology that is locally available. Chert is not abundant at the bedrock locations, reflecting a lack of chert lenses, nodules, or cobbles in local Queen and Seven Rivers Formations outcrops that would have been large enough to manufacture stone tools. For terraces in Last Chance Canyon (LA 150383 and LA 155867), the principal lithologies reflect not only the surrounding Queen Formation bedrock outcrops, but also lithologies upstream of the sites. The "fusulinid chert," a distinctive material with a dark orange-brown cortex and abundant, very large fusulinids, is found at both of these sites, but it has not been documented in the local Queen or Seven Rivers Formation outcrops. Hayes (1964) documented nodules of fusulinid chert that weather out of the Cherry Canyon Sandstone, a lateral equivalent of the uppermost unit of the San Andres Formation, the Fourmile Draw Member. Outcrops of the Cherry Canyon Sandstone occur in Last Chance Canyon to the west of the sites (Hayes 1964).

The Opalized Caliche Group sites and survey areas are local possible lithic sources where the Ogallala Formation sandstones have been cemented with silica, some so much so that local lenses of silcrete and opal have formed. The location near Jal, New Mexico, includes extensive outcrops of Ogallala Formation sandstone with variable degrees of silica cementation, ranging from very poorly cemented with some carbonate cement, to such abundant silica cement that chalcedony has precipitated in vugs and along fractures. Silica tends to be concentrated in lower, older parts of caliche horizons because the upper, younger parts undergo soil carbonate dissolution, creating a very alkaline solution that allows for supersaturation by silica (Reeves 1970). Silica deposition requires a long time because reaction time is quite slow, which also may account for the greater concentration of silica in lower parts of the caliche (Reeves 1970).

Kelley (1971) described an Ogallala pediment gravel "blanket" that covered much of southeastern New Mexico prior to the uplift of the Guadalupe Mountains. As the Guadalupe Mountains rose and the Delaware Basin subsided, the gravels from Ogallala-age deposits were gradually let down onto the modern plains of the Pecos River, and this is one possible explanation for the abundance of siliceous gravels on modern terraces and near the river. Alternatively, Ogallala-age or pre-Ogallala-age gravels were exposed and reworked during reexcavation of the Pecos River valley (Kelley 1971). The two older terraces recognized in the vicinity of Artesia are the Orchard Park terrace, which is 2–8 m (ca. 6–26 feet) above the lowest terrace surface adjacent to the Pecos River, and the Blackdom terrace, which is 13–33 m (ca. 43–108 feet) above the Orchard Park terrace (Kelley 1971). Both of these surfaces include abundant siliceous gravels with quartz, chert, quartzite, and lesser granite, rhyolite, schist, and diorite (Kelley 1971).

The Upper and Lower Pecos River sites and survey areas reflect the geomorphic surfaces upon which they are located. The Lower Pecos River Group includes cobbles collected from a point bar on the river itself near Malaga, New Mexico. Another Lower Pecos River site, LA 43423, includes a variety of lithologies in the cobble fraction, including quartzite, chert, micrite, and andesite, among others. This mixture of materials is common for gravels carried by the Pecos River (e.g., Bretz and Horberg 1949), especially given that the Pecos River and its tributaries drain a wide variety of outcrop types. Alternatively, this site may include cobbles left behind by the retreating Llano Estacado escarpment as the Ogallala Formation conglomerates were weathered away.

The Upper Pecos River Group sites and survey parcels are located on older Quaternary surfaces above the Pecos River that have been incised and locally deflated. These surfaces are unlikely to be the Lakewood or Orchard Park terraces because they are almost 100 m (ca. 328 feet) above the current river floodplain. The oldest and highest terrace, the Blackdom terrace is only about 30 m (ca. 98 feet) above the floodplain (Fiedler and Nye 1933; Kelley 1971; McCraw et al. 2011). The cobbles on these surfaces probably reflect remanent Ogallala Formation cobbles and pebbles, left as a gravel surface and representing material transferred from mountain ranges to the west and northwest but may include relict Blackdom terrace surfaces. For example, numerous cobbles of andesite were observed that are most likely from the Sierra Blanca volcanic field to the west. One of these sites, LA 29500, is most likely a mixture of old Pecos River gravels and erosional remanents of the Ogallala Formation, left behind as the caprock escarpment retreated to the east.

The two isolated sites are separated because they are on or near bedrock or geomorphic surfaces not already described. LA 122842 is located immediately adjacent to an outcrop of Ogallala Formation conglomerate with abundant micrite cobbles. However, the surface upon which the site is located includes a wider variety of lithologies than is represented in the outcrop nearby. This site probably represents a mixture of gravels eroding out of the Ogallala outcrop onto an older Pecos River terrace or a pediment surface. Kelley (1971) described the pediment surface east of the Pecos River as 5–10-feet-thick widespread gravels of quartzite, chert, and other siliceous rocks that probably derived from the retreat of the Llano Estacado to the east. LA 169668 is located on reworked aeolian sheet sands and is probably a deflated pediment surface. The gravel fraction is widely distributed across the surface and includes a wide variety of lithologies, including abundant siliceous pebbles and cobbles, in a gypsiferous soil. This site is not located near any bedrock outcrops or near any obvious terraces.

Two sites include rare cobbles of material that looks similar to the Thunderbird rhyolite from the Franklin Mountains in western Texas, near El Paso (Kottlowski et al. 1973; Thomann 1981). This material has a dark gray to greenish black groundmass with distinctive pink feldspar phenocrysts and occasionally round quartz phenocrysts. Although it is possible that this material could be Thunderbird rhyolite that was transported into the area, the Franklin Mountains are a part of the Rio Grande Basin, so there is little geologic connection between the Franklin Mountains and the Pecos River Basin studied here. This material thus represents the only clearly allochthonous material observed in the study area.

Conclusions

The cobble and pebble fractions reflect the local bedrock geology or local geomorphic unit on which each of the sites and survey parcels observed is located. San Andres Group locations are solely chert and dolostone occurring in bedrock outcrops. Artesia Group locations on bedrock outcrops are dominated either by dolostone from the Queen, Seven Rivers or Yates Formations, or if located on a geomorphic surface, such as a terrace, include material from geologic units exposed upstream as well as local bedrock exposures. The Opalized Caliche Group locations include material eroded from exposed silicified horizons just below the caliche caprock of the Ogallala Formation. The Lower and Upper Pecos River Group locations are on old Quaternary surfaces that include a mixture of possible old terrace deposits and pediment gravels related to erosion of the Ogallala Formation and retreat of the Llano Estacado. The Isolated Sites Group reflects local geomorphic and bedrock units independent of the groups defined above. The presence of material possibly attributable to the Thunderbird rhyolite from the Franklin Mountains of Texas is the only potentially allocthonous material observed in the field. All other materials are either derived from local bedrock units or from gravels associated with Ogallala Formation and/or Pecos River deposition.

CHAPTER 4

Gravel Lithology

Bradley J. Vierra, Kate E. Zeigler, and Michael J. Dilley

Introduction

Southeastern New Mexico has a long and varied tectonic and depositional history. Therefore, a variety of rock types and sources were available to the prehistoric inhabitants of the region, including bedrock sources of limestone, dolostone, and chert, with gravel sources that contain quartzite, chert, limestone, dolostone, igneous rocks, and other rock types. During the Middle and Late Permian, much of southeastern New Mexico was covered by shallow marine waters, with lesser fluvial deposition. The Middle Permian San Andres Formation includes several chert-bearing horizons and the Upper Permian Artesia Group units include dolostone and some chert. After deposition of Permian rocks, nearly 20 million years of erosion followed before deposition began again in the Late Triassic with the Santa Rosa Formation and overlying mudstones and sandstones of the rest of the Upper Triassic Chinle Group. The record of Jurassic though Oligocene deposition was mostly eroded prior to the deposition of the Miocene–Pliocene Ogallala Formation, which filled in a deeply incised landscape and deposited a wide variety of materials from its source in the Rocky Mountains to the northwest and the Sacramento and Guadalupe Mountains to the west. Ogallala Formation conglomerates include quartzite, chert, limestone, dolostone, igneous rocks, and clastic sedimentary rocks. The overlying caliche caprock includes a zone of variably silicified "opalized caliche," which can be extremely well cemented. By the beginning of the Pleistocene, the modern Pecos River drainage was established after an ancestral stream eroded northward and captured the ancestral Brazos River near Portales. The Pecos River carries a gravel bed load that includes many different lithologies, including quartzite, chert, limestone, dolostone, and igneous rocks, reflecting the variety of bedrock sources that the Pecos River watershed drains.

This chapter presents the results of the analysis of cobbles that were systematically collected from multiple locations across the project area. These data will be used to identify the lithology of these gravel deposits and identify the potential sources of lithic raw materials. The sites and survey parcels examined for this study have been lumped into groups by the bedrock and/or geomorphic units on which they are located. Groups are designated as Upper Pecos River, Artesia, Lower Pecos River, Isolated Sites, San Andres, and Opalized Caliche. Lower and Upper Pecos River Group locations reflect not only different terraces of the river, but different input from major tributaries to the Pecos River along its course. Artesia Group locations are found on or near bedrock exposures of the Queen, Seven Rivers, and Yates Formations. These units include limestone, dolostone, and lesser amounts of chert. Isolated Sites are not linked to a particular geologic unit or geomorphic setting but reflect both isolated outcrops of the Ogallala Formation as well as gravel-lag deposits of an old, incised pediment or terrace surface. San Andres locations are found on bedrock exposures of the San Andres Formation, which includes lenses and nodules of chert. Opalized caliche occurs in a laterally variable zone a few meters below the caliche caprock at the top of the Ogallala Formation.

Methods

Studies of secondary gravel deposits have been conducted by several researchers in the study area and the nearby Rio Grande valley and Hueco Bolson (Church 2000; Mauldin et al. 1998:78; Shelley 1993; Vierra 1997a). The sampling strategies among these studies have varied greatly, ranging from 100-m-long and 2.5-m-wide transects to collect information on extensive surface gravels, to 1-by-1-m quadrats that included recording all nodules larger than 5 cm in diameter up to a total of 100 nodules on a gravel terrace. Shelley's (1993) approach involved recording all nodules larger than 5 cm in diameter within a 20-by-20-m quadrat up to a total of 200 nodules. A modified version of this approach was implemented for the current study. That is, a 1-by-1-m grid was initially set up and expanded to include a larger area until approximately 200 nodules greater than 5 cm in diameter were collected. This approach provided greater flexibility in dealing with varying gravel-nodule densities and provided for an accurate measure of nodule density per square meter. Gravel samples were taken from all the locations, with the exception of those where no gravel deposits were present. The latter included bedrock outcrops at locations in the San Andres Group (LA 144349, LA 161046, and the Meadow Hill Survey Area) and isolated locations with opalized caliche (Opalized Caliche Locality and LA 149992).

Nodules were collected and returned to the laboratory for detailed analysis. Data were recorded on material type, material subtype, material grain, shape, and dimensions. Material type refers to the general rock type (e.g., quartzite), and material subtype refers to a specific variety (e.g., purple quartzite). Material grain was recorded as fine (e.g., chalcedony), medium (e.g., chert), coarse (e.g., quartzite) or very coarse (e.g., sandstone). Shape was recorded as spheroid, angular, or tabular. Lastly, each nodule was measured for maximum length, width, and thickness (in mm). In addition, counts were taken of all nodules less than 5 cm in size that were collected in the sample, and the material composition for these pebbles was summarized.

In all, 1,281 cobbles were analyzed during the course of the analysis from six different locations. Two locations were selected from the Upper Pecos River Group (LA 146857 and LA 29500), two from the central Artesia Group (LA 130417 and LA 155867), and two from the Lower Pecos River/Isolated Sites Groups (LA 43423 and LA 122842), the latter grouped together here because of their spatial proximity. The results appear to provide a representative sample of the gravel lithology in the study area.

Gravel Lithology

Table 1 presents the summary information on material type, subtype, and material grain for the total sample. Limestone made up about half (55.7 percent) of the sample, with chert (21.3 percent), quartzite (17.2), and other materials. The latter included igneous rocks, caliche, sandstone, and chalcedony. The generalized cherts ranged from tans to grays in color, including pale brown, light brownish gray, pale yellowish brown, dark yellowish brown, light bluish gray, medium dark gray, dark gray, and pale red. The generalized quartzites were pale brown, light brownish gray, yellowish brown, pale yellowish brown, medium dark gray, and pale red in color. Small numbers of a visually distinctive subtype were identified consisting of San Andres chert, fossiliferous chert, purple quartzite, and a mustard quartzite. The San Andres chert often contained a distinctive gray banding with a brownish gray, medium gray, and medium-dark gray color. The fossiliferous chert contained large fusulinid fossils about the size of a grain of rice and graded from a brownish gray to light brownish gray to light gray in color. The purple quartzite ranged from a grayish purple to a grayish red purple to a very dusky purple, and the mustard quartzite ranged from a dusky yellow to a moderate yellowish brown,

Material grain generally corresponds with the specific rock type, including medium-grain chert, and coarse-grain limestone, quartzite, and igneous rocks; however, there was some medium-grain limestone,

Table 1. Material Type, Material Subtype, and Grain for Total Sample

Material Type	Material Subtype	Material Quality	Total
Andesite		coarse	15
Caliche		coarse	24
Chalcedony		fine	2
Chert		coarse	19
Chert		medium	252
Chert	fossiliferous	medium	2
Limestone		coarse	685
Limestone		medium	29
Quartz		coarse	1
Quartzite		coarse	164
Quartzite	mustard	coarse	3
Quartzite	purple	coarse	49
Quartzite (ortho)		coarse	3
Rhyolite		coarse	22
Rhyolite		medium	3
Sandstone		very coarse	8
Total			1,281

which was also identified. This material appeared to grade from a limestone into a dolostone. Most of the medium-grain dolostone was identified in gravels located within the Artesia Group. This is generally more knappable than the typical limestone.

The information on cobble shape is provided in Table 2. The majority of the limestone was angular shaped with some tabular shaped and a few spheroids. This is not surprising given the proximity of limestone-bedrock outcrops to the sample locations. By contrast, most of the chert and quartzite cobbles were spheroids, which would seem to indicate that they were transported from distant sources. Some of the tabular and angular pieces of chert were presumably derived from local sources. Lastly, igneous rocks tended to be angular shaped, also indicating that they were probably derived from local sources.

Sample sizes varied among the different rock types, so the metrical information is best for limestone, chert, and quartzite (Table 3). Limestone cobbles tended to be the largest in size with a mean weight of 270 gm. Chert and quartzite cobbles were somewhat smaller in size with mean weights of 223 and 225 gm, respectively. Overall, only 121 pebbles less than 5 cm in diameter were collected and recorded during the analysis. No quantitative data were recorded on specific material types for this pebble sample; however, subjective notes indicate that most of these consisted of limestone, with the exception of quartzite at two sample locales (LA 29500 and LA 146857).

A comparison of the six sample locations indicates some important similarities and differences (Table 4). The Upper Pecos River Group was dominated by quartzite (47 percent), with less chert and limestone. These deposits are derived from the Pecos River gravels and the Ogallala Formation (Figure 14). Some of the cobbles collected from LA 29500 exhibited a heavy coating of caliche indicating that they had previously been buried. By contrast, the Artesia Group was almost solely limestone, with a single chert cobble recorded. These deposits are sitting on, or near, outcrops of the Queen Formation, which is predominately dolostone (Figure 15). However, dolostone would have been classified as limestone in our study. The Lower Pecos River/Isolated Sites Groups contrasted markedly between the two sample locations.

Table 2. Cobble Shape

Material Type	Shape	Total
Andesite	angular	13
	spheroid	2
Caliche	angular	23
	tabular	1
Chalcedony	spheroid	2
Chert	angular	40
	tabular	11
	spheroid	222
Limestone	angular	514
	tabular	160
	spheroid	40
Quartz	spheroid	1
Quartzite	angular	30
	tabular	16
	spheroid	170
Quartzite (ortho)	spheroid	3
Rhyolite	angular	15
	tabular	2
	spheroid	8
Sandstone	angular	3
	tabular	2
	spheroid	3
Total		1,281

LA 122842 primarily contained limestone (86 percent), due to the fact that it is located near outcrops of the Ogallala Formation that contains numerous limestone cobbles (Figure 16); whereas, LA 43423 contained mostly chert (56 percent) and is situated on a gravel-lag surface that may be a pediment or a very old terrace (Figure 17). Chert and other siliceous materials observed in old pediment or terrace surfaces such as this one may be coming from Paleozoic limestones in the northern headwaters of the Pecos River or may have eroded out of the Ogallala Formation as the Llano Estacado retreated to the east.

The density of cobbles appears to vary greatly across the project area. The densest gravels were situated in the Lower Pecos River/Isolated Sites Groups. LA 43423 contained 175 and LA 122842 contained 189 cobbles per square meter. This contrasted markedly from the other two sample areas. The Upper Pecos River samples varied from 52 at LA 29500 to 98 cobbles per square meter at LA 146857, and the Artesia Group ranged from 28 at LA 155867 to 98 cobbles per square meter at LA 130417.

Regional Gravel Lithology

Systematic studies of Ogallala gravel deposits have been conducted by Hurst et al. (2010) and Backhouse et al. (2009) along the eastern Llano Estacado in West Texas. These studies therefore provide a comparative baseline with the data collected during the current project. Figure 18 illustrates the relative contributions of limestone, chert, quartzite, and other materials for the Upper Pecos River, Artesia, and Lower Pecos

Table 3. Cobble Measurements

Material Type	Inventory Count	Average Maximum Length	Standard Deviation from Maximum Length	Average Maximum Width	Standard Deviation from Maximum Width	Average Maximum Thickness	Standard Deviation from Maximum Thickness	Average Inventory Weight	Standard Deviation from Inventory Weight
Andesite	15	95.33	24.36	73.87	22.47	42.80	19.06	462.93	413.13
Caliche	24	68.54	16.57	75.54	103.17	38.21	14.79	190.79	234.82
Chalcedony	2	55.50	6.36	40.00	9.90	29.50	6.36	89.00	45.25
Chert	273	76.08	21.44	54.70	16.44	34.44	13.29	223.22	215.19
Limestone	714	83.30	26.16	58.10	17.80	33.83	14.09	270.35	327.50
Quartz	1	52.00		46.00		27.00		98.00	
Quartzite	216	74.77	20.97	55.34	14.45	34.18	11.28	225.34	202.85
Quartzite (ortho)	3	60.00	6.56	50.67	3.21	31.33	9.07	131.33	51.03
Rhyolite	25	87.04	30.09	60.00	18.73	39.52	12.69	319.32	307.87
Sandstone	8	89.50	50.19	71.38	26.70	39.25	21.14	445.25	569.21
Total	1,281								

Table 4. Cobble Lithic-Material Types, by Group and Site

Site	Material Type	Total
	Artesia Group	
LA 130417	limestone	195
LA 155867	chert	11
	limestone	185
	Lower Pecos River/Isolated Sites Groups	
LA 122842	caliche	3
	chert	6
	limestone	164
	quartzite	14
	sandstone	2
LA 43423	andesite	1
	caliche	10
	chert	197
	limestone	99
	quartz	1
	quartzite	37
	rhyolite	5
	Upper Pecos River Group	
LA 146857	andesite	14
	caliche	1
	chalcedony	1
	chert	27
	limestone	47
	quartzite	86
	quartzite (ortho)	1
	rhyolite	15
	sandstone	4
LA 29500	caliche	10
	chalcedony	1
	chert	32
	limestone	24
	quartzite	79
	quartzite (ortho)	2
	rhyolite	5
	sandstone	2

Figure 14. Surface gravels at LA 29500.

Figure 15. Dolostone at LA 130417.

Figure 16. Limestone cobbles in outcrop at LA 122842.

Figure 17. Surface gravels at LA 43423.

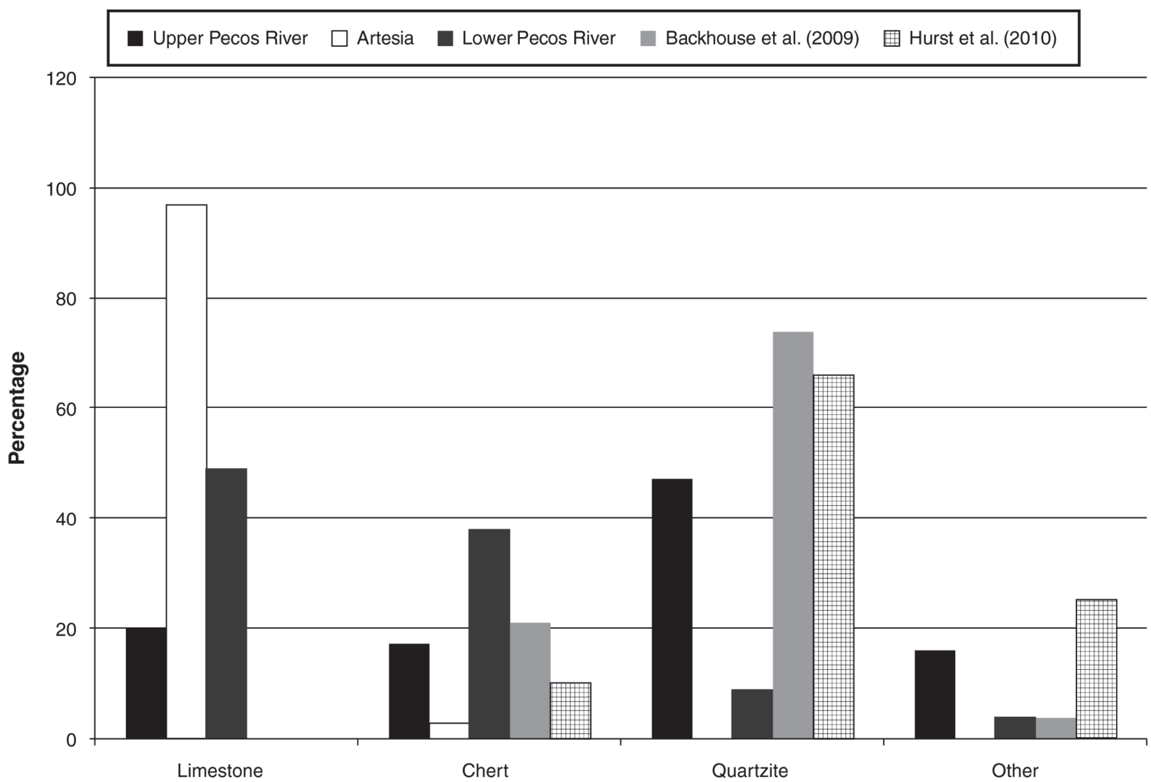

Figure 18. Lithic-material types by group and study.

River/Isolated Sites Groups. As can be seen, the West Texas samples were primarily composed of quartzite with some cherts and other materials. The quartzites were segregated into the Potter Member, purple and other varieties by Hurst et al. (2010:104). In addition, they noted the presence of silcrete at one locality, with minor amounts of chalcedony, silicified wood, basalt, and siltstone.

The "Macy silcrete" described by Hurst et al. (2010) is most likely equivalent to the "opalized caliche" observed in this study. A lack of description of color, texture, and depth below the caliche caprock surface limits our ability to be certain this is the same material, but the occurrence of "linear ledges along the upper portion of the Ogallala Formation" (Hurst et al. 2010:104) suggests that the Macy silcrete is a similar zone of silicified Ogallala. The Potter Member quartzite is a "chert-silicified siltstone" that ranges in color from blue-green to gray or tan and varies in the degree of silicification observed (Hurst et al. 2010). Because of lithologic similarities, Backhouse et al. (2009) have hypothesized that Potter Member quartzites may be reworked cobbles weathered out of Jurassic Morrison Formation outcrops in eastern New Mexico and carried and redeposited in West Texas as part of the Ogallala Formation.

Certainly the total absence of limestone cobbles in the Ogallala gravels from West Texas stands in marked contrast to the current project's sample. However, this relates in a large part to the exposures of limestone in the project area. Otherwise, the Upper Pecos River sample was most similar to the Ogallala gravels. This is not surprising given that these locations include gravels derived from the Pecos River and the Ogallala Formation, which have eroded down from the nearby escarpment of the Llano Estacado. The Upper Pecos River sample primarily consisted of quartzite, with some chert like the West Texas samples; however, they also contained some limestone and igneous rocks. Purple quartzite made up a slightly larger proportion of the current sample from the Upper Pecos River (24 percent) vs. the West Texas quartzite (19 percent) from the Hurst et al. (2010) study.

Bedrock Outcrops

Sites and survey parcels on or near the San Andres Formation are located on surfaces developed on the Bonney Canyon Member, the middle unit of the formation. The Bonney Canyon Member is primarily a tan dolostone or variably dolomitized limestone that includes lenses and nodules of chert (Figure 19). Locally, the chert-bearing horizons are found between 12.2 and 18.3 m (40 and 60 feet) above the basal contact with the underlying Rio Bonito Member. An isolated piece of bedded chert recorded in the field was 1.50 m (ca. 5 feet) long and about 15 cm (ca. 6 inches) in width and thickness. The chert was either a distinctive striped material, the "fingerprint" chert, or appeared in a variety of other colors, including pale gray, grayish brown, and a mottled white and yellow with a brownish orange cortex (e.g., Meadow Hill Survey Area). The Bonney Canyon Member grades laterally to the south into the Cherry Canyon Sandstone (Hayes 1964; Kelley 1971). Chert nodules that weather out of the Cherry Canyon Sandstone often include a type of fossiliferous chert with distinctive, very large fusulinids (Hayes 1964). A distinctive pale blue-gray chert with a reddish orange cortex occurs as elongate, thin stringers and small nodules in a dolostone bed near the top of the Yates Formation as observed at the Adobe Draw Survey Area.

Zones of laterally discontinuous opalization occur 6–10 m (ca. 10–33 feet) below the caliche caprock of the Ogallala Formation. The degree of opal development is highly variable. At LA 149992, silicification of the Ogallala Formation sandstones below the caprock has not progressed to development of opal, but it has caused growth of chalcedony in vugs within the rock (Figure 20). At the Opalized Caliche Locality, small nodules and lenses of opal are present throughout an interval that is 1 m (approximately 3 feet) thick.

The presence of opal below the caprock is related to the development of the caprock itself. Holliday and Welty (1981:209) distinguished silicified caliche from opalized caliche, which is present in the caprock of West Texas. They also noted that the former grades into the latter depending on the degree of silicification that has occurred, with both being used for the production of stone tools. This material is quite variable at both the Opalized Caliche Locality and at LA 43423. It ranges from a mottled grayish orange-pink and white, to a grayish orange-pink matrix. Although some of the mottled pieces appeared to be more opalized, the latter seemed more similar to a silicified sandstone (also see McCoy 2011).

Figure 19. Chert in San Andres Formation limestone at LA 144349.

Figure 20. Opalized-caliche outcrop at LA 14992.

CHAPTER 5

Lithic-Quarry Studies

Bradley J. Vierra

Introduction

The by-products of stone-tool manufacturing are some of the most ubiquitous remains in the archaeological record. Stone was the primary source of raw material until the arrival of the Spanish into the American Southwest during the sixteenth and seventeenth centuries. Chipped stone, ground stone and architectural building stones were all obtained from bedrock outcrops or secondary gravel sources. However, specific material types were necessary to meet the functional requirements of the various tool types. Therefore, the prehistoric inhabitants of the region had to solve the problem of obtaining stone (or lithic) raw materials that were differentially distributed across the landscape. The result was a complex process involving the acquisition of raw materials, tool production, tool use, and the subsequent discard of expended tools. Stone tools, therefore, offer a direct link to understanding how people coped with the uncertainties of living in the arid Southwest.

How people procured stone raw materials and whether they obtained them from local or nonlocal sources are important for understanding the organization of past economic and land-use strategies. Two important concepts need to be defined: procurement strategy and procurement tactic. *Procurement strategy* refers to the specific material types selected for tool production. This information is readily available in the varying proportions of worked-material types in the archaeological record. *Procurement tactic*, on the other hand, refers to the specific methods used to procure them (Vierra 1993:141). Raw materials can be obtained in three ways. An *embedded* tactic involves the collection of raw material incidentally to subsistence-related movements (Binford 1977, 1983; Binford and Stone 1985). A *direct* tactic involves making a trip to the source location for the sole purpose of collecting raw materials (Binford 1977; Gould and Saggers 1985; Renfrew 1975:41). A distinction is made here between embedded and direct tactics, although these have often been subsumed under direct procurement tactics (see Ericson 1984:6; McAnany 1988; Meltzer 1989). An *indirect* tactic involves obtaining items from an intermediary, usually in some form of trade or exchange relationship (Earle and Ericson 1977; Ericson and Earle 1982; Renfrew 1975, 1977; Santley et al. 1986).

It has generally been argued that hunter-gatherer groups in the Southwest procured lithic raw materials using an embedded procurement tactic (Shackley 1990:63, 1995; Vierra 1985, 1990, 1993), replacing tools with locally available materials during their annual rounds. The distribution of these materials may provide information about the procurement range or annual range traversed by hunter-gatherer groups. In contrast, agriculturalists in the Southwest could have obtained lithic raw materials using embedded, direct, or indirect procurement tactics (Brown 1990; Cameron 1984, 2001; Findlow and Bolognese 1980, 1982a, 1982b; Harry 1989; Parry 1987; Vierra 1993, 1997a, 1997b; Walsh 1997, 1998; Young and Harry 1989). A direct procurement tactic involved the bulk acquisition of raw materials that were stored for future use, possibly including nodules, prepared cores, or formal tools made of raw materials that were not locally available.

Stone-Tool Technology

Stone-tool design is often characterized as a dichotomy between core reduction and bifacial-tool production. Most rock types can be used for the production of simple flake tools because the sharp edge is used for a relatively short period and then discarded. However, higher-quality materials that are easily worked by both percussion- and pressure-flaking techniques are required for the production of bifacial tools that are maintained over longer periods of time. Core-reduction activities tend to be associated with the use of low-quality materials (e.g., quartzite) available within the vicinity of the habitation site. In contrast, the production of bifacial tools is associated with the use of fine-grained materials, such as chert and obsidian, which are found in restricted locations across the landscape and can be recovered in the archaeological record as nonlocal rock types. Nonetheless, stone-tool technologies include a mix of both core reduction and bifacial-tool production as a means of coping with the uncertainties of food procurement and processing (Andrefsky 1994; Bamforth 1986; Goodyear 1979; Johnson and Morrow 1987; Kelly 1988; Nelson 1991; Odell 1996; Parry and Kelly 1987; Sullivan and Rozen 1985; Vierra 1990, 1993).

The term *reduction trajectory* refers to the "stagelike sequence of stone-tool manufacture beginning with the initial core selection and preparation, through the end point of final tool completion" (Chapman 1982:237). For example, Vierra (2005, 2010) identified the specific reduction tactics used at the Late Archaic period site of Cerro Juanaqueña. Tactic No. 1 involved the removal of flakes from cortical platforms along a single face of a cobble. Tactic No. 2 involved the removal of flakes from platform cores that were produced by initially splitting the cobble roughly in half. Tactic No. 3 also involved the removal of flakes from platform cores, but the end of the cobble was removed and used as a platform. Lastly, Tactic No. 4 involved the use of large flakes as cores (Vierra 2010). Tactics Nos. 1–3 involved the use of secondary cobble materials, whereas, Tactic No. 4 involved the use of bedrock materials. In addition, more-general reduction techniques have also been identified, including cobble uniface flake, platform-core flake tool, or bifacial-core tool.

This reduction process can occur at different locations across the landscape, including at quarry and residential sites (Andrews et al. 2004; Beck 2008; Beck et al. 2002; Burke 2007; Doelman et al. 2001; Gramly 1980; Lepper et al. 2001). Vierra (2005) provides a comparative regional baseline study that identified three general lithic-assemblage groups: (1) quarry and pueblo habitation sites with an emphasis on core reduction, (2) pit house and Late Archaic period habitation sites with a mix of core reduction and biface production/maintenance, and (3) Late Archaic period campsites with an increased emphasis on biface production/maintenance.

Prehistoric Quarries

Holmes 1974 represents one of the seminal studies of prehistoric quarries in North America. This early review identified potential quarrying implements and the various by-products of stone-tool production that remained at these locales. The latter included a variety of cores and large unfinished (or roughed out) bifaces. He stated that "breakage took place at every stage of the shaping work, and the refuse shows plainly. . . that the only form sought. . . in the quarry shops was the thin leaf-blade form best suited for the manufacture of ordinary chipped implements" (Holmes 1974:165). The implication of this study was that quarry sites were the locations where the initial "rough outs" were made and then transported back to the residential site. So, artifact studies that focused on a residential locale in fact represented only a fraction of the tool production process.

Understanding the reduction process at quarries has been a central theme in lithic studies. Ericson and Purdy's (1984) volume provides an excellent example of studies concerned with understanding the complexities of quarries. These studies range from simple procurement sites to large mines where prepared cores were produced for later exchange. Nonetheless, in all these cases, the researchers encountered the by-products of the reduction process and were able to reconstruct the general sequences represented. Indeed, it was sometimes possible to refit items, indicating that a large amount of debris might be produced simply to create a single desired item. But the intensity of production depended on how much material was ultimately being transported back to the residential site. In a way, these procurement strategies varied with respect to social complexity. For example, an embedded tactic would have been efficient for foraging groups; an open direct-procurement tactic could have been used by people residing in villages near a quarry, where anyone had access (e.g., for local production); and a closed direct-procurement tactic could have been used by a single group in situations involving territoriality and controlled access to a quarry (e.g., for large-scale exchange).

Certainly, foraging and agricultural societies form the basis of research in the American Southwest and nearby regions. Several recent studies in the Great Basin have provided some insightful results and central-place foraging models were used to derive expectations of quarry assemblage composition. That is, one would expect less time and energy were invested in the production of tools at quarries located near residential locations where the transports costs were low. By contrast, one would expect more time and energy invested in the production of tools at quarries located at a greater distance from the residential site, where transport costs were high. Therefore, the former situation would be characterized by an emphasis on the early stages of reduction, fewer debitage types, and less formal tools; whereas, the latter situation would be characterized by an increased emphasis on the later stages of reduction, more debitage types, and more formal tools (Beck 2008; Beck et al. 2002).

Other studies have focused on the archaeological implications of embedded and direct procurement tactics; however, Bamforth's (2006) recent study runs counter to the previous discussion. That is, Bamforth has suggested that quartzite was mined by foraging groups in the Colorado Rockies. This material is not found at great distances from the quarry, and he argues that these foraging groups indeed may have procured this material using an embedded tactic, but one that involved the extraction of this material from pits. Yet, he also identified the prevalence of late-stage bifaces at the site indicating that the "knappers appear to have carried biface reduction through to completion much more often suggesting that they were producing tools for immediate, rather than future use" (Bamforth 2006:524). Although this fits the concept of an embedded procurement tactic, the emphasis on late-stage bifaces implies a greater investment and therefore an attempt to reduce transport costs while moving over greater distances. The data in this case may not support the previous argument made by Beck et al. (2002) and Beck (2008), although no detailed comparison of quarry and residential sites has been conducted.

Lepper et al. (2001) suggested that large number of Archaic period points made out of nonlocal cherts represent the use of an embedded procurement tactic at a chert quarry site. That is, exhausted tools were discarded and replaced with new items made of local chert. By contrast, a direct procurement tactic was employed by later Hopewell groups because no projectile points dating to this period were identified at the quarry. Rather, these groups dug quarry pits and produced large quantities of cores and biface preforms for transport back to their residential sites.

Some researchers have suggested that raw-material size and shape can have an important effect on the particular reduction tactics carried out at quarries (Andrefsky 1994; Shelley 1993). For example, a bipolar-reduction technique is often associated with the reduction of small nodules when simple flakes are required (Andrefsky 1994); however, as Carmichael (1986:189–190) has shown, small obsidian pebbles can also be reduced using a split-pebble (platform-core) technique. In addition, arrow points could be made from these small obsidian pebbles but not dart points. Shelley (1993) also noted that raw materials consisting of large quartzite cobbles would have been suitable for the production of large flake blanks and reduction using a split-cobble or cobble uniface-reduction technique. On the other hand, disk-shaped materials made of chalcedony would have been selected for the production of bifaces because of the quality of the material and the overall shape, which resembled a biface. Another example of how shape and size affected reduction is that thin tabular pieces of raw material are more easily worked using a bifacial-core technique, with flakes being removed from opposite faces (Hurst et al. 2010; Vierra 1993). Nonetheless, although raw-material size and shape can constrain the potential reduction techniques, they do not in themselves predict the required finish product (e.g., a flake or biface). Rather, the specific tool needed is conditioned by the foods being procured and the techniques being used to procure them. Stated another way, the presence or absence of small obsidian pebbles did not affect decisions on using spear and atlatl or bow and arrow, rather the small size of these pebbles limited them for use in arrow production.

Permian Basin

In contrast to other areas of the Southwest, the Permian Basin is generally perceived of as a region with poor lithic resources. This contrasts markedly with the nearby Sacramento Mountains where bedrock outcrops of the San Andres Formation contain abundant nodules and lenses of chert. Nonetheless, both the San Andres and Yeso Formations contain distinctive cherts that extend down into the Sacramento section of the study area, which drains down into the nearby Pecos River valley. That is, chert materials would have been available from both primary bedrock and secondary gravel sources. The perception of a resource-poor region probably derives from the Mescalero plain and Llano Estacado where secondary gravel deposits containing lithic source materials are thought to be limited in distribution; however, the Dockum Group does contain chert and the Ogallala Formation contains quartzite and an opalized (silicified) caliche or sandstone (Banks 1990; Church et al. 1996; Holliday 1997:247–250; Holliday and Welty 1981; Hurst et al. 2010). Is this an accurate representation of the lithic landscape and how does the differential availability of raw materials in bedrock and gravel sources affect prehistoric procurement strategies and tactics?

Several researchers have attempted to address these questions with respect to the eastern Llano Estacado of West Texas. Holliday and Welty (1981) represent an initial attempt to characterize the regional geology and identify potential source formations for lithic raw materials suitable for stone-tool production (also see Banks 1990:91–96). Lithic materials derived from several of these formations appear to have been used by prehistoric groups. Alibates chert (also referred to as flint or agate) is derived from the Quartermaster Formation. Tecovas chert (or jasper) and quartzite are available from the Tecovas Formation of the Dockum Group. Light-to-dark gray chert can be found in exposed sections of the Edwards Formation. However, the Ogallala Formation contains “the most abundant and varied material for making lithic tools” (Holliday and Welty 1981:208), including a variety of quartzites and cherts. Lastly, an opalized caliche is also occasionally present in the caprock caliche.

The study by Backhouse et al. (2009) focused on the Ogallala Formation gravels. Their intensive study of the formation lithology indicated that quartzites were the dominant knappable material present, with very little chert. Not surprisingly, quartzites also dominated the archaeological assemblages at the research sites, although there was relatively more chert represented. Overall, the lithic assemblage was dominated by debitage (48 percent) and cores (36 percent), with some informal flake tools. Relatively few examples of formal retouched tools were identified, including bifaces (and projectile points) and unifaces; however, chert was preferentially selected for the production of the retouched tools. The authors suggested that these latter items were brought to the sites and discarded at these locations. Refitting indicates that the by-products of the reduction process were often left in place, typically no more than about 2 m (ca. 6 feet) apart. The researchers suggested that “the initial knapping and testing of cobbles has occurred in a largely ad hoc manner as different rocks were encountered within the gravels by the prospective knapper(s)” (Backhouse et al. 2009:270). This also included the use of a bipolar-reduction technique. The sites appeared to represent palimpsests, with projectile points indicating occupations dating from Late Archaic to Protohistoric times; however, they also suggested that these sites should not only be viewed as simple procurement sites, because evidence of hearths and domestic activities have been identified in and near these locations (Backhouse and Johnson 2007). Nonetheless, the implication of their study would be that these sites were periodically visited by hunter-gatherers using an embedded procurement tactic.

This avenue of research was continued by Hurst et al. (2010). They noted that quartzite, silcrete, and chert were the most frequent in their samples, with a little basalt, chalcedony, silicified wood, and siltstone. Basalt, chalcedony, chert, and quartzite (Potter Member) were selected for lithic reduction activities in similar proportions to the gravels. The archaeological assemblages were dominated by debitage (72 percent), cores (21 percent), and fewer hammerstones, unifaces, bifaces, and projectile points. The prevalence of debitage in this study is presumably because of the use of in-field analysis vs. the systematic collection and later laboratory analysis by the two other projects. The majority of the flakes exhibited cortex indicating that the initial stages of core reduction were emphasized at these locales. By contrast, few retouched tools were identified; most of these were unifaces. Tested and multidirectional cores were the prevalent reduction technique, with limited evidence of informal or formal tools. Therefore, the researchers suggested that cores and flakes were transported to another locality for further reduction and tool production. Contrary to the previous study, formal tools were primarily made of local quartzite, with very few of chert. Therefore, these tools were primarily manufactured at the site and not brought to this location and subsequently discarded as exhausted items. Sites dating from the Late Archaic period to the late prehistoric period have been identified in the area, which attests to the long-term use of these gravels. Again, the implication of the study by Hurst et al. (2010) is that hunter-gatherers used an embedded procurement tactic; however, they suggested that the use of informal core-reduction techniques was related to the abundance of raw materials, which negated the need to conserve raw materials.

The disparate distribution of lithic raw materials across the landscape was always a problem that hunter-gatherers needed to resolve. As previously noted, one tactic was simply to coordinate raw-material procurement with subsistence-related activities. Another tactic was to cache raw material or worked items in anticipation of returning to a lithic resource–poor area at some future time (e.g., Bamforth 2009; Bamforth and Woodman 2004; Kelly 1988). Wiseman et al. (1994) reported on the collection of eight bifacial cores as part of a cache found in southeastern New Mexico. Six of the artifacts were identified as made of Edwards Formation chert, one was of Long Arroyo (San Andres Formation) chert, and one was made of Rock House Canyon chert, derived from sources situated up to 200 km from the site location. Their review of the literature indicated that caches in the area of the Llano Estacado primarily consisted of large bifaces (or cores) and formal tools made of high-quality lithic materials. The former were assumed to date to the Paleoindian and/or Late Archaic periods; whereas, the latter included projectile points, scrapers, preforms, and sometimes ground stone artifacts, which primarily date to the late prehistoric period.

CHAPTER 6

Methods

Christine G. Ward and Scott H. Kremkau

The study area contained a total of 19 locations: 14 previously recorded sites, 2 archaeological survey areas, and 3 locales visited solely for geologic study. All 19 locations were visited as part of the geologic study, as described in Chapters 2 and 3. Subsequently, 14 sites and 2 survey areas were revisited by SRI archaeologists and surveyed, and all cultural resources at the 14 sites and 2 survey areas were documented. This chapter outlines the methods used during recording and evaluation. The results of this fieldwork are presented in Chapter 7.

Archaeological Survey Methods

Following the geologic field study (see Chapters 2 and 3), a second phase of in-field recording was carried out at 14 sites and 2 survey areas. This fieldwork involved describing surface-artifact and feature distributions at each location. The survey method entailed overlaying a virtual 15-by-15-m grid tied to the World Geodetic System 1984 Universal Transverse Mercator (UTM) grid system over the entire area of each site and survey parcel. Artifacts identified during the survey were counted, analyzed, and recorded in cells of the 15-by-15-m grid, allowing all archaeological manifestations identified to be spatially located at a resolution of 15 m.

Prior to the start of fieldwork, SRI staff generated a 15-by-15-m grid unit for each site and survey parcel in the study area. The grid's origin point was the nearest UTM 000E/000N point to the southwestern corner of the project area [redacted] The grid covered the entire area within the boundary of each site or survey parcel in the study area, plus a buffer around each boundary.

SRI surveyed each site and survey parcel in the study area with a field crew of 3 or 4 people, each equipped with a Trimble Geo XT or Juno Global Positioning System (GPS) unit loaded with the boundaries and the 15-by-15-m grid. Crew members walked across each site and survey parcel in linear transects spaced at 15-m intervals. Survey was conducted using either north–south or east–west transects, depending on the layout and topography. While surveying, the crew observed the ground surface for visible manifestations of cultural activity, arroyo banks, and two-track roads; when encountered, other areas of recent natural or cultural disturbance were also examined for evidence of features or cultural materials.

Data Collection

The survey methods used in this project required the creation of a custom program by SRI's geographic information systems (GIS) and data specialists. This application was used for collecting digital data each time a grid unit that contained a cultural resource was encountered. There are two primary aspects to this data-collection method: the provenience designation system and the Field Information Digital Organizer system.

A provenience designation system developed by SRI to integrate all aspects of field recording was used to organize field data into one numerical sequence. A series of numbers was used to assign provenience designations to each positive cell, collected artifact, and feature and to several types of site-specific units, such as shovel tests and photograph points. Each Trimble GPS unit (the GeoXT or GeoXH and each Juno unit) used during the survey and recording was assigned a separate set of 1,000 provenience designation numbers; because each set of numbers was not necessarily completely used during the course of fieldwork, there were gaps in the final numbering system. An advantage of the provenience designation system is that it does not require parallel sets of numbers or documents for categories of activities and items, and one outcome of the system is that numbers do not run sequentially by category. For example, features within a single site may have a wide range of provenience designation numbers, because they could have been recorded at separate times during the survey or by crew members carrying different GPS instruments.

The digital data-collection system was developed with the intent of integrating SRI's provenience designation system and the recording system. Each data record's provenience designation number (as assigned when a positive survey unit was first identified) was used to digitally link spatial data (e.g., location) to tabular data (e.g., attribute). Each positive cell's geographic location and artifact and feature attributes were digitally collected. The positive cell's location, topographic setting, visibility, and intactness were first recorded, and then, artifacts and features located within the cell were recorded according to the schema discussed briefly below. In addition to general recording at the level of the individual grid cell, locations of features, trowel tests, shovel tests, and collected artifacts were point-provenienced with the mapping-grade GPS unit.

Artifact Recording and Analyses

The attributes recorded for lithic artifacts within each grid cell included material type, artifact type, and presence/absence of cortex. These data were used to define the specific reduction sequences (trajectories) by material type represented for each site and survey parcel. For example, the presence of tested nodules, cobble unifaces, and core flakes exhibiting cortex represents the initial stages of reduction, whereas the presence of platform cores and core flakes with little or no cortex represents core preparation and reduction.

Although the presence of angular debris is an indication of core-reduction activities, it is often difficult to distinguish cultural from natural breakage at quarry sites. Therefore, in-field analysts often use a more-restricted definition for debitage that can bias the sample toward flakes. The intensity of core-reduction activities can be gauged in regard to the presence of single, bidirectional, and multidirectional cores.

Lastly, tool-production activities can be identified by the presence of biface flakes and tool preforms. Evidence for the replacement of exhausted tools (e.g., tool production and discarded tools), gearing-up activities (e.g., production of blanks for transport), bulk acquisition of raw materials (e.g., production of prepared cores for transport), and caching activities (e.g., blanks or finished tools) was also evaluated. The identification of specific debitage types (e.g., core, biface, and uniface flakes) provides for a more-detailed and accurate method of lithic-artifact analysis than the indirect method proposed by Sullivan and Rozen (1985). Detailed lithic-artifact definitions are provided in Appendix C.

Feature Recording and Analyses

All identified features were measured, trowel tested, fully documented, photographed, and individually point-plotted with the Trimble GeoXT unit during the survey phase of the project. Attribute information, such as the quantity, sizes, and shapes of elements or materials that constituted a feature, was recorded where appropriate. In addition, artifacts were recorded with features if they were determined to be associated, including ground stone fragments that had been recycled through use as thermal elements, even though for the purposes of site-definition criteria, they were first considered not as artifacts but as fire-cracked rock (FCR).

Test Excavations

In total, 45 test pits were excavated at the 14 sites and 2 survey areas in the study area. The number of test pits excavated at each site varied by location size, and between 1 and 8 test pits were excavated at each location. All 45 test pits were placed within previously recorded boundaries, in areas where artifacts were visible on the surface. The purpose of the test pits was to determine whether subsurface deposits were present. When possible, units were excavated to 20 cm below the last artifacts found. However, in most cases, sites were located on top of limestone bedrock or layers of caliche or gypsum, and there was no subsurface potential; so, many test pits were less than 5 cm deep. All excavated soils were screened through $^{1}/_{8}$-inch shaker screens. Artifacts were collected in paper bags labeled with appropriate unit and level information. When possible, artifacts found in situ during excavation were point-located and drawn on field maps.

At the completion of each test pit, crew members filled out appropriate forms documenting soil type and color, any cultural materials that were recovered, and other relevant information. All test pits were backfilled upon completion.

Photographs and Photograph Points

Overview photographs were taken at each site and survey parcel. Features and, on occasion, specific artifacts were also photographed. For sites, photograph points were documented in the GIS application and point-located using the Trimble GeoXT or GeoXH unit. For features, documentation of photograph points was not deemed necessary, because the features themselves were individually point-located.

Postfield Analyses

All laboratory analyses and recording of artifacts and materials collected mirrored the in-field recording, with the addition of a series of new, detailed attributes. All of the field and laboratory observations collected were entered into SRI's relational database, which provided relational links among the spatial, feature-level, and material-culture data collected during the project.

The lithic analysis focused on technological attributes and raw-material procurement as means of identifying specific reduction sequences and location function. Information about material selection, lithic reduction, and tool use was collected, and attempts were made to distinguish local from nonlocal materials. The lithic-reduction study provided information about core-reduction techniques and stages of reduction and evidence of tool production and maintenance. The tool-use analysis provided information on tool function, including the presence/absence of use wear and the variation exhibited by ground stone tools.

Specific recorded attributes for all artifacts included artifact type, material type, material grain, condition, and measurements. Platform type, number of platforms, cortex type, percentage cortex, and damaged loci were recorded for cores. Platform type, platform preparation, cortex type, cortex placement, and presence/absence of edge damage were recorded for debitage. Number of separate retouched edges, edge outline, edge angle, presence/absence of edge damage, biface shape, and hafting type were recorded for retouched tools. Lastly, number of use faces, cross section, surface shape, and surface modification were recorded for ground stone tools.

The one piece of obsidian collected was submitted for X-ray-fluorescence (XRF) analysis to Steven M. Shackley at the Archaeological XRF Laboratory in Albuquerque.

Updated Laboratory of Anthropology site forms were completed, and all collected archaeological materials will be curated at the Museum of Indian Arts and Culture/Laboratory of Anthropology in Santa Fe.

CHAPTER 7

Cultural Resource Descriptions

Scott H. Kremkau

Sites and survey parcels in four different geologic regions were visited for the current study: the San Andres Group, the Upper Pecos River Group, the Artesia Group, and the Lower Pecos River Group. Additionally, two sites were located in isolated geologic contexts. The order of presentation of the groups here is somewhat different from the order in the geologic chapters of this report. That is, the groups were organized in the geologic chapters by geologic time period, whereas the groups in this chapter are organized spatially, roughly from north to south. In addition, in this discussion, LA 149992 is included with LA 169668 in the Isolated Sites group, because it contained so few artifacts, and LA 122842 is included with LA 43423 in the Lower Pecos River Group because of the spatial proximity of the two sites.

The sites and survey parcels in the study area can be divided into three basic types: quarries, procurement locales, and campsites. The first two constitute the majority of the types in the study. Only one campsite, LA 155867, was surveyed as part of the current study. Quarries and procurement locales are distinguished based on their geologic contexts. Quarries are areas in which lithic resources were acquired from their primary geologic contexts, and procurement locales are places where tool-stone materials were transported from the original primary geologic contexts and deposited some distance away, such as on alluvial fans or in gravel deposits. The formation processes behind these types result in very different raw-material assemblages, as detailed in Chapter 3. Here, quarries were associated with accessing chert nodules embedded in limestone, whereas at procurement locales, a wide range of material types was present, and chert and quartzite were focuses. The results of the archaeological field investigations are presented below. In Chapter 8, we present an analysis of the results, comparing the artifact collections from quarries and procurement locales in order to try to understand how the different types of locations were utilized by prehistoric peoples.

Sites and Survey Areas in the San Andres Group

Three resources were located in the western end of the study area, amid the hills and ridges that make up part of the Sacramento Mountains range. Two previously recorded sites were relocated, and a newly recorded resource was located in the Meadow Hill Survey Area.

LA 144349

Setting

LA 144349 is a very small site located on top of a high ridge near the Rio Peñasco. The site sits on top of limestone outcrops with little to no soil development. Scattered nodules of “fingerprint” chert are present within the limestone bedrock. There are few disturbances on the site, but a relay tower and a small outbuilding are just northeast of the site. Vegetation consists of juniper trees, small agave, and other desertscrub plants. Ground visibility was very good, approaching 90 percent.

Site Description

The site was originally recorded by Southern New Mexico Archaeological Services, Inc., in 2004 (Browning 2004). It measured 50 by 45 m and covered an area of 2,250 m^2. It was classified as a BLM Category 1 site and was described as a small scatter of lithic artifacts, primarily cores, tested cobbles, and debitage. No diagnostic artifacts or features were noted, but the original records suggested that the site's age may range from the Early Archaic period to the late Puebloan period, based on the ages of other sites in the area.

SRI was able to relocate the site but found a few artifacts on the surface (Figure 21). Chert nodules were very sparse, and only small numbers of artifacts were noted. Limestone bedrock was present at the site surface, and no soil development was present. No subsurface testing was possible; so, a single 1-by-1-m surface-collection unit was placed at the site.

Artifacts

Only 10 artifacts were noted on the site surface: 3 tested cobbles, 1 unidirectional core, and 6 pieces of debitage (Table 5). The debitage consisted entirely of core flakes, and the artifacts were all made of fingerprint chert. The quality of the chert at the location was variable, and some nodules contained obvious inclusions and other imperfections. A small quantity of angular debris was present at the site, but it was unclear whether it resulted from lithic reduction or natural spalling.

Three additional artifacts (2 pieces of debitage and a tested cobble) were recovered from the collection unit.

Summary

LA 144349 is a small chert quarry that was minimally utilized by prehistoric groups. It is possible that other small outcrops are present along the hilltop and that this site represents one small locus of a larger pattern of tool-stone acquisition.

LA 161046

Setting

LA 161046 is located on top of a west–east-trending ridge. Limestone outcrops are present throughout the site, nodules of fingerprint chert are present within the limestone, and these nodules are eroding onto the site surface. Vegetation consists of juniper trees, small agave, cholla, and other desertscrub plants. The site is located within pasture land, and a cattle trail runs through the southern side of the site. Ground visibility was very good, approaching 90 percent.

Site Description

The site was originally recorded by the BLM-CFO in 2008 (Stein and Robinson 2008). It measured approximately 230 by 110 m and covered an area of just over 25,000 m^2. It was described as a small lithic workshop consisting of chert artifacts, mostly cores and debitage as well as one biface. Many of the chert nodules were small and had weathered into small, angular pieces. Most of the artifacts were small, as well.

SRI was able to relocate the site and found it in the same general condition as had been previously described (Figure 22). The site occupies a hilltop with a large limestone outcrop on top and thin soils

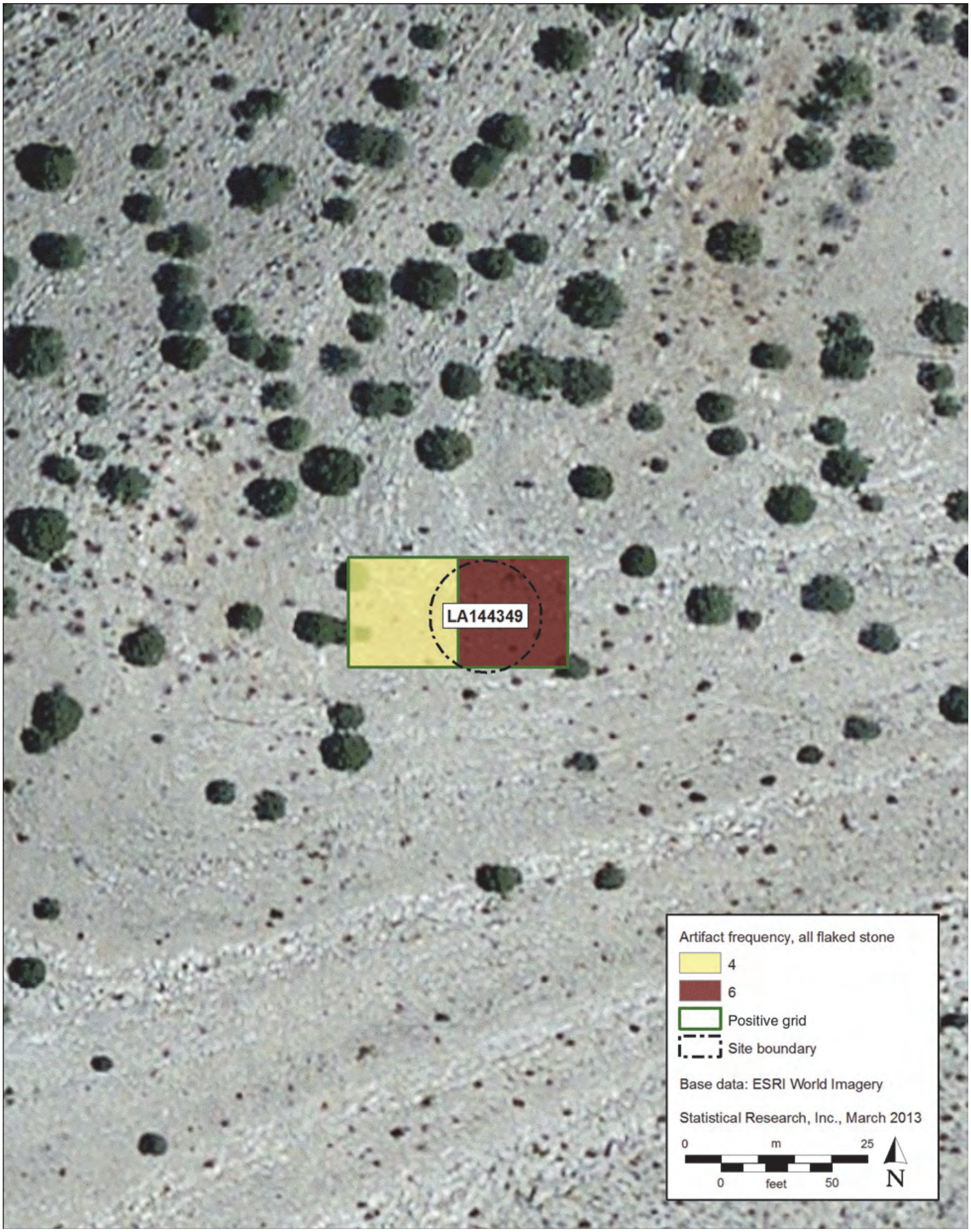

Figure 21. Site map of LA 144349.

Table 5. Artifacts from the Surface of LA 144349

Artifact Type, by Technological Type	Material Type		Total
	San Andres Chert	Granite	
Cores			
Unidirectional core	1	—	1
Tested cobble	3	—	3
Subtotal, cores	4	—	4
Debitage			
Core flake	4	2	6
Subtotal, debitage	4	2	6
Total	8	2	10

along the sides. Most of the artifacts were found along the northern and southern sides of the site, where the bulk of the natural chert outcrops are. As noted earlier, there were few chert nodules larger than 15 cm, and the chert has eroded into blocky, angular forms. The artifacts were mixed together with the natural spalls, and some of the angular debris may have resulted from lithic reduction. No subsurface deposits are possible at the site because of the widespread limestone outcrops and thin soils. Two 1-by-1-m units were placed in artifact concentrations on the northern end of the site, for sample collection.

Artifacts

In total, 286 artifacts were recorded at the site: 46 cores, 15 tested cobbles, 1 cobble biface, 220 pieces of debitage, 1 retouched flake, 1 uniface, 1 scraper, and 1 biface (Table 6). The artifacts were made entirely of fingerprint chert. All but 9 of the flakes were core flakes.

Twenty artifacts were recovered from the two collection units: 1 biface, 2 cores, 15 pieces of debitage, 1 retouched flake, and 1 notch (Table 7).

Summary

LA 161046 represents a small chert quarry. The chert is generally good quality but was present in small nodules that may have been difficult to work. It appeared that prehistoric visitors to the site tested small nodules and created small cores. The small number of tools at the site suggests that most of the tool manufacture took place away from the site. Based on these findings, we believe that the site should be classified as a BLM Category 1 site.

Meadow Hill Survey Area

Setting

The Meadow Hill Survey Area is located on top of a south–north-trending ridge that drops off steeply to the north and east and slopes more gently to the west. The top of the ridge is covered in limestone outcrops, and soils are very thin. Chert nodules are eroding out of the limestone, and at least two different types of chert are present. The most common type is a chert that is blue-gray and has small fusulinid fossils within the stone. In some cases, very large numbers of fossils were present within the stone,

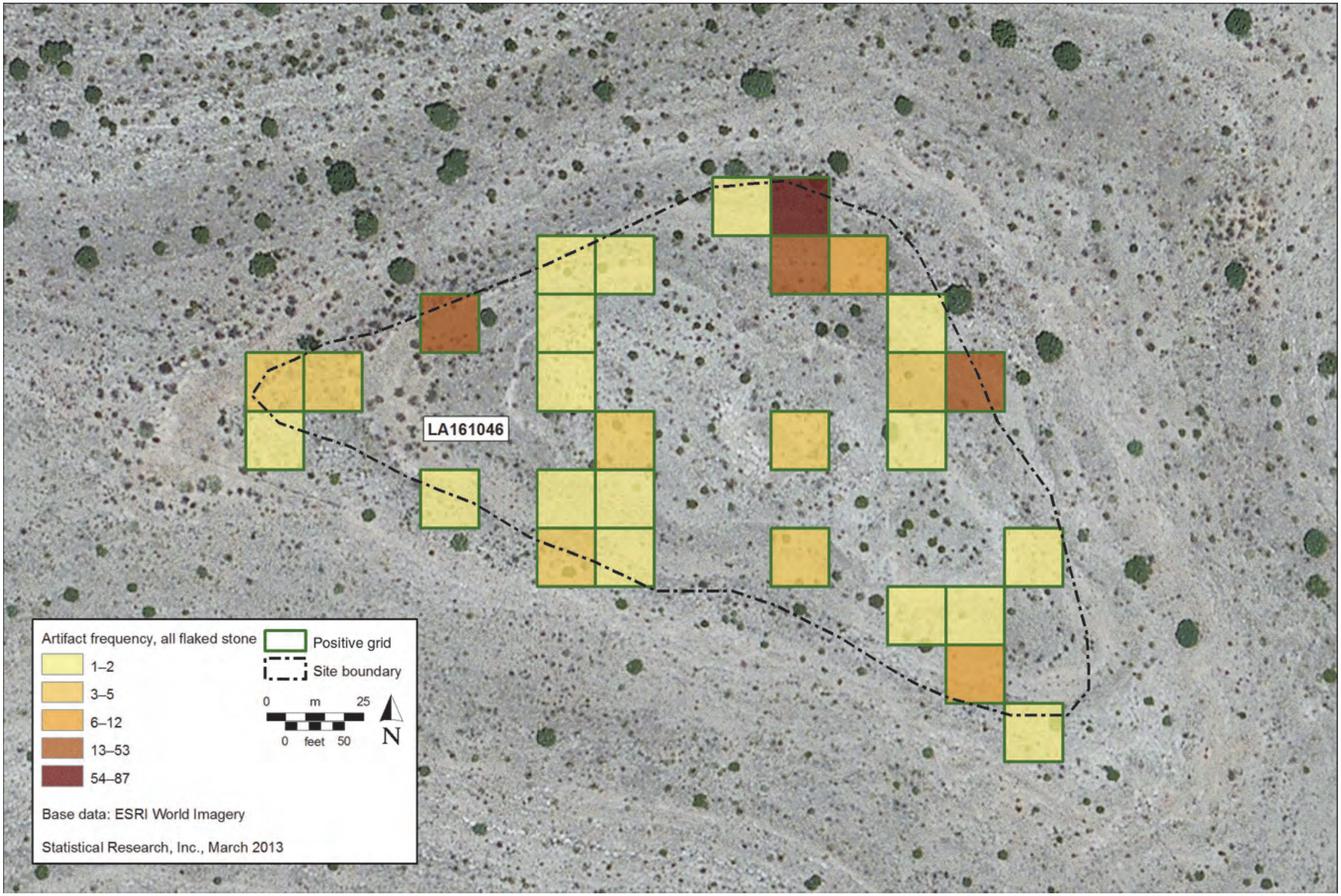

Figure 22. Site map of LA 161046.

Table 6. Artifacts from the Surface of LA 161046

Artifact Type, by Technological Type	Material Type		Total
	Chert	San Andres Chert	
Cores			
Bidirectional core	1	15	16
Multidirectional core	—	20	20
Unidirectional core	—	7	7
Unidentifiable core	—	3	3
Cobble biface	—	1	1
Tested cobble	1	14	15
Subtotal, cores	2	60	62
Debitage			
Core flake	1	210	211
Biface flake	1	—	1
Undetermined flake	—	8	8
Subtotal, debitage	2	218	220
Retouched tools			
Retouched piece	—	1	1
Uniface	—	1	1
Scraper	—	1	1
Biface	—	1	1
Subtotal, retouched tools	—	4	4
Total	4	282	286

Table 7. Artifacts from Collection Units at LA 161046

Artifact Type, by Technological Type	Material Type		Total
	Chert	San Andres Chert	
Cores			
Bidirectional core	—	1	1
Flake core	—	1	1
Subtotal, cores	—	2	2
Debitage			
Core flake	6	7	13
Core-trimming flake	—	2	2
Subtotal, debitage	6	9	15
Retouched tools			
Retouched piece	—	1	1
Notch	1	—	1
Biface	1	—	1
Subtotal, retouched tools	2	1	3
Total	8	12	20

which would have made it difficult to reduce in a controlled fashion. The other type of chert, a gray, banded fingerprint chert, was much less common. Vegetation consists of juniper trees, small agave, cholla, and other desertscrub plants. A dirt road runs through the center of the location, which is otherwise in good condition. Ground visibility was very good, approaching 90 percent.

Description

A small survey was conducted at locations in which artifacts had been noted in the past. The survey area measured approximately 220 by 220 m and covered an area of 42,000 m^2 (Figure 23). Small numbers of artifacts were present within the survey area and were located primarily along the edges of the hilltop. There were few chert nodules larger than 15 cm, and the chert, particularly the chert containing fusulinid fossils, has eroded into blocky, angular forms. The artifacts were mixed together with the natural spalls, and some of the angular debris may have resulted from lithic reduction. Because of the thin soils, subsurface deposits are not possible at the location. Three 1-by-1-m surface-collection units were placed where small numbers of artifacts were noted, and all artifacts inside the units were collected. No features were noted.

Artifacts

In total, 61 artifacts were present: 9 cores, 12 tested cobbles, 36 pieces of debitage, 2 retouched flakes, 1 uniface, and 1 scraper (Table 8). All but 3 of the flakes were core flakes, and all of the artifacts were made from chert, with 2 exceptions: a sandstone core flake and a piece of obsidian angular debris found on the surface. It was a small, blocky piece that measured approximately 1 cm^2. XRF analysis of the item indicated that it was Cerro Toledo obsidian, the closest source of which would be the Rio Grande gravels (Church 2000).

Ten artifacts were recovered from the collection units: 3 bifaces, 1 core, and 6 pieces of debitage (Table 9).

Summary

The Meadow Hill Survey Area represents a small source of lithic raw materials. Based on the small number of artifacts, it appears that the location was not intensively utilized, but the area outside the survey boundary was not examined, and additional artifacts may be present beyond the current boundaries. Because of the small assemblage, we believe that the location should be classified as a BLM Category 1 site.

Sites in the Upper Pecos River Group

Three sites were located near the Pecos River, in the northern part of the study area. All three were associated with thin gravel deposits on top of sandstone formations.

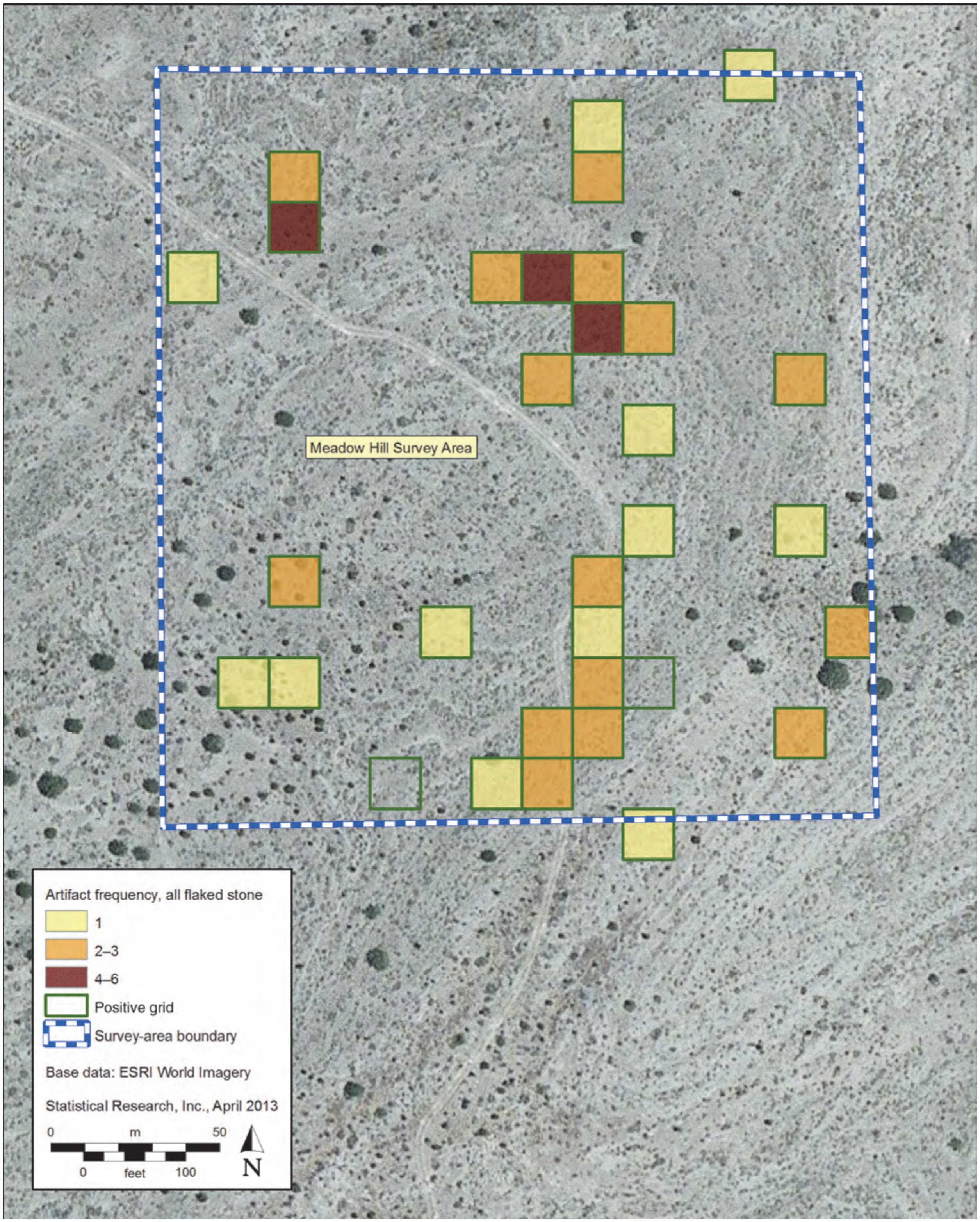

Figure 23. Map of the Meadow Hill Survey Area.

Table 8. Artifacts from the Surface of the Meadow Hill Survey Area

Artifact Type, by Technological Type	Material Type						Total
	Chert	Chert (Fusulinid)	San Andres Chert	Subtotal, All Chert	Obsidian	Sandstone	
Cores							
Bidirectional core	1	1	1	3	—	—	3
Multidirectional core	—	1	4	5	—	—	5
Unidirectional core	—	—	1	1	—	—	1
Tested cobble	4	5	3	12	—	—	12
Subtotal, cores	5	7	9	21	—	—	21
Debitage							
Angular debris	—	—	—	—	1	—	1
Core flake	5	18	8	31	—	1	32
Biface flake	—	—	2	2	—	—	2
Undetermined flake	—	—	1	1	—	—	1
Subtotal, debitage	5	18	11	34	1	1	36
Retouched tools							
Retouched piece	1	—	1	2	—	—	2
Uniface	—	—	1	1	—	—	1
Scraper	—	—	1	1	—	—	1
Subtotal, retouched tools	1	—	3	4	—	—	4
Total	11	25	23	59	1	1	61

Table 9. Artifacts from Collection Units in the Meadow Hill Survey Area

Artifact Type, by Technological Type	Material Type		Total
	Chert	San Andres Chert	
Cores			
Unidirectional core	1	—	1
Subtotal, cores	1	—	1
Debitage			
Core flake	1	3	4
Utilized debitage	1	1	2
Subtotal, debitage	2	4	6
Retouched tools			
Biface	—	3	3
Subtotal, retouched tools	—	3	3
Total	3	7	10

LA 29500

Setting

The site is located in a broad plain with low, rolling hills. Soils at the site are rocky caliche with a thin layer of topsoil above. Small pieces of limestone are abundant. Small numbers of cobbles were present with the limestone, primarily quartzite and chert. Vegetation consists of sparse grasses, creosote bush, whitethorn acacia, and other desertscrub species. Ground visibility was very good, approaching 90 percent.

Site Description

The site was originally recorded in 1981 by the Eastern New Mexico University Agency for Conservation Archaeology (ENMU AFCA 1981) and classified as a BLM Category 2 site. The site was revisited by Mesa Field Services in 2001 (Smith and Hermann 2001), by the BLM-CFO in 2008, and by Boone Archaeological Services, LLC, in 2011. The site measured 250 by 223 m and covered 55,750 m^2. In all cases, the site was described as a small lithic-procurement site containing cores, tested material, and debitage. No features or diagnostic artifacts were recorded during any previous site visit.

SRI was able to relocate the site but did not find the same density of artifacts described by earlier investigators. SRI located only 34 total artifacts, spread diffusely across the site (Figure 24). Crew members only surveyed within the boundaries provided by the BLM-CFO; so, it is possible that the site has been partially misplotted and that additional artifacts are present outside these boundaries. Raw material was only available in very limited quantities, and most of the chert and quartzite cobbles were less than 10 cm each in length.

Two 1-by-1-m test pits were excavated at the site. In both cases, the units were placed over artifacts found at the surface. Both units were extremely shallow, and large concentrations of limestone were present within 5 cm of the surface. No additional artifacts were found in either unit.

Artifacts

In total, 34 artifacts were identified on the site surface (Table 10): 1 cobble uniface, 6 tested cobbles, 26 pieces of debitage, and a retouched flake. Most of the artifacts were made of quartzite; there were smaller numbers of chert and rhyolite. Of the 26 pieces of debitage, 24 were core flakes, and the other 2 were unidentifiable.

In total, 6 flakes were recovered from the test pits, including 4 core flakes, 1 piece of angular debris, and an unidentifiable flake. The core flakes were 2 pieces of quartzite, 1 piece of chert, and 1 piece of chalcedony. The angular debris was made of quartzite, and the unidentifiable flake was chalcedony.

Summary

LA 29500 is a small, sparse lithic-procurement site. There is a chance that other artifacts are located outside the currently plotted boundaries, but SRI's observations suggest that the site was not frequently visited. Based on our findings, we believe that the site should be classified as a BLM Category 1 site.

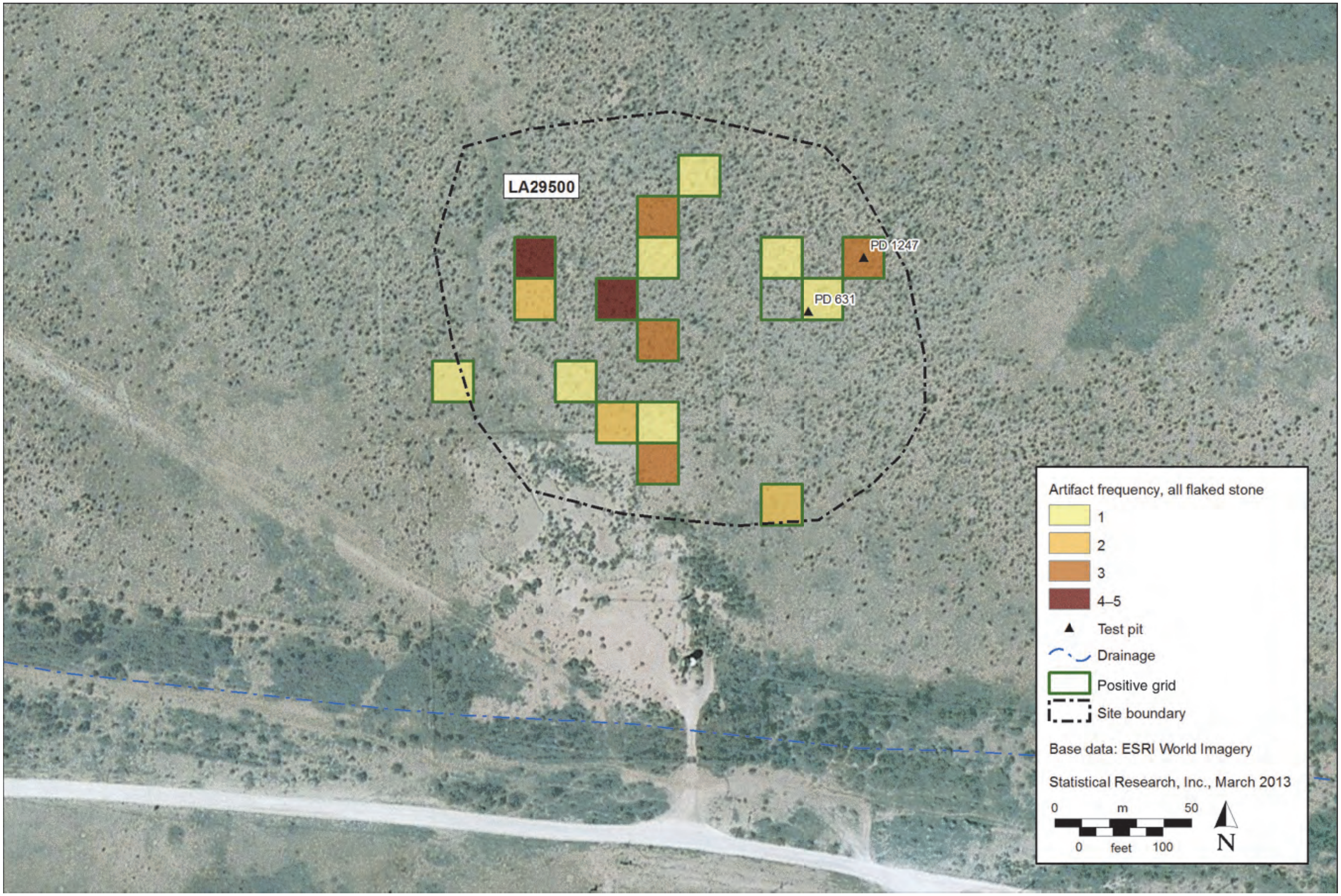

Figure 24. Site map of LA 29500.

Table 10. Artifacts from the Surface of LA 29500

Artifact Type, by Technological Type	Material Type						Total
	Chert	Quartzite	Mustard Quartzite	Purple Quartzite	Subtotal, All Quartzite	Rhyolite	
Cores							
Cobble uniface	1	—	—	—	—	—	1
Tested cobble	1	4	—	—	4	1	6
Subtotal, cores	2	4	—	—	4	1	7
Debitage							
Core flake	6	6	2	9	17	1	24
Undetermined flake	1	—	—	1	1	—	2
Subtotal, debitage	7	6	2	10	18	1	26
Retouched tools							
Retouched piece	1	—	—	—	—	—	1
Subtotal, retouched tools	1	—	—	—	—	—	1
Total	10	10	2	10	22	2	34

LA 146857

Setting

The site is located near the western edge of a 3.5-km-wide, shallow basin in a shallow, ephemeral wash, on top of sandstone bedrock. The surface of the site is primarily loose, reddish sand, but intact bedrock outcrops are present at the center of the site. Quartzite and chert cobbles were abundant across most of the site, and they appeared to have weathered out onto the present ground surface. Vegetation is sparse and consists of whitethorn acacia, yucca, creosote bush, and other small desert shrubs. Ground visibility was very good, approaching 90 percent. A large, active oil well and pad were located immediately east of the site and may have cut into part of it.

Site Description

The site was originally recorded in 2005 by Southern New Mexico Archaeological Services, Inc., and was revisited by Boone Archaeological Services, LLC, later that same year (Rein 2005). It measured 170 by 150 m and covered 25,500 m^2. The site was described as a large lithic scatter containing thousands of quartzite and chert artifacts, including cores, tested cobbles, and debitage. No diagnostic artifacts or features were observed at the site, but it was classified as a BLM Category 2 site.

SRI was able to relocate the site, and it appeared to be in a condition similar to what had been previously recorded (Figure 25). A large number of cobbles were spread across the surface of the site, and the site boundaries could be mapped onto the cobble scatter; few artifacts were found beyond the scatter (Figure 26). The artifact density was quite high; over 1,200 artifacts were recorded on the surface, and they were concentrated mostly in the center of the site. Two 1-by-1-m test pits were excavated at the site, and both had little depth because of decomposing sandstone bedrock found within 5 cm of the ground surface. No diagnostic artifacts or features were identified at the site.

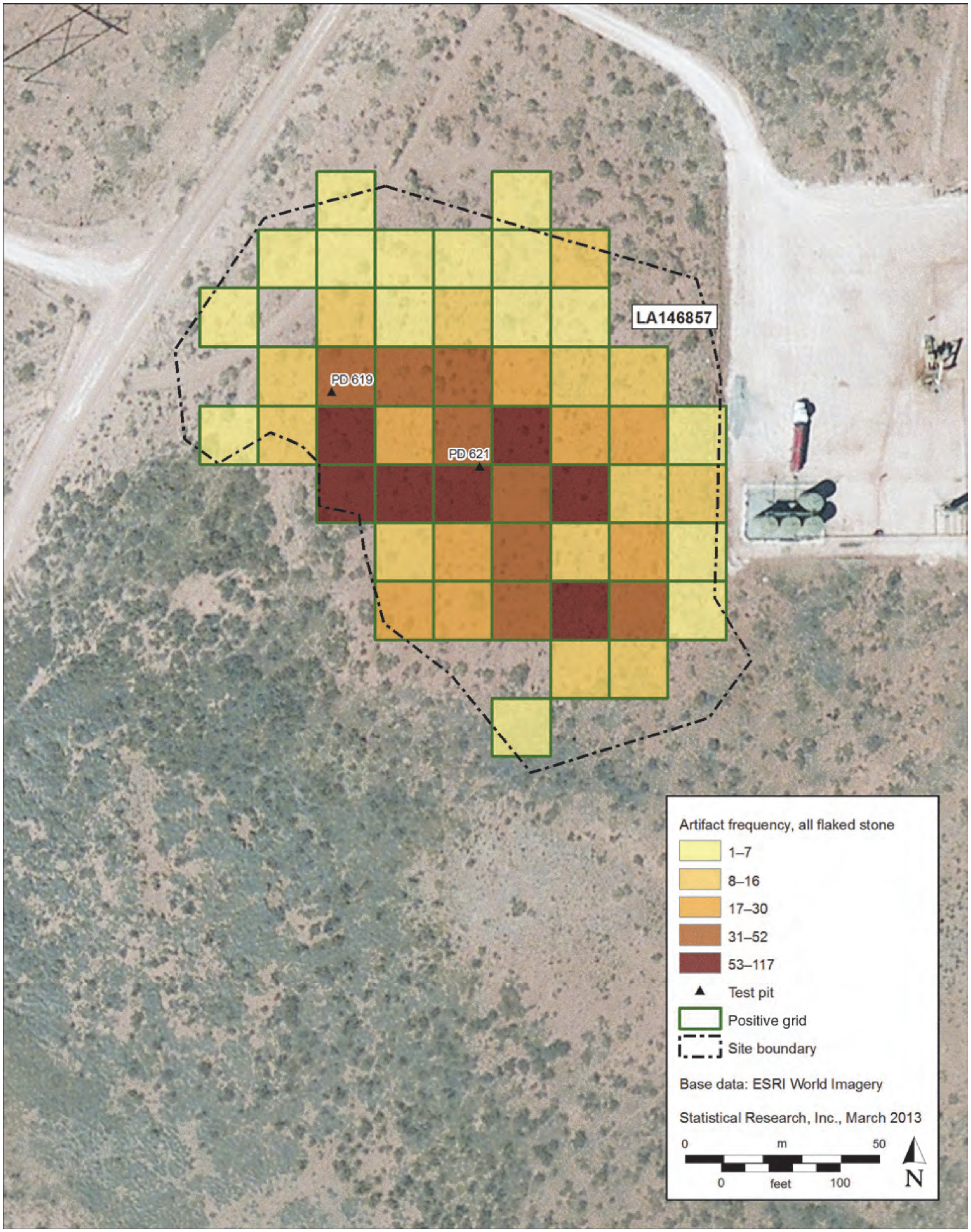

Figure 25. Site map of LA 146857.

Figure 26. Cobbles on the surface of LA 146857, view to the east.

Artifacts

Over 1,200 artifacts were recorded on the site surface (Table 11)—the largest assemblage of any site in the project—including 94 cores, 1 cobble uniface, 11 cobble choppers, 153 tested cobbles, 963 pieces of debitage, 7 retouched flakes, and 1 biface. Roughly two-thirds of the artifacts were made of quartzite, and chert composed most of the rest. Smaller numbers of chalcedony and rhyolite artifacts were also recorded. All of these materials were present as natural cobbles at the site.

In total, 65 artifacts were collected from the two test pits: 6 cores, 56 pieces of debitage, 2 hammerstones, and a uniface (Table 12). The majority of the artifacts (n = 46, or 71 percent) were quartzite; there were smaller numbers of chert, chalcedony, petrified wood, and a coarse-grained igneous material.

Summary

LA 146857 is a small site that contains a large artifact concentration. It appears that the site was intensively used as a lithic-procurement site. Few finished tools were noted on the site surface, suggesting that cores were tested and reduced but that formal tool manufacture occurred in other locations. Based on the large site assemblage, we believe that the site should be classified as a BLM Category 2 site.

Table 11. Artifacts from the Surface of LA 146857

Artifact Type, by Technological Type	Material Type									Total
	Chalcedony	Chert	Chert (Fusulinid)	Subtotal, All Chert	Quartzite	Mustard Quartzite	Purple Quartzite	Subtotal, All Quartzite	Rhyolite	
Cores										
Bidirectional core	—	4	—	4	6	—	4	10	—	14
Multidirectional core	—	28	—	28	18	2	13	33	6	67
Unidirectional core	—	—	—	—	3	1	1	5	1	6
Unidentifiable core	—	7	—	7	—	—	—	—	—	7
Cobble uniface	—	—	—	—		1	—	1	—	1
Cobble biface	—	—	—	—	6	3	2	11	—	11
Tested cobble	—	6	—	6	71	1	70	142	5	153
Subtotal, cores	—	45	—	45	104	8	90	202	12	259
Debitage										
Angular debris	6	10	—	10	39	—	18	57	—	73
Core flake	18	208	—	208	200	12	226	438	30	694
Biface flake	1	15	1	16	1	2	2	5	4	26
Undetermined flake	4	35	—	35	51	—	69	120	11	170
Subtotal, debitage	29	268	1	269	291	14	315	620	45	963
Retouched tools										
Retouched piece	—	4	—	4	2	—	—	2	1	7
Biface	—	1	—	1	—	—	—	—	—	1
Subtotal, retouched tools	—	5	—	5	2	—	—	2	1	8
Total	29	318	1	319	397	22	405	824	58	1,230

Table 12. Artifacts from Test Pits at LA 146857

Artifact Type, by Technological Type	Material Type							Total
	Chalcedony	Chert	Igneous (Coarse Grained)	Petrified Wood	Quartzite	Purple Quartzite	Subtotal, All Quartzite	
Cores								
Bidirectional core	—	—	—	—	—	1	1	1
Bifacial core	—	—	—	—		1	1	1
Flake core	—	—	—	—	1	2	3	3
Undetermined core	—	—	—	—	—	1	1	1
Subtotal, cores	—	—	—	—	1	5	6	6
Debitage								
Angular debris	—	—	—	1	—	3	3	4
Core flake	2	11	1	2	14	20	34	50
Utilized debitage	—	1	—	—	1	—	1	2
Subtotal, debitage	2	12	1	3	15	23	38	56
Retouched tools								
Uniface	—	1	—	—	—	—	—	1
Subtotal, retouched tools	—	1	—	—	—	—	—	1
Other								
Hammerstone	—	—	—	—	1	1	2	2
Subtotal, other	—	—	—	—	1	1	2	2
Total	2	13	1	3	17	29	46	65

LA 163991

Setting

The site is located on a north–south-trending finger ridge. The surface is covered in small limestone rocks, and quartzite and chert cobbles are spread across the surface. A large, deep wash runs through the center of the site. Vegetation is sparse and consists of whitethorn acacia, yucca, creosote bush, and other small desert shrubs. A large oil-well pad is located just west of the site. Another pad occupies much of the southern part of the site and has destroyed the site portion that it covers. Ground visibility was very good, approaching 90 percent.

Site Description

The site was originally recorded in 2009 by Southern New Mexico Archaeological Services, Inc., and was revisited by APAC in 2011 (Pangburn 2011). It was classified as a BLM Category 2 site measuring 295 by 165 m and covering an area of 48,000 m^2. The site was recorded as a quarry site at which naturally occurring quartzite and chert cobbles were tested and reduced. It contained a dispersed lithic scatter of at least 100 artifacts that consisted of cores, tested cobbles, hammerstones, and debitage. No features or diagnostic artifacts were present.

SRI was able to relocate the site and found it in the same condition as described in previous recordings (Figure 27). In total, 172 artifacts were found on the surface, spread mostly across the central and northern portions of the site. The artifacts, as well as the cobble formation containing the lithic raw materials, were sitting directly on top of a sterile sandstone formation. A deep wash runs through the center of the site and has exposed several profiles. Based on these profiles, it appears that in most areas, the cobble formation is less than 10 cm thick, and the sandstone formation beneath the cobbles contains virtually no large stones.

Four 1-by-1-m test pits were excavated at the site. The three units located in the central portion of the site, near a relatively dense area of surface artifacts, were excavated to approximately 10 cm below the surface, where the soil changed to decomposing sandstone. The fourth test pit, Provenience Designation (PD) 629, was located at the northern end of the site, at the location of a large scatter of chert flakes and core fragments. No subsurface artifacts were found in any of the units. The chert artifact scatter was composed of at least three chert cores, the largest of which was at least 25 cm in length, and several core-reduction flakes. The chert was a very poor-quality material with several inclusions and other imperfections. It appeared that people had attempted to remove the outer portions of the cores in hopes of finding higher-quality tool stone within the rocks. All three rocks were noted as discards near the flakes.

Artifacts

In total, 172 artifacts were recorded on the surface of the site (Table 13): 17 cores, 15 tested cobbles, 2 cobble unifaces, 1 cobble chopper, 125 pieces of debitage, 7 retouched flakes, 3 hammerstones, a uniface, and an early-stage biface. Over half the artifacts were made of quartzite; chert, rhyolite, and chalcedony made up smaller percentages. The majority of the debitage was composed of core flakes, but nearly 20 percent of the collection was composed of biface flakes, indicating that some reduction occurred on-site.

In addition to the surface artifacts, 21 artifacts were collected in the four test pits: 1 biface, 2 cores, 13 pieces of debitage, 2 notches, 2 split cobbles, and 1 tested cobble (Table 14). The artifacts were made of either chert or quartzite.

Summary

LA 163991 is a lithic-procurement site consisting of cores, debitage, and a small number of tools. Prehistoric visitors to the site apparently utilized the available lithic raw materials, tested cobbles, and produced flaked stone artifacts. There is no subsurface component to the site, and no diagnostic artifacts or features were found. Based on the large site assemblage, we believe that the site should be classified as a BLM Category 2 site.

Sites and Survey Areas in the Artesia Group

In total, six resources were located in the Artesia Group: five previously recorded sites and one newly recorded resource.

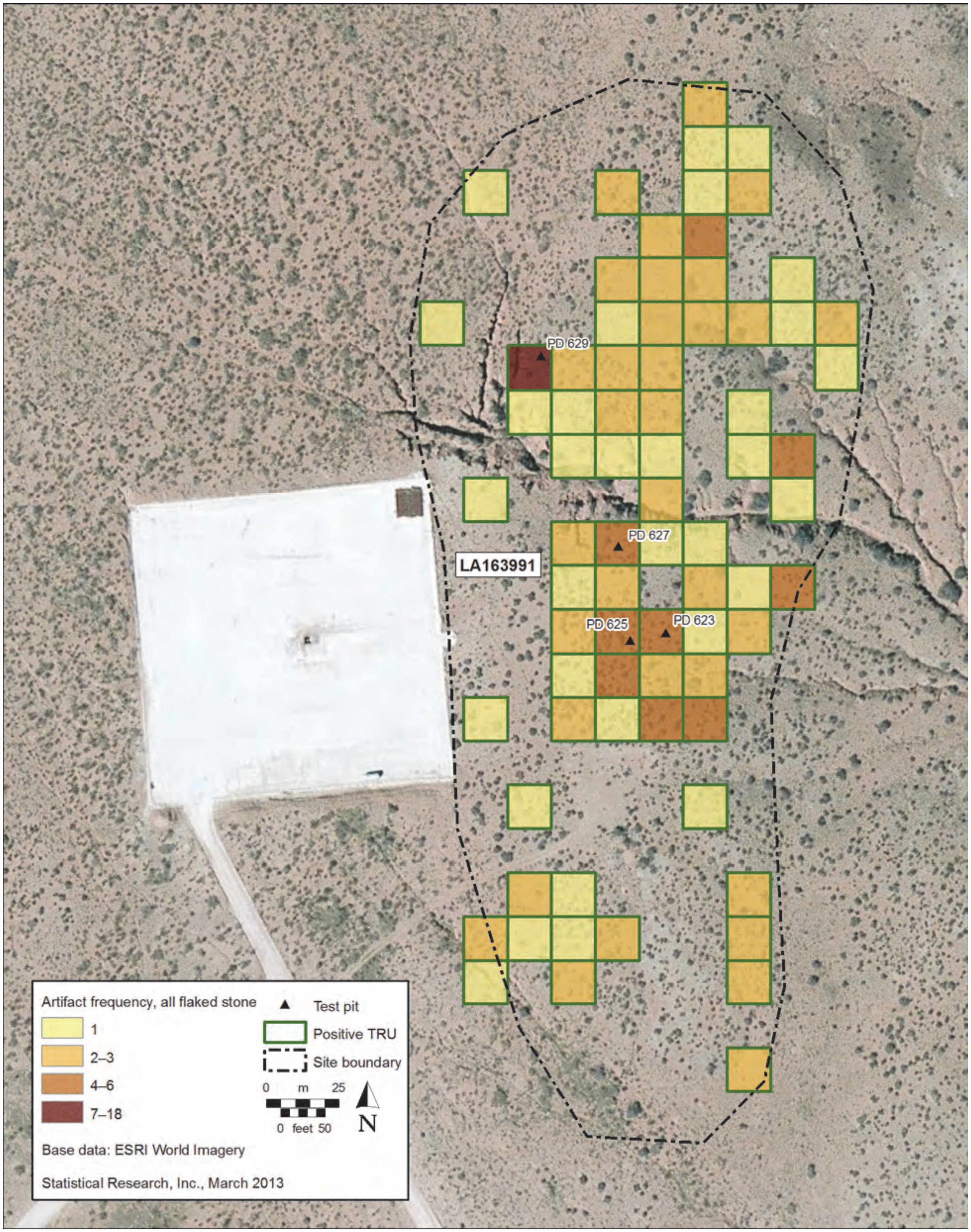

Figure 27. Site map of LA 163991.

Table 13. Artifacts from the Surface of LA 163991

Artifact Type, by Technological Type	Material Type									Total
	Chalcedony	Chert	Chert (Fusulinid)	Subtotal, All Chert	Quartzite	Mustard Quartzite	Purple Quartzite	Subtotal, All Quartzite	Rhyolite	
Cores										
Bidirectional core	—	4	—	4	1	—	1	2	1	7
Multidirectional core	—	5	—	5	1	—	—	1	—	6
Unidirectional core	—	1	—	1	—	—	1	1	—	2
Unidentifiable core	—	2	—	2	—	—	—	—	—	2
Cobble uniface	—	1	—	1	—	—	—	—	1	2
Cobble biface	—	—	—	—	1	—	—	1	—	1
Tested cobble	1	6	—	6	3	—	4	7	1	15
Subtotal, cores	1	19	—	19	6	—	6	12	3	35
Debitage										
Angular debris	—	—	—	—	—	—	2	2	—	2
Core flake	6	14	1	15	33	1	34	68	5	94
Biface flake	—	15	—	15	1	2	4	7	—	22
Undetermined flake	—	1	—	1	3	—	1	4	2	7
Subtotal, debitage	6	30	1	31	37	3	41	81	7	125
Retouched tools										
Retouched piece	—	3	—	3	2	—	—	2	2	7
Uniface	—	—	—	—	1	—	—	1	—	1
Biface	—	—	—	—	1	—	—	1	—	1
Subtotal, retouched tools	—	3	—	3	4	—	—	4	2	9
Other										
Hammerstone	—	—	—	—	2	—	1	3	—	3
Subtotal, other	—	—	—	—	2	—	1	3	—	3
Total	7	52	1	53	49	3	48	100	12	172

Table 14. Artifacts from Test Pits at LA 163991

Artifact Type, by Technological Type	Material Type				Total
	Chert	Quartzite	Purple Quartzite	Subtotal, All Quartzite	
Cores					
Bifacial core	2	—	—	—	2
Tested cobble	—	—	1	1	1
Split cobble	—	2	—	2	2
Subtotal, cores	2	2	1	3	5
Debitage					
Angular debris	1	—	—	—	1
Core flake	8	2	—	2	10
Core-trimming flake	—	1	—	1	1
Utilized debitage	1	—	—	—	1
Subtotal, debitage	10	3	—	3	13
Retouched tools					
Notch	—	2	—	2	2
Biface	1	—	—	—	1
Subtotal, retouched tools	1	2	—	2	3
Total	13	7	1	8	21

LA 119804

Setting

This site is on a low rise that runs north from a large limestone terrace. The rise is also composed of limestone, and the low areas around the rise consist of alluvial soils. A small number of chert nodules was present on the site surface, although in much lower concentrations than on the larger terrace to the south. Vegetation consists of sparse grasses, creosote bush, whitethorn acacia, and other desertscrub species. Ground visibility was very good, approaching 90 percent.

Site Description

The site was originally recorded by Lone Mountain Archaeological Services in 1997 and was classified as a BLM Category 2 site (Fredine and Allen 1997). The site was recorded as a small scatter of lithic artifacts covering a low rise. It measured 200 by 115 m and covered an area of 23,000 m^2. Two concentrations were identified, in the central and southern portions of the site. In total, over 100 artifacts were noted, including primarily debitage, a small number of cores, and a crude biface. A trowel test was excavated into the southern part of the site to a depth of approximately 35 cm. The investigators reported that a flake was found in the trowel test and that additional subsurface deposits were possible.

SRI was able to relocate the site as part of the current survey. Since the original recordation, a large site, LA 130417 (see below), has been recorded on the terrace to the south of LA 119804. The boundary for LA 130417 extends north of the terrace and essentially overlaps the boundary of LA 119804 (Figure 28).

LA 119804 generally matched previous descriptions in terms of its location, but SRI was not able to relocate many of the artifacts identified in 1997. In total, SRI identified three artifacts: a cobble uniface

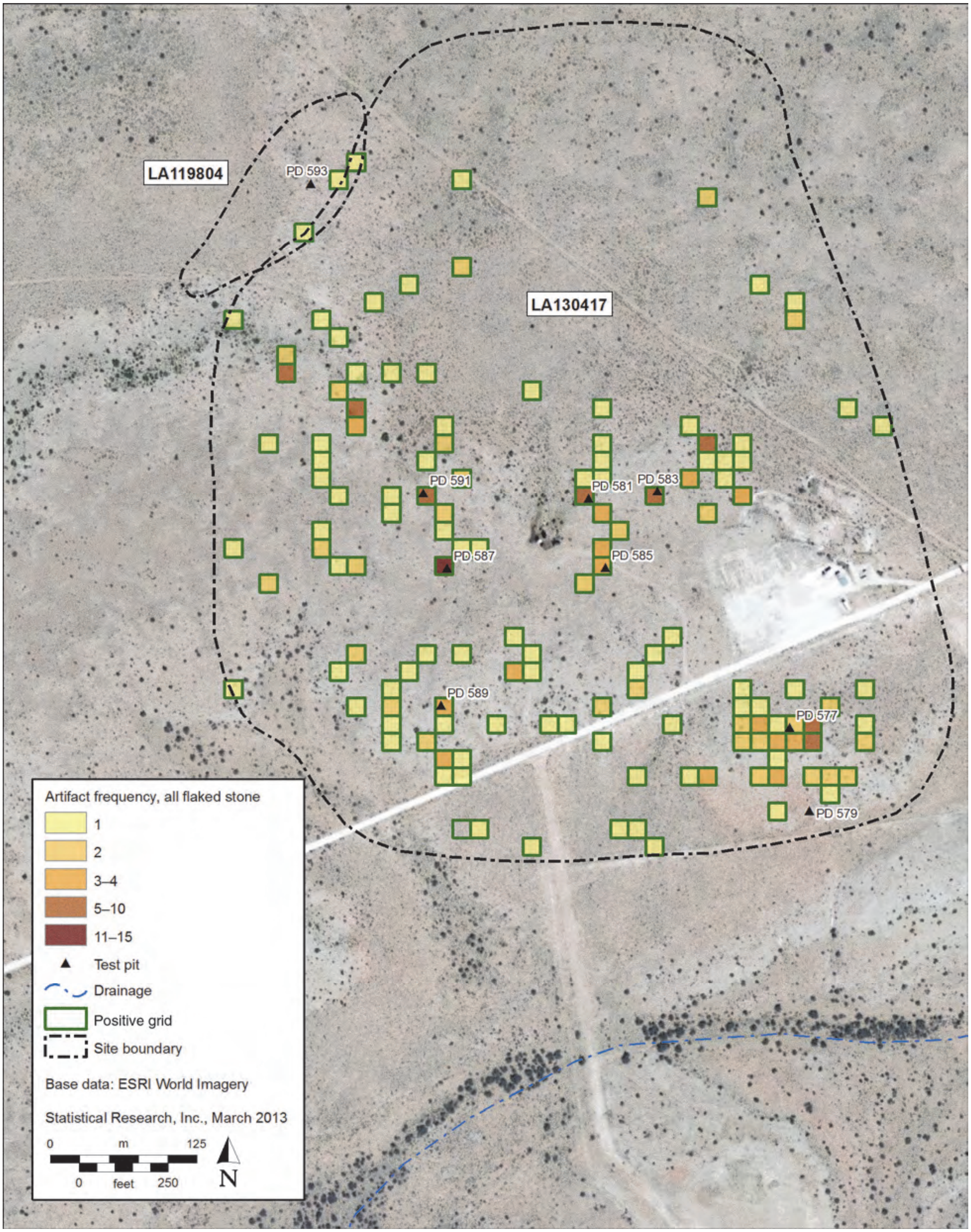

Figure 28. Site map of LA 119804 and LA 130417.

and two flakes. A small number of chert nodules were present on the site surface, but few showed any evidence of human modification. A 1-by-1-m test pit was excavated in the location of the previously recorded central artifact scatter and was placed over a small number of apparent artifacts on the surface. The test pit was excavated to a depth of 20 cm, where the soil became too rocky to continue excavation. No artifacts were found below the ground surface. A number of rodent burrows and other evidence for bioturbation were present at the site. Given the somewhat uncontrolled nature of the trowel test that found a subsurface artifact in 1997, it seems possible that the artifact had been either knocked in from the surface or brought below ground via bioturbation. The site's location on an eroding limestone ridge seems to preclude the possibility of significant subsurface deposits.

Artifacts

Only three artifacts were recorded on the surface: a cobble uniface and two pieces of debitage (a core flake and a biface flake). The few artifacts on the surface of the test pit turned out to be natural spalls.

Summary

The site consists of a small number of chert artifacts scattered on a low rise. No subsurface deposits and no diagnostic tools were identified at the site. The site may actually be part of LA 130417, located to the south. Based on these findings, we believe that the site should be classified as a BLM Category 1 site.

LA 121969

Setting

The site is located on a high ridgetop overlooking Rocky Arroyo, which is approximately 1,400 m to the north. The ridgetop is composed of limestone bedrock with very thin soils. A small number of small chert nodules was present on the surface, but none showed any human modification. Vegetation consists of sparse grasses, agave, yucca, whitethorn acacia, and other desertscrub species. Ground visibility was very good, approaching 90 percent.

Site Description

The site was originally recorded by Archaeological Survey Consultants (ASC) in 1998 as a BLM Category 1 site (Sciscenti and Griffiths 1998). It was described as a small lithic scatter consisting of a handful of silicified-limestone artifacts, primarily lithic debitage. The site measured just 12 by 3 m and covered an area of 37 m^2. It was located near a recently constructed oil well and associated pad. No diagnostic artifacts were noted.

SRI was unable to relocate artifacts within the previously recorded site boundaries. Given the small size of the site and the site's location near a large oil well, it could have been destroyed or misplotted. The original recorders also noted that at least some of the artifacts at the site may not, in fact, have been real, because they were composed of limestone, which is plentiful as a bedrock outcrop.

Artifacts

No artifacts were identified at the recorded site location.

Summary

SRI could not relocate the site during survey.

LA 130417

Setting

The site occupies the top of a limestone terrace as well as the lower areas north and south of the terrace. The terrace itself features abundant limestone on the surface and a thin layer of soil. Small chert nodules are present across the terrace. The lower areas to the south also contain abundant limestone outcrops, although soils there are deeper in places. The lower areas to the north contain very little stone at the surface, and alluvial and aeolian soils are present throughout. Vegetation consists of sparse grasses, creosote bush, whitethorn acacia, and other desertscrub species. Ground visibility was generally good, approaching 90 percent, except on the southern side of the site, where grasses were denser. A large oil-well pad was located on top of the terrace, in the east-central portion of the site, and an access road runs east–west just south of the pad. Other structures and containers related to oil production were also located on top of the terrace, west of the pad.

Site Description

The site was originally recorded in 2000 by Desert West Archaeological Services, Inc. (DWAS 2000), and test excavations were carried out by Mesa Field Services later that same year (Smith and Hermann 2000). The site measured 290 by 238 m and covered over 47,000 m^2. The site as originally recorded occupied the southern margin of the terrace as well as the southern low areas. Thousands of artifacts, including a variety of debitage types, scrapers, and cores, were noted at the site. In addition to the artifacts, three features were noted: two small concentrations of burned caliche and FCR and a large, low ring midden composed of approximately 300 pieces of limestone FCR. The site was classified as a BLM Category 2 site.

SRI was able to relocate the site. At some point after the original recording, the site boundary was expanded to include the entire terrace as well as a large area north of the terrace, extending all the way to LA 119804. The current site boundary measured 700 by 600 m and covered just over 410,000 m^2 (see Figure 28). SRI was able to identify only 263 artifacts on the surface of the site—nowhere close to the thousands of artifacts recorded in 2000. Large numbers of angular pieces of broken chert were present at the site, but it was not clear whether they resulted from lithic reduction or simply natural processes. Angular debris was noted in the previous site records; so, it may have been included in the earlier artifact counts. Most of the artifacts identified at the site were located on top of the terrace and in the low areas south of the terrace. Very few artifacts were found north of the terrace. The artifacts on the surface showed very little spatial patterning; most were spread evenly across the central and southern portions of the site.

None of the three features could be relocated. The burned-caliche feature had been located near the road that cuts through the center of the site and was reported to be near the route of an underground pipeline; so, this feature may have been destroyed. The FCR feature and the ring midden had been located in the southern part of the site, south of the terrace. That area was littered with limestone, but no definitive features could be located.

In total, eight 1-by-1-m test pits were excavated across the site; seven were located on the terrace surface, and one (PD 579) was located near the recorded location of the ring midden, south of the terrace. All of the units were placed over small scatters of surface artifacts. The artifacts on top of the terrace all encountered limestone bedrock within 10 cm of the site surface. No artifacts besides those recorded on the surface were found in the units. The test pit south of the terrace was excavated slightly deeper, but no artifacts or soil changes were noted.

Artifacts

The 263 artifacts on the surface were 22 cores, 1 cobble uniface, 17 tested cobbles, 196 pieces of lithic debitage, 13 retouched flakes, 1 uniface, 3 bifaces, 5 scrapers, and 5 pieces of limestone FCR (Table 15). All but 3 of the artifacts were made of chert: 1 rhyolite core and 2 flakes made from quartzite and an indeterminate metamorphic stone, both material types that are not native to the site and must have been brought in from elsewhere.

The cores were 16 multidirectional cores, 2 unidirectional cores, 1 bidirectional core, and 3 unidentifiable cores. The majority of the debitage consisted of core flakes (n = 144, or 72 percent); there were low numbers of biface flakes, angular debris, and unidentifiable flake fragments. It seems that a main focus on the site was testing small chert nodules and that tool production was not an important activity.

The eight excavation units recovered a total of 43 chert artifacts: 2 bifaces, 1 uniface, 1 retouched tool, and 39 pieces of debitage (Table 16). The debitage consisted of 29 core flakes, 9 pieces of angular debris, and an unidentifiable flake.

Summary

LA 130417 is a large lithic-procurement site. The small chert nodules present at the site were tested, usually by removal of a handful of flakes. If the material was not suitable, the nodule was rejected. The features recorded previously suggest that the site may have been used as a temporary camp, as well. Test pits showed that there was little potential for buried deposits, at least in the parts of the site with the greatest numbers of artifacts. The features could not be relocated, and there were no subsurface deposits, but because of the large and complex lithic assemblage, we believe that the site should be classified as a BLM Category 2 site.

LA 150383

Setting

The site is located on a south–north-trending finger ridge on the southern side of Last Chance Draw, on two gravel terraces within the ridge: an upper terrace in the center of the site and a lower terrace extending around the western, northern, and eastern ends. The upper terrace is located on a crumbling limestone outcrop; numerous pieces of limestone and dolomite were present at the surface. Chert nodules were present within the limestone bedrock and scattered across the surface of the site. Limestone was somewhat less abundant on the lower terrace, which had slightly more soil development. Vegetation consists of sparse grasses, creosote bush, whitethorn acacia, and other desertscrub species. Ground visibility was very good, approaching 90 percent.

Site Description

LA 150383 was originally recorded in 2005 by ASC, in advance of construction of an oil-well pad (Sciscenti and Griffiths 2005). ASC defined the site as a BLM Category 2 site and recorded it as a large artifact scatter measuring approximately 300 by 280 m and covering an area of more than 86,000 m^2. Artifacts included numerous chert cores, tested nodules, and flakes from various stages of lithic reduction as well as bifaces, unifaces, and retouched flakes. No features or diagnostic artifacts were identified by ASC.

SRI was able to relocate the site during the current study. The site is U-shaped, with the open end to the south, corresponding to the location of a large oil-well pad (Figure 29). The pad measured 60 by 90 m, and an additional disturbed area immediately west of the pad measured 30 by 90 m. During the survey, SRI was not able to relocate many of the plotted artifacts depicted in the previous site record. The

Table 15. Artifacts from the Surface of LA 130417

Artifact Type, by Technological Type	Material Type								Total
	Chert	Chert (Fusulinid)	San Andres Chert	Subtotal, All Chert	Limestone	Metamorphic (Indeterminate)	Quartzite	Rhyolite	
Cores									
Bidirectional core	—	1	—	1	—	—	—	—	1
Multidirectional core	5	9	1	15	—	—	—	1	16
Unidirectional core	2	—	—	2	—	—	—	—	2
Unidentifiable core	3	—	—	3	—	—	—	—	3
Cobble uniface	—	1	—	1	—	—	—	—	1
Tested cobble	10	6	1	17	—	—	—	—	17
Subtotal, cores	20	17	2	39	—	—	—	1	40
Debitage									
Angular debris	4	12	—	16	—	—	1	—	17
Core flake	107	36	—	143	—	1	—	—	144
Biface flake	6	4	1	11	—	—	—	—	11
Undetermined flake	10	14	—	24	—	—	—	—	24
Subtotal, debitage	127	66	1	194	—	1	1	—	196
Retouched tools									
Retouched piece	5	8	—	13	—	—	—	—	13
Uniface	—	1	—	1	—	—	—	—	1
Scraper	1	4	—	5	—	—	—	—	5
Biface	2	1	—	3	—	—	—	—	3
Subtotal, retouched tools	8	14	—	22	—	—	—	—	22
Other									
Fire-cracked rock	—	—	—	—	5	—	—	—	5
Subtotal, other	—	—	—	—	5	—	—	—	5
Total	155	97	3	255	5	1	1	1	263

Table 16. Artifacts from Test Pits at LA 130417

Artifact Type, by Technological Type	Material Type			Total
	Chert	Chert (Fusulinid)	San Andres Chert	
Debitage				
Angular debris	9	—	—	9
Core flake	21	1	7	29
Undetermined flake	1	—	—	1
Subtotal, debitage	31	1	7	39
Retouched tools				
Retouched piece	1	—	—	1
Uniface	1	—	—	1
Biface	2	—	—	2
Subtotal, retouched tools	4	—	—	4
Total	35	1	7	43

site featured a sparse scatter of small chert cores, core-reduction flakes, and tested nodules as well as a few bifaces, unifaces, and retouched tools. There appeared to be a greater concentration of artifacts at the northwestern end of the site, particularly along the lower terrace. Additional artifacts were noted to the west of the site, on another terrace, which was separated from the recorded site boundary by a 50-m-wide, shallow wash. A large quantity of flakes, cores, and other artifacts were noted on the surface of the terrace, which may have been the main part of the site.

In total, three 1-by-1-m test pits were excavated at the site. The test pits were laid out on a roughly east–west axis across the site and targeted the western and eastern sides of the lower terrace as well as the upper terrace in the center of the site. Each of the test pits was excavated approximately 10 cm into the soil, where the soil became so rocky that additional excavation was not possible. The three test pits were placed over surface scatters of artifacts, but no artifacts were found below the ground surface.

Artifacts

Only 40 artifacts were recorded on the site surface during survey: 5 cores, 2 tested cobbles, 1 cobble uniface, 26 pieces of lithic debitage, 2 bifaces, 2 unifaces, and 2 retouched flakes (Table 17). All but 2 of the artifacts were made from chert: a multidirectional core and a core flake, both made of chalcedony.

The three test pits recovered only seven artifacts: two cores and five pieces of debitage (Table 18). All seven artifacts were made of chert. The debitage included one core flake and four pieces of angular debris. The cores were a unidirectional core and a bidirectional core.

Summary

LA 150383 is a large, sparse lithic-procurement site. It appeared that the majority of the artifacts resulted from testing of locally available chert nodules. Artifacts consisted of cores, tested nodules, and core flakes, most of which featured cortex on the dorsal surfaces. Given the size of the raw chert nodules, it seems that the pattern of acquisition involved testing nodules and that once a suitable piece was found, it

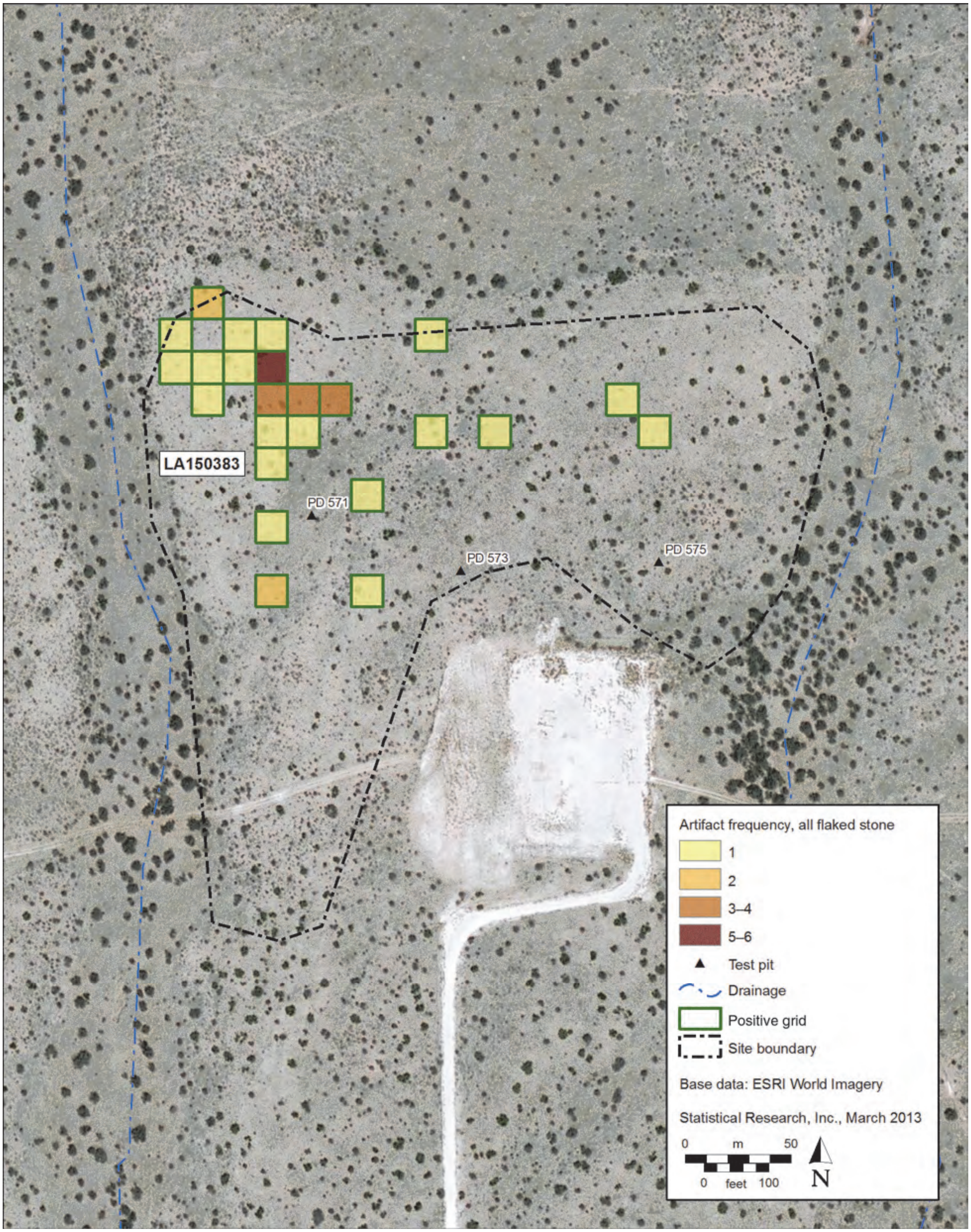

Figure 29. Site map of LA 150383.

Table 17. Artifacts from the Surface of LA 150383

Artifact Type, by Technological Type	Material Type				Total
	Chalcedony	Chert	Chert (Fusulinid)	Subtotal, All Chert	
Cores					
Bidirectional core	—	2	—	2	2
Multidirectional core	1	1	1	2	3
Cobble uniface	—	1	—	1	1
Tested cobble	—	1	1	2	2
Subtotal, cores	1	5	2	7	8
Debitage					
Core flake	1	17	2	19	20
Biface flake	—	—	1	1	1
Undetermined flake	—	—	5	5	5
Subtotal, debitage	1	17	8	25	26
Retouched tools					
Retouched piece	—	—	2	2	2
Uniface	—	1	1	2	2
Biface	—	1	1	2	2
Subtotal, retouched tools	—	2	4	6	6
Total	2	24	14	38	40

Table 18. Artifacts from Test Pits at LA 150383

Artifact Type, by Technological Type	Material Type
	Chert
Cores	
Bidirectional core	1
Unidirectional core	1
Subtotal, cores	2
Debitage	
Angular debris	4
Core flake	1
Subtotal, debitage	5
Total	7

was not reduced further on-site but was instead transported off-site. Both a visual assessment of the setting and the test excavations showed that there were no subsurface deposits at the site. Based on these findings, we believe that the site should be classified as a BLM Category 1 site.

LA 155867

Setting

LA 155867 is located on a low finger ridge that runs west–east along the northern side of Last Chance Draw. Soils at the site are a silty loam, and limestone cobbles are present, particularly along the southern margin of the site, where it is eroding into the draw. Vegetation consists of sparse grasses, creosote bush, whitethorn acacia, and other desertscrub species. Dark Canyon Road runs along the northern edge of the site, and parts of the southeastern end of the site are eroding into the draw. Ground visibility was very good, approaching 90 percent.

Site Description

The site was originally recorded in 2007 by the BLM-CFO and was classified as a BLM Category 2 site (Smith 2007). The site measured 245 by 55 m and covered an area of 13,475 m^2. It was described as a lithic scatter with 24 features, 22 of which were thermal features. The remaining 2 were a small stone alignment and a small artifact concentration composed of 34 flakes and 4 cores. The several-hundred artifacts noted across the site included cores, debitage, and a small number of formal tools, including 2 Gypsum points. All of the recorded artifacts were made of chert, which was present in a variety of colors. No ground stone or ceramic artifacts were noted.

SRI relocated the site and found it in similar condition to what had been noted in the previous site record (Figure 30). Just over 300 lithic artifacts were recorded on the surface of the site, and 23 of the 24 previously recorded features were relocated. The only feature that was not relocated was Feature 21, a short alignment of limestone cobbles. Although abundant chert debitage and cores were present at the site, there were relatively few natural chert cobbles, indicating that the cores may have been brought in from another source. Chert cobbles were present approximately 500 m to the north of the site, on a large limestone terrace that may have been the source of lithic raw materials at the site.

The 23 features identified at the site included 22 FCR concentrations and an artifact concentration. The thermal features contained between 5 and 205 pieces of FCR each, with an average of just under 40. Most of the features were sitting on the site surface and had been disturbed to varying degrees. Trowel tests were excavated into all of the features, but no charcoal was found, and no soil changes were noted. They all appeared to be deflated and to lack any potential for subsurface components. The artifact concentration was also relocated, but only 24 flakes and 5 cores were relocated.

A single 1-by-1-m test pit was excavated in the southern part of the site, at a small concentration of flakes and cores. The test pit was excavated to a depth of 20 cm, but no artifacts were found below 5 cm. The soil was a soft silty loam, and few rocks of any size were present. The site is located on a deflating and eroding surface; so, it seems unlikely that subsurface deposits are present.

Artifacts

In total, 310 artifacts were recorded on the site surface (Table 19): 27 cores, 4 cobble unifaces, 15 tested cobbles, 207 pieces of debitage, 7 retouched flakes, 5 bifaces, 1 hammerstone, 2 pieces of a broken milling stone, and 42 pieces of FCR. Nearly three-quarters of the debitage was composed of core flakes, but some biface flakes and pieces of angular debris were found, as well. Twenty of the flakes were broken and could not be identified by type. The vast majority of the artifacts, nearly 80 percent, were made of

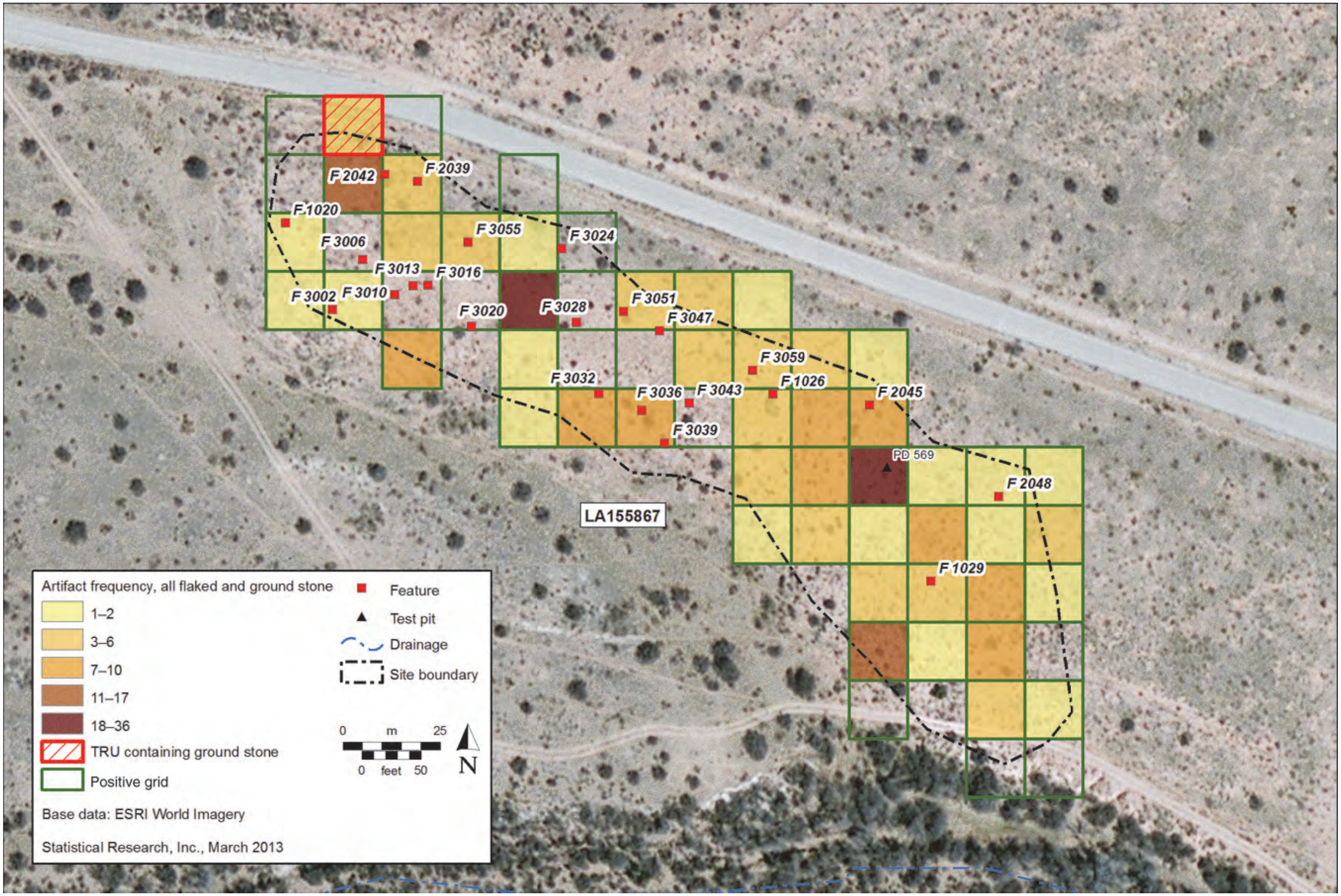

Figure 30. Site map of LA 155867.

Table 19. Artifacts from the Surface of LA 155867

Artifact Type, by Technological Type	Material Type										Total
	Chalcedony	Chert	Chert (Fusulinid)	Subtotal, All Chert	Granite	Limestone	Quartzite	Quartzite (Ortho)	Rhyolite	Sandstone	
Cores											
Bidirectional core	—	3	—	3	—	—	—	—	—	—	3
Multidirectional core	—	13	—	13	—	1	—	—	—	—	14
Unidirectional core	—	2	—	2	—	—	—	—	—	—	2
Unidentifiable core	—	3	4	7	—	1	—	—	—	—	8
Cobble uniface	—	—	2	2	—	2	—	—	—	—	4
Tested cobble	—	13	2	15	—	—	—	—	—	—	15
Subtotal, cores	—	34	8	42	—	4	—	—	—	—	46
Debitage											
Angular debris	—	18	2	20	—	1	—	—	—	—	21
Core flake	4	118	9	127	—	10	—	1	1	—	143
Biface flake	—	22	1	23	—	—	—	—	—	—	23
Undetermined flake	—	13	6	19	—	—	1	—	—	—	20
Subtotal, debitage	4	171	18	189	—	11	1	1	1	—	207
Retouched tools											
Retouched piece	—	5	2	7	—	—	—	—	—	—	7
Biface	—	4	—	4	—	1	—	—	—	—	5
Subtotal, retouched tools	—	9	2	11	—	1	—	—	—	—	12
Ground stone											
Milling stone	—	—	—	—	—	—	—	—	—	2	2
Subtotal, ground stone	—	—	—	—	—	—	—	—	—	2	2
Other											
Hammerstone	—	—	—	—	—	1	—	—	—	—	1
Fire-cracked rock	—	—	—	—	1	40	—	—	—	1	42
Subtotal, other	—	—	—	—	1	41	—	—	—	1	43
Total	4	214	28	242	1	57	1	1	1	3	310

chert, and small numbers of limestone, chalcedony, quartzite, and rhyolite artifacts were also present. The majority of the FCR was limestone, but some sandstone, and granite were also noted.

In addition to the surface artifacts, 25 pieces of debitage, all made of chert, were recovered from the test pit excavated in the southern end of the site: 10 core flakes, 5 biface flakes, 8 pieces of microdebitage, and 2 unidentifiable flakes (Table 20).

Summary

LA 155867 is a moderately sized prehistoric site that likely functioned as a campsite. The numerous thermal features across the site as well as the small number of ground stone artifacts suggest some type of residential occupation. Likewise, the lack of unworked cobbles makes it unlikely that the site was used as a primary source of raw materials. The bedload in the ephemeral streambed adjacent to the site was identical to the material found at the site itself. However, we observed no chert cobbles in the Dark Canyon drainage but only on the terrace above the site, which included abundant chert. Two gypsum points were found by previous investigators, but no other diagnostic artifacts were noted, and none of the features contained any charcoal or other datable materials. The features have deteriorated, and there were no subsurface deposits, but because of the large and complex lithic assemblage, we believe that the site should be classified as a BLM Category 2 site.

Adobe Draw Survey Area

Setting

This location is on one of several south–north-trending finger ridges running from higher ridges to the south and features exposures of limestone bedrock. Numerous chalcedony nodules are eroding from the area. Vegetation consists of sparse grasses, creosote bush, whitethorn acacia, and other desertscrub species. Ground visibility was very good, approaching 90 percent.

Description

This survey area consists of a number of reduction loci scattered across the ridge, interspersed between unmodified chert nodules (Figure 31). The survey parcel measured 100 by 50 m and covered 5,000 m^2. Much of the raw material is very poor quality, having many inclusions, voids, and other imperfections. However, a few loci that contain a high-quality, fine-grained chert were identified. Several cores, pieces of debitage, and tested nodules were associated with these loci, and a single 1-by-1-m test pit was excavated at one of these loci. There is virtually no soil development, and the unit extended only a few centimeters below the ground surface. Several artifacts were recovered from the surface of the test pit, mostly flakes and core fragments.

Artifacts

In total, 61 artifacts were recorded on the surface (Table 21): 2 cores, 6 tested cobbles, 51 pieces of debitage, 1 uniface, and 1 retouched flake. The debitage consisted of 49 core flakes and 2 indeterminate flake fragments. All 61 artifacts were classified as chalcedony in the field; however, they appeared upon further inspection to represent a light bluish gray chert.

Thirty-one artifacts were recovered from the test pit: 29 flakes (24 core flakes, 3 core-trimming flakes, and 2 pieces of angular debris) and 2 pieces of tested material (Table 22).

Table 20. Artifacts from Test Pits at LA155867

Artifact Type, by Technological Type	Material Type		Total
	Chert	Chert (Fusulinid)	
Debitage			
Core flake	10	—	10
Biface flake	4	1	5
Microdebitage	5	3	8
Undetermined flake	2	—	2
Total	21	4	25

Summary

This location represents a small quarry and consists of a small number of lithic-reduction loci set within an outcrop of the lower Yates Formation with eroding chert nodules. The small numbers of artifacts suggest that it was not a widely used source of lithic raw materials. Based on these findings, we believe that this location should be classified as a BLM Category 1 site.

Sites in the Lower Pecos River Group

Two large sites were located near the Pecos River, toward the southern portion of the study area. One site was located immediately east of the river, and the second was located approximately 11 km east of the river, near some minor tributaries.

LA 43423

Setting

The site is located on a broad, southern-sloping plain between ephemeral drainages. The surface of the site is covered in dense gravel and cobble deposits consisting of chert, quartzite, rhyolite, and various other material types. The gravel is concentrated primarily in a series of low ridges through the center of the site. A bladed dirt road runs through the center of the site, and a graded pad with storage tanks was present in the northwestern part of the site. Vegetation is sparse and consists of whitethorn acacia, yucca, creosote bush, and other small desert shrubs. Ground visibility was very good, approaching 90 percent.

Site Description

The site was originally recorded in 1968 for an unknown oil or gas project. It measured approximately 630 by 440 m and covered an area of 270,000 m^2. The site was revisited several times beginning in 1974, as part of the El Paso Natural Gas Clearance project. It was revisited again in 1998 by Southern New Mexico Archaeological Services, Inc. (Saunders 1998), and in 2010 and 2011 by Boone Archaeological Services, LLC (Rein 2010). These previous studies described the site as a large lithic scatter of variable

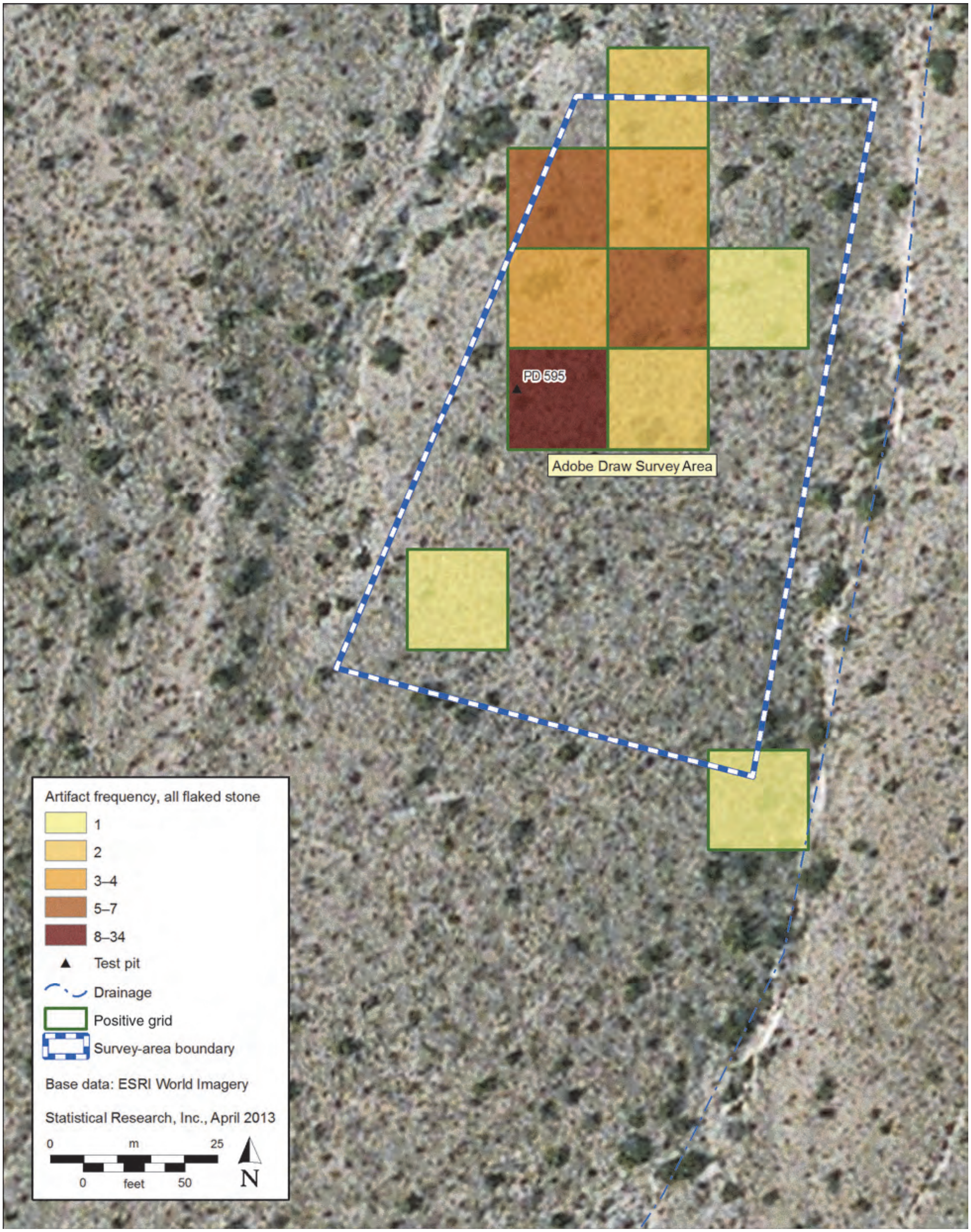

Figure 31. Map of the Adobe Draw Survey Area.

Table 21. Artifacts from the Surface of the Adobe Draw Survey Area

Artifact Type, by Technological Type	Material Type
	Chert
Cores	
Bidirectional core	1
Multidirectional core	1
Tested cobble	6
Subtotal, cores	8
Debitage	
Core flake	49
Undetermined flake	2
Subtotal, debitage	51
Retouched tools	
Retouched piece	1
Uniface	1
Subtotal, retouched tools	2
Total	61

Table 22. Artifacts from Test Pits in the Adobe Draw Survey Area

Artifact Type, by Technological Type	Material Type
	Chert
Cores	
Tested cobble	2
Subtotal, cores	2
Debitage	
Angular debris	2
Core flake	24
Core-trimming flake	3
Subtotal, debitage	29
Total	31

density and classified it as a BLM Category 2 site. Artifacts numbered in the thousands, and the collections consisted primarily of cores, tested cobbles, and flakes. A single projectile point was found, but ceramic artifacts were absent. The site was tentatively dated to the Middle to Late Archaic period. Two FCR concentrations were also identified in the center of the site.

SRI was able to relocate the site, which was in the same general condition as had been previously recorded. The site is quite large, and the density of artifacts varied greatly (Figure 32). The densest parts of the site were located on several low ridges that run through the center of the site. The gravel- and cobble-lag deposits were concentrated at these ridges, and artifacts were mixed with unmodified cobbles and rocks. The northern and eastern portions of the site as well as the disturbed areas along the graded rock featured few artifacts.

In total, six 1-by-1-m test pits were excavated across the site, in areas where artifact densities were high. Each test pit was excavated to a depth of approximately 5 cm, where a sterile layer of caliche and gypsum crystals was encountered. The cobbles on the surface of the site appeared to be sitting directly on top of that layer, and so, there seemed to be little potential for subsurface deposits at the site.

One of the two previously recorded FCR features was relocated during survey. The feature (Feature 3200) consisted of approximately 14 pieces of FCR spread over a 2.5-m-diameter area. The feature was completely disturbed, and all of the rocks were sitting directly on the ground surface. A trowel test was excavated into the center of the feature, but no charcoal or artifacts were identified.

Artifacts

In total, 639 artifacts were recorded on the site surface (Table 23), including 103 cores, 8 cobble unifaces, 7 cobble choppers, 103 tested cobbles, 379 pieces of debitage, 23 retouched flakes, 1 tabular knife, 3 unifaces, 2 bifaces, 7 scrapers, and 3 pieces of FCR. The majority of the debitage was composed of core flakes, and there were small numbers of biface flakes, angular debris, and other unidentified flakes. In addition, 14 pieces of FCR (from Feature 3200) and 2 gypsum crystals were also present. The majority of the artifacts were made of quartzite and chert, and there were small numbers of limestone, chalcedony, petrified wood, quartz, and rhyolite artifacts.

Overall, the lithic collection indicated that the site was used as a source of lithic raw materials. The vast majority of the artifacts were either cores or tested cobbles and core flakes. Most of the tools that were present were simple retouched flakes made from these materials. It appears that the main acquisition strategy involved testing cobbles to see whether they were suitable and then reducing them and carrying them off-site to where formal tools were made.

In addition to the surface artifacts, 44 artifacts were recovered from the six test pits: 1 biface, 5 cores, 35 pieces of debitage, 1 tested cobble, and 2 unifaces (Table 24). Most of the artifacts were chert, and there were smaller numbers of quartzite, chalcedony, and limestone.

Summary

LA 43423 is a large lithic-procurement site with surface lag gravels and cobbles that provided good-quality raw materials. Prehistoric visitors to the site apparently utilized the available lithic raw materials, tested cobbles, and produced flaked stone artifacts. No subsurface component to the site was detected, and no diagnostic artifacts were found. The features have deteriorated, and there were no subsurface deposits, but because of the large and complex lithic assemblage, we believe that the site should be classified as a BLM Category 2 site.

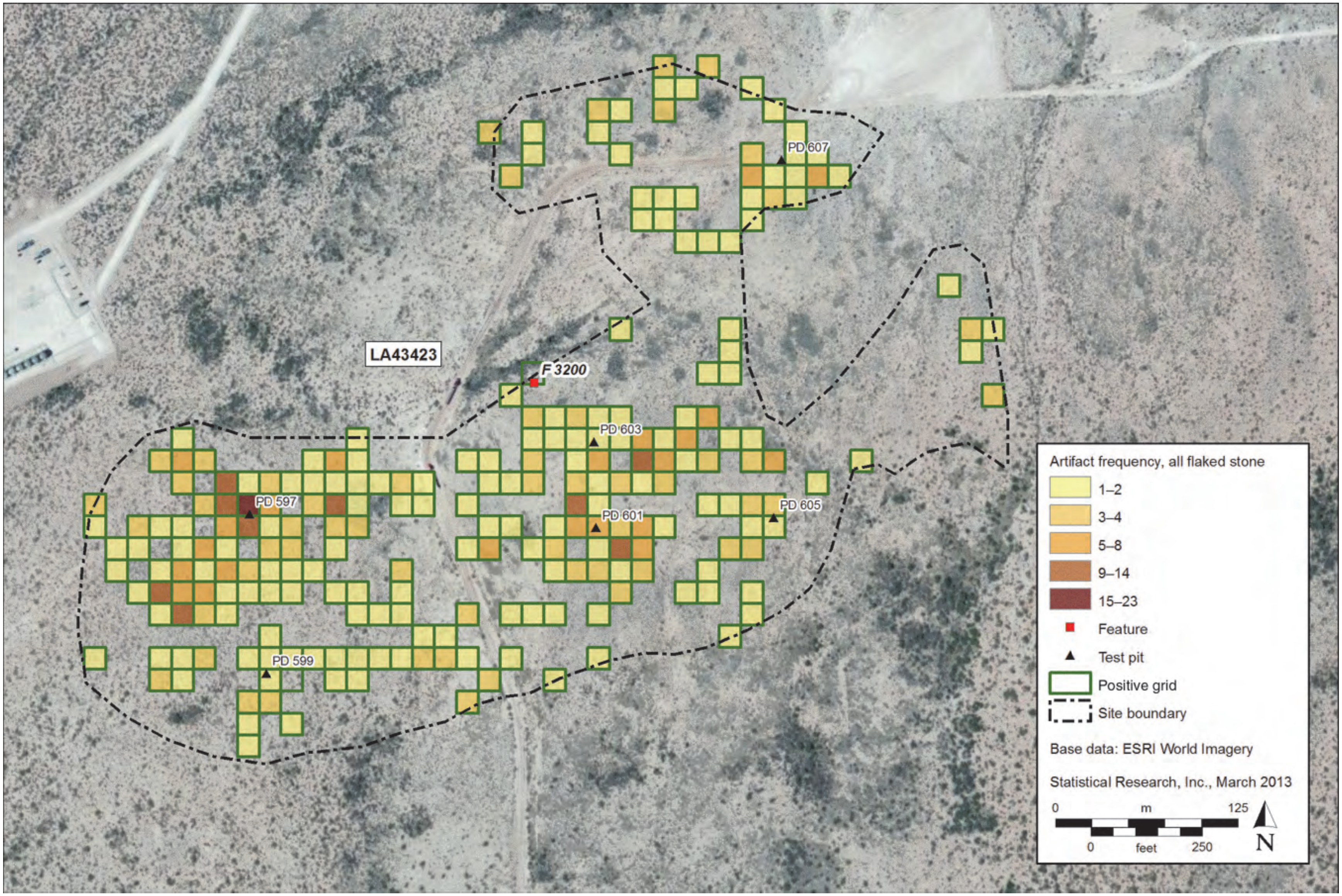

Figure 32. Site map of LA 43423.

Table 23. Artifacts from the Surface of LA 43423

Artifact Type, by Technological Type	Material Type														Total
	Chalcedony	Chert	Chert (Fusulinid)	San Andres Chert	Subtotal, All Chert	Limestone	Petrified Wood	Quartz	Quartzite	Mustard Quartzite	Purple Quartzite	Subtotal, All Quartzite	Rhyolite	Sandstone	
Cores															
Bidirectional core	4	15	1	—	16	1	—	—	16	—	1	17	—	—	38
Multidirectional core	6	13	6	—	19	—	—	—	9	1	7	17	2	—	44
Unidirectional core	—	9	1	—	10	—	—	—	3	—	4	7	—	—	17
Unidentifiable core	—	3	—	—	3	—	—	—	1	—	—	1	—	—	4
Cobble uniface	—	—	1	—	1	1	—	—	2	—	4	6	—	—	8
Cobble biface	—	1	—	—	1	1	—	—	4	—	1	5	—	—	7
Tested cobble	4	32	4	—	36	1	—	1	29	6	26	61	—	—	103
Subtotal, cores	14	73	13	—	86	4	—	1	64	7	43	114	2	—	221
Debitage															
Angular debris	—	2	1	1	4	—	—	—	2	—	1	3	—	—	7
Core flake	42	120	11	5	136	2	1	1	67	5	49	121	1	2	306
Biface flake	3	5	1	—	6	—	—	—	5	1	4	10	—	1	20
Undetermined flake	13	5	4	—	9	—	—	—	2	5	17	24	—	—	46
Subtotal, debitage	58	132	17	6	155	2	1	1	76	11	71	158	1	3	379
Retouched tools															
Retouched piece	—	7	3	—	10	1	—	—	5	1	6	12	—	—	23
Tabular knife	—	—	—	—	—	—	—	—	1	—	—	1	—	—	1
Uniface	—	1	—	—	1	—	—	—	1	—	1	2	—	—	3
Scraper	—	1	3	—	4	—	—	—	2	—	1	3	—	—	7
Biface	1	1	—	—	1	—	—	—	—	—	—	—	—	—	2
Subtotal, retouched tools	1	10	6	—	16	1	—	—	9	1	8	18	—	—	36

Artifact Type, by Technological Type	Material Type														Total
	Chalcedony	Chert	Chert (Fusulinid)	San Andres Chert	Subtotal, All Chert	Limestone	Petrified Wood	Quartz	Quartzite	Mustard Quartzite	Purple Quartzite	Subtotal, All Quartzite	Rhyolite	Sandstone	
Other															
Fire-cracked rock	—	—	—	—	—	3	—	—	—	—	—	—	—	—	3
Subtotal, other	—	—	—	—	—	3	—	—	—	—	—	—	—	—	3
Total	73	215	36	6	257	10	1	2	149	19	122	290	3	3	639

Table 24. Artifacts from Test Pits at LA 43423

Artifact Type, by Technological Type	Material Type								Total
	Chalcedony	Chert	San Andres Chert	Subtotal, All Chert	Limestone	Quartzite	Purple Quartzite	Subtotal, All Quartzite	
Cores									
Bidirectional core	—	3	—	3	—	—	—	—	3
Unidirectional core	—	1	—	1	—	—	1	1	2
Tested cobble	1	—	—	—	—	—	—	—	1
Subtotal, cores	1	4	—	4	—	—	1	1	6
Debitage									
Angular debris	2	3	—	3	—	1	1	2	7
Core flake	—	15	2	17	2	9	—	9	28
Subtotal, debitage	2	18	2	20	2	10	1	11	35
Retouched tools									
Uniface	—	1	—	1	—	1	—	1	2
Biface	—	1	—	1	—	—	—	—	1
Subtotal, retouched tools	—	2	—	2	—	1	—	1	3
Total	3	24	2	26	2	11	2	13	44

LA 122842

Setting

LA 122842 is located approximately 600 m east of the Pecos River and occupies the top and sides of a small but prominent hill that rises approximately 20–25 m above the surrounding terrain. Another, smaller knoll is located approximately 200 m west of the site. The northern side of the hill has been washed out and drops off steeply, and the southern side slopes gradually away. The washed-out areas on the northern side of the site are littered with quartzite, chert, and other cobbles. In some areas, particularly near the summit of the hill, Ogallala Formation conglomerate bedrock (the source of the loose cobbles found around the site) is visible at the surface. Vegetation is sparse and consists of whitethorn acacia, yucca, creosote bush, and other small desert shrubs. A large, graded pad with storage tanks was present at the northern end of the site. Ground visibility was very good, approaching 90 percent.

Site Description

The site was originally recorded by Southern New Mexico Archaeological Services, Inc., in 1998 and was revisited by Mesa Field Services in 2001. The site was classified as a BLM Category 2 site. It measured 400 by 300 m and covered just over 120,000 m^2. It was described as large lithic scatter of variable density. The surface of the site was covered with cobbles of quartzite, chert, chalcedony, and other materials, which were the sources of the artifacts at the site. Artifacts were recorded as numbering in the thousands and included cores, tested cobbles, and debitage, which consisted primarily of flakes from the early stages of reduction. Most of the artifacts identified were on the top of the hill.

Despite the large numbers of artifacts, no features or diagnostic artifacts were noted. It was originally proposed that the site may in fact be several smaller sites clustered together, but Mesa Field Services determined that there was a continuous, albeit sparse, scatter of artifacts across all of those areas.

SRI was able to relocate the site and found it in generally the same condition as had been described in previous site records (Figure 33). The surface of the site was covered in chert and quartzite cobbles, and some other materials were also present. Most of the artifacts were located at the summit of the hill and consisted of tested cobbles, cores, and debitage. Fewer artifacts were found on the slopes and base of the hill, but a small concentration was identified on the eastern slope of the hill.

SRI identified two previously unrecorded features at the summit of the hill: a large rock ring (Feature 1189) and a smaller FCR cluster (Feature 1192). Feature 1189 (Figure 34) measured approximately 6 m in diameter and was composed of thousands of small rocks that were generally less than 10 cm each in length. The ring was approximately 2.5 m thick and had a 1-m-diameter open area in the center. Approximately 10 larger rocks were lying on the surface, in the center. The small rocks that composed the actual ring were not fire affected and appeared to have been piled up from the area immediately surrounding the feature. Several pieces of quartzite debitage were noted within the rocks, and it appeared that artifacts were included as part of the ring's foundation. At least 1 rusted sanitary can was located on the feature, as well. A metal-rebar datum as well as some wooden stakes had been recently placed on the side of the feature. A large trowel test was excavated into the center of the feature, but no charcoal or artifacts were identified. The feature seemed to be sitting directly on top of the hill, and little sediment appeared to have accumulated within the open area in the center.

Feature 1192, the FCR feature, was located 2 m northeast of the ring and consisted of 10–15 pieces of thermally altered limestone and quartzite spread over a 1-m-diameter area. The feature was directly on top of the site surface, and a trowel test in the center showed that the feature did not continue below the ground surface. The dating of these two features was ambiguous. Neither of the previous investigators had mentioned them, although it was clear from their documentation that they had visited the summit of the hill. It is possible that both features were modern, or at least historical period, and not related to the prehistoric occupation of the site.

In total, four 1-by-1-m test pits were excavated at the site. Three were excavated on top of the hill, around Feature 1189, and the fourth was excavated on the eastern slope of the hill, in a small concentration of surface artifacts. The three test pits on the surface of the site were each excavated to a depth of less than 5 cm, where intact cobble deposits were encountered. The fourth test pit was excavated on a small ridge, in soft soils, but a layer of gypsum crystals was encountered at approximately 10 cm below the ground surface.

Artifacts

In total, 240 artifacts were recorded on the site surface (Table 7.21): 28 cores, 27 tested cobbles, 4 cobble choppers, 1 cobble uniface, 174 pieces of debitage, 5 retouched pieces, and 1 scraper. Nearly 70 percent of the artifacts were made from quartzite; chert was the second-most-prevalent raw-material type. Small numbers of chalcedony, limestone, rhyolite, and sandstone artifacts were also recorded. Most of the debitage on the surface was composed of core flakes. There was also a large quantity of angular debris on the site surface. However, little of that material could be definitively identified as cultural; therefore, it was not included in the artifact counts. This could account for the discrepancy between the artifact counts in previous site records and those reported here.

In total, 108 artifacts were recovered from the four test pits: 1 biface, 9 cores, 95 pieces of debitage, 2 notches, 1 biface, and a tested cobble (Table 7.22). The vast majority (n = 225) came from a test pit (PD 611) located north of Feature 1192. As seen in Figure 33, this coincides with the densest part of the site, based on the surface survey. The debitage consisted of 68 core flakes, 2 biface flakes, 9 pieces of microdebitage, 1 piece of utilized debitage, and 15 pieces of angular debris.

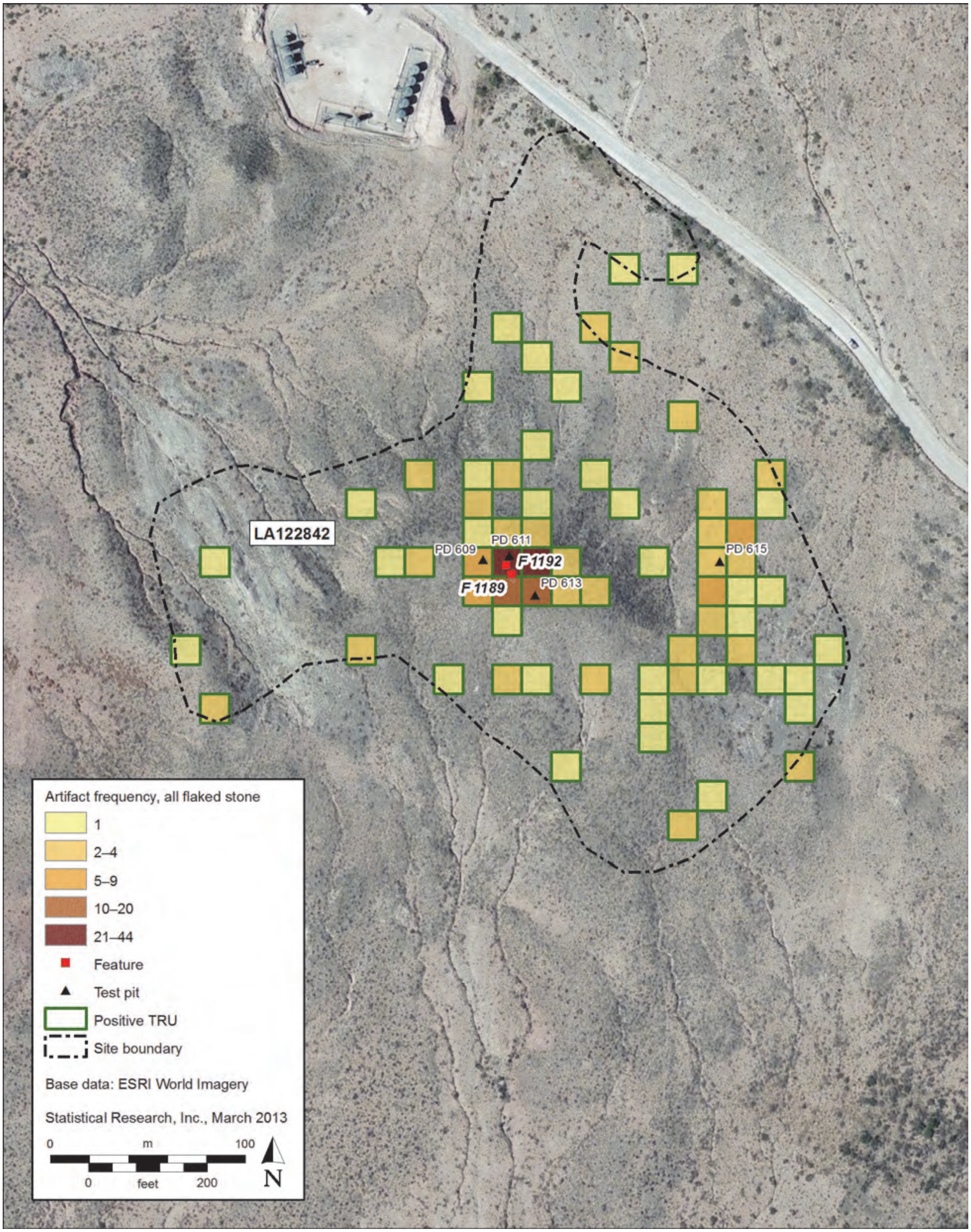

Figure 33. Site map of LA 122842.

Figure 34. Feature 1189 at LA 122842, view to the northwest.

Summary

LA 122842 was a medium-sized lithic-procurement site. In contrast to LA 43423, where there were several concentrations of artifacts associated with lag deposits, the majority of the artifacts at LA 122842 were concentrated on the hilltop, and a sparse scatter of artifacts defined much of the rest of the site (see Figure 33). The hilltop concentration was also associated with two features, but it was not clear whether the features were contemporaneous with the scatter or were modern or historical-period intrusions. The features were deteriorated, and there were no subsurface deposits, but because of the large and complex lithic assemblage, we believe that the site should be classified as a BLM Category 2 site.

Isolated Sites

Two sites were located in isolated parts of the study area, outside the other, discrete geological units.

LA 149992

Setting

The site is located on a sandy plain, near an eroding outcrop of opalized caliche. Several shallow washes run south from the outcrop but do not deeply scour the ground surface. Vegetation consists of sparse grasses,

Table 25. Artifacts from the Surface of LA 122842

Artifact Type, by Technological Type	Material Type												Total
	Chalcedony	Chert	Chert (Fusulinid)	San Andres Chert	Subtotal, All Chert	Limestone	Quartzite	Mustard Quartzite	Purple Quartzite	Subtotal, All Quartzite	Rhyolite	Sandstone	
Core													
Bidirectional core	1	—	—	—	—	—	1	—	2	3	1	—	5
Multidirectional core	—	2	—	—	2	—	1	—	9	10	—	—	12
Unidirectional core	—	1	—	—	1	—	5	—	2	7	—	—	8
Unidentifiable core	—	1	—	—	1	—	2	—	—	2	—	—	3
Cobble uniface	—	—	—	—	—	1	—	—	—	—	—	—	1
Cobble biface	—	—	—	—	—	—	2	—	1	3	—	1	4
Tested cobble	—	8	—	—	8	1	6	—	12	18	—	—	27
Subtotal, cores	1	12	—	—	12	2	17	—	26	43	1	1	60
Debitage													
Core flake	10	37	—	1	38	1	19	1	87	107	1	—	157
Biface flake	1	1	—	—	1	—	—	—	3	3	—	—	5
Undetermined flake	2	2	—	—	2	—	2	—	6	8	—	—	12
Subtotal, debitage	13	40	—	1	41	1	21	1	96	118	1	—	174
Retouched tools													
Retouched piece	—	1	1	—	2	—	1	—	2	3	—	—	5
Scraper	—	1	—	—	1	—	—	—	—	—	—	—	1
Subtotal, retouched tools	—	2	1	—	3	—	1	—	2	3	—	—	6
Total	14	54	1	1	56	3	39	1	124	164	2	1	240

Table 26. Artifacts from Test Pits at LA 122842

Artifact Type, by Technological Type	Material Type: Chalcedony	Chert	Limestone	Petrified Wood	Quartzite	Purple Quartzite	Subtotal, All Quartzite	Rhyolite	Total
Cores									
Bidirectional core	—	—	—	—	—	1	1	—	1
Multidirectional core	—	1	—	—	2	—	2	—	3
Undetermined core	—	—	—	—	—	1	1	—	1
Unidirectional core	—	—	—	—	3	1	4	—	4
Tested cobble	—	—	—	—	—	1	1	—	1
Subtotal, cores	—	1	—	—	5	4	9	—	10
Debitage									
Angular debris	—	4	—	—	1	10	11	—	15
Core flake	9	31	1	1	8	17	25	1	68
Biface flake	—	1	—	—	—	1	1	—	2
Microdebitage	3	5	—	—	1	—	1	—	9
Utilized debitage	—	1	—	—	—	—	—	—	1
Subtotal, debitage	12	42	1	1	10	28	38	1	95
Retouched tools									
Notch	—	1	—	—	—	1	1	—	2
Biface	—	1	—	—	—	—	—	—	1
Subtotal, retouched tools	—	2	—	—	—	1	1	—	3
Total	12	45	1	1	15	33	48	1	108

agave, yucca, whitethorn acacia, and other desertscrub species. Ground visibility was very good, approaching 90 percent.

Site Description

The site was previously recorded in 2005 by Ecosystem Management, Inc. (Ecosystem Management 2006), and was classified as a BLM Category 2 site. It was described as a large lithic scatter consisting of thousands of artifacts, most of which were composed of silicified sandstone (here called opalized caliche), which was readily available at the site. The site measured 185 by 124 m and covered 22,940 m^2. Most of the artifacts were multidirectional and unidirectional cores, hammerstones, and debitage. No formal tools or diagnostic artifacts were noted.

SRI was able to relocate the site but does not believe it to be as extensive as previously recorded (Figure 35). There were many opalized-caliche nodules present at the site, concentrated in the shallow washes that run south from the sandstone outcrop outside the site boundary. An examination of these nodules showed that the vast majority were rocks that had broken as a result of natural processes that created curved spalls superficially resembling cores and flakes. Only small numbers of artifacts were noted

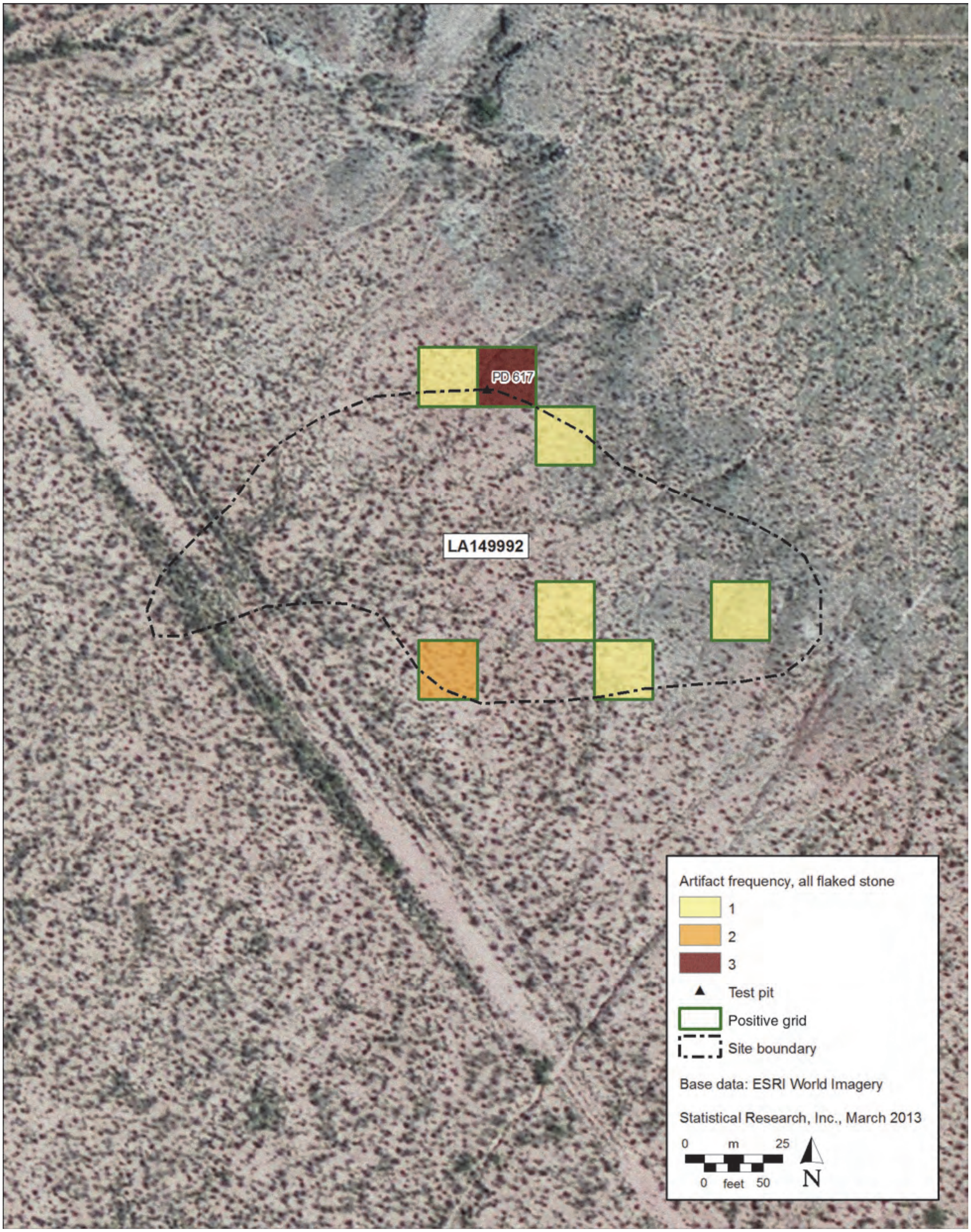

Figure 35. Site map of LA 149992.

at the site, including chert artifacts and a few pieces of opalized-caliche debitage that had platforms, bulbs of percussion, and other diagnostic attributes.

One 1-by-1-m test pit was excavated where a few artifacts were noted. The artifacts were all sitting on top of eroded sandstone bedrock, and no artifacts were found below the ground surface.

Artifacts

Only 10 artifacts were recorded on the site surface (Table 27): 1 core, 1 tested cobble, and 8 pieces of debitage. The core was made of chert, and the tested cobble was made of quartzite. The debitage included 5 pieces of opalized caliche and 1 piece each of chert, quartzite, and chalcedony.

Two additional opalized-caliche core flakes were recovered from the test pit.

Summary

In reality, there were very few actual artifacts at this site. The majority of the materials on the site surface consisted of sandstone nodules that had naturally spalled to create ecofacts resembling human-made artifacts. Given the small number of sandstone artifacts present, it seems likely that although prehistoric inhabitants were aware of the locale, it was not an important source of lithic raw materials. Because of the small site assemblage, we believe that the site should be classified as a BLM Category 1 site.

LA169668

Setting

The site is located on the southern margin of Lone Tree Draw, a shallow, northeast–southwest-trending wash. The site is situated on a long, low ridge that forms the southern side of the draw, and part of the site spreads down to the floor of the wash. The ridgetop features a degrading caliche-and-gypsum cap with a shallow soil on top. The floor of the wash cuts through underlying alluvial-sand deposits. Small quantities of cobbles, primarily quartzite and chert, were present with the caliche soils. Several small washes run down from the ridgetop in the floor of the draw, and the cobbles on the ridgetop have been washed into those areas and concentrated. Vegetation is sparse, consisting of grasses, agave, whitethorn acacia, and other desertscrub species as well as juniper and mesquite. Ground visibility was generally good, varying from 70 to 90 percent in most areas, although portions of the ridgetop were covered in denser grasses.

Site Description

The site was originally recorded by Lone Mountain Archaeological Services in 2011 (Schultheis and Francisco 2011) and was described as a large, sparse scatter composed of lithic debitage, hammerstones, cores, and a small number of ceramic sherds. The site measured 537 by 452 m, covered an area of 242,724 m^2, and was classified as a BLM Category 2 site. Most of the recorded artifacts were located at the northern edge of the site, in the small washes that run from the ridgetop to the floor of the draw. Approximately 150 pieces of FCR were noted on-site, though not in any significant concentrations.

SRI was able to relocate the site, and it appeared to conform generally to the earlier recording (Figure 36). However, SRI was not able to relocate a number of the artifacts, particularly the hammerstones, ceramics, and FCR. A number of fist-sized quartzite cobbles were noted on the site surface, but only a few showed modifications typical of use as hammerstones. FCR, primarily burned caliche, was noted throughout the site but numbered only roughly half the previously recorded counts. As noted in the previous site record, the majority of the artifacts were concentrated in the shallow washes leading from the

Table 27. Artifacts from the Surface of LA 149992

Artifact Type, by Technological Type	Material Type				Total
	Chalcedony	Chert	Quartzite	Opalized Caliche	
Cores					
Unidentifiable core	—	1	—	—	1
Tested cobble	—	—	1	—	1
Subtotal, cores	—	1	1	—	2
Debitage					
Core flake	—	1	1	4	6
Undetermined flake	1	—	—	1	2
Subtotal, debitage	1	1	1	5	8
Total	1	2	2	5	10

ridgetop to the floor of the draw. It appeared that prehistoric visitors to the site selected cobbles found in these washes and tested them to check their suitability as tool-stone material. One deflated concentration of FCR was found in the center of the site. It contained approximately 20 pieces of FCR and no other artifacts. A trowel test was excavated into the feature, but no soil change or carbonized organic material was identified.

In total, six 1-by-1-m test pits were excavated across the site. The six units were placed where artifacts were identified on the site surface. Five of the six units ended within 5 cm of the site surface, where the thin layer of topsoil changed to a layer of caliche and gypsum crystals. One test pit was excavated on the floor of the draw, to a depth of 20 cm. The soil there was a soft, silty sand, and although several cobbles and pebbles were present on the surface, no rocks were encountered below the ground surface. No artifacts were found below the ground surface in any of the units.

Artifacts

In total, 171 artifacts were recorded on the surface of the site (Table 28): 3 cores, 1 cobble uniface, 1 cobble biface, 43 tested cobbles, 50 pieces of debitage, 1 biface, 5 hammerstones, and 67 pieces of FCR. Among the cores and tested materials, as well as the debitage, there were roughly equal numbers of chert and quartzite artifacts and small numbers of artifacts of other materials. The FCR fragments were primarily burned caliche, and some were limestone and quartzite.

Fourteen artifacts were recovered from the test pits: 1 cobble uniface, 1 core, 11 pieces of debitage, and 1 uniface (Table 29). The debitage consisted of 10 core flakes and 1 piece of angular debris.

Summary

LA 169668 is a large but sparse lithic assemblage. It appears that the site was utilized as a source of lithic raw materials, but given the limited availability of usable cobbles at the site, it seems probable that the site was not frequently visited. There were no subsurface deposits at the site. Because of the small site assemblage, we believe that LA 169668 should be classified as a BLM Category 1 site.

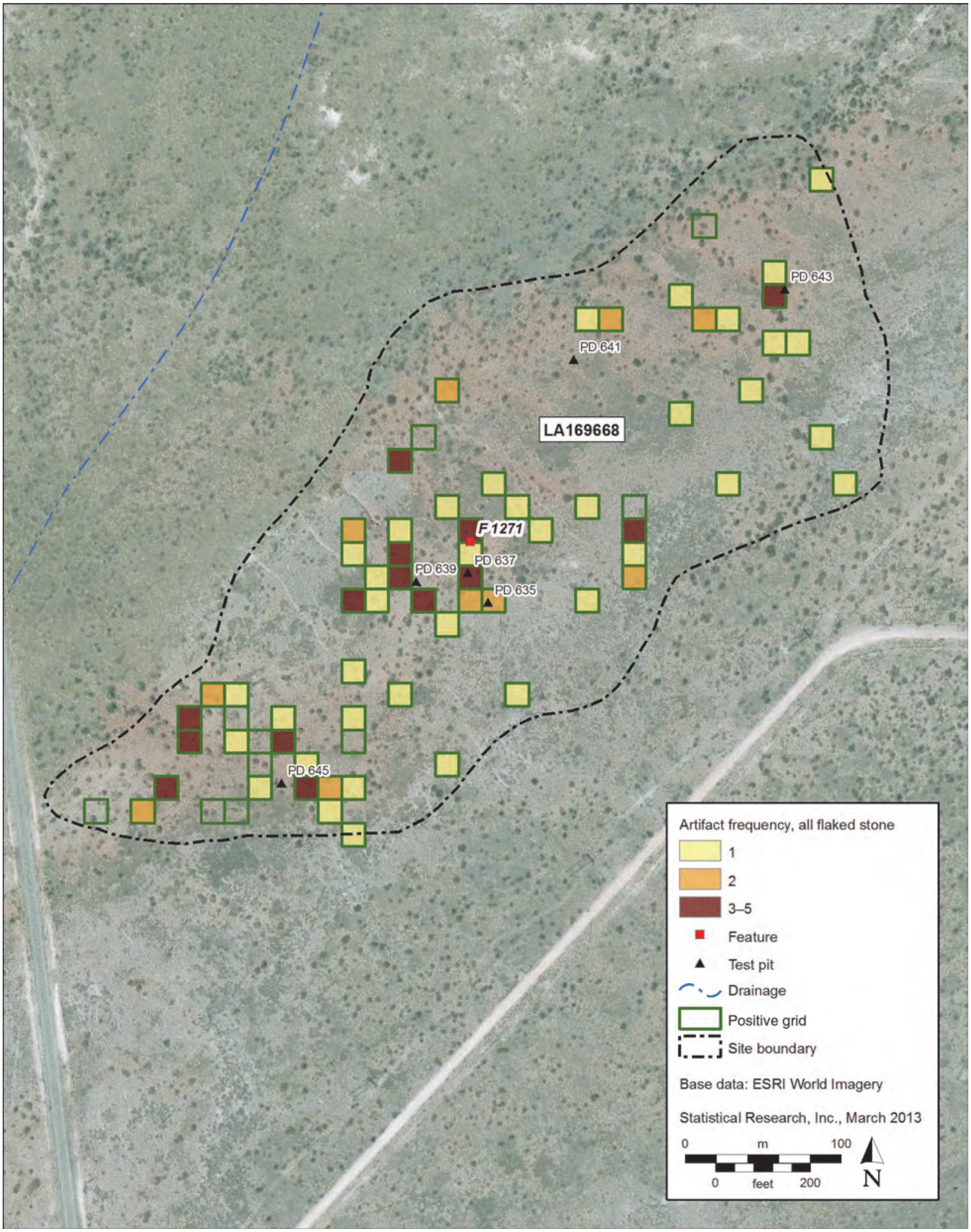

Figure 36. Site map of LA 169668.

Table 28. Artifacts from the Surface of LA 169668

Artifact Type, by Technological Type	Material Type												Total
	Caliche	Chalcedony	Chert	Chert (Fusulinid)	San Andres Chert	Subtotal, All Chert	Limestone	Quartzite	Mustard Quartzite	Purple Quartzite	Subtotal, All Quartzite	Rhyolite	
Cores													
Bidirectional core	—	—	2	—	—	2	—	—	—	1	1	—	3
Cobble uniface	—	—	1	—	—	1	—	—	—	—	—	—	1
Cobble biface	—	—	—	—	—	—	—	1	—	—	1	—	1
Tested cobble	—	—	15	3	3	21	1	12	1	8	21	—	43
Subtotal, cores	—	—	18	3	3	24	1	13	1	9	23	—	48
Debitage													
Angular debris	—	1	2	—	—	2	—	—	—	2	2	—	5
Core flake	—	—	18	1	1	20	—	7	—	8	15	2	37
Biface flake	—	—	2	—	—	2	—	—	—	—	—	—	2
Undetermined flake	—	1	—	—	—	—	—	3	1	1	5	—	6
Subtotal, debitage	—	2	22	1	1	24	—	10	1	11	22	2	50
Retouched tools													
Biface	—	1	—	—	—	—	—	—	—	—	—	—	1
Subtotal, retouched tools	—	1	—	—	—	—	—	—	—	—	—	—	1
Other													
Hammerstone	—	—	—	—	—	—	—	2	—	3	5	—	5
Fire-cracked rock	53	—	—	—	—	—	10	4	—	—	4	—	67
Subtotal, other	53	—	—	—	—	—	10	6	—	3	9	—	72
Total	53	3	40	4	4	48	11	29	2	23	54	2	171

Table 29. Artifacts from Test Pits at LA 169668

Artifact Type, by Technological Type	Material Type						Total
	Chalcedony	Chert	Petrified Wood	Quartzite	Purple Quartzite	Subtotal, All Quartzite	
Cores							
Unidirectional core	—	1	—	—	—	—	1
Cobble uniface	—	—	1	—	—	—	1
Subtotal, cores	—	1	1	—	—	—	2
Debitage							
Angular debris	—	1	—	—	—	—	1
Core flake	2	5	—	2	1	3	10
Subtotal, debitage	2	6	—	2	1	3	11
Retouched tools							
Uniface	—	—	—	—	1	1	1
Subtotal, retouched tools	—	—	—	—	1	1	1
Total	2	7	1	2	2	4	14

Summary

The 14 sites and 2 survey areas described here varied widely in terms of their geologic settings, sizes, and artifact assemblages. In the following chapter, we analyze the lithic assemblages from each location and compare sites to each other and to other sites in southeastern New Mexico.

CHAPTER 8

Lithic Procurement and Stone-Tool Technology

Bradley J. Vierra and Scott H. Kremkau

Introduction

This chapter presents the results of the in-field analysis of over 4,000 lithic artifacts recorded during the course of the fieldwork. Lithic artifacts were found at 15 of the 16 locations investigated by SRI. No artifacts were found at LA 121969 (see Chapter 7). This chapter has four parts. The first three are as follows: an analysis of the artifacts from all 15 locations in SRI's study area as a single group; a second analysis, which segregates the locations by geomorphic area; and a review of the variability exhibited by the locations with respect to assemblage size and artifact-type richness. The fourth and final section compares the 15 locations within the SRI study area to other sites in the region, in order to compare and contrast the stone-tool technology represented at procurement locales vs. habitation sites.

The 15 locations in the SRI study area were of three different types: campsites, of which LA 155867 was the only example; lithic-procurement locales; and quarries. The last two, though similar, are distinguished by the nature of the parent material that was collected by prehistoric peoples. To take the latter first, quarries are locations in which raw materials were directly extracted from their primary geologic contexts. Within the current study, this refers to the sites and survey parcels within the Artesia and San Andres Groups as well as to isolated site LA 149992. In these locations, lithic raw material was recovered from the bedrock in which it had formed. Sites in the Upper and Lower Pecos River Groups as well as isolated site LA 169668 represent procurement locales, where the lithic raw material was moved from its primary geologic context. In the cases presented here, the raw materials were waterworn cobbles present in gravel formations along the Pecos River.

Project-Wide Analysis

In total, 4,508 artifacts were recorded during the course of the in-field analysis (Table 30). The entire recorded assemblage consisted of 472 worked cobbles, 384 cores, 2,572 pieces of debitage, 118 retouched tools, 3 ground stone tools, 9 hammerstones, and a quartz crystal. In addition, 949 isolated pieces of burned rock that were not associated with specific features were also recorded.

The majority of the flaked stone artifacts were made of either chert (49.5 percent) or quartzite (40.9 percent); there were fewer made of chalcedony, rhyolite, or other materials (Figure 37). The cherts were subdivided into three groups: generalized cherts (64.3 percent), San Andres chert (18.6 percent), and cherts containing fusulinid fossils (17.1 percent). The quartzites were also segregated into generalized quartzites (46.0 percent), purple quartzite (50.5 percent), and mustard quartzite (3.5 percent). Two milling stones and a pestle were made of sandstone, and nine hammerstones were made of quartzite, purple quartzite, and limestone. Limestone (86.7 percent) was the dominant rock type that exhibited thermal alteration and therefore the dominant type classified as FCR.

Table 30. Project Lithic-Artifact Types, by Material Type

Artifact Type, by Technological Type	Caliche	Chalcedony	Chert	Chert (Fusulinid)	San Andres Chert	Granite	Limestone	Metamorphic (Indeterminate)	Petrified Wood	Quartz	Quartzite	Mustard Quartzite	Purple Quartzite	Quartzite (Ortho)	Rhyolite	Sandstone	Total
Cores																	
Bidirectional core	—	6	32	3	16	—	1	—	—	—	24	—	9	—	2	—	93
Multidirectional core	—	8	67	18	25	—	1	—	—	—	29	3	33	—	9	—	193
Unidirectional core	—	—	15	1	9	—	—	—	—	—	11	1	10	—	1	—	48
Unidentifiable core	—	—	23	18	3	—	3	—	—	—	3	—	—	—	—	—	50
Cobble uniface	—	—	4	6	—	—	7	—	—	—	2	1	4	—	1	—	25
Cobble biface	—	—	1	—	1	—	1	—	—	—	14	3	4	—	—	1	25
Tested cobble	—	12	97	23	24	—	4	—	—	1	126	8	120	—	7	—	422
Subtotal, cores	—	26	239	69	78	—	17	—	—	1	209	16	180	—	20	1	856
Debitage																	
Angular debris	—	8	45	44	1	—	2	—	—	—	42	1	23	—	—	—	166
Core flake	—	130	664	97	230	2	19	1	1	1	333	21	413	1	41	7	1,961
Biface flake	—	5	69	11	3	—	—	—	—	—	7	5	13	—	4	1	118
Undetermined flake	—	23	73	44	9	—	1	—	—	—	62	6	95	—	13	1	327
Subtotal, debitage	—	166	851	196	243	2	22	1	1	1	444	33	544	1	58	9	2,572
Retouched tools																	
Retouched piece	—	1	28	20	2	—	1	—	—	—	10	1	8	—	3	—	74
Tabular knife	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	1
Uniface	—	1	2	2	2	—	—	—	—	—	2	—	1	—	—	—	10
Scraper	—	—	3	8	2	—	—	—	—	—	2	—	1	—	—	—	16
Biface	—	2	9	3	1	—	1	—	—	—	1	—	—	—	—	—	17
Subtotal, retouched tools	—	4	42	33	7	—	2	—	—	—	16	1	10	—	3	—	118
Ground stone																	

Artifact Type, by Technological Type	Caliche	Chalcedony	Chert	Chert (Fusulinid)	San Andres Chert	Granite	Limestone	Metamorphic (Indeterminate)	Petrified Wood	Quartz	Quartzite	Mustard Quartzite	Purple Quartzite	Quartzite (Ortho)	Rhyolite	Sandstone	Total
Milling stone	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	2
Pestle	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1
Subtotal, ground stone	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	3
Other																	
Hammerstone	—	—	—	—	—	—	1	—	—	—	4	—	4	—	—	—	9
Fire-cracked rock	54	—	2	1	—	2	823	—	—	—	4	—	2	—	—	61	949
Crystal	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	2
Subtotal, other	54	—	2	1	—	2	824	—	—	1	9	—	6	—	—	61	960
Total	54	196	1,134	299	328	4	865	1	1	3	678	50	740	1	81	74	4,509

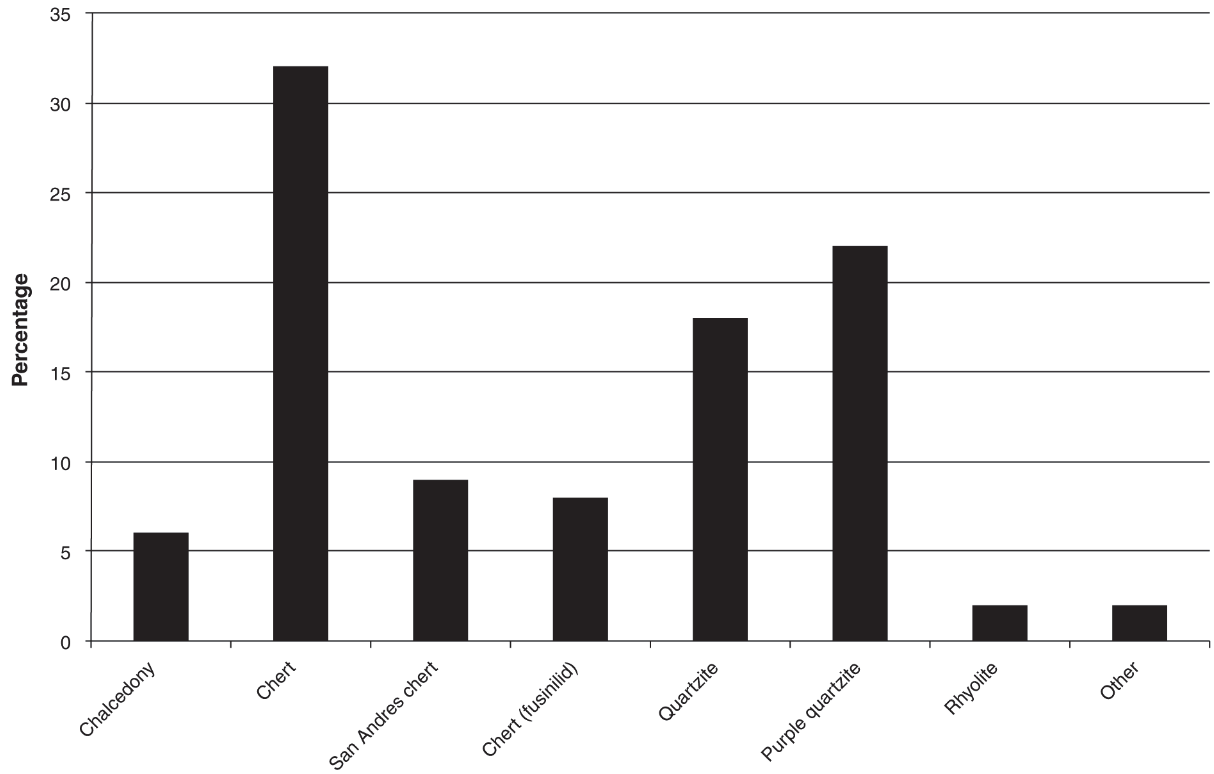

Figure 37. Lithic-material types.

Lithic Reduction

Core reduction was the primary activity that occurred at the lithic-procurement locales. Figure 38 illustrates that the overall project assemblages primarily consisted of core flakes; there were fewer worked cobbles and cores. Retouched tools, ground stone, and hammerstones were much less frequently recorded. It is not surprising that tested cobbles (n = 422) were prevalent and that there were a few cobble unifaces and bifaces. However, quartzite cobbles (60.1 percent) were more often tested and discarded than were chert cobbles (34.1 percent). This pattern corresponds with the information for platform cores. That is, quartzite was more highly represented as worked cobbles, whereas chert was more intensively worked and therefore was represented by increasing numbers of unidirectional (n = 25), bidirectional (n = 51), and multidirectional cores (n = 110).

As previously noted, core flakes constituted the dominant artifact type at the procurement locales, and there were fewer pieces of angular debris and fewer biface flakes. Of course, it is very difficult to distinguish culturally modified debris from naturally fractured pieces in surface gravels. Therefore, the amount of debris may be underestimated. Core-reduction activities focused on chert (50.1 percent) and quartzite (39.6 percent) materials, and tool-production activities focused on the use of chert (70.3 percent). This provides further support to the contention that chert was more highly reduced at the surveyed locations than was quartzite, including for both core-reduction and tool-production activities.

Although there were relatively few retouched tools recorded during the in-field analysis, simple retouched flakes (62.7 percent) far outnumbered the formal tool types, like unifaces, scrapers, and bifaces. Chert (69.4 percent) was preferentially selected for the production of retouched tools, and there was much less selection of quartzite (22.8 percent).

All the tools identified during the survey were made of locally available materials. That is to say, within the San Andres and Artesia Groups, tools were all made from chert, and tools from the Upper and

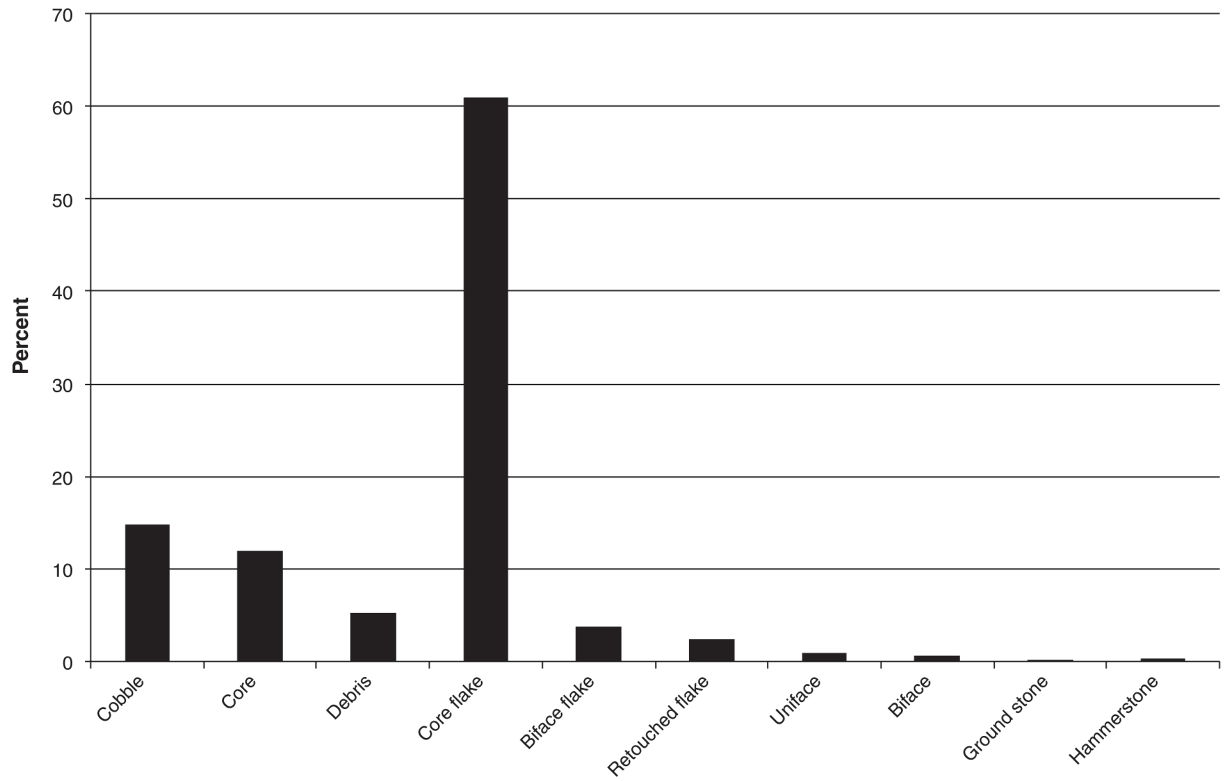

Figure 38. Lithic-artifact types.

Lower Pecos River Groups and LA 169668 were made of chert, quartzite, chalcedony, and a few other materials that were available within the cobble deposits. Only LA 149992 featured a relatively high proportion of nonlocal materials; half the materials were nonlocal chert, quartzite, and chalcedony. However, because of the limited number of artifacts (n = 10), this does not represent a meaningful pattern. Only one piece of obsidian, a small nodule fragment, was found at any of the study locations. This item was made of Cerro Toledo obsidian, and the closest source would be the Rio Grande gravels (Church 2000).

Flaked stone tools, both formal and informal, were quite rare in comparison to debitage and cores. Retouched flakes constituted the most common tool type, and there were 74 from the entire project area. Smaller numbers of cobble bifaces and cobble unifaces, with retouched bifaces, unifaces, and scrapers as well as a tabular knife, were also found. Among all tool types, chert was the most common material, with the exception of the cobble bifaces and cobble unifaces, which were dominated by quartzite. However, the cobble bifaces and coble unifaces recorded at the sites seemed to be primarily cores and tested cobbles. Most did not seem to have been used as choppers or other cobble tools.

It is unclear what quartzite was used for at sites in the Upper and Lower Pecos River Groups or at LA 169668. Quartzite was the most common material type at all of these sites, but most of the tools were chert. Utilized flakes were primarily chert, and less than one-third of the assemblage was composed of quartzite flakes. Even at sites with abundant quartzite, chert flakes were still preferred for producing utilized flakes. However, obvious edge scarring might be more visible on chert than on quartzite flakes during in-field analysis.

Site-Group Analysis

The previous information can be segregated by group for the project area. The San Andres Group is situated in an area with outcrops of San Andres limestone that contains a distinctive gray, banded chert. In total, 357 lithic artifacts were recorded in that area (Table 31). It is not surprising that 99 percent of the artifacts were made of chert and that practically all were made of San Andres chert. There was no quartzite represented; there were some cherts containing fusulinid fossils and some generalized cherts. The assemblage was similar to that of the overall project area, in that there were abundant tested cobbles, an emphasis on core-reduction activities, and little evidence of tool production or retouched tools.

The Artesia Group was also dominated by the use of chert because of the prevalence of limestone outcrops in the area (Table 32). However, most of the chert consisted of generalized chert, and there was some chert containing fusulinid fossils, which is weathering out of the Cherry Canyon sandstone, where it occurs as nodules. This formation is the lateral equivalent of the San Andres limestone. It seems likely that the small amounts of chert containing fusulinid fossils recorded in the San Andres Group were probably derived from the area of the Artesia Group. Likewise, the few pieces of San Andres chert may have been brought into the area from the San Andres Group source area. Again, there was almost no quartzite present in the Artesia Group assemblages, but some limestone was worked at those locations.

Most of the assemblages in the Upper and Lower Pecos River Groups and at isolated sites were located in cobble fields, and a mix of material types was present (Tables 33–35). The lone exception to this was LA 149992, located at an outcrop of silicified sandstone, but there were so few artifacts at the site that it had little effect on the averages. Most of the artifacts were composed of a chert or quartzite, about 40–50 percent of which was purple quartzite. A number of other material types were also present, of which rhyolite was the most common, particularly among the Upper Pecos River Group sites.

An analysis of the artifacts by group enables us to get some overall impressions of these different areas. As discussed in the introduction to this chapter, the locations in the study area can be classified as either primary quarries or secondary procurement areas. These designations refer to the geologic contexts of the locations and whether or not the lithic raw materials utilized were from primary geologic sources. In practice, this difference should be visible archaeologically. There should be relatively more tested cobbles at procurement areas and more cores at quarries.

When we look at core types among the different groups, we do see some patterning. Tested cobbles made up between 35 and 37 percent of the total core numbers at locations in the San Andres and Artesia Groups. The number was much higher at sites in the Upper and Lower Pecos River Groups and at LA 169668, where tested material composed 61, 49, and 92 percent of the core totals, respectively.

There are also some interesting patterns perceived when looking at the ratio of flakes with cortex to flakes without cortex. At locations in the Artesia and San Andres Groups, approximately one-third of the flakes had no cortex, and two-thirds had at least some cortex present. Sites in the Upper Pecos River Group and LA 169668 had ratios of flakes with cortex to flakes without cortex that were similar to those of locations in the Artesia and San Andres Groups. Flakes with cortex were much more common at sites in the Lower Pecos River Group, where 84 percent of flakes featured at least some cortex.

It is not surprising that flakes at locations in the Artesia and San Andres Groups should have somewhat less cortex, because people reduced blocks of chert that were taken directly from bedrock outcrops. However, it is not clear why sites in the Upper Pecos River Group and LA 169668 should have similar ratios and Lower Pecos River Group sites should have so many more flakes with cortex. Locations in the Artesia and San Andres Groups were dominated by chert, and locations in the Upper and Lower Pecos River Groups and LA 169668 featured large quantities of quartzite. Considering the greater percentages of tested material at these locations and the larger number of quartzite cobbles, it would be expected that there should be relatively more flakes with cortex there.

The locations in the Artesia Group had a nearly identical ratio of flakes with cortex to flakes without cortex to the ratio for locations in the San Andres Group (Artesia, 35 percent without cortex; San Andres, 34 percent without cortex). However, the Artesia Group locations collectively featured a much higher debitage-to-core ratio (Artesia, 0.21; San Andres, 0.33), and this difference remained when tested cobbles were excluded from the core count (Artesia, 0.12; San Andres, 0.22). In fact, the Artesia Group locations had the highest debitage-to-core ratio of any of the study groups. The parent nodules were generally small at the Artesia Group locations, and apparently, visitors to those locations reduced cores more intensively (i.e., generated more flakes per core) than did visitors to locations in other groups.

Table 31. San Andres Group Lithic-Artifact Types, by Material Type

Artifact Type, by Technology Type	Material Type							Total
	Chert	Chert (Fusulinid)	San Andres Chert	Total Chert	Granite	Obsidian	Sandstone	
Cores								
Bidirectional core	2	1	16	19	—	—	—	19
Unidentifiable core	—	—	3	3	—	—	—	3
Multidirectional core	—	1	24	25	—	—	—	25
Unidirectional core	—	—	9	9	—	—	—	9
Cobble biface	—	—	1	1	—	—	—	1
Tested cobble	5	5	20	30	—	—	—	30
Subtotal, cores	7	7	73	87	—	—	—	87
Debitage								
Angular debris	—	—	—	—	—	1	—	1
Biface flake	1	—	2	3	—	—	—	3
Core flake	6	18	222	246	2	—	1	249
Undetermined flake	—	—	9	9	—	—	—	9
Subtotal, debitage	7	18	233	258	2	1	1	262
Retouched tools								
Retouched piece	1	—	2	3	—	—	—	3
Uniface	—	—	2	2	—	—	—	2
Scraper	—	—	2	2	—	—	—	2
Biface	—	—	1	1	—	—	—	1
Subtotal, retouched tools	1	—	7	8	—	—	—	8
Total	15	25	313	353	2	1	1	357

Site Types

The lithic-procurement locales represent a continuum from small to large and diverse assemblages that reflect the cumulative effects of multiple occupations. The number of artifacts per location ranged from a low of 3 at LA 119804 to a high of 1,230 at LA 146857. This variation represents a wide range in the intensity of location use from extremely ephemeral to more-intense and/or repeated occupations. A regression analysis of total artifacts by total artifact types was conducted using the project data, with two extreme outliers removed from the analysis: LA 146857 and LA 43423 (n = 679). There is a significant linear relationship between these two variables ($p < .01$; $r^2 = 0.49$). A visual inspection of Figure 39 indicates that the scatter plot can be segregated into three groups: locations with less than 105 artifacts (Group 1), those with 106–300 artifacts (Group 2), and those with more than 300 artifacts (Group 3). Group 1 locations reflect very limited use of the lithic sources. Three of these are in the Artesia Group, two are in the San Andres Group, one is in the Upper Pecos River Group, and one is an isolated site. Group 2 locations also represent ephemeral use of the lithic sources. One of the sites is located in the Upper Pecos River Group, one is in the San Andres Group, one is in the Artesia Group, and one is an isolated site. Group 3 actually includes two different site types: LA 155867, a campsite with numerous features, and LA 146857 and LA 43423, the largest lithic-procurement sites.

Table 32. Upper Pecos River Group Lithic-Artifact Types, by Material Type

Artifact Type, by Technology Type	Material Type									Total
	Chalcedony	Chert	Chert (Fusulinid)	Total Chert	Quartzite	Mustard Quartzite	Purple Quartzite	Total Quartzite	Rhyolite	
Cores										
Bidirectional core	—	8	—	8	7	—	5	12	1	21
Multidirectional core	—	33	—	33	19	2	13	34	6	73
Unidirectional core	—	1	—	1	3	1	2	6	1	8
Unidentifiable core	—	9	—	9	—	—	—	—	—	9
Cobble uniface	—	2	—	2	—	1	—	1	1	4
Cobble biface	—	—	—	—	7	3	2	12	—	12
Tested cobble	1	13	—	13	78	1	74	153	7	174
Subtotal, cores	1	66	—	66	114	8	96	218	16	301
Debitage										
Angular debris	6	10	—	10	39	—	20	59	—	75
Biface flake	1	30	1	31	2	4	6	12	4	48
Core flake	24	228	1	229	239	15	269	523	36	812
Undetermined flake	4	37	—	37	54	—	71	125	13	179
Subtotal, debitage	35	305	2	307	334	19	366	719	53	1,114
Retouched tool										
Retouched piece	—	8	—	8	4	—	—	4	3	15
Uniface	—	—	—	—	1	—	—	1	—	1
Biface	—	1	—	1	1	—	—	1	—	2
Subtotal, retouched tools	—	9	—	9	6	—	—	6	3	18
Other										
Hammerstone	—	—	—	—	2	—	1	3	—	3
Subtotal, other	—	—	—	—	2	—	1	3	—	3
Total	36	380	2	382	456	27	463	946	72	1,436

Table 33. Artesia Group Lithic-Artifact Types, by Material Type

Artifact Type, by Technology Type	Material Type											Total
	Chalcedony	Chert	Chert (Fusulinid)	San Andres Chert	Total Chert	Limestone	Metamorphic (Indeterminate)	Quartzite	Quartzite (Ortho)	Rhyolite	Sandstone	
Cores												
Bidirectional core	—	5	1	—	6	—	—	—	—	—	—	6
Multidirectional core	1	19	10	1	30	1	—	—	—	1	—	33
Unidirectional core	—	4	—	—	4	—	—	—	—	—	—	4
Unidentifiable core	—	6	4	—	10	1	—	—	—	—	—	11
Cobble uniface	—	1	4	—	5	2	—	—	—	—	—	7
Tested cobble	—	24	9	1	34	—	—	—	—	—	—	34
Subtotal, cores	1	59	28	2	89	4	—	—	—	1	—	95
Debitage												
Angular debris	—	22	14	—	36	1	—	1	—	—	—	38
Biface flake	—	29	6	1	36	—	—	—	—	—	—	36
Core flake	5	242	47	1	290	10	1	—	1	1	—	308
Undetermined flake	—	23	25	—	48	—	—	1	—	—	—	49
Subtotal, debitage	5	316	92	2	410	11	1	2	1	1	—	431
Retouched tools												
Retouched piece	—	10	12	—	22	—	—	—	—	—	—	22
Uniface	—	1	2	—	3	—	—	—	—	—	—	3
Scraper	—	1	4	—	5	—	—	—	—	—	—	5
Biface	—	7	2	—	9	1	—	—	—	—	—	10
Subtotal, retouched tools	—	19	20	—	39	1	—	—	—	—	—	40
Ground stone												
Milling stone	—	—	—	—	—	—	—	—	—	—	2	2
Subtotal, ground stone	—	—	—	—	—	—	—	—	—	—	2	2

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Artifact Type, by Technology Type	Material Type											Total
	Chalcedony	Chert	Chert (Fusulinid)	San Andres Chert	Total Chert	Limestone	Metamorphic (Indeterminate)	Quartzite	Quartzite (Ortho)	Rhyolite	Sandstone	
Other												
Hammerstone	—	—	—	—	—	1	—	—	—	—	—	1
Subtotal, other	—	—	—	—	—	1	—	—	—	—	—	1
Total	6	394	140	4	538	17	1	2	1	2	2	569

Table 34. Lower Pecos River Group Lithic-Artifact Types, by Material Type

Artifact Type, by Technology Type	Material Type														Total
	Chalcedony	Chert	Chert (Fusulinid)	San Andres Chert	Total Chert	Limestone	Petrified Wood	Quartz	Quartzite	Mustard Quartzite	Purple Quartzite	Total Quartzite	Rhyolite	Sandstone	
Cores															
Bidirectional core	5	15	1	—	16	1	—	—	17	—	3	20	1	—	43
Multidirectional core	6	15	6	—	21	—	—	—	10	1	16	27	2	—	56
Unidirectional core	—	10	1	—	11	—	—	—	8	—	6	14	—	—	25
Unidentifiable core	—	4	—	—	4	—	—	—	3	—	—	3	—	—	7
Cobble uniface	—	—	1	—	1	2	—	—	2	—	4	6	—	—	9
Cobble biface	—	1	—	—	1	1	—	—	6	—	2	8	—	1	11
Tested cobble	4	40	4	—	44	2	—	1	35	6	38	79	—	—	130
Subtotal, cores	15	85	13	—	98	6	—	1	81	7	69	157	3	1	281
Debitage															
Angular debris	—	2	1	1	4	—	—	—	2	—	1	3	—	—	7
Biface flake	4	6	1	—	7	—	—	—	5	1	7	13	—	1	25
Core flake	52	157	11	6	174	3	1	1	86	6	136	228	2	2	463
Undetermined flake	15	7	4	—	11	—	—	—	4	5	23	32	—	—	58

Artifact Type, by Technology Type	Material Type														Total
	Chalcedony	Chert	Chert (Fusulinid)	San Andres Chert	Total Chert	Limestone	Petrified Wood	Quartz	Quartzite	Mustard Quartzite	Purple Quartzite	Total Quartzite	Rhyolite	Sandstone	
Subtotal, debitage	71	172	17	7	196	3	1	1	97	12	167	276	2	3	553
Retouched tools															
Retouched piece	—	8	4	—	12	1	—	—	6	1	8	15	—	—	28
Tabular knife	—	—	—	—	—	—	—	—	1	—	—	1	—	—	1
Uniface	—	1	—	—	1	—	—	—	1	—	1	2	—	—	3
Scraper	—	2	3	—	5	—	—	—	2	—	1	3	—	—	8
Biface	1	1	—	—	1	—	—	—	—	—	—	—	—	—	2
Subtotal, retouched tools	1	12	7	—	19	1	—	—	10	1	10	21	—	—	42
Total	87	269	37	7	313	10	1	2	188	20	246	454	5	4	876

Table 35. Lithic-Artifact Types at Isolated Sites, by Material Type

Artifact Type, by Technology Type	Material Type												Total
	Chalcedony	Chert	Chert (Fusulinid)	San Andres Chert	Total Chert	Limestone	Quartzite	Mustard Quartzite	Purple Quartzite	Total Quartzite	Rhyolite	Sandstone	
Cores													
Bidirectional core	—	2	—	—	2	—	—	—	1	1	—	—	3
Unidentifiable core	—	1	—	—	1	—	—	—	—	—	—	—	1
Cobble uniface	—	1	—	—	1	—	—	—	—	—	—	—	1
Cobble biface	—	—	—	—	—	—	1	—	—	1	—	—	1
Tested cobble	—	15	3	3	21	1	13	1	8	22	—	—	44
Subtotal, cores	—	19	3	3	25	1	14	1	9	24	—	—	50

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Artifact Type, by Technology Type	Material Type												Total
	Chalcedony	Chert	Chert (Fusulinid)	San Andres Chert	Total Chert	Limestone	Quartzite	Mustard Quartzite	Purple Quartzite	Total Quartzite	Rhyolite	Sandstone	
Debitage													
Angular debris	1	2	—	—	2	—	—	—	2	2	—	—	5
Biface flake	—	2	—	—	2	—	—	—	—	—	—	—	2
Core flake	—	19	1	1	21	—	8	—	8	16	2	4	43
Undetermined flake	2	—	—	—	—	—	3	1	1	5	—	1	8
Subtotal, debitage	3	23	1	1	25	—	11	1	11	23	2	5	58
Retouched tools													
Biface	1	—	—	—	—	—	—	—	—	—	—	—	1
Subtotal, retouched tools	1	—	—	—	—	—	—	—	—	—	—	—	1
Other													
Hammerstone	—	—	—	—	—	—	2	—	3	5	—	—	5
Subtotal, other	—	—	—	—	—	—	2	—	3	5	—	—	5
Total	4	42	4	4	50	1	27	2	23	52	2	5	114

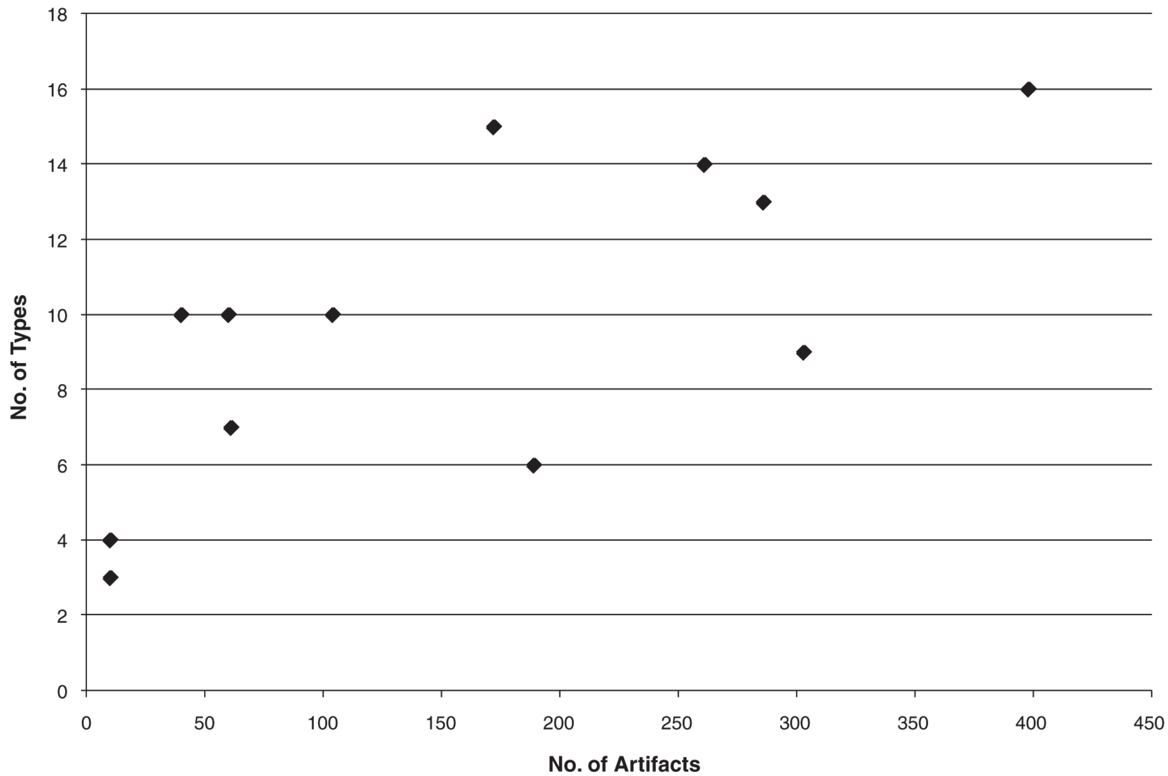

Figure 39. Scatter plot of the total number of artifacts by the total number of artifact types.

The locations in Groups 2 and 3 had quite diverse assemblages, averaging over 13 artifact types per location, and the Group 1 locations were much less diverse, with less than 6 types per location, on average. Not surprisingly, Group 3 had more tools than the other groups, followed by Group 2 and then Group 1, where locations had few or no tools (tools here are defined as bifaces, unifaces, retouched flakes, scrapers, and tabular knives).

LA 155867 was defined as a campsite based on the presence of numerous thermal features (at least 23) and the relative absence of lithic raw material, which seems to have been located a short distance north of the site. An analysis of the artifacts from the quarries and procurement locales suggested that some of these locations may have been used as more than just sources of raw materials. For example, LA 130417, in Group 2, had 22 tools in an assemblage of just 258 artifacts (9 percent of the total). This included 13 retouched flakes, the second-highest number of any location in the project area. LA 43423, which had the second-largest assemblage of any location in the study area, was first, with 23 retouched flakes.

LA 130417 also included five scrapers, three bifaces, and a uniface. Although the site appeared to have been primarily a limited-use quarry site, it may have functioned as a resource-processing area, as well. LA 130417 had more retouched flakes and scrapers (n = 18, or 7 percent of the total site assemblage) than LA 155867 (n = 13, or 3 percent of the total site assemblage), which functioned primarily as a campsite. Previous site records noted that at least two thermal features and a possible ring midden were present at LA 130417. These features were not relocated during the current study, but if they were present, that would lend further credence to the idea that the site had other functions besides lithic-procurement activities.

Similarly, LA 43423 had 50 percent more tools (n = 36, or 6 percent of the site total) than the next-highest site total. As with LA 130417, the majority (n = 30, or 83 percent of all tools) were retouched flakes and scrapers. Tool materials at LA 43423 were evenly split between quartzite and chert. Of the five sites within the Upper and Lower Pecos River Groups, four fell within Groups 2 and 3, in terms of assemblage size and artifact diversity. Of those four, artifacts at LA 122842, LA 146857, and LA 163991 were nearly twice as likely to be quartzite as chert. However, at LA 43423, quartzite was only slightly more common than chert (46–40 percent of the total assemblage). Chert seems to have been more intensively targeted and utilized at LA 43423 than at other locations in very similar geologic settings.

This is seen further in a breakdown of gross artifact types at the three sites. At LA 122842, LA 146857, and LA 163991, debitage was at least twice as likely to be quartzite as chert, but at LA 43423, the two materials were virtually even (41–40 percent of debitage). Tested cobbles and cores were also telling. LA 163991 did not have many cores or tested cobbles; so, it is excluded here. At LA 122842, LA 146857, and LA 43423, quartzite tested cobbles were at least twice as common as chert. Quartzite cores were much more common at LA 122842 and LA 146857, but there were equal numbers of chert and quartzite cores at LA 43423.

Given the small sample size and because we did not have data for neighboring sites to use in our comparison, it is difficult to say what these patterns mean for LA 43423, but it seems that there was an usually high interest in chert at the site in comparison to other sites in similar geologic settings, as well as a much larger percentage of tools, particularly utilized flakes and scraping implements.

Excavated Artifacts

In total, 399 lithic artifacts were recovered during the test excavations conducted at the project locations (Table 36): 37 cores, 339 pieces of debitage, 21 retouched tools and 2 hammerstones. The samples ranged from 2 to 108 artifacts collected per location. This contrasts with the total 4,508 lithic artifacts recorded from surface contexts during the in-field analysis. Figure 40 contrasts the surface- and subsurface-artifact assemblages. As can be seen, relatively more debitage, including core flakes and angular debris, was recorded in the excavated sample. The increased presence of angular debris was to be expected, because those items are extremely difficult to distinguish from naturally fractured rock during in-field analysis. Therefore, field personnel tend to bias their field recording toward clearly defined flakes.

Material Selection

The majority of the cores and debitage pieces were made of chert and quartzite; however, most of the retouched tools were made of chert. The chert was primarily generalized chert, and there was some San Andres and chert containing fusulinid fossils; most of the quartzite was the purple variety. A single piece of nonlocal obsidian debitage was identified. Figure 41 contrasts material types from surface and subsurface contexts. The excavated sample contained relatively more chert and less chert containing fusulinid fossils than the surface artifacts. That is because chert containing fusulinid fossils was only identified at two locations in the Artesia Group, whereas San Andres chert was identified at two locations in the San Andres Group but also at LA 43423, in the Lower Pecos River Group. Purple quartzite was widely distributed across the study area; it was recovered from all three sites in the Upper Pecos River Group, from LA 161046 in the San Andres Group, and from LA 122842 and LA 43423 in Lower Pecos River Group.

Lithic Reduction

Cores

Eight worked cobbles and 25 platform cores were identified. The worked cobbles consisted of tested cobbles (n = 5), split cobbles (n = 2), and cobble unifaces (n = 1). The tested cobbles and cobble unifaces represent the initial stage of reduction, in which flakes were removed from cortical platforms, and the split cobble reflects the initial creation of a platform core, in which flakes were presumably removed from the freshly broken section of a cobble. The platform cores can be segregated into unidirectional (n = 8), bidirectional (n = 6), multidirectional (n = 3), flake (n = 3), bifacial (n = 3), and undetermined fragments (n = 2). Both chert and quartzite were represented by the worked cobbles and platform cores, and the majority of the quartzite was the purple variety.

Table 36. Excavated Lithic-Artifact Types, by Material Type

Artifact Type, by Technological Type	Material Type													Total
		Chert								Quartzite				
	Chalcedony	Chert	Chert (Fusulinid)	San Andres Chert	Total Chert	Igneous (Coarse Grained)	Limestone	Opalized Caliche	Petrified Wood	Quartzite	Purple Quartzite	Total Quartzite	Rhyolite	
Cores														
Bidirectional core	—	4	—	1	5	—	—	—	—	—	2	2	—	7
Bifacial core	—	2	—	—	2	—	—	—	—	—	1	1	—	3
Flake core	—	—	—	1	1	—	—	—	—	1	2	3	—	4
Multidirectional core	—	1	—	—	1	—	—	—	—	2	—	2	—	3
Unidirectional core	—	4	—	—	4	—	—	—	—	3	2	5	—	9
Unidentifiable core	—	—	—	—	—	—	—	—	—	—	2	2	—	2
Cobble uniface	—	—	—	—	—	—	—	—	1	—	—	—	—	1
Tested cobble	1	2	—	1	3	—	—	—	—	—	2	2	—	6
Split cobble	—	—	—	—	—	—	—	—	—	2	—	2	—	2
Subtotal, cores	1	13	—	3	16	—	—	—	1	8	11	19	—	37
Debitage														
Angular debris	2	24	—	—	24	—	—	—	1	2	15	17	—	44
Core flake	14	134	1	21	156	1	3	2	3	35	40	75	1	255
Core-trimming flake	—	3	—	2	5	—	—	—	—	1	—	1	—	6
Biface flake	—	5	1	—	6	—	—	—	—	—	1	1	—	7
Microdebitage	3	10	3	—	13	—	—	—	—	1	—	1	—	17
Undetermined flake	1	3	—	—	3	—	—	—	—	—	—	—	—	4
Utilized debitage	—	4	—	1	5	—	—	—	—	1	—	1	—	6
Subtotal, debitage	20	183	5	24	212	1	3	2	4	40	56	96	1	339

continued on next page

Artifact Type, by Technological Type	Material Type													Total
		Chert								Quartzite				
	Chalcedony	Chert	Chert (Fusulinid)	San Andres Chert	Total Chert	Igneous (Coarse Grained)	Limestone	Opalized Caliche	Petrified Wood	Quartzite	Purple Quartzite	Total Quartzite	Rhyolite	
Other														
Hammerstone	—	—	—	—	—	—	—	—	—	1	1	2	—	2
Subtotal, other	—	—	—	—	—	—	—	—	—	1	1	2	—	2
Retouched tool														
Retouched piece	—	1	—	1	2	—	—	—	—	—	—	—	—	2
Notch	—	2	—	—	2	—	—	—	—	2	1	3	—	5
Uniface	—	3	—	—	3	—	—	—	—	1	1	2	—	5
Biface	—	6	—	3	9	—	—	—	—	—	—	—	—	9
Subtotal, retouched tools	—	12	—	4	16	—	—	—	—	3	2	5	—	21
Total	21	208	5	31	244	1	3	2	5	52	70	122	1	399

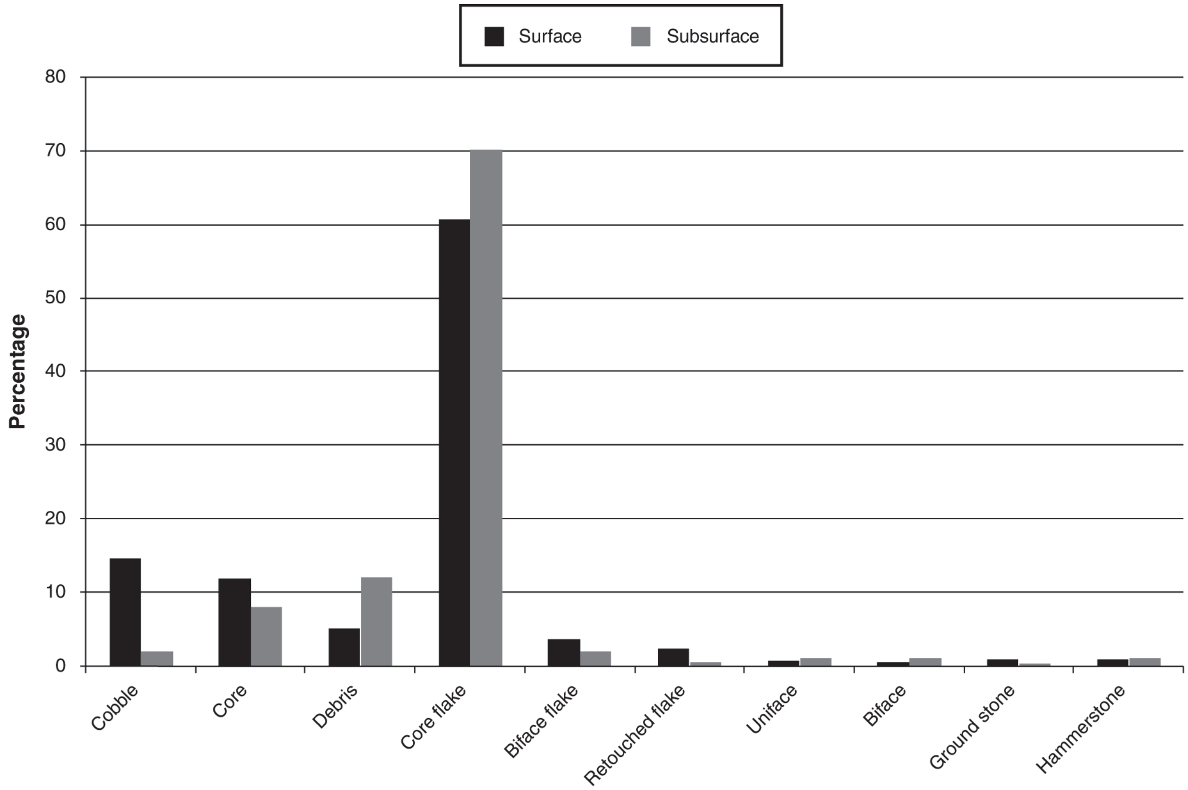

Figure 40. Surface vs. subsurface artifact types.

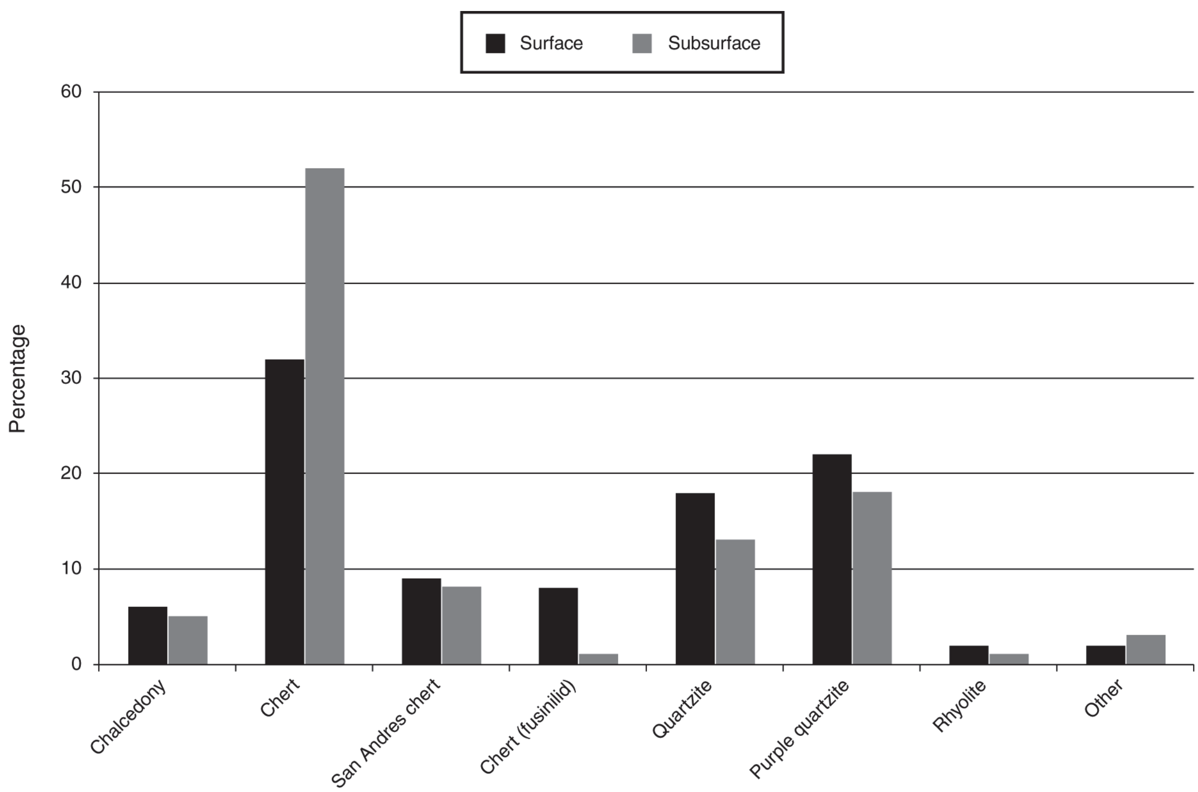

Figure 41. Surface vs. subsurface lithic-material types.

Overall, it appears that four separate reduction trajectories were represented: (1) tested cobble to cobble uniface to flake, (2) tested cobble to flake core to flake, (3) tested cobble to bifacial core to flake, and (4) split cobble to unidirectional/bidirectional/multidirectional core to flake. Trajectories 1 and 2 were primarily used to work quartzite, and Trajectories 3 and 4 were often used for chert. Both the flake and bifacial cores tended to be made on large purple-quartzite flakes. The bifacial cores seemed to represent very large and roughly shaped bifaces from which flakes could be removed from their broad, flat surfaces. Two of the three were broken during the reduction process.

Debitage

The debitage was dominated by core-reduction activities and primarily consisted of core flakes; there were fewer pieces of angular debris, biface flakes, core-trimming flakes, and pieces of microdebitage. The core-trimming flakes indicate an attempt to extend the use life of both chert and quartzite cores. Of the 107 whole core flakes recorded during the analysis, 32 percent exhibited cortex, including platform and complete dorsal (n = 4), platform and partial dorsal (n = 18), platform only (n = 15), and dorsal only (n = 38). All of this reflects an emphasis on the reduction of platform cores and the later stages of core reduction.

The majority of the core flakes exhibited cortical (n = 47) and single-faceted (n = 57) platforms; there were fewer collapsed (n = 35), crushed (n = 15), dihedral (n = 1), and indeterminate (n = 1) platforms; however, this did appear to vary somewhat between chert and quartzite flakes. That is, there were relatively more quartzite cortical platforms (n = 20, or 42 percent) than single-faceted chert platforms (n = 40, or 50 percent). There were relatively similar proportions of crushed platforms (13 percent vs. 10 percent) but more quartzite collapsed platforms (13 percent vs. 3 percent). This seems to indicate a greater emphasis on the reduction of quartzite cobbles vs. chert platform cores. At least some platform preparation occurred, given the presence of crushing along the platform edges; however, there appears to have been somewhat less preparation for quartzite, given the larger proportion of collapsed platforms.

The majority of the core flakes were whole (n = 107); there were fewer proximal (n = 56), midsection (n = 9), distal (n = 56), lateral (n = 10), and undetermined (n = 16) fragments. The equal numbers of proximal and distal fragments indicate that the flakes tended to break in half. However, most of the chert flakes were whole (n = 60, or 44 percent), whereas the quartzite flakes tended to be broken (n = 54, or 72 percent). Although the chert flakes were characterized by relatively similar numbers of proximal (n = 28) and distal (n = 29) fragments, the broken quartzite flakes tended to be proximal (n = 23) rather than distal (n = 15) fragments. The sample size was small; so, it is unclear whether this is actually a meaningful difference.

Table 37 presents information regarding the lengths (mm) of worked cobbles, platform cores, core flakes, and retouched tools. It appears that potential maximum lengths of about 60 mm were possible for the cobbles and platform cores; however, the broader surface of a bifacial core could produce a flake up to 80 mm in length. This is similar to the mean length of chert and quartzite cobbles (75 mm), as noted in Chapter 4. The core flakes exhibited a much shorter mean length of 38 mm, and retouched tools ranged from 37 to 61 mm in mean length. The smaller core flakes were discarded, and larger flakes presumably were selected for further use.

Retouched tools

The majority of the retouched tools recovered during the excavation consisted of informal items, like retouched flakes, unifaces, or notches. The unifaces and notches were made of chert and quartzite, whereas all the retouched flakes were made of chert. Unifaces are thick flakes that have been unifacially worked to create a steep edge. Edge angles ranged from 65° to 72° for all three artifact types, indicating that scraping activities were important tool functions.

The bifaces appeared to have been discarded during the early stage of the manufacturing process; only a single biface was broken. Like the retouched flakes, all the bifaces were made of chert.

Table 37. Artifact Metrics, by Technological Type

Artifact Type	Inventory Count	Average Maximum Length	Standard Deviation from Maximum Length	Average Maximum Width	Standard Deviation from Maximum Width	Average Maximum Thickness	Standard Deviation from Maximum Thickness	Average Inventory Weight	Standard Deviation from Inventory Weight
					Cores				
Bidirectional core	7	54	21	53	20	39	17	157.9	223.5
Unidirectional core	8	43	13	61	20	43	18	154.9	106.3
Multidirectional core	3	56	18	55	7	27	5	98.4	60.4
Flake core	4	63	24	66	22	35	12	132.9	57.2
Bifacial core	1	79		70		26		158.6	
Tested cobble	6	61	20	48	20	38	11	152.4	97.3
Split cobble	2	59	2	39	9	27	6	78.3	8.2
Cobble uniface	1	48		34		22		39.8	
					Debitage				
Core flake	255	38	18					13.7	30.5
					Retouched Tool				
Uniface	5	61	13	46	18	24	8	75.2	44.9
Retouched flake	2	44	3	32	0	14	5	19.6	5.6
Notch	5	37	17	32	13	15	7	20.8	16.8
Biface	9	49	17	35	11	17	6	30.1	31.6

Regional Comparison: Lithic-Procurement Sites vs. Habitation Sites

Lithic-Procurement Sites

Several studies of lithic-procurement sites have been conducted in the region. These include studies of the Ogallala gravels along the eastern side of the Llano Estacado in west Texas conducted by Backhouse et al. (2009), Holliday and Welty (1981), and Hurst et al. (2010). In southeastern New Mexico, studies of surface gravels associated with the Ogallala and Dockum Formations have been conducted by Bowman et al. (1990) and Zamora (2000). Both the SRI and Backhouse et al. (2009) studies were conducted through in-field analysis, and the other studies involved field collections and laboratory analyses. Figure 42 illustrates the variability in lithic-artifact types among these separate studies. Trojan Hill was studied by Zamora (2000), and LA 21177 and LA 27676 were studied by Bowman et al. (1990). As can be seen, debitage dominated all the lithic assemblages, followed by cores (the "Cores" category also included worked cobbles). The presence of retouched tools seems to have varied from project to project, and there were very few hammerstones or ground stone artifacts.

The Zamora (2000) analysis included artifact types very similar to those recorded by SRI, including debitage types. The sample was dominated by core flakes (62.3 percent), and there were fewer pieces of angular debris (37.7 percent) and only a single biface flake out of 11,806 total pieces of debitage. The SRI sample was also dominated by core flakes (76.2 percent), but there were far fewer pieces of angular debris (6.4 percent), more biface flakes (4.5 percent), and an additional category of undetermined flakes (12.7 percent) (n = 2,572). As previously noted, the marked increase in the number of pieces of angular debris recorded by Zamora was

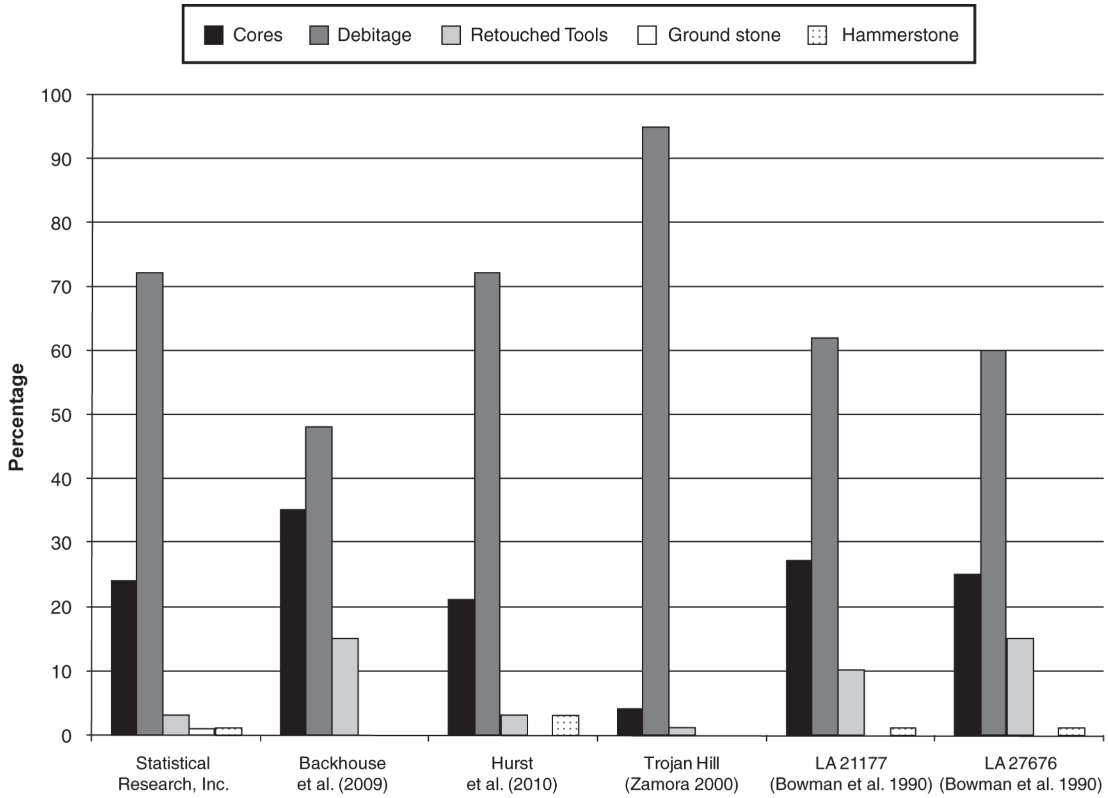

Figure 42. Lithic-artifact types for lithic-procurement sites.

presumably due to the use of laboratory-analysis as opposed to in-field-analysis methods. Another notable difference between the two studies is the relative abundance of tested cobbles in comparison to platform cores. In the case of Zamora, there were more platform cores (62.8 percent) than tested cobbles, whereas there were more tested cobbles (52.3 percent) than platform cores in the SRI sample. Nonetheless, tested cobbles and cores made substantial contributions to both studies.

Figure 43 illustrates the variability in lithic-material types for the separate studies. There are certainly obvious differences between materials recorded along the eastern side of the Llano Estacado and those recorded at locations to the west of the Llano Estacado. That is, the eastern samples were dominated by quartzite, and the western samples were characterized by a mix of chert and quartzite. With the exception of the two Bowman et al. (1990) sites, there were relatively few other materials identified; other materials included chalcedony, silicified calcrete, silicified wood, and siltstone in the west Texas samples and chalcedony, limestone, sandstone, silicified wood, siltstone, and igneous rocks in the southeastern New Mexico samples. Purple quartzite was identified in both areas.

For the purposes of this analysis, materials were grouped into chert, quartzite, and other, because chert and quartzite tended to dominate the assemblages across all the sites. The four sites compared here are similar to the sites/survey parcels in the SRI study area in that they featured a wide variation in material-type frequencies. At LA 21177, there were roughly equal numbers of chert and quartzite. At LA 27676 and Trojan Hill, chert was more common than quartzite. At the sites studied by Hurst et al. (2010), presented together, quartzite was much more abundant.

The amount of cortex present on debitage can provide information about the reduction stages that took place at a given site. Flakes with cortex are usually from earlier stages of reduction than flakes without cortex. Generally speaking, flakes, regardless of material type, were more likely than not to feature at least some cortex on the dorsal surfaces. At the two sites investigated by Bowman et al. (1990), between 73 and 80 percent of the quartzite flakes had cortex, 70–74 percent of the chert flakes had cortex, and 71–73 percent of all other flakes had cortex. At Trojan Hill, 55 percent of the quartzite flakes, 60 percent of the chert

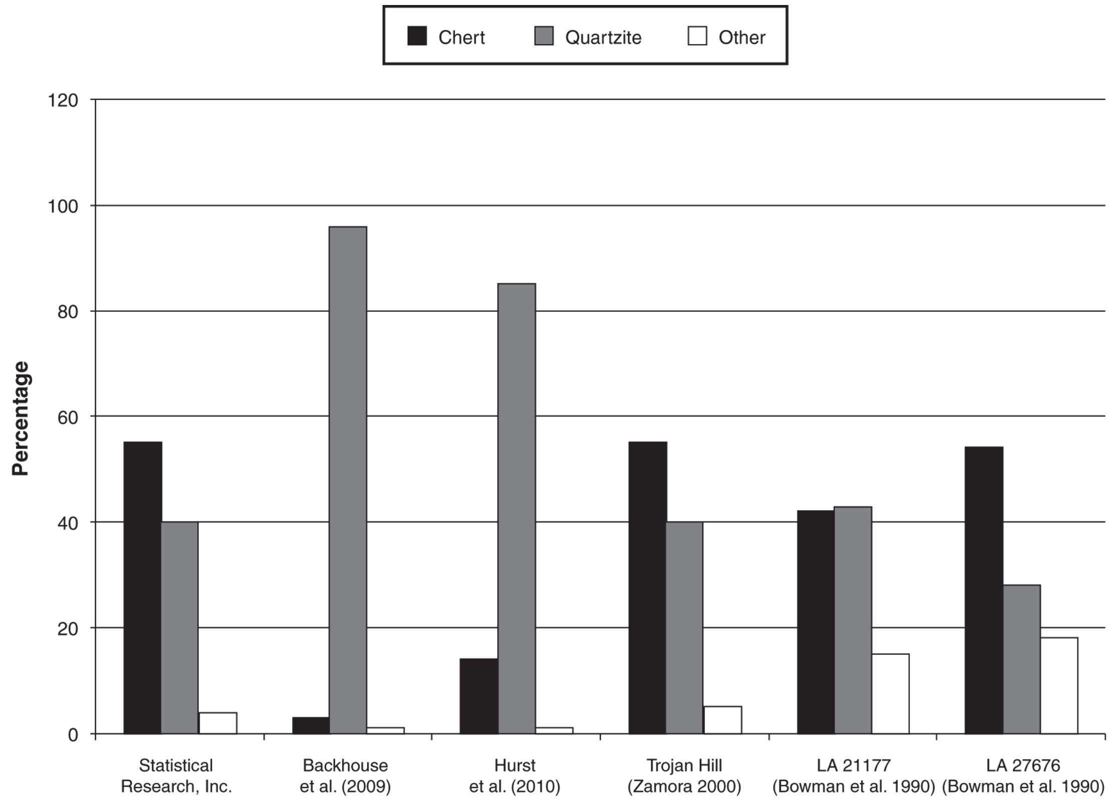

Figure 43. Lithic-material types for lithic-procurement sites.

flakes, and 71 percent of flakes of other materials had cortex. In the study by Hurst et al. (2010), cortex was even more common; 91 percent of the quartzite flakes, 96 percent of the chert flakes, and 89 percent of flakes of other materials contained at least some cortex. This matched well with the locations investigated by SRI, where between 67 and 82 percent of the quartzite flakes, between 61 and 90 percent of the chert flakes, and between 60 and 92 percent of flakes of other materials had cortex, based on the five groups.

Habitation Sites

A number of studies have been conducted at habitation sites throughout southeastern New Mexico. Most of these sites appear to have been temporary camps consisting of several thermal features and scatterings of lithic artifacts and pottery. Unfortunately, it is difficult to further separate these sites based on time period. In many cases, multiple radiocarbon dates or diagnostic artifacts were recovered from single sites, spanning sometimes several-thousand years. These sites include the Macho Dunes site (Zamora 2000), the Boot Hill site (Brown 2011), Laguna Plata (Brown 2010), Punto de los Muertos (Wiseman 2003), and Laguna Gatuna (Bullock 2001). These five sites were selected because they represent recent excavations with detailed lithic analyses. Of the 16 locations investigated by SRI, only LA 155867 could be classified as a campsite. As described in the previous chapter, the site consists of at least 23 thermal features and a moderately sized scatter of lithic artifacts.

At all of these locations, debitage was the primary artifact type; there were small numbers of cores and formal tools. The investigators at the different sites recorded and presented data in differing fashions; so, data were not always cross-comparable. However, some generalizations can be made. Chert and other fine-grained materials were most common at all of the sites. Chert and chalcedony combined accounted for 71–88 percent of all debitage, and quartzite composed just 9–26 percent (Table 38). These are consistent with the results at LA 155867, where 91 percent of the debitage was chert, and only two quartzite flakes (1 percent) were identified (see Table 19).

Table 38. Lithic-Material Types for Excavated Sites

Site	Quartzite (%)	Chert (%)	Chalcedony (%)	Other(%)
Macho Hill	21	75	1	3
Boot Hill	9	44	40	6
Punto de Los Muertos	26	67	4	3
Laguna Gatuna	9	88		3

Table 39. Presence or Absence of Cortex at Excavated Sites

Site	Cortex (%)	No Cortex (%)
Macho Hill	27	73
Boot Hill	36	64
Laguna Plata	49	51
Punto de Los Muertos	29	71
Laguna Gatuna	29	71

The preference of chert and chalcedony over other material types can be seen in the types of cores and flaked stone tools present at these sites, as well. The number of cores varied widely between sites; only a single core was present at Laguna Gatuna, and 40 were present at Laguna Plata. With the exception of Laguna Gatuna, all of the sites had at least 20 cores, and those four sites all showed a preference for fine-grained materials. Either chert or chalcedony composed the majority of the cores, and the two materials combined accounted for between 73 and 96 percent of cores. The numbers were similar for flake tools and bifaces. No material types were reported for tools at the Punto de los Muertos site, but at Macho Dunes, Boot Hill, Laguna Plata, and Laguna Gatuna, chert and chalcedony combined accounted for between 76 and 95 percent of flaked stone tools.

At LA 155867, no quartzite artifacts were identified. The bulk of the cores (n = 60, or 91 percent) and tools (n = 21, or 78 percent) were chert; a single chalcedony core and a handful of limestone cores and flake tools were also recorded. The focus on chert at LA 155867 is not surprising, considering the site's location near limestone outcrops with chert nodules.

Interestingly, although several procurement locales within the SRI study area featured large quantities of quartzite, it was virtually absent from all of the habitation sites mentioned above. Given the small number of sites used in these comparisons, the lack of quartzite likely reflects a sampling issue. Further research should include a large number of sites from across the region, to assess how quartzite flakes were utilized at habitation sites.

The presence and absence of flake cortex can be useful indicators of the types of reduction activities that took place at a particular site. Flakes with no cortex were much more common at most of the habitation sites from which data were available, composing between 64 and 73 percent of all debitage (Table 39). The only exception was Laguna Plata, where roughly equal numbers of flakes with and without cortex were found. This contrasts to the quarries and procurement locales described above, where flakes with cortex were much more common. The implication is that raw materials were brought to habitation sites already partially reduced. The debitage at LA 155867 was similar to that at Laguna Plata, containing roughly equal numbers of flakes with and without cortex. Given the close proximity to outcrops of raw materials at LA 155867, people may have spent less time reducing cores at the raw-material source and brought more cores back that had been only partially reduced.

CHAPTER 9

Spatial Analysis

Phillip O. Leckman

By linking all artifact observations to a 15-by-15-m grid (see Chapter 6), the survey methods employed for recording purposes during this project provided a relatively fine-grained framework for tracing distributions of material culture, one that was well suited for intrasite spatial analysis in a GIS environment. When artifact frequencies are linked to the virtual grid cells in which they occurred and then depicted graphically across a site or survey area in terms of such variables as artifact type or material class, areas of high or low artifact frequency may be readily identified, spatially diffuse or tightly focused distributional patterns may appear, or illuminative contrasts or associations between particular material or artifact types may be discerned. In the present case, these observations served to identify areas of particularly intense activity within lithic-procurement loci, to distinguish artifact-distributional patterns influenced by topography or lithic-resource availability from patterns shaped by human behavior, and, at some locations, to differentiate spatially distinct activity areas linked to particular stages of lithic reduction or other activities.

Artifact observations suitable for distributional analysis were made at 13 of the 14 archaeological sites evaluated during this project as well as at the Meadow Hill and Adobe Draw Survey Areas. As noted in Chapter 7, no artifacts were identified at LA 121969. Overall artifact-distributional patterns for all lithic artifacts documented at these sites and survey parcels are depicted on the maps appearing in Chapter 7 of this report, but they are discussed in more detail in the section that follows. At many locations, as discussed earlier, only relatively small numbers of lithic artifacts were identified. At three sites (LA 42423, LA 146857, and LA 155867), however, documented lithic assemblages were large and relatively diverse enough to warrant further analysis beyond the broad distributional patterns mapped in Chapter 7. Artifact distributions across a variety of artifact and material classes at these three sites are discussed separately in this chapter.

General Patterns

Three general distributional patterns were present at the locations we investigated during the course of the project. At six sites (LA 29500, LA 43423, LA 149992, LA 130417/LA 119804, LA 163991, and LA 169668) and the Meadow Hill Survey Area, artifacts appeared to be scattered fairly consistently across the surface without strong patterns of clustering. At another five sites (LA 122842, LA 144349, LA 146857, LA 150383, and LA 161046) and the Adobe Draw Survey Area, however, artifact frequencies were strongly concentrated in one or more distinct locations within each location, and markedly fewer artifacts were located elsewhere. Finally, a single site (LA 155867) incorporated both a lithic-procurement locus and a relatively large, presumably multioccupation campsite at which lithic reduction was linked to occupational activities that exhibited a marked spatial segregation from more-intensive quarrying activities.

At some locations with smaller lithic assemblages, such as at LA 29500 (see Figure 24) and LA 149992 (see Figure 35), artifacts were scattered sparsely across the site surface without any evidence of culturally or naturally derived patterning. At many larger locations, however, the concentrated or dispersed nature of surface lithic assemblages can be explained in part by natural factors, such as the distribution of lithic raw materials or the topographic or hydrographic setting. The numerous artifacts observed at LA 43423 (see

Figure 32), for example, occurred in relatively high frequencies across the two small ridges that make up the southern portion of the site, corresponding to the relatively abundant gravel- and cobble-lag deposits concentrated atop these features. Although several concentrated areas are present within the broader distribution, artifacts are present more or less continuously across these central ridgetops (although this continuous artifact distribution is obscured somewhat by the bladed modern road that runs through the middle of the area). Similarly, at LA 163991 (see Figure 27), lag-gravel deposits containing chert and quartzite nodules occur in a thin layer across the site surface, and potential lithic raw materials are present throughout the site area. Relatively low frequencies of flaked stone artifacts are likewise distributed fairly evenly across the site; a single grid cell contained 18 artifacts representing a single large chert cobble that had been extensively tested and flaked. At LA 130417 (see Figure 28), flaked stone artifacts were scattered widely across the southern two-thirds of the site surface with no apparent patterning. However, artifact frequencies were highest in an east–west band corresponding to the edge of the limestone terrace that bisects the middle of the site. Limestone and chert nodules were most accessible along this terrace edge, and based on the distribution of artifacts, it appeared to have been the primary locus for cobble procurement and testing at the site. The relatively abundant artifacts found in the portions of the site below this terrace probably represent raw materials and artifacts transported by alluvial action as well as tested cobbles removed through human action. As noted in Chapter 7, artifacts were found only sparsely in the northern portion of the site, upslope from the terrace edge. At LA 169668 (see Figure 36), located along a northwest-sloping ridge above Lone Tree Draw, alluvial action has washed chert and quartzite cobbles out from the local caliche soils, concentrating them along the numerous small drainages that run across the site. The flaked stone artifacts produced by lithic procurement and testing were thus deposited along these drainages, as well.

Lithic-artifact frequencies at locations with more-concentrated patterns of artifact distribution appeared even more closely tied to those locations where raw materials could be easily procured, either directly from an underlying matrix or as a result of deflationary processes. In each case, these concentrations probably reflect areas in which testing and primary reduction activities were focused as well as locations in which raw materials were most frequent and accessible. This pattern was most pronounced at LA 144349 (see Figure 21), where the handful of documented artifacts was located in direct proximity to a location where chert cobbles were quarried from limestone bedrock. Similarly, the much larger artifact assemblage documented at LA 122842 (see Figure 33) was likewise concentrated in close proximity to the hilltop location where quartzite and chert cobbles were the most abundant and easily obtained. At LA 161046 (see Figure 22), located atop a small limestone knoll, areas with high frequencies of lithic artifacts were located along the northern edges of the knoll, where spalled chert nodules have weathered out of exposed chert outcrops. Flaked stone artifacts were fairly sparse elsewhere. At LA 146857 (see Figure 25), both lithic artifacts and raw materials were found across the site surface but were most abundant in the central portion of the site, where hundreds of chert nodules and artifacts were exposed in a large deflated area. Finally, the concentrated pattern of artifact distribution present in the sparse lithic assemblage documented at LA 150383 (see Figure 29) appeared to be focused on a deflated area on the lower terrace of a finger ridge characterized by chert nodules found within local gravels.

Artifact- and Material-Type Analyses

In addition to documenting assemblage-level distributional patterns for lithic artifacts at all locations, three sites (LA 43423, LA 146857, and LA 155867) were subjected to a more detailed analysis that examined the distribution of finer-grained categories, such as individual material and artifact types. As discussed in Chapter 7 and above, two of these three sites (LA 43423 and LA 146857) were primarily large, heavily used lithic-procurement sites containing abundant raw material and hundreds or thousands (in the case of LA 146857) of artifacts. LA 155867 contained hundreds of artifacts and ample evidence for lithic reduction but also included 22 FCR features; it appeared also to have served as a relatively large campsite, perhaps one subjected to multiple short-term occupational episodes over an extended period of time.

LA 43423

As discussed above and in Chapter 7, LA 43423 consisted of a large, fairly dense scatter of lithic artifacts and raw materials concentrated on a series of low ridges located in the south-central portion of the site. Although artifacts clustered in two locations within this zone, a modern bladed road runs across a low spot between these two concentrated loci, and modern disturbance may have accentuated the gap between them. The distribution of shallow, cobble-rich-lag deposits across the southern portion of the site suggests that artifact distributions may once have been more continuous across the southern portion of the site. Artifacts were located more or less continuously within each concentrated area, and artifact frequencies per grid cell were relatively high, ranging from 1–2 artifacts up to 23 artifacts per grid cell in the western locus and up to 14 artifacts per grid cell in the somewhat smaller and less-dense eastern locus (see Figure 32). Although only one grid cell contained more than 14 artifacts, multiple cells containing between 9 and 14 artifacts were noted within each locus. Outside the central zone, artifacts were sparse and were found in much smaller frequencies, with a maximum frequency per grid cell of 8. Most positive grid cells in outlying portions of the site contained no more than 4 artifacts.

Cores were likewise concentrated in the two central loci. Platform cores were located fairly extensively across this zone (Figure 44), and multiple grid cells containing three or more cores each were scattered across the two areas. Like overall artifact frequencies, platform cores appeared to be somewhat more frequent in the western locus. Worked cobbles (i.e., tested cobbles, cobble unifaces, and cobble bifaces) suggestive of raw-material testing and initial processing (Figure 45) had a similar distribution, although they were found in somewhat lower frequencies per grid cell, on the whole. If the distributions of platform cores and worked cobbles are compared directly (Figure 46), it appears that both artifact categories were located widely across the south-central portion of the site, worked cobbles were somewhat more dispersed, and platform cores were more concentrated in high-density areas. Among the 24 grid cells in which both platform cores and worked cobbles were present, cobbles outnumbered platform cores in 6 locations, and 3 grid cells contained more platform cores. The other 15 cells contained equal frequencies of each type. On the whole, the data suggest an emphasis on primary lithic reduction and material testing that was somewhat focused on a few high-density locations but occurred across more or less the entire central portion of the site. The distribution of retouched tools (Figure 47), which were found across the site but were generally quite infrequent, further supports an emphasis on initial raw-material reduction and testing at LA 43423. Moreover, at least a portion of the retouched-tool assemblage was made up of roughly retouched quartzite bifaces that may represent a stage in the initial reduction process rather than finished products.

The distribution of lithic debitage (Figure 48) at LA 43423 displayed a similar pattern. Debitage was located across most of the site surface, in the handful of concentrated areas noted above. However, debitage with cortex present (Figure 49) was much more frequent and widespread than debitage without cortex (Figure 50), which was found in only a few scattered areas. In total, 134 grid cells contained debitage with cortex but no debitage without cortex, and only 17 cells contained debitage without cortex only (Figure 51). Among the 26 grid cells in which both types of debitage were found, 7 grid cells contained a higher frequency of debitage without cortex, and 8 grid cells contained more debitage with cortex; the remaining 11 grid cells contained equal frequencies of artifacts of both types. Within the grid cells in which debitage without cortex outnumbered debitage with cortex, it did so by ratios as great as 8 to 1.

In terms of material types present, the distribution of quartzite artifacts (Figure 52) generally mirrored the distribution of artifacts as a whole. Quartzite artifacts were located more or less continually across the central portion of the site, and there were occasional small, spatially localized high-density areas. The distribution of chert artifacts, however, exhibited a very different pattern (Figure 53); though still found widely across the site, chert artifacts appeared to be strongly concentrated in the western locus. This high-frequency area did not appear to correspond to fluctuations in raw-material availability, because

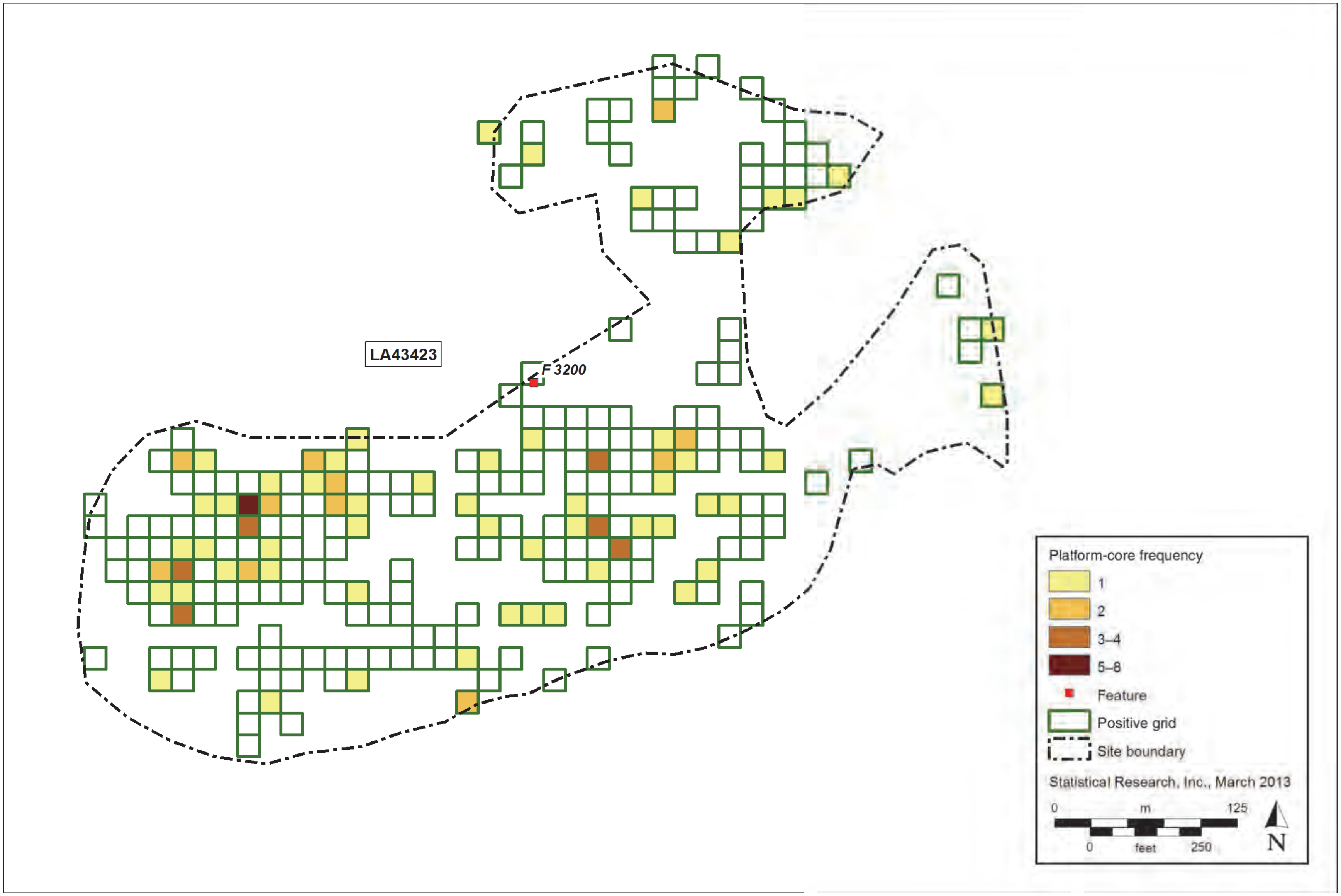

Figure 44. Frequency of platform cores at LA 43423.

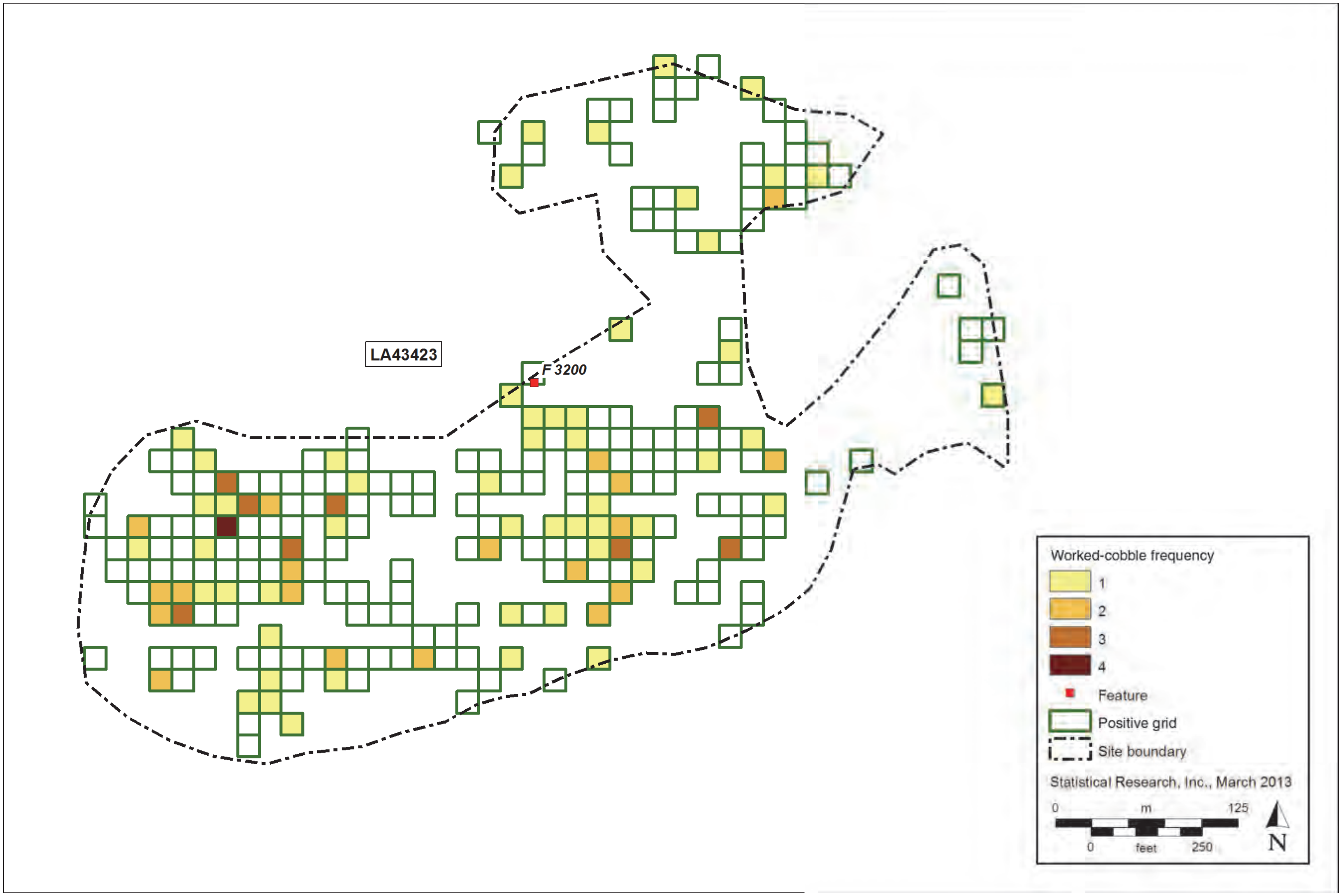

Figure 45. Frequency of worked cobbles at LA 43423.

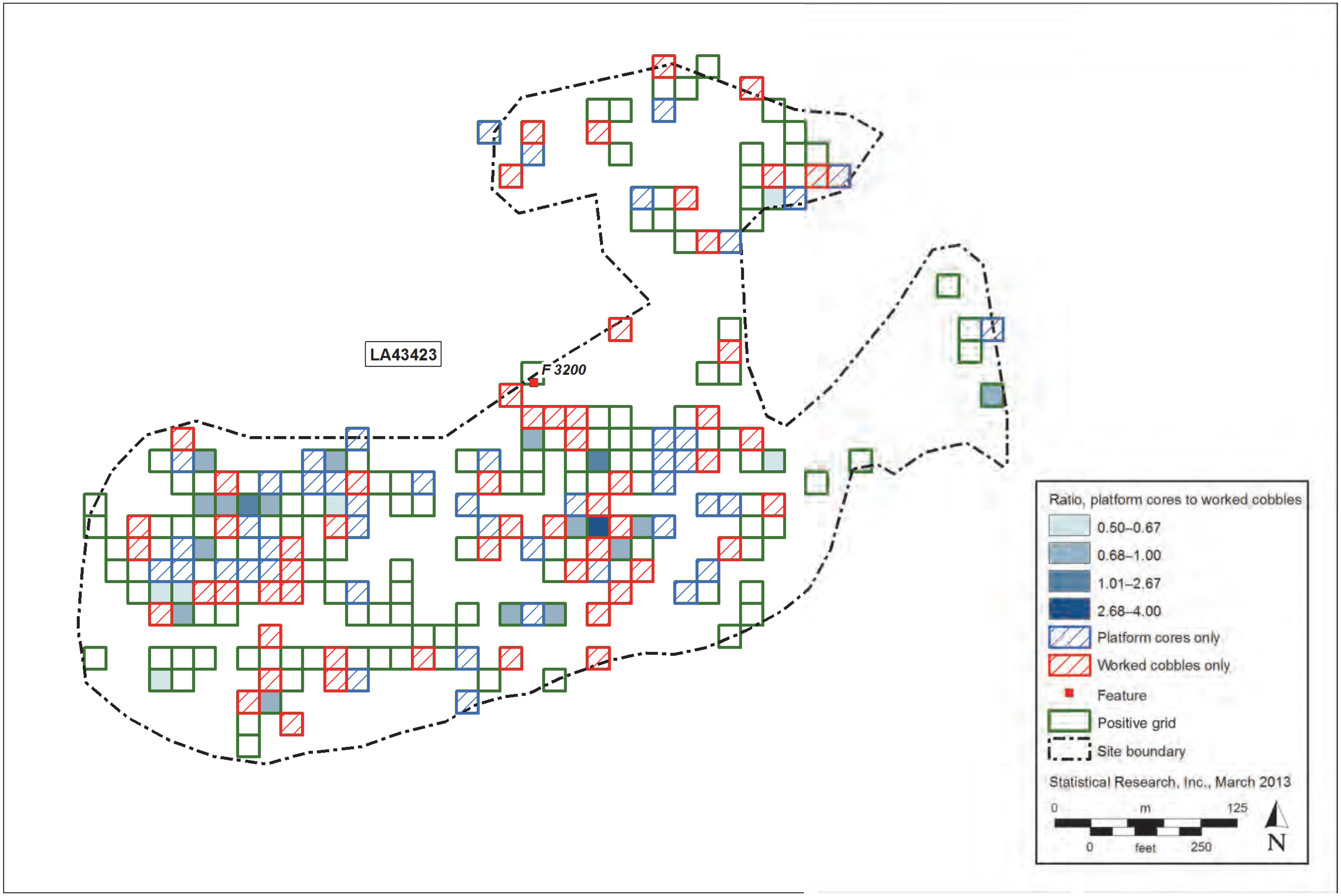

Figure 46. Ratio of platform cores to worked cobbles at LA 43423.

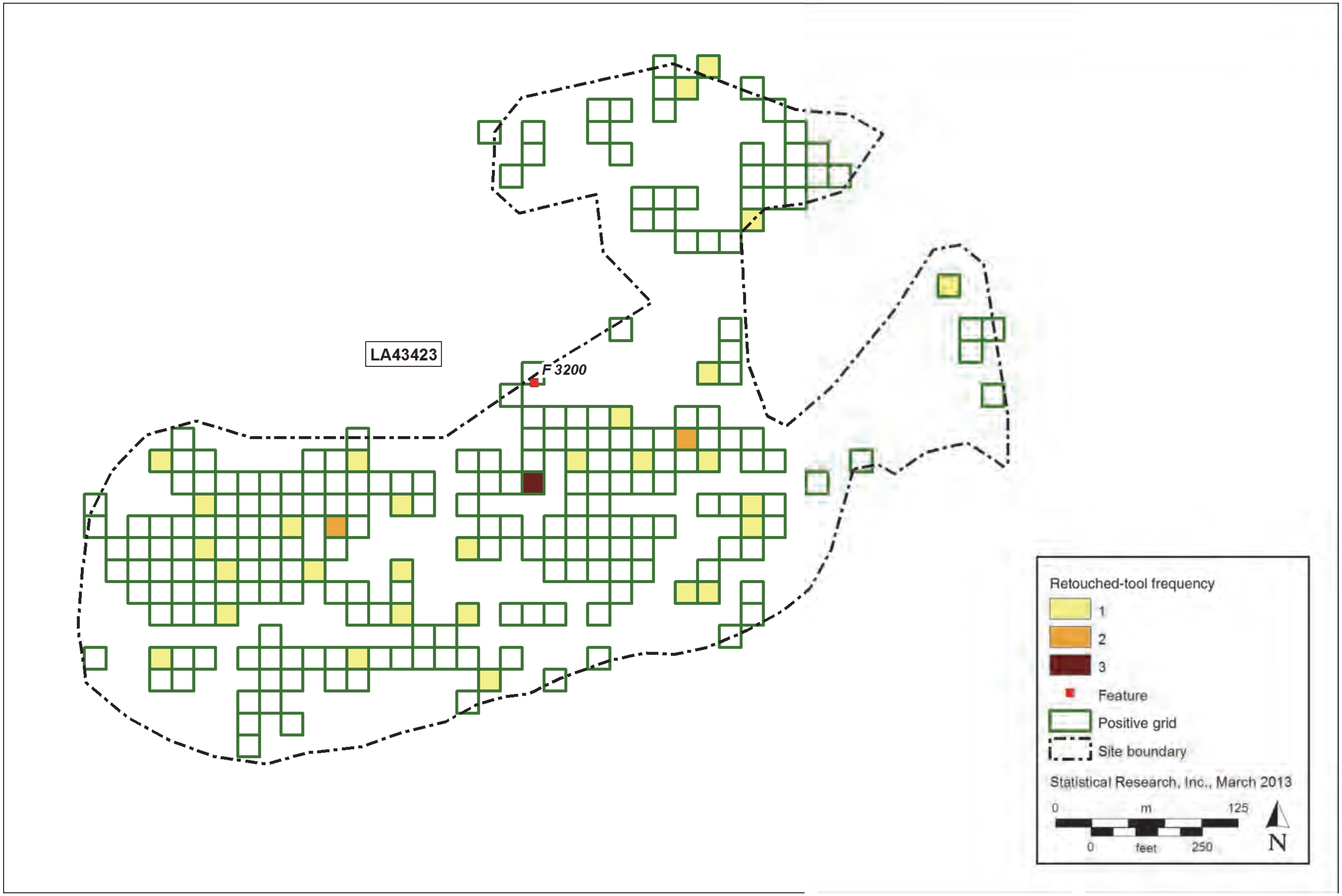

Figure 47. Frequency of retouched tools at LA 43423.

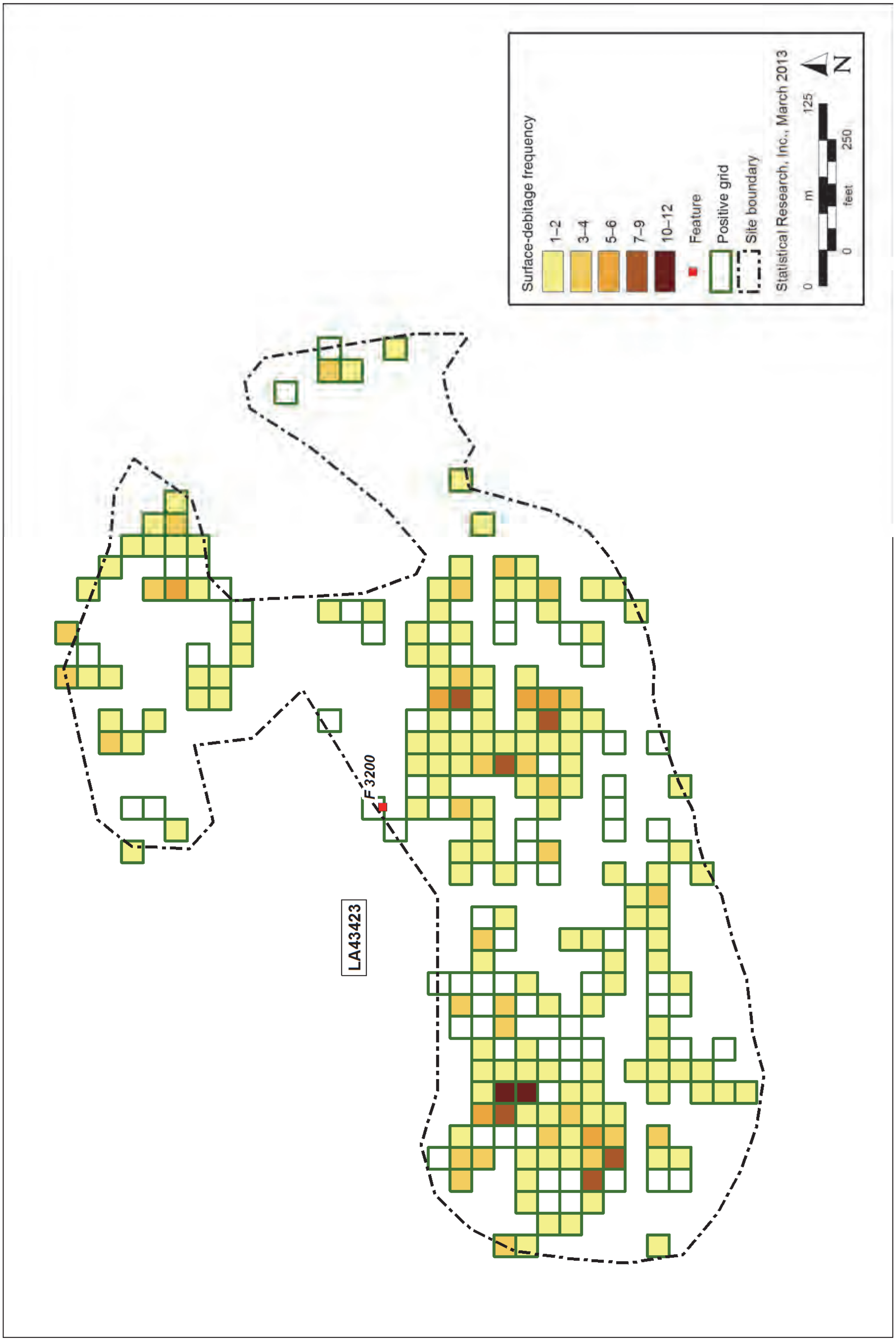

Figure 48. Frequency of lithic debitage at LA 43423.

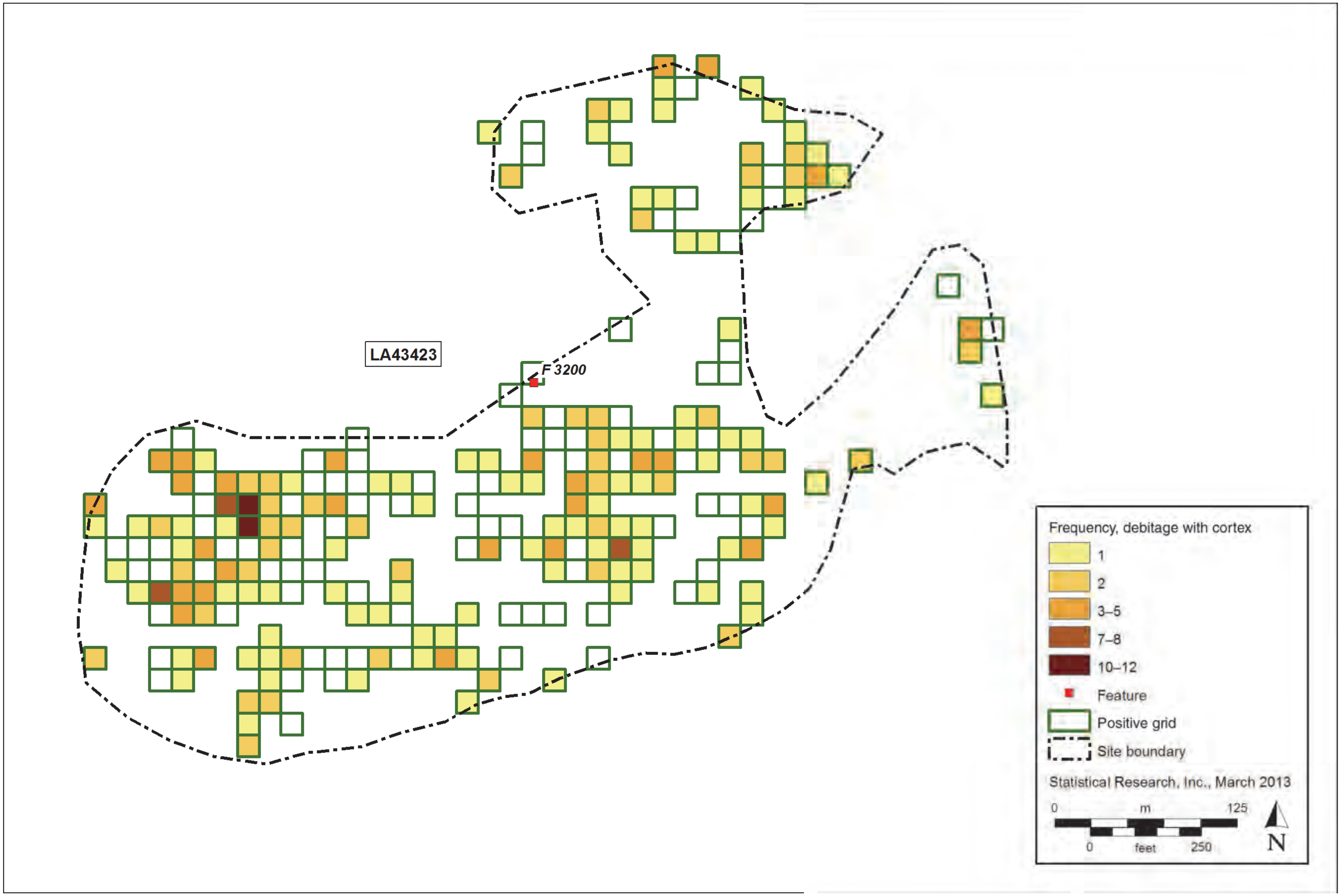

Figure 49. Frequency of debitage with cortex at LA 43423.

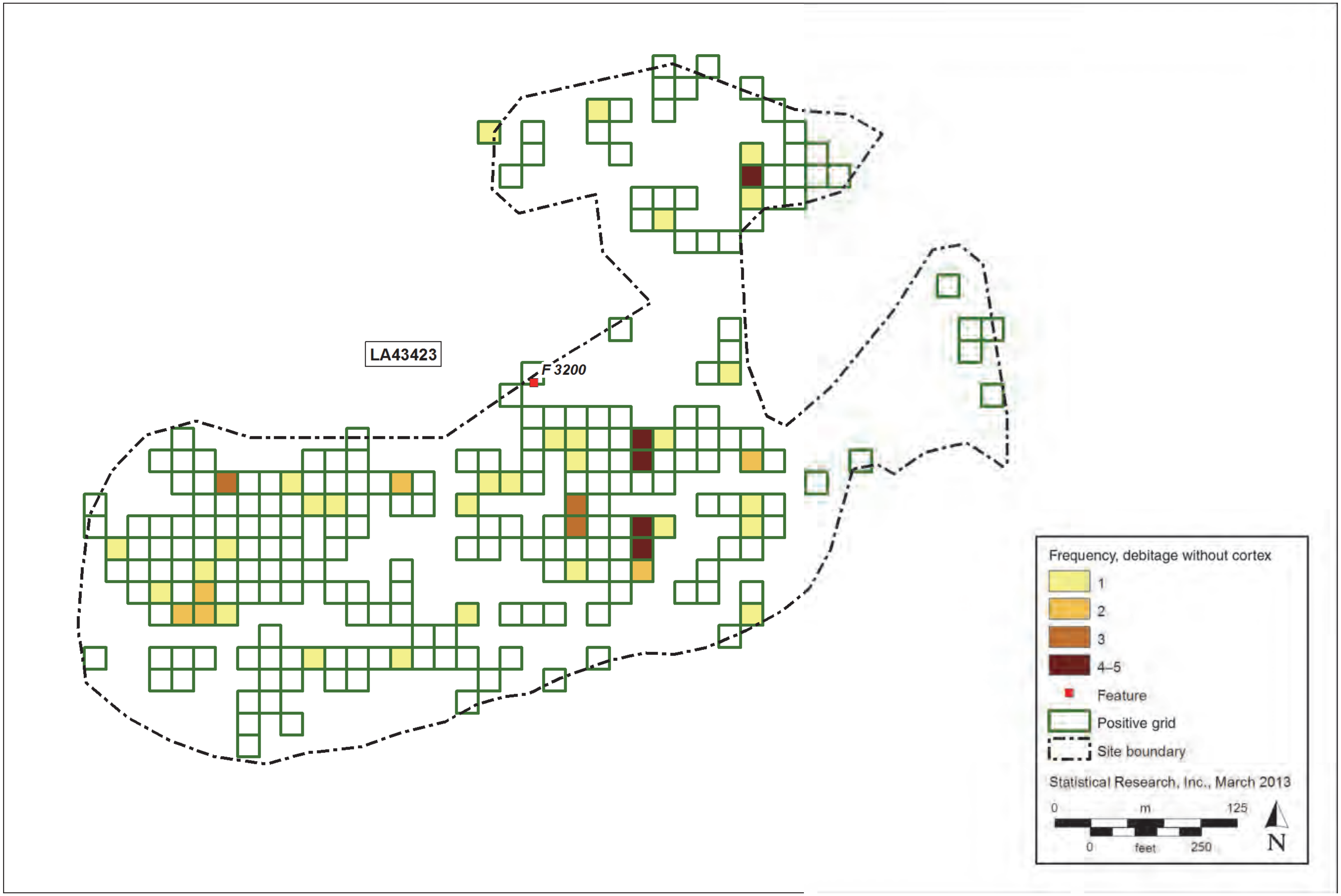

Figure 50. Frequency of debitage without cortex at LA 43423.

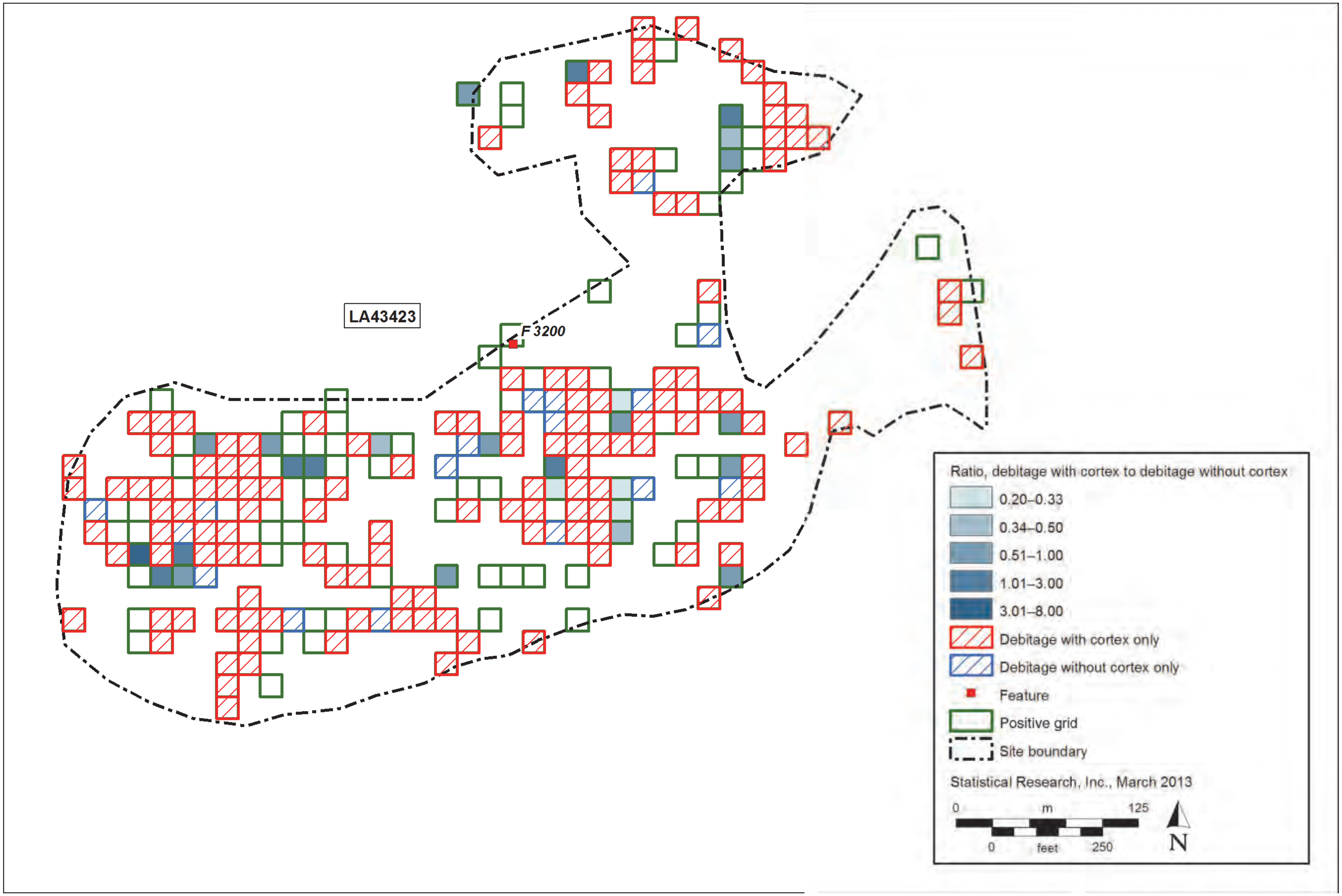

Figure 51. Ratio of debitage with cortex to debitage without cortex at LA 43423.

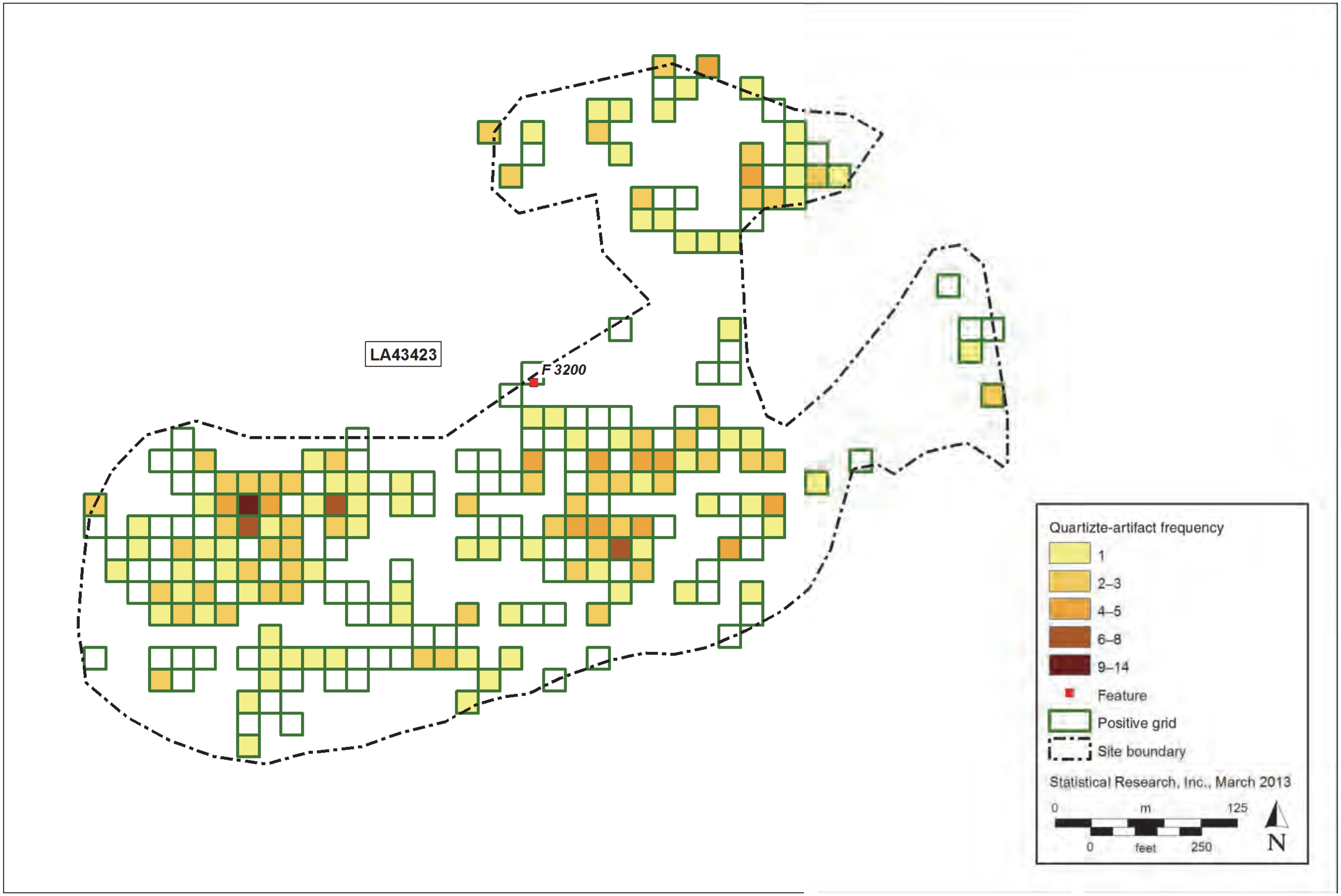

Figure 52. Frequency of quartzite artifacts at LA 43423.

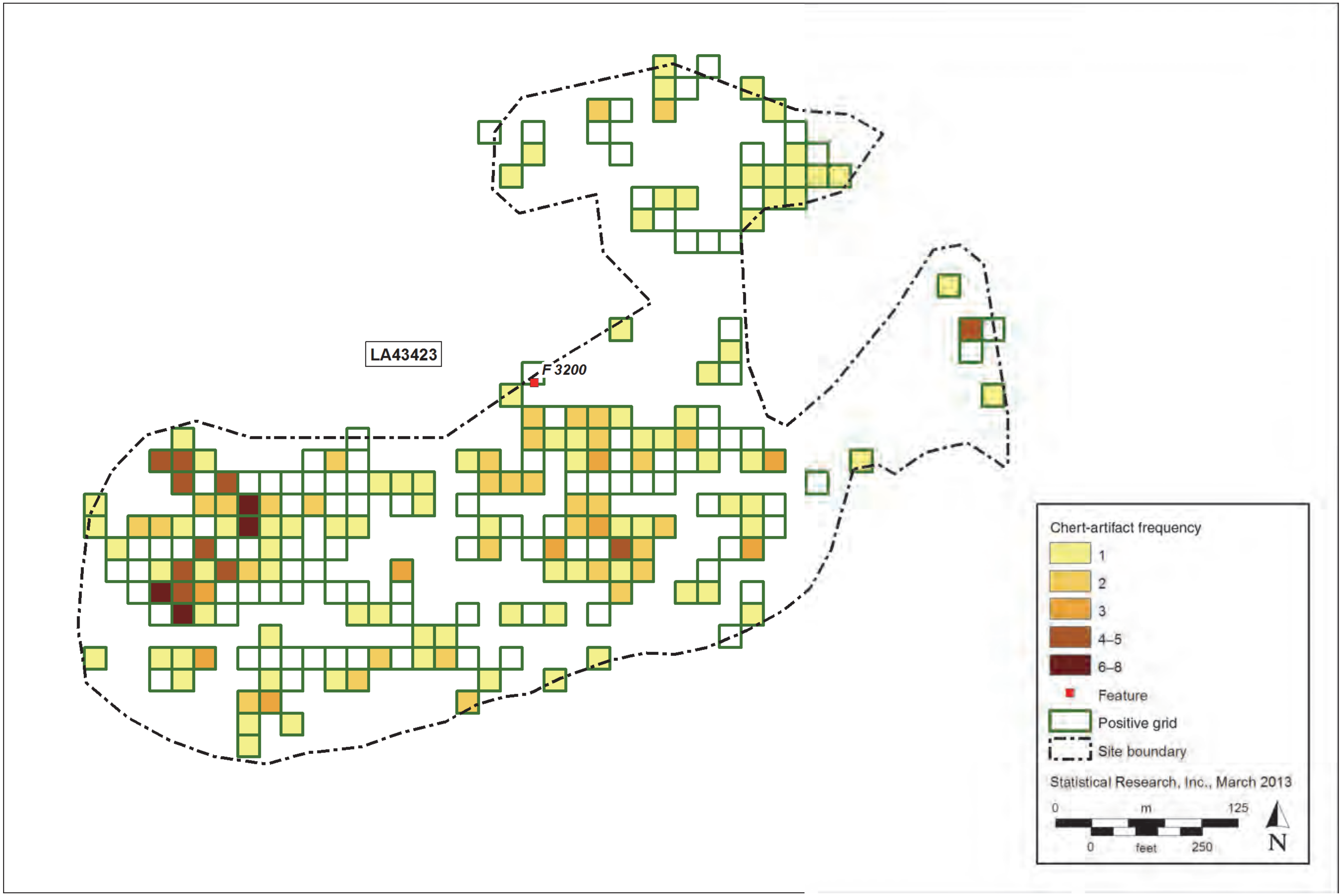

Figure 53. Frequency of chert artifacts at LA 43423.

shallow gravels containing chert nodules were located throughout the central portion of the site. It may, therefore, reflect the preferential use of that portion of the site for testing, reducing, and processing chert.

LA 146857

Though relatively small, LA 146857 was associated with a large assemblage of flaked stone artifacts that was centered, as mentioned above, on a relatively low, blown-out area in the south-central portion of the site (see Figure 25). The area is characterized by an extremely dense cobble field containing abundant nodules of both chert and quartzite. Mirroring the distribution of lithic raw materials, artifacts were found across the site surface but were densest in the deflated zone. Individual grid-cell artifact frequencies ranged as high as 117. Grid cells containing 31 or more artifacts were common across the area, in sharp contrast to the low-frequency grid cells scattered around the site's margins. In general, lithic distributions at LA 146857 reflected a focus on fairly intensive, relatively large-scale raw-material testing and reduction.

Both platform cores (Figure 54) and worked cobbles (Figure 9.55) were abundant at the site. As at LA 43423, worked cobbles were most frequent in the blown-out area but had a much more extensive distribution, whereas platform cores were highly concentrated in the central blowout and were nearly absent elsewhere. Even in that area, though, worked cobbles outnumbered platform cores when both were found together, sometimes to a considerable degree (Figure 56). Interestingly, grid cells containing only platform cores were located at the margins of the site, away from the densest areas in which raw-material testing and reduction appeared to have been conducted most intensively. To some extent, this mirrored the distribution of retouched tools at LA 146857 (Figure 57), where they were found sparsely and mostly around the site's margins.

Lithic debitage (Figure 58) was, as elsewhere, the most abundant artifact type at the site, scattered across nearly the entire site surface. Debitage with cortex present (Figure 59) was found in far-higher frequencies than debitage without cortex (Figure 60), and similar to platform cores, the distribution of debitage without cortex was somewhat less extensive and more concentrated in the central, deflated zone. Only a single grid cell contained only debitage without cortex, and in grid cells in which both debitage types were found together, debitage with cortex typically outnumbered debitage without cortex, and ratios ranged up to 17.5 to 1 (Figure 61).

As described in Chapter 7, chert and quartzite were the predominant material types at LA 146857; the latter represented roughly two-thirds of the total assemblage, and the former made up roughly one-third. Chert artifacts were somewhat more concentrated in the central, deflated area (Figure 62) than quartzite artifacts (Figure 63), although the distributions of both material types were similar. Interestingly, grid cells with the highest frequencies of chert artifacts did not directly correspond to grid cells with the highest frequencies of quartzite; instead, the highest-frequency quartzite grid cells were located around the margins of the areas with the highest chert frequencies.

LA 155867

Unlike LA 43423 and LA 146857, which displayed evidence for relatively intense lithic processing and material testing to the exclusion of other activities, LA 155867 was both a lithic-processing site and a relatively large campsite. Although lithic artifacts were found across the site surface (see Figure 30), domestic activities and lithic processing at the site appeared to have been somewhat spatially segregated. The 22 FCR features identified were concentrated in the western two-thirds of the site (Figure 64), and the ground stone identified at the site was also found in that area. Conversely, lithic-reduction and -processing activities appeared to have been focused primarily in the eastern third of the site.

This segregation of activities was illustrated by the distribution of cores and retouched tools at LA 155867. Platform cores (Figure 65) predominantly were found in the northwestern portion of the site, in association with the areas containing the highest feature densities. Retouched tools (Figure 66), though relatively scarce in general, also were found almost entirely in the vicinity of the site's FCR features.

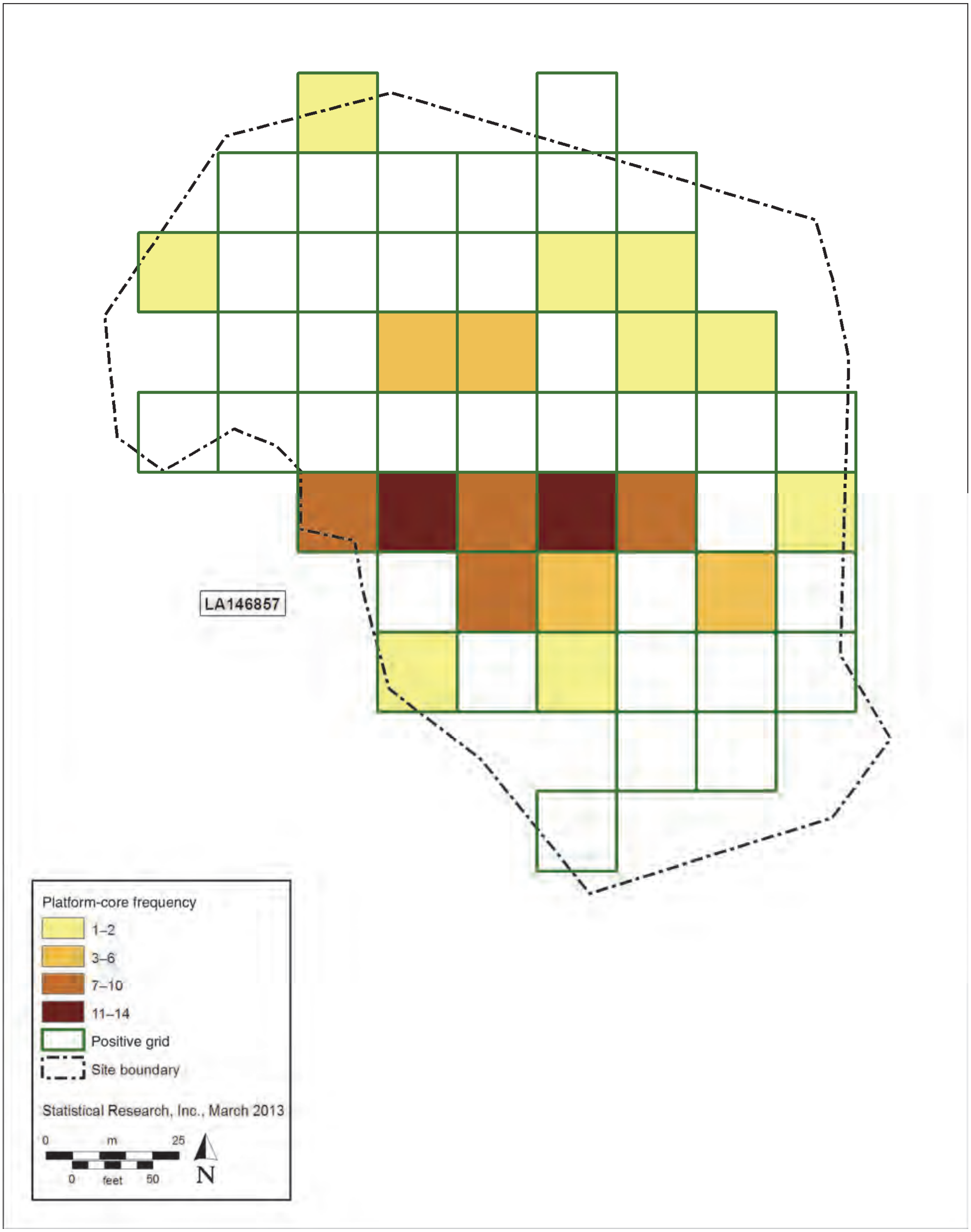

Figure 54. Frequency of platform cores at LA 146857.

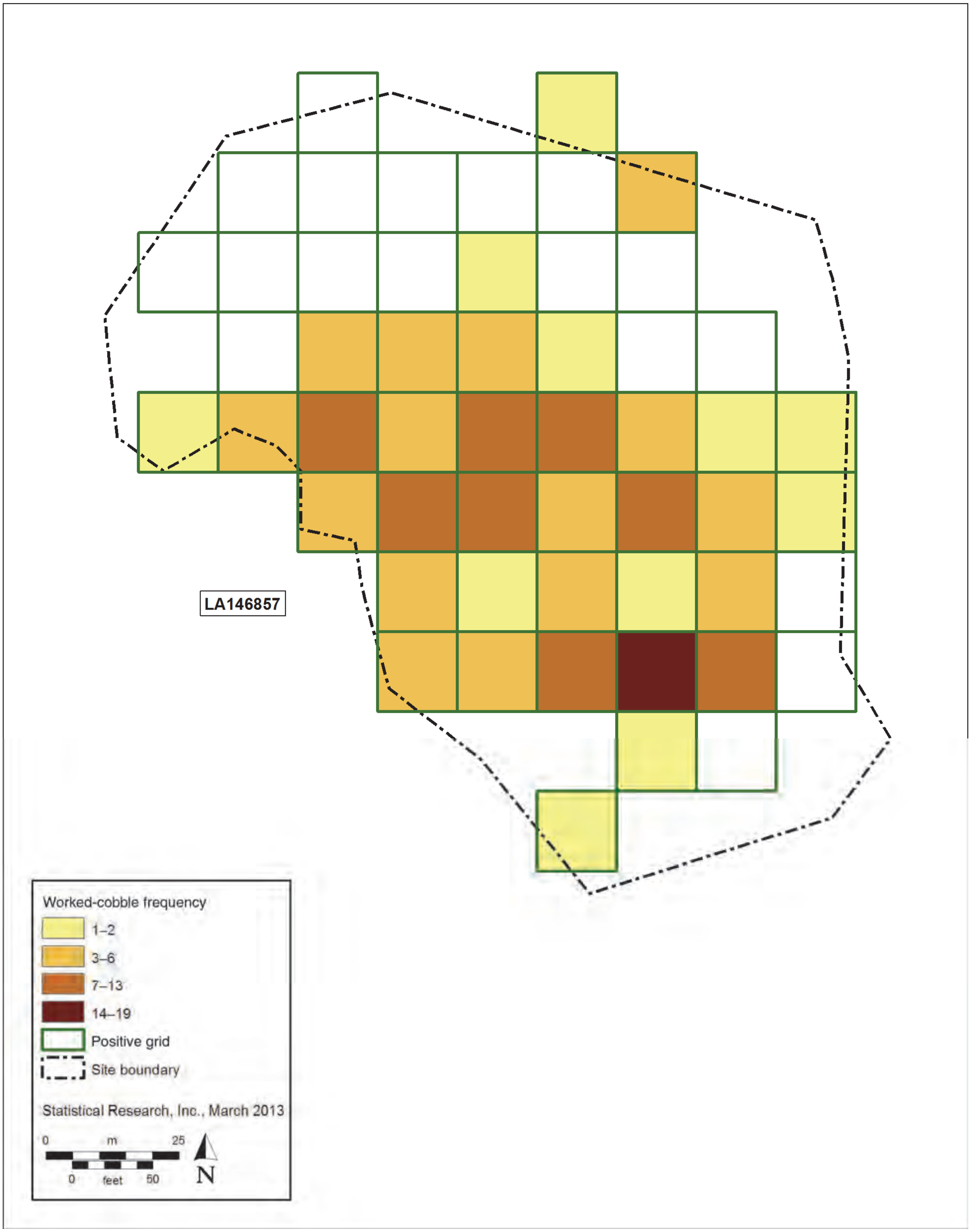

Figure 55. Frequency of worked cobbles at LA 146857.

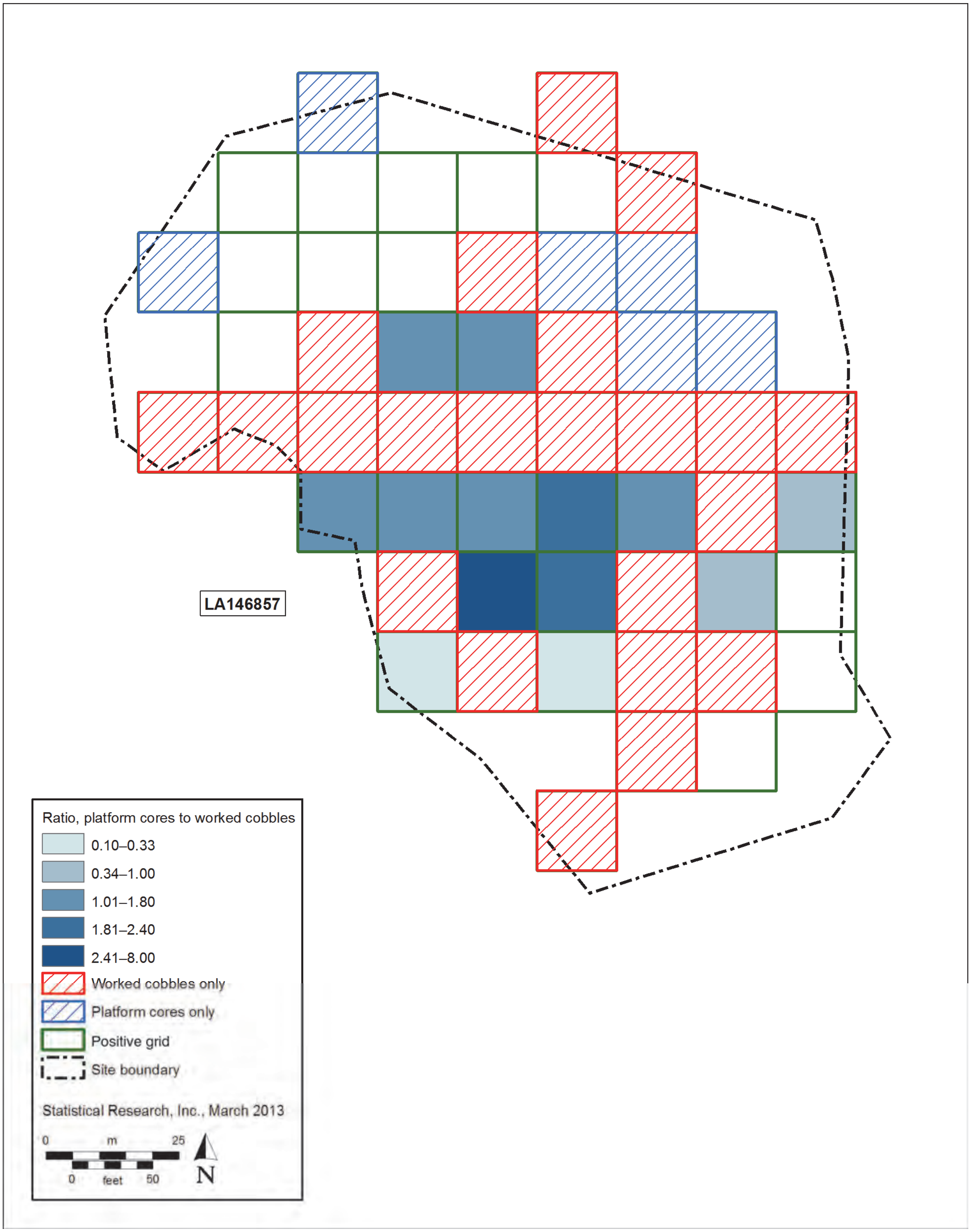

Figure 56. Ratio of platform cores to worked cobbles at LA 146857.

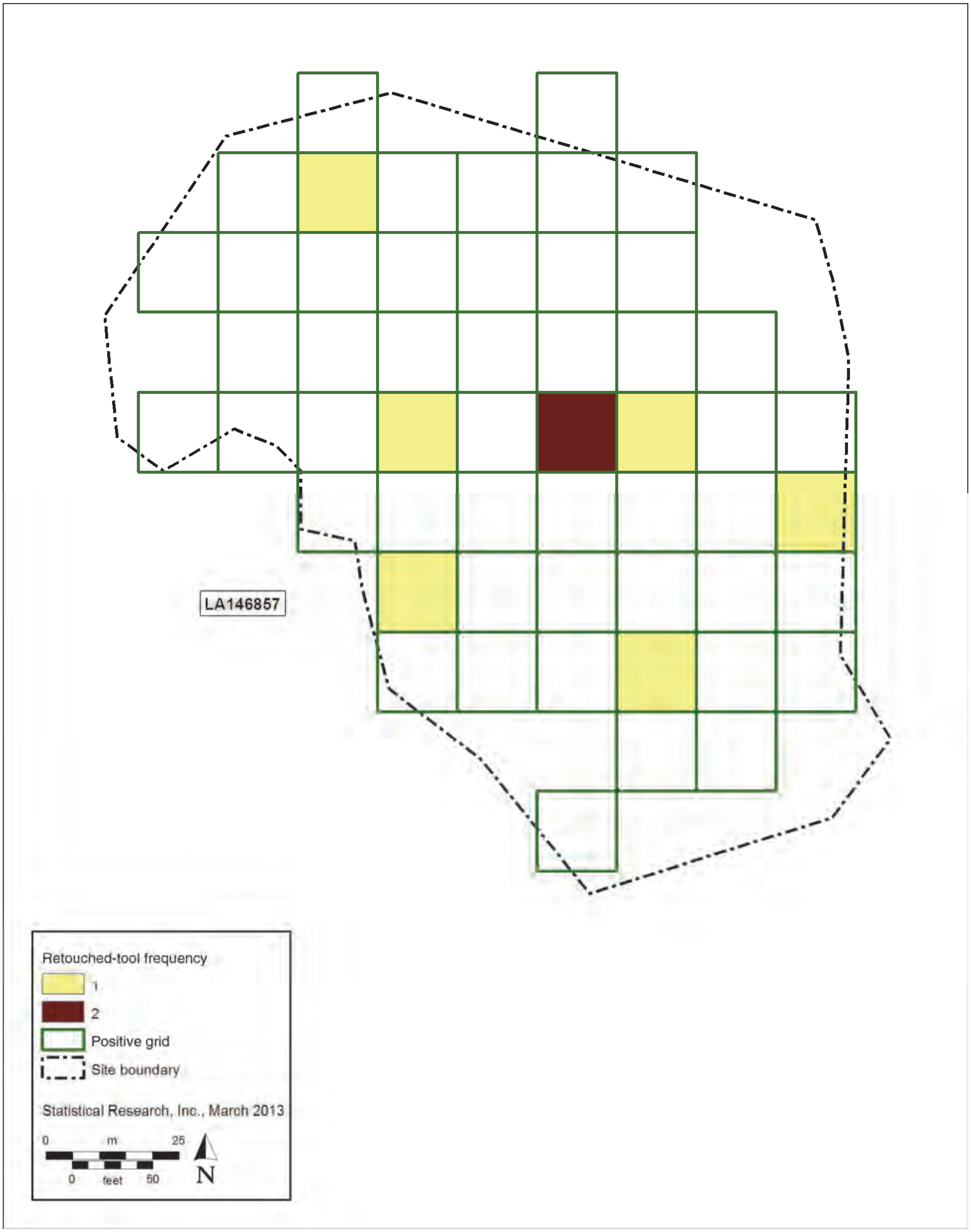

Figure 57. Frequency of retouched tools at LA 146857.

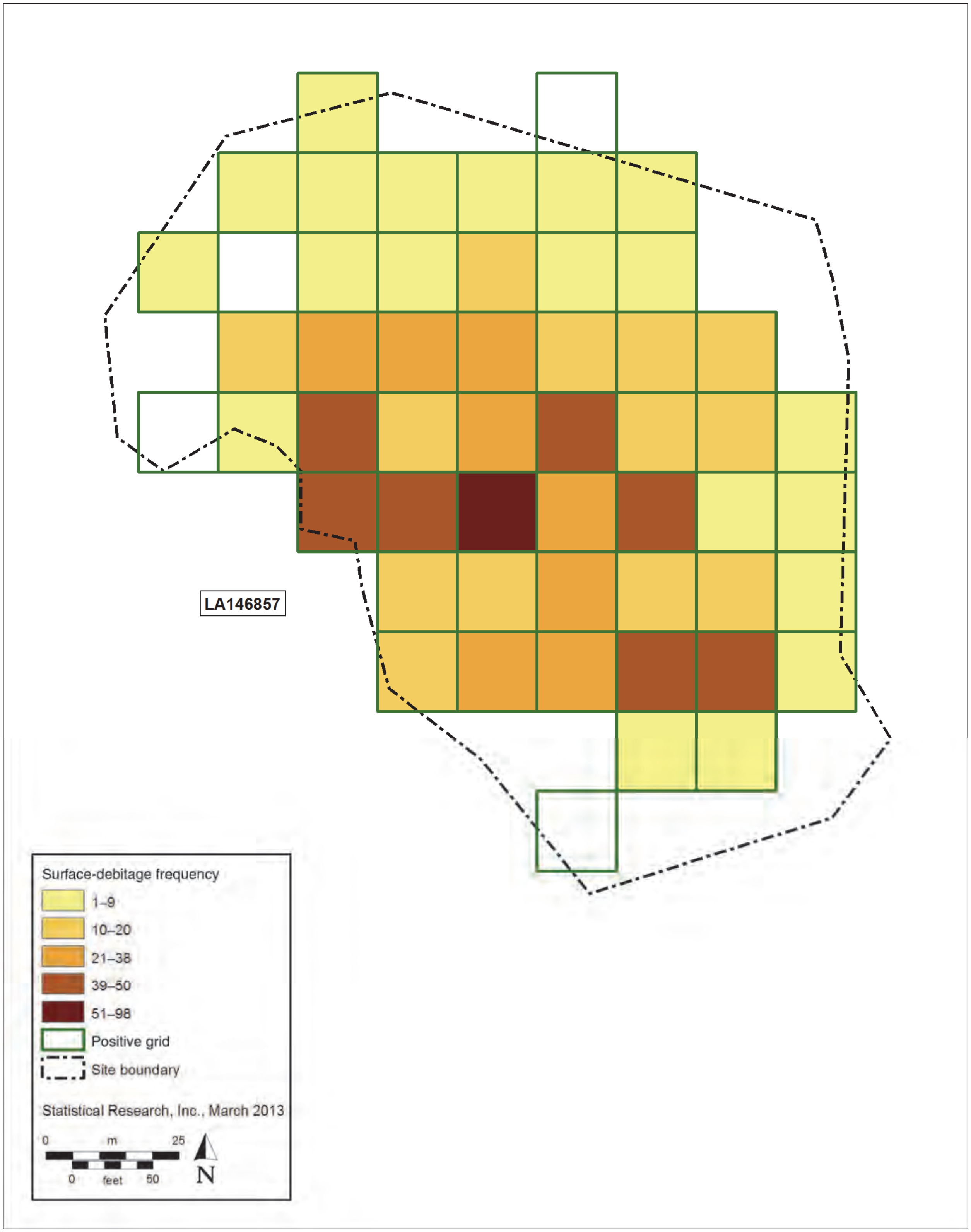

Figure 58. Frequency of lithic debitage at LA 146857.

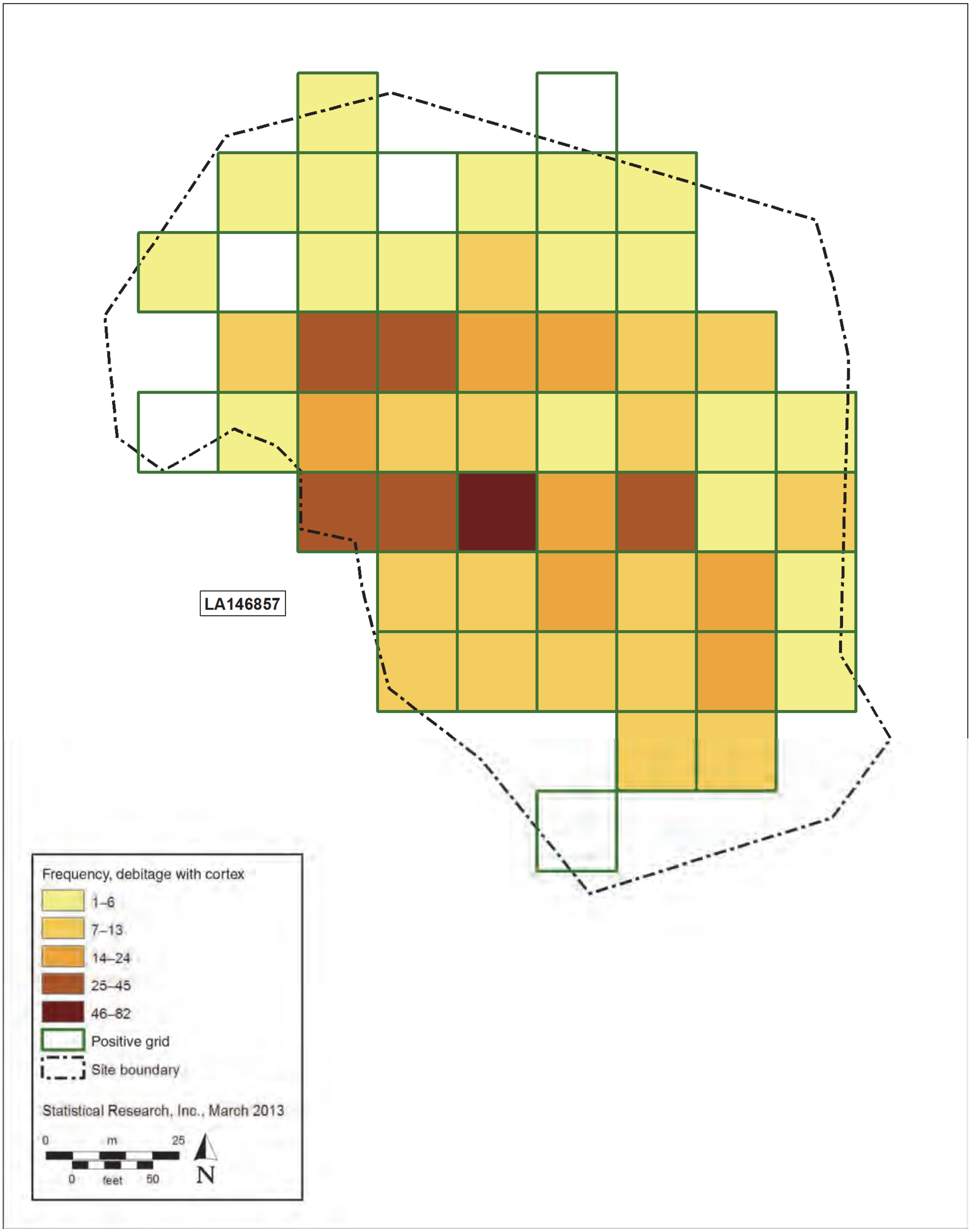

Figure 59. Frequency of debitage with cortex at LA 146857.

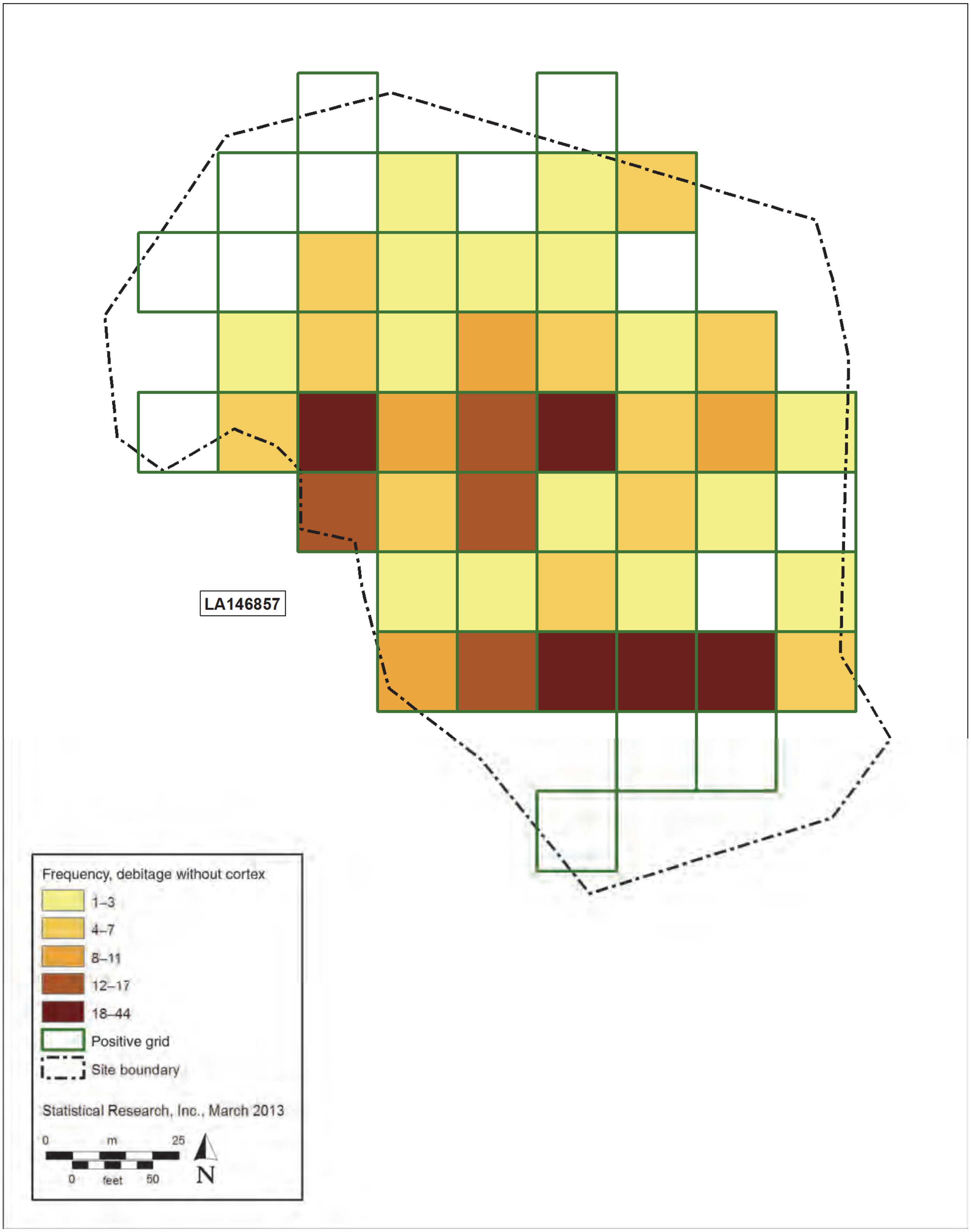

Figure 60. Frequency of debitage without cortex at LA 146857.

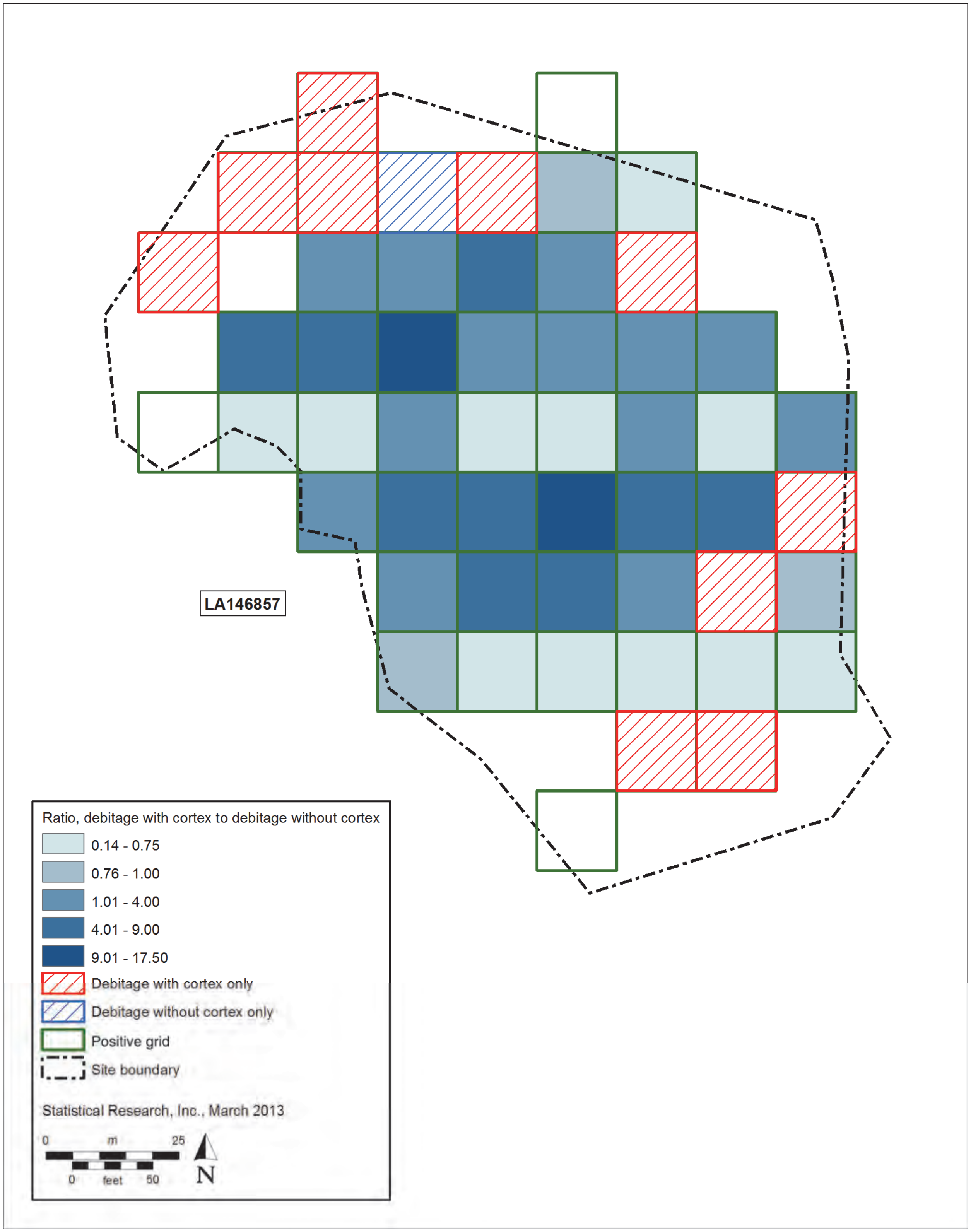

Figure 61. Ratio of debitage with cortex to debitage without cortex at LA 146857.

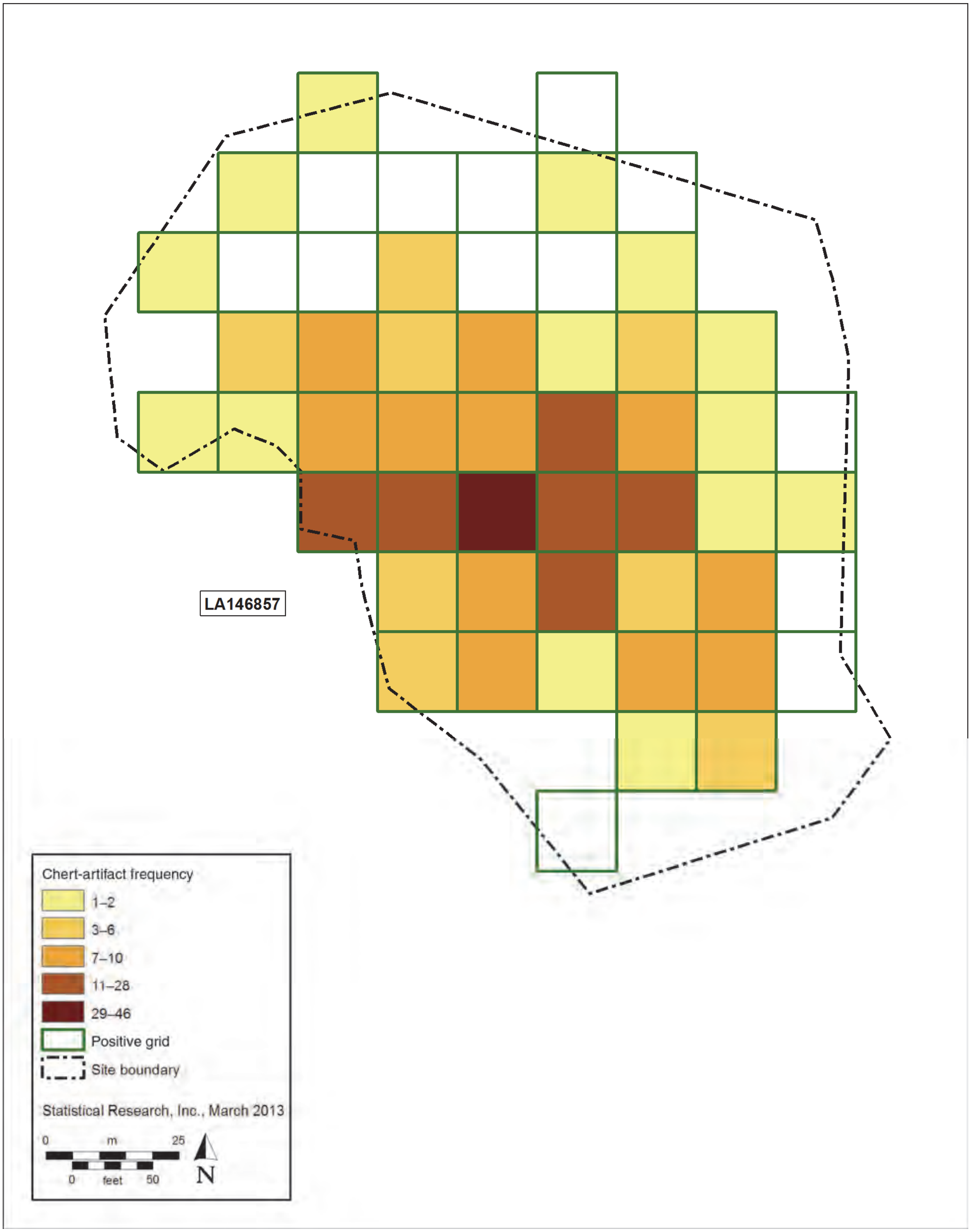

Figure 62. Frequency of chert artifacts at LA 146857.

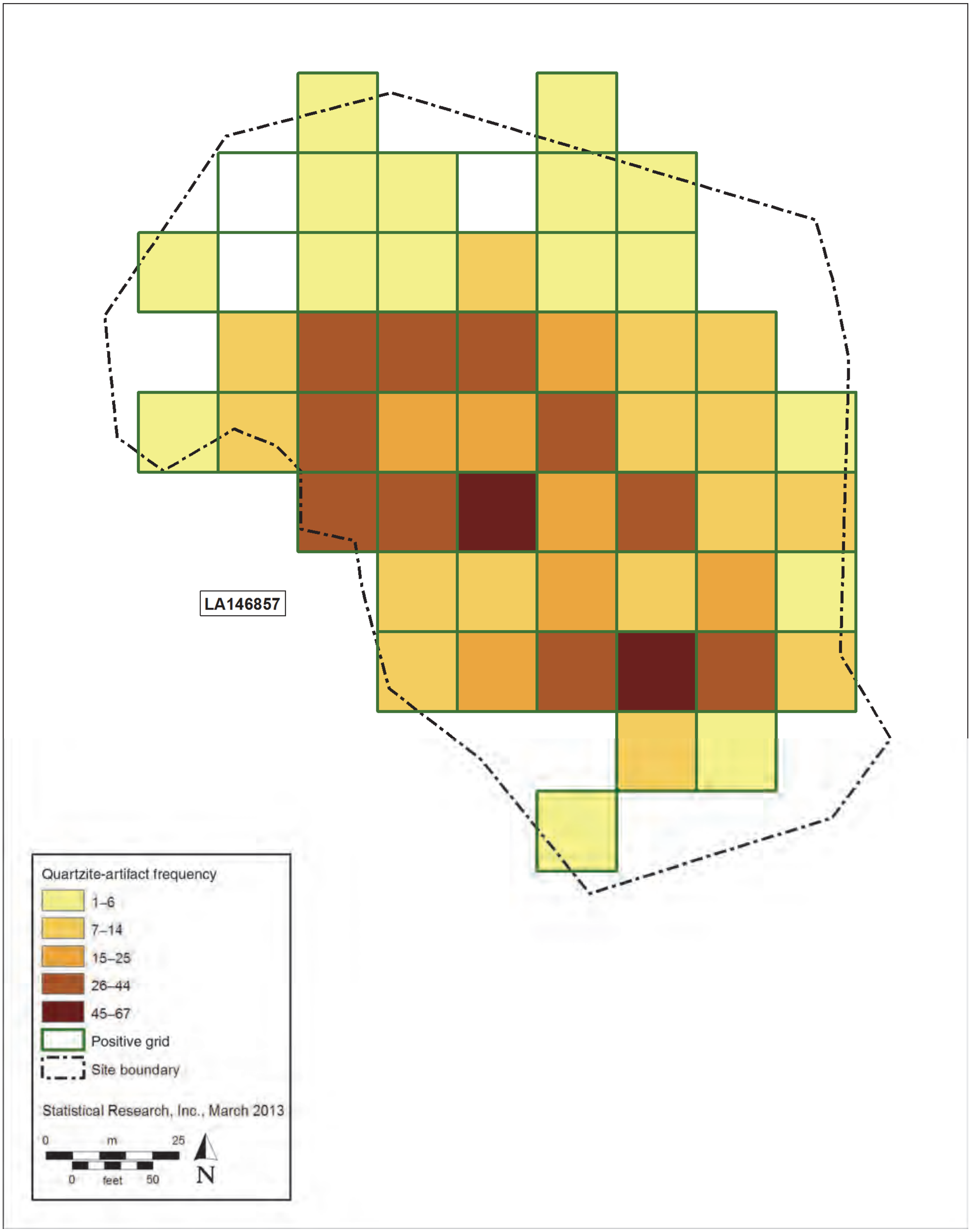

Figure 63. Frequency of quartzite artifacts at LA 146857.

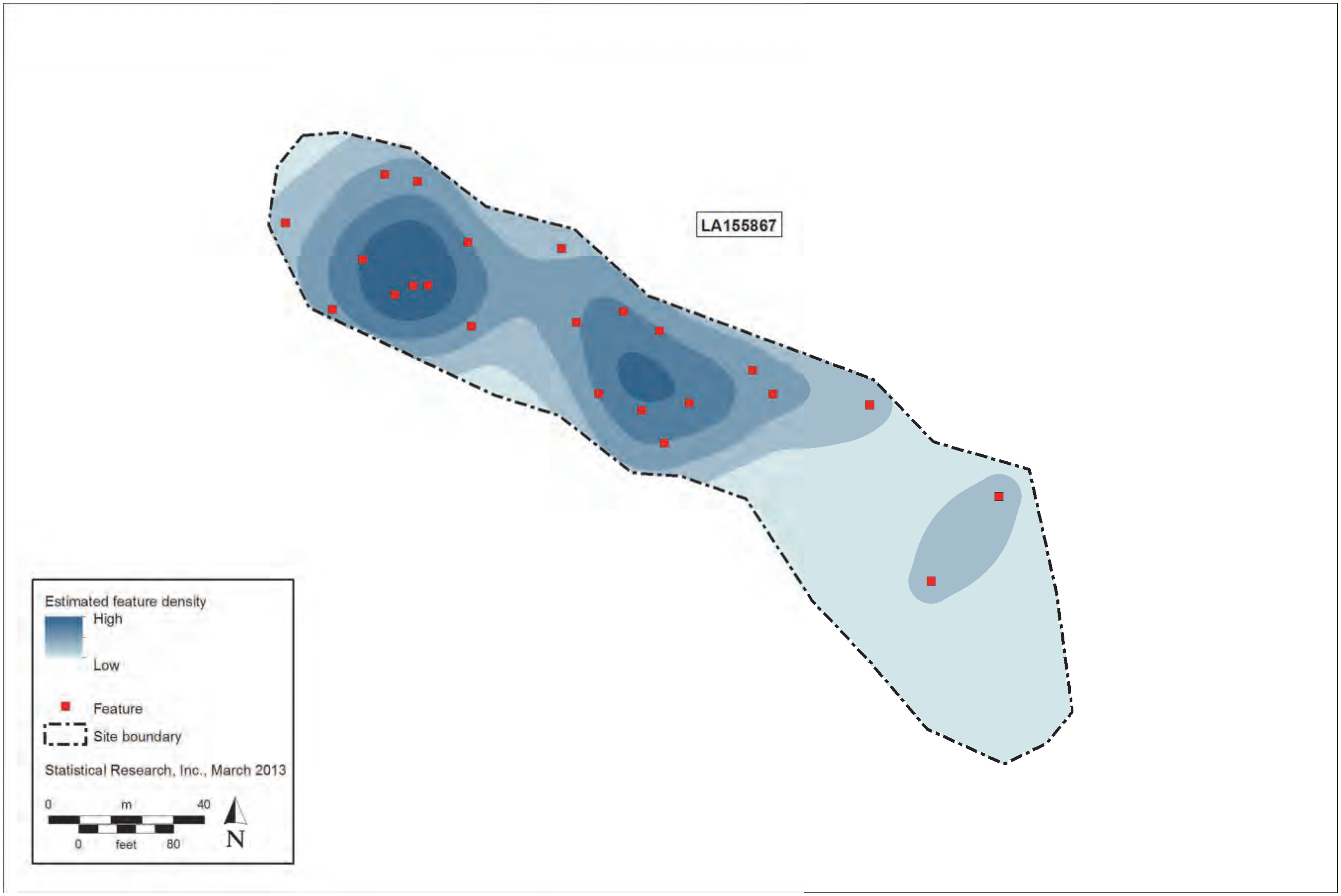

Figure 64. Feature density at LA 155867.

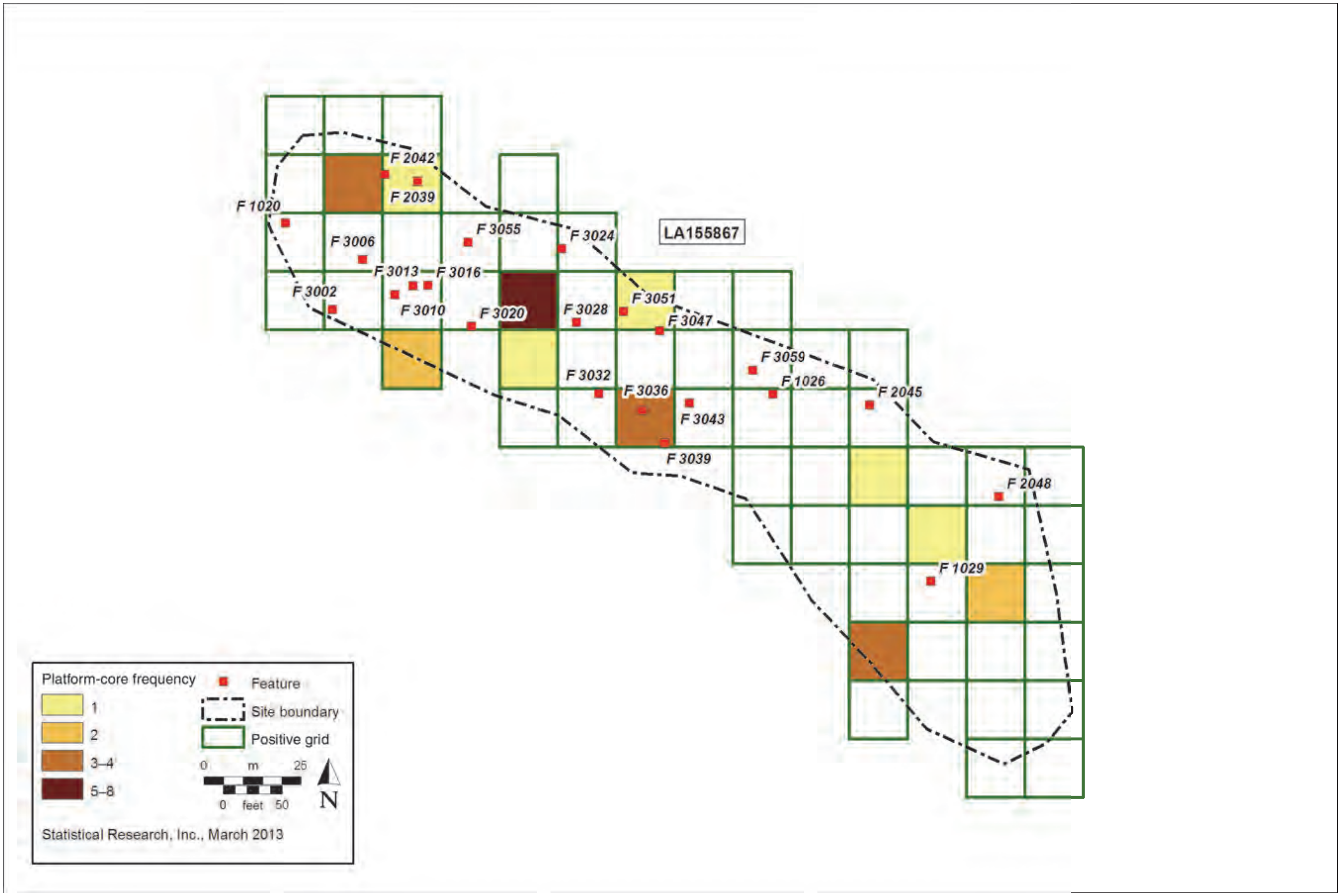

Figure 65. Frequency of platform cores at LA 155867.

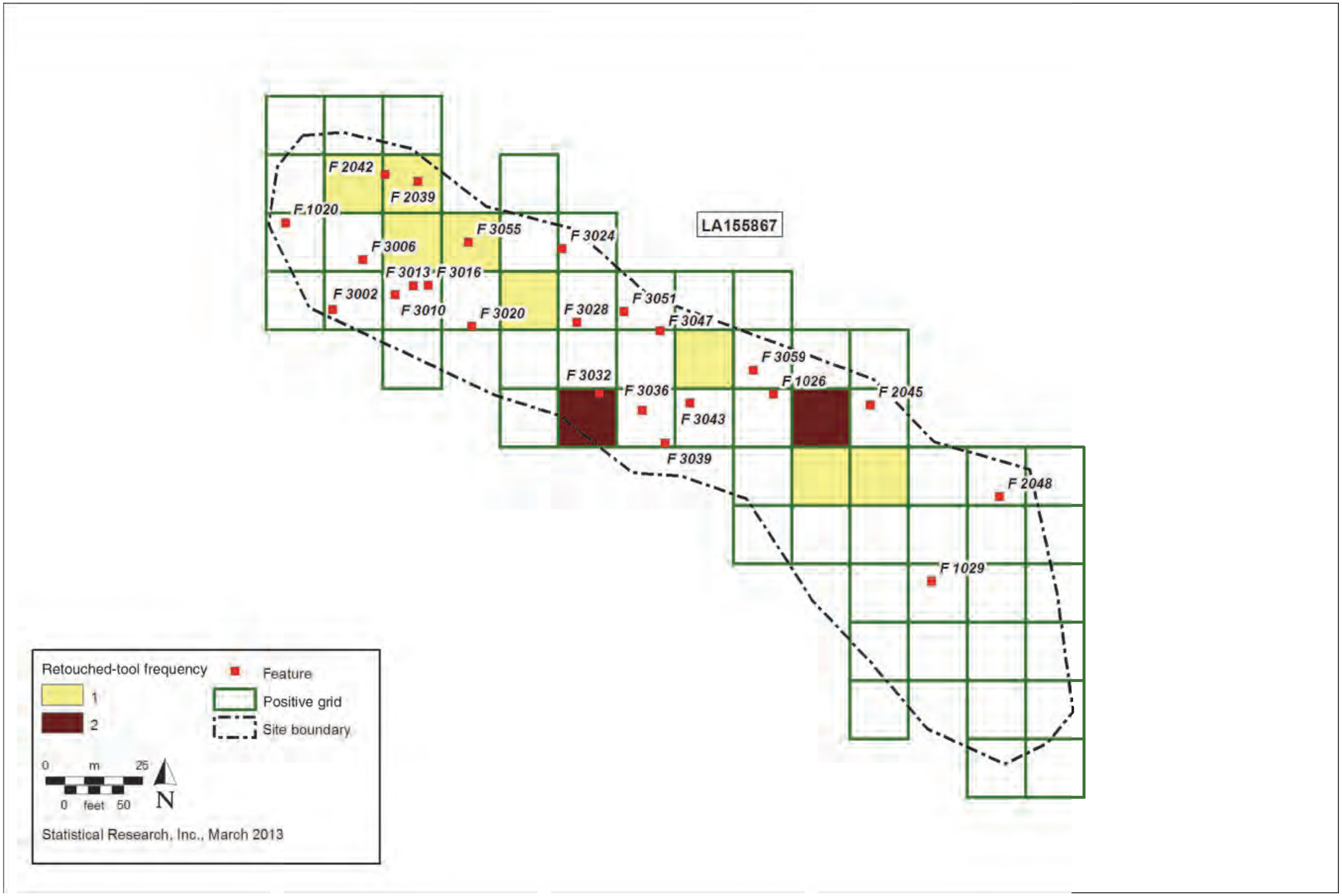

Figure 66. Frequency of retouched tools at LA 155867.

In contrast to the two intensive lithic-procurement sites, at which worked cobbles were both more numerous and much more extensively distributed than platform cores, worked cobbles were relatively uncommon at LA 155867 (Figure 67). For the most part, they were found in the eastern third of the site, where FCR features were uncommon. This contrast is readily apparent when distributions of both core categories are illustrated together (Figure 68); grid cells containing only platform cores were almost entirely limited to the northern, domestically focused portion of the site, and grid cells with worked cobbles only were similarly distributed in the southern portion of the site. Where both core categories were found together, platform cores generally outnumbered worked cobbles, reflecting their greater overall frequency.

Lithic debitage (Figure 69) was also more frequent and widespread in the eastern third of the site, although debitage was found throughout the site area. Given the predominance of platform cores at LA 155867, it is unsurprising that debitage without cortex (Figure 70), with a total of 109 artifacts reported, was much more common than at either LA 43423 or LA 146857, slightly outnumbering the 98 examples of debitage with cortex (Figure 71). Likewise, frequencies of debitage without cortex exceeded or equaled frequencies of debitage with cortex in 12 of the 24 cells in which both debitage types were present—another marked contrast to patterns elsewhere (Figure 72).

Although the two debitage types were both distributed across the entire site surface, grid cells containing only debitage with cortex appeared to be somewhat concentrated along the site's eastern margin, and three of the six grid cells in which both types were present but in which debitage with cortex predominated were located in the southeastern portion of the site. This pattern supports the evidence from core distributions, indicating that early-stage lithic processing was focused in the southeast, away from domestic areas. Conversely, many grid cells that contained a predominance of debitage without cortex were located in the northwestern, domestic portion of the site, suggesting that later-stage reduction activities took place in that area as well as in the southeastern portion of the site. However, the northeastern area appeared to have been the primary focus for later-stage lithic production as well as for initial processing: five of the six grid cells with the greatest predominance of debitage without cortex were located in the northeastern portion of the site. The distribution of later-stage flake types, such as biface flakes (Figure 73), also indicated that later-stage lithic reduction was carried out most intensively in the northeastern portion of the site, beyond domestic areas.

Together, core and debitage distributions at LA 155867 likely reflect a different set of lithic-processing activities than occurred at LA 43423 and LA 146857. As indicated in Chapter 7, unworked lithic cobbles were not identified at LA 155867, suggesting that it was not a primary source of lithic raw materials. Although the numerous cores and worked cobbles identified at the site clearly indicated relatively intensive lithic processing at all stages of the reduction sequence, a significantly greater emphasis on late-stage reduction was also apparent; as discussed earlier, flakes recorded at LA 155867 were, on the whole, much smaller than flakes at LA 43423 or LA 146867. Although some of this late-stage processing was evidently linked to the site's domestic and occupational functions, as demonstrated by the distributions of platform cores and debitage without cortex discussed above, the selective use of areas beyond the site's domestic zone for intensive lithic processing at all stages of the reduction sequence suggests that lithic production at LA 155867 was conducted at a scale exceeding the needs of its domestic component.

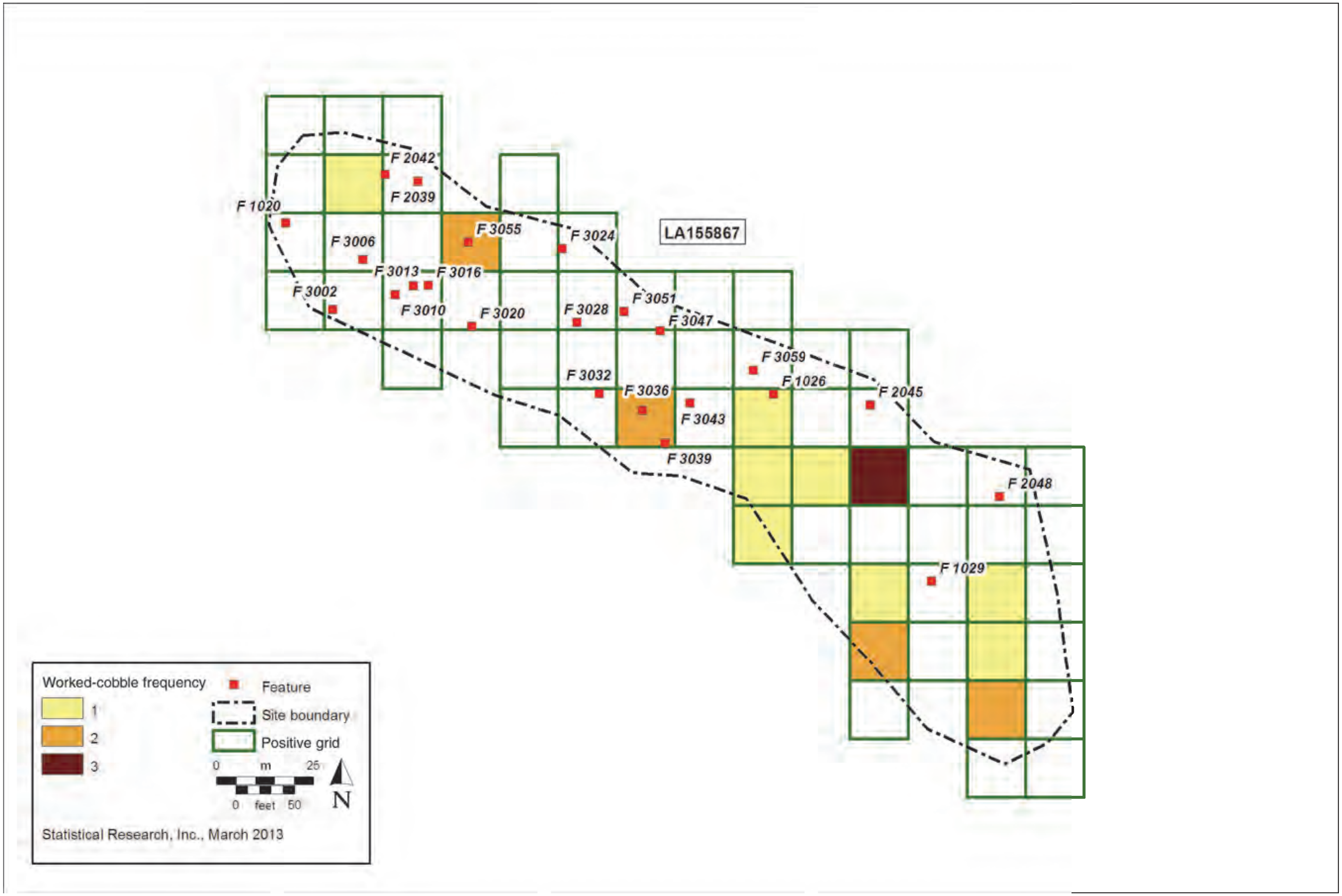

Figure 67. Frequency of worked cobbles at LA 155867.

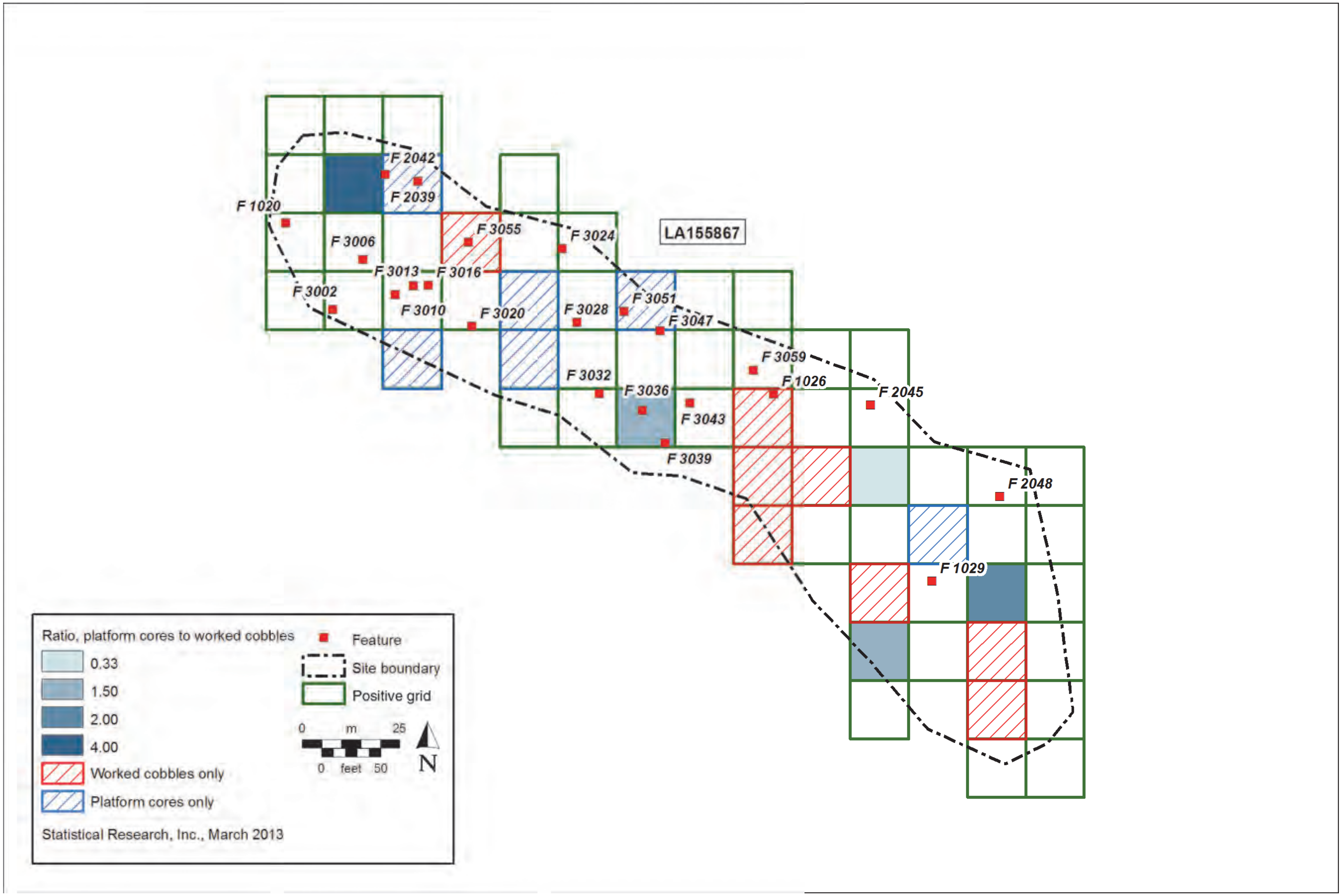

Figure 68. Ratio of platform cores to worked cobbles at LA 155867.

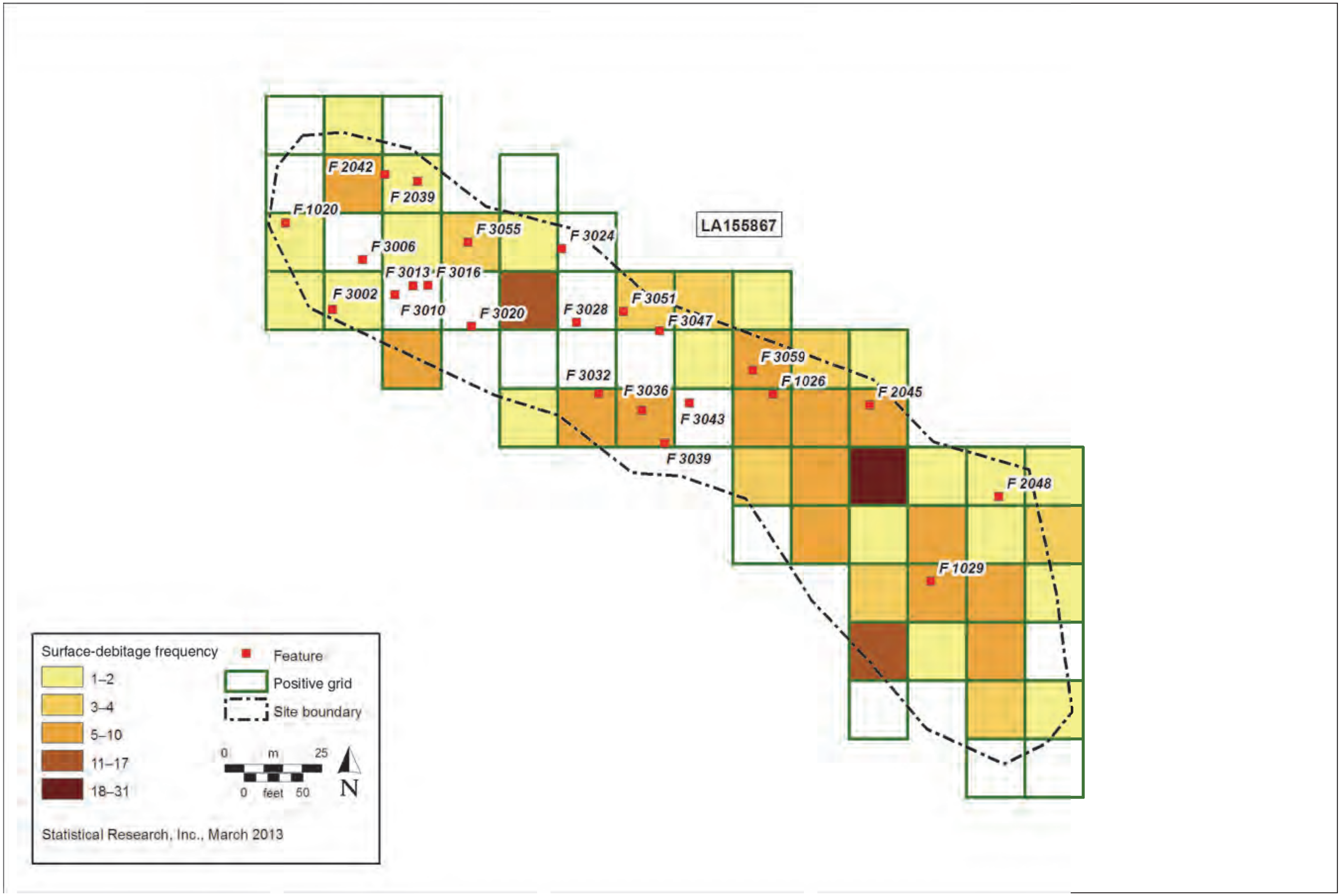

Figure 69. Frequency of lithic debitage at LA 155867.

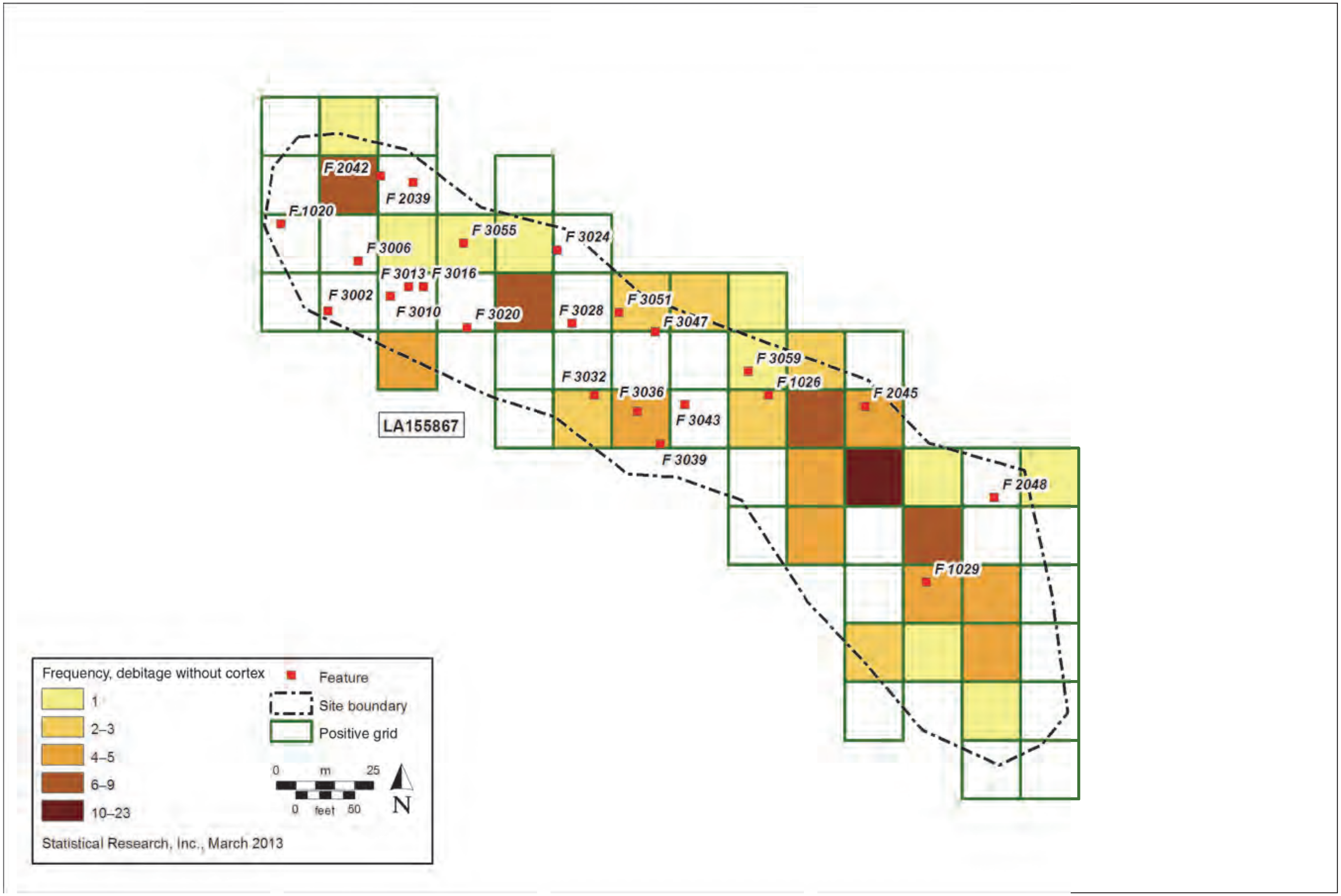

Figure 70. Frequency of debitage without cortex at LA 155867.

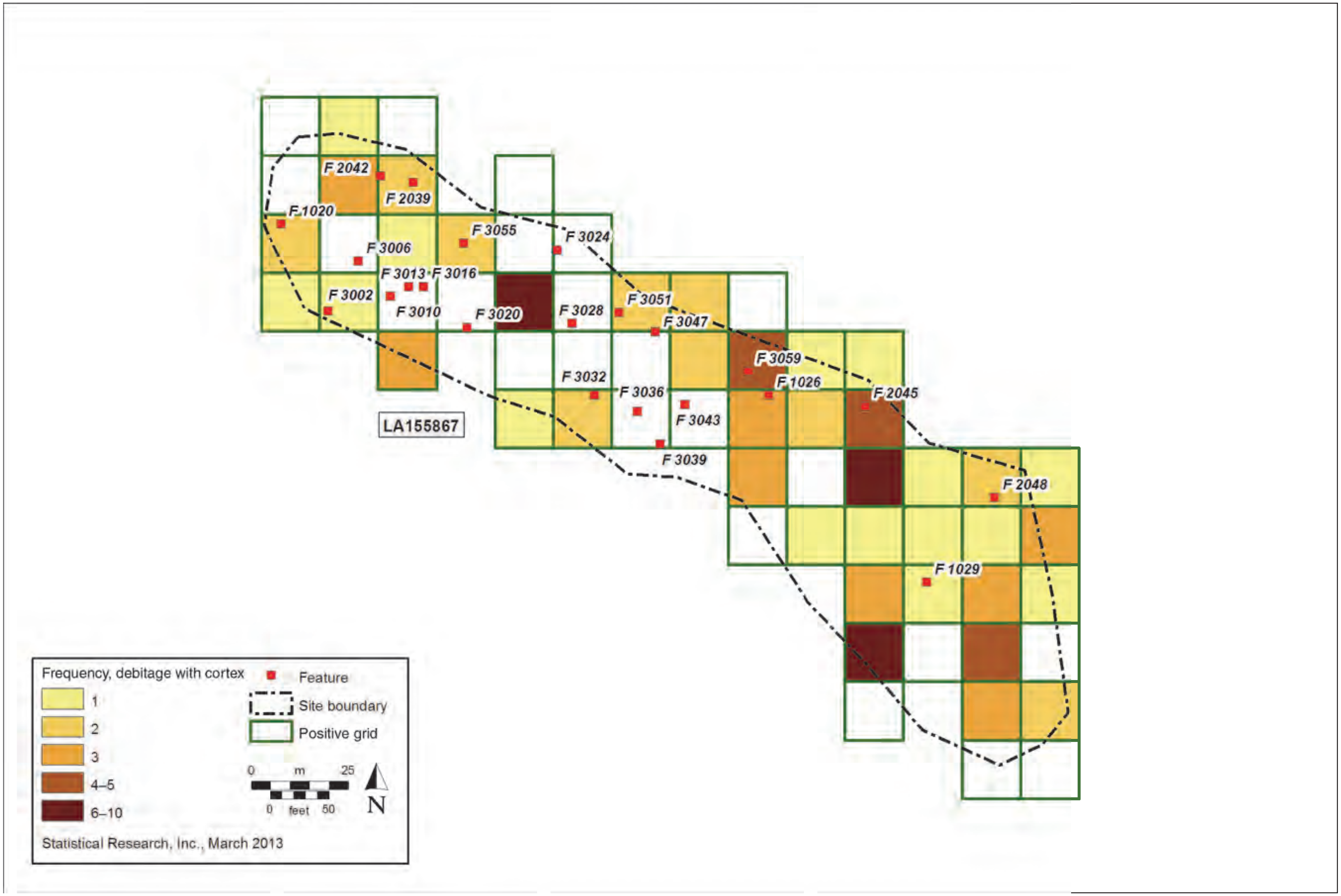

Figure 71. Frequency of debitage with cortex at LA 155867.

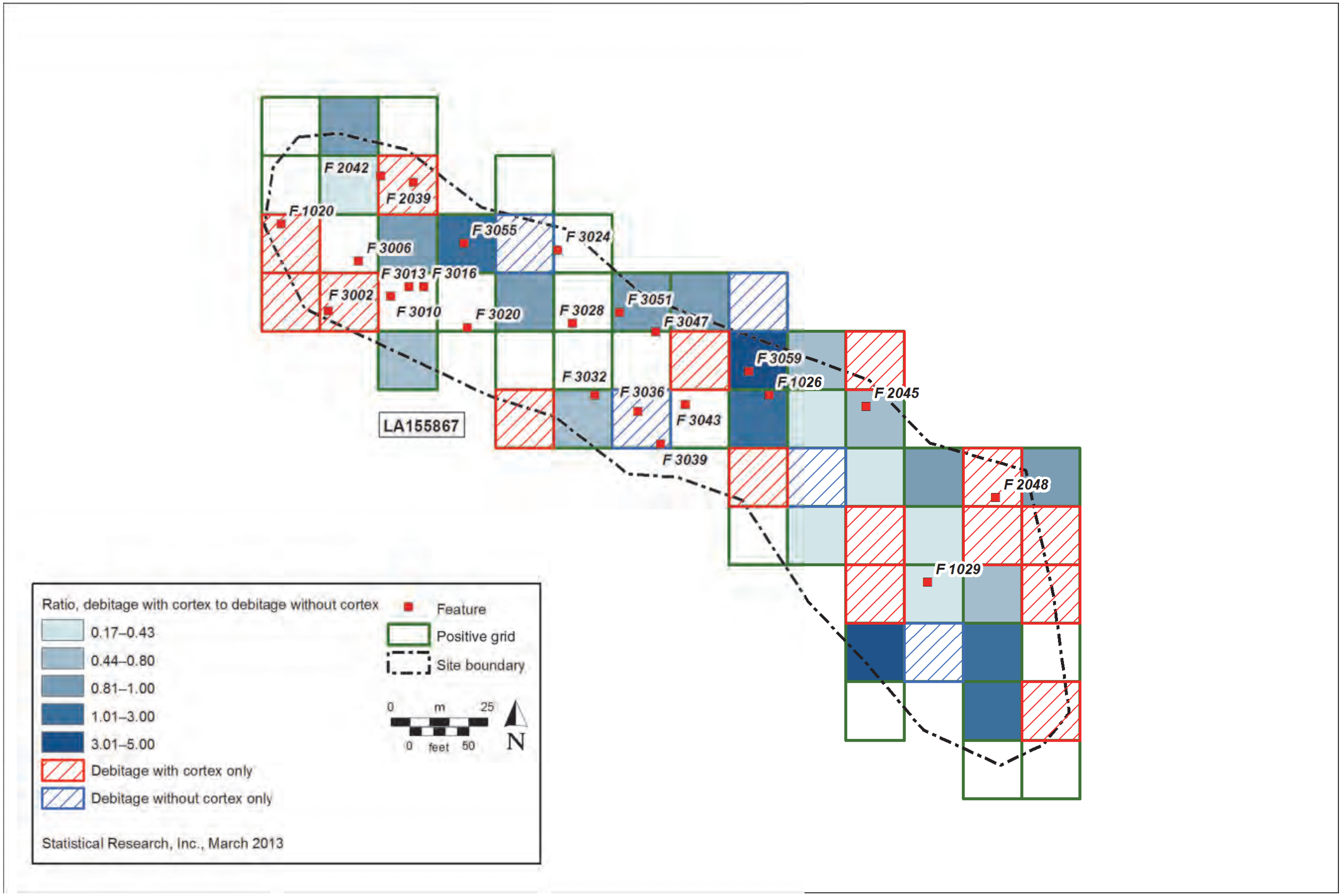

Figure 72. Ratio of debitage with cortex to debitage without cortex at LA 155867.

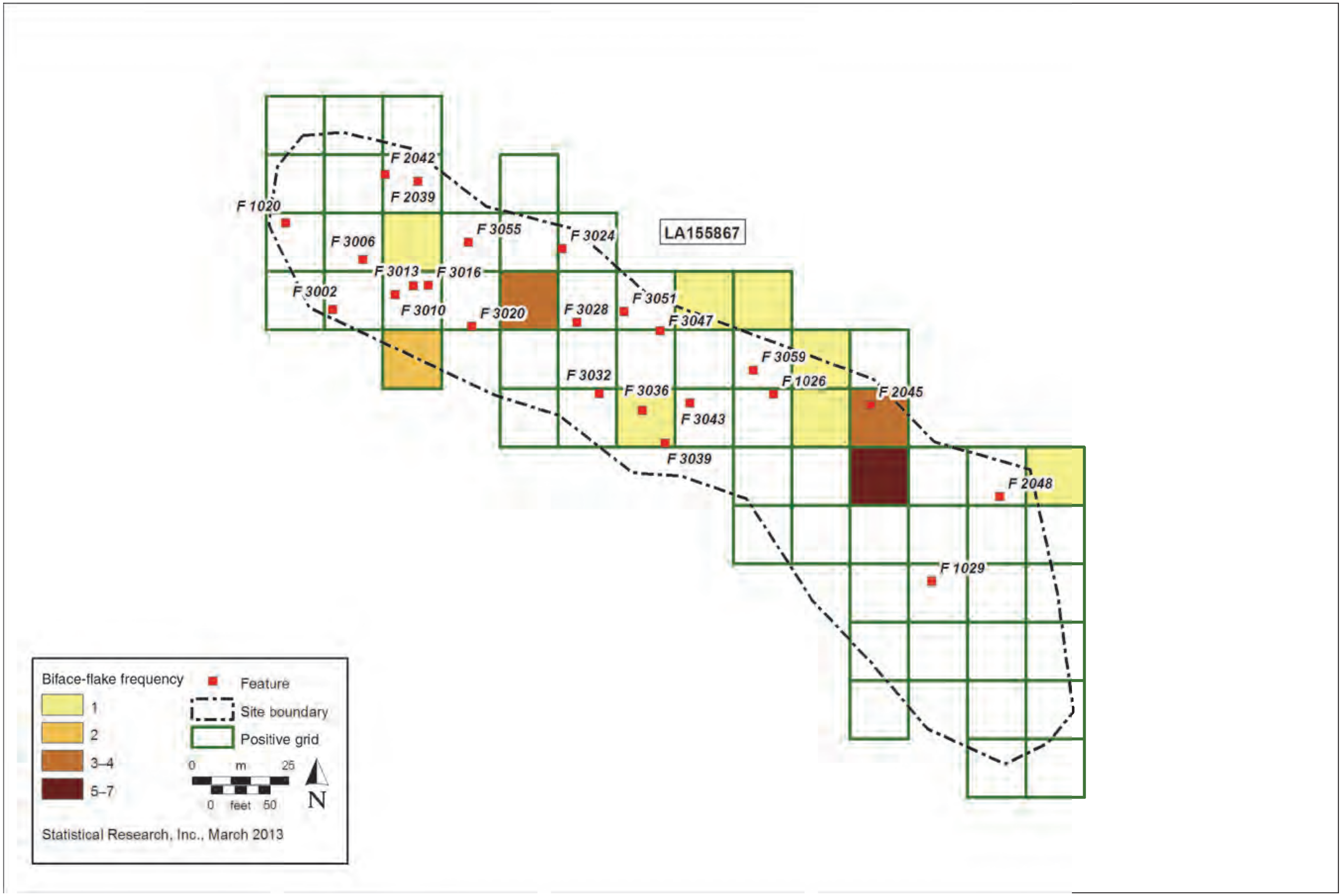

Figure 73. Frequency of biface flakes at LA 155867.

CHAPTER 10

Site/Survey-Area Evaluations

Scott H. Kremkau

Introduction

This chapter outlines SRI's approach to evaluating the eligibility of sites for listing in the NRHP and presents our evaluation of each of the 14 sites and 2 survey parcels in the study area. The chapter first reviews the general criteria used for evaluating sites, as defined by Section 106 of the National Historic Preservation Act of 1966, as amended. Next, some of the challenges of evaluating quarries and lithic-procurement locales are discussed, highlighting how archaeologists have tackled these issues. Then, SRI's criteria for evaluating the resources are presented. Finally, eligibility recommendations for all 16 locations are presented.

NRHP Criteria

Section 106 of the NHPA requires federal agencies to take into account the effects of an undertaking on historic properties, defined as cultural resources listed in or eligible for listing in the NRHP. Determinations of NRHP eligibility for cultural resources prior to making a finding of effect are made according to the following criteria:

> The quality of significance in American history, architecture, archaeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling and association, and:
>
> (a) that are associated with events that have made a significant contribution to the broad patterns of our history; or
> (b) that are associated with the lives of persons significant in our past; or
> (c) that embody the distinctive characteristics of a type, period, method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack distinction; or
> (d) that have yielded, or may be likely to yield, information important to prehistory or history [Code of Federal Regulations, Title 36, Part 60.4 (36 CFR 60.4)].

If cultural resources do not meet the above criteria, they are not considered eligible for listing in the NRHP and are not further considered in the Section 106 process.

In addition to these four criteria, there is a general stipulation that a historic property be 50 or more years old (for exceptions, see 36 CFR 60.4, Criteria Considerations) and that the site have integrity for the period of significance. The period of significance is the date or span of time within which significant events transpired or significant individuals made important contributions. Integrity is the authenticity of a historical resource's physical identity, as evidenced by the survival of characteristics or historic fabric that existed during the resource's period of significance. Simply put, resources must retain enough of their character or appearance to be recognizable as historic properties and to convey the reasons for their significance.

Evaluating Quarries and Procurement Locales

No locations in the study area are considered eligible for listing in the NRHP under Criterion a, b, or c. In many cases, prehistoric sites are evaluated under Criterion d, and because of the nature of the resources in the current study, this will be the focus of the remainder of this chapter. To assess whether or not a site is eligible under Criterion d, archaeologists develop research designs and then examine the data from a given site to see if the data can address any of the proposed research questions. It is difficult to evaluate surface-artifact scatters for listing in the NRHP under Criterion d, because they generally lack many of the data types archaeologists consider important, such as the presence of datable materials and intact subsurface deposits, and often, they are palimpsests, accumulations of artifacts over long periods of time that have become mixed together. At quarry and procurement sites, these problems can be even greater, because there is often far fewer artifact types at quarries than at habitation sites. However, a number of archaeologists have begun to tackle the issue of evaluating quarries and procurement sites. Of particular interest is the work done in the deserts of the U.S. West. In Arizona, California, and Nevada, similar types of quarries and procurement sites have been studied in great detail. These studies have focused on three main areas: dating the sites, determining intersite and intrasite variability, and placing the sites in a regional context. In most cases, these studies combine aspects of all three areas; for example, the ability of Byrd et al. (2005) and Byrd et al. (2009) to date the procurement sites at Fort Irwin was dependent on having comparable regional data (see below), but it is useful to examine these studies from a variety of perspectives to see how investigators have used different approaches in dealing with quarry sites.

Dating Quarries and Procurement Sites

One of the key aspects of evaluating sites is being able to place them in a regional chronological context. Dating quarry and procurement sites is notoriously difficult because of the lack of datable materials. There are often few diagnostic artifacts, such as projectile points, and even fewer hearths or other features that could include charcoal or other datable materials. Moreover, because quarries and procurement sites often lack subsurface deposits, the surface materials are often a palimpsest of many different episodes of use. To get around these obstacles, archaeologists have devised ways of indirectly dating sites.

One way to approach dating quarries and procurement sites is by comparing the artifact types found at a quarry or procurement site with those found at nearby habitation sites. Bergin and Warren (1983) examined a large procurement site, the Bow Willow South site, in Fort Irwin, California. In their research design for data recovery excavations at the site, they posited that if the site served as a source for lithic raw material for long periods of time, changes in lithic technology that occurred through time should be archaeologically visible at the site:

> A. Lithic-reduction subsystems from different periods or cultural units will exhibit a different knapping style or styles. Knapping styles may be unique to each of the lithic-reduction subsystems, but they may also correlate with the use of different forms or types of raw material. For example the use of thin slabs of chalcedony at the Bow Willow site is more conducive to biface manufacture than to the production of large keeled or high-domed scrapers. Therefore it seems unlikely that this procedure represents the early stages of the Pinto lithic reduction system as known from the artifacts and cache of basalt flakes at the Awl site.
>
> B. Some loci at Bow Willow South will contain several stages of reduction, while others contain only the earliest stage. Some lithic-reduction systems may have included more reduction stages at the source than others did.
>
> C. Differences in edge preparation, flaking techniques and percussor attrition can be identified on the same material type suggesting the presence of different knapping styles [Bergin and Warren 1983:71–72].

Byrd et al. (2005) and Byrd et al. (2009) followed a similar method. They investigated a number of quarries and procurement sites at Fort Irwin, California, in the Central Mojave Desert. Although quarries are often larger and feature more diverse artifact assemblages than procurement sites, Byrd et al. (2005:137) noted that procurement sites do offer some advantages over quarries in terms of the types of analysis that can be conducted. Because procurement sites are generally less dense than quarries, it is sometimes possible to break out individual reduction episodes (Segregated Reduction Loci [SRLs]), which usually consist of debitage and perhaps a core fragment or a hammerstone. SRLs represent “moments in time” in which a single core was reduced by a single person and can provide more fine-grained analysis of reduction strategies.

Byrd et al. (2005) proposed an alternative method of dating procurement sites, one that relied on detailed analysis of the cores and debitage found at procurement sites and comparative data from nearby residential sites. In their analysis of residential sites in the Mojave Desert, Byrd et al. (2005:141–166) found that there were differences in the types of lithic materials that were used in stone tools and differences in the sizes of certain artifact types, particularly cores. With this information in hand, they were then able to date various secondary quarries by comparing the types of cores that were produced at the quarries and how these types related to artifacts reduced at the nearby residential sites.

Site Variability and Spatial Patterning

Another issue with quarries and procurement sites is that it can be difficult to determine how the sites were used. This is particularly true at quarries, which tended to be used over longer periods of time, and more intensively. Changes in technology and quarrying strategies that may have occurred over time can be difficult to detect because of the complex nature of the sites. However, archaeologists have used both intersite and intrasite comparisons to look at spatial patterning.

Haynes (1996) examined a large lithic scatter (26NY7920) near Yucca Mountain, Nevada, that contained a large assemblage composed of debitage, cores, and flaked stone tools. Like the locations in SRI’s study area, 26NY7920 did not contain subsurface deposits. These types of sites are very common throughout the region but have remained largely under-studied because of the lack of subsurface deposits and, often, of diagnostic artifacts. Haynes’s approach was to determine whether there was variability in the distribution of artifacts within the site and whether the variability was related to changes in lithic technology.

26NY7920 and similar sites could result from either many short-term occupation episodes or a smaller number of much-more-intense depositional episodes. In the former case, Haynes predicted a much-more-even distribution of artifacts, with no distinct clustering. He suggested that in the latter case, artifact distribution should be more uneven, given the smaller number of episodes (Haynes 1996:104–106).

To test this, artifacts were recorded at the site in a 20-by-20-m grid and then analyzed for variations. Three discrete artifact clusters were found at the site, separated by areas with few artifacts. Haynes looked at variations in debitage and tools at each cluster, based on the totals from each 20-by-20-m-grid unit. Haynes (1996:215–216) concluded that although there was a small degree of variation between clusters, the variations were not statistically significant, and thus the site likely represented a series of short-term occupations producing generally similar artifact types.

Bloomer (1991) examined a number of sites associated with the Tosawihi quarries in north-central Nevada. These included quarry sites, reduction loci, and habitation sites. Bloomer analyzed both debitage and tools, as did Haynes, but focused on bifaces and biface production. The Tosawihi quarries cover approximately 9 km^2; the main quarry areas are located in the center, and reduction loci and residential sites are spread across the periphery. Research questions at the quarries focused on the economics of lithic procurement and processing and how these sites fit into the regional economy (Bloomer 1991:204). The main goal of the study was to characterize biface-reduction strategies present at various site types in the quarries as a way to interpret variability in biface production at the quarries. These patterns in biface reduction could then be used to examine issues of hunter-gatherer mobility across the region.

In his study, Bloomer divided debitage into four types: interior flakes, edge-preparation flakes, and early-stage- and late-stage-percussion flakes. By examining variations in the ratios of these flake types at different sites, he was able to deduce that three stages of reduction were carried out at different sites—core reduction, early-stage biface reduction, and late-stage biface reduction—and that different levels of reduction were carried out at different sites. Although Bloomer stopped short of a regional analysis and interpretation of what the differences meant, he was able to show that detailed recording at quarry sites can detect patterning.

Both of these investigators were able to identify artifact clusters at the sites they studied and were able to determine whether there were significant variations between them. Although the authors either found no variations or stopped short of interpreting variations, the takeaway is that fine-grained analyses of the spatial distribution of artifacts within quarries and reduction areas can be useful for teasing out changes in technology and resource-acquisition strategies.

Quarries and Procurement Sites in Regional Contexts

Besides dating sites and understanding spatial patterning at sites, it is important to understand how quarries and procurement areas relate to other sites in a given region. This is particularly important for areas in which mobile groups of hunter-gatherers were the norm for much of prehistory, such as southeastern New Mexico, because changes in mobility and settlement patterns would have affected how stone-tool sources were utilized.

When looking at issues of mobility, many researchers have focused on the concepts of embedded and direct procurement strategies (sensu Binford 1979). These strategies refer to how raw materials were acquired. In an embedded strategy, people traveled to quarries and procurement sites during the course of other activities. For example, a hunting party may have stopped at procurement sites that were on the way to regularly visited hunting grounds. In this scenario, less emphasis was placed on the quality of the lithic material, and more emphasis was placed on the ease of acquiring it. In contrast, a direct procurement strategy would involve a special trip to a resource area for the express purpose of acquiring that resource. Because of the increased travel costs tied to direct procurement, there is usually an emphasis on high-quality raw materials. These concepts have some bearing on how we interpret prehistoric lifeways. For example, the use of an embedded procurement strategy implies greater residential mobility and a fairly flexible lithic toolkit (Kelly 1988; Shott 1986). Direct procurement implies a more sedentary settlement pattern and a more specialized toolkit, requiring high-quality materials (Bleed 1987; Kelly 1983). These different strategies should leave different archaeological signatures at quarries and procurement sites, and thus, we should be able to learn something about settlement patterns by looking at how quarries and procurement sites were used.

As discussed above, Byrd et al. (2005) and Byrd et al. (2009) were able to identify differences in the types of artifacts produced at various procurement sites at Fort Irwin, California. By comparing the different types of artifacts produced at the procurement sites to those found at dated habitation sites elsewhere at Fort Irwin, they were able to indirectly date the procurement sites. And once they knew how old the procurement sites were, they were able to look at changes in procurement strategies and lithic technology through time.

Giambastiani (2008) was able to show similar patterns at a large number of procurement sites in three areas at the U.S. Marine Corps Air Ground Combat Center near Twentynine Palms, California. The three areas consisted of several sites of varying size and complexity. A detailed analysis of the core types and debitage showed that at least two different procurement strategies were utilized. In better-watered areas, sites with higher-quality raw materials were more intensively utilized through direct procurement, whereas sites in drier areas were visited less often, likely as part of embedded procurement strategies.

Evaluation-Criteria Summary

Based on the discussions above, SRI proposes that three interrelated criteria be used to evaluate each location in the study area:

1. To what extent can chronological determinations (absolute or relative) be made for the site/survey area?

2. Are intrasite artifact variation and spatial patterning present at the site/survey area?

3. Can assemblages from project locations be compared to other sites in the region, such as other quarries or procurement areas?

No charcoal or other datable materials were recovered from any of the features found at the locations in the study area, nor were any relative chronological indicators (e.g., projectile points and ceramics) found. The single exception was the few ceramic sherds at LA 169668. The thermal features were generally in poor condition, with FCR scattered over relatively wide areas and no subsurface deposits. The rock-ring feature at LA 122842, likewise, did not have any subsurface deposits or associated datable artifacts. Diagnostic projectile points were found by previous investigators at only two sites, LA 155867 and LA 43423, tentatively dating both sites to the Archaic period. Although there was little in the way of directly dating any of the project locations, detailed analyses of artifact distributions at the sites may provide additional ways of dating them.

A few of the locations had assemblages large enough to show spatial patterning: LA 43423, LA 122867, LA 146857, and LA 155867. Generally, it was the larger locations with more diverse artifact types that tended to have greater spatial patterning. Spatial analysis of this patterning at LA 43423 and LA 146857, two gravel-procurement sites in the Lower and Upper Pecos River Groups, and LA 155867, a campsite in the Artesia Group, found that there was some variability in the distribution of artifacts across the locations (see below for discussions of individual locations). It is beyond the scope of the current study to analyze what these patterns mean, but there does appear to be enough data on the surface that future research should investigate how the locations were used. These data would include the collection and detailed analyses of artifacts that would be used to further clarify the nature of the spatial clustering, activities, and site function.

Site/Survey-Area Evaluations

All 14 sites and the 2 survey parcels in SRI's study area have previously been evaluated for eligibility for listing in the NRHP. As part of the current study, however, the BLM requested that SRI re-evaluate all 16 locations. Our criteria have been presented above. Below, we present a discussion and recommendation for each site, as well as its previous eligibility recommendation.

Sites and Survey Areas in the San Andres Group

LA 144349

The site was originally recorded by Southern New Mexico Archaeological Services, Inc., in 2004. It measured 50 by 45 m and covered an area of 2,250 m^2. The site was described as a small scatter of lithic artifacts, primarily cores, tested cobbles, and debitage. No diagnostic artifacts or features were noted, but the original records suggested that the site may date from the Early Archaic period to the late Puebloan period, based on the ages of other locations in the area.

The current study found few artifacts on the surface. Chert nodules were very sparse, and only a small number of artifacts were noted. Limestone bedrock was present at the site surface, and no soil development was present.

The site was originally classified as a BLM Category 1 site and recommended not eligible by Browning (2004) based on the lack of diagnostic artifacts. Likewise, during the current study, no diagnostic artifacts or features were present that might be used to date the site. The geologic setting suggested that there is little potential for buried deposits. Because of the lack of artifacts, the site has no research potential and is not eligible under Criterion d. Therefore, SRI recommends the site not eligible for listing in the NRHP (Table 40).

Table 40. NRHP-Eligibility Recommendations, by Regional Group

Site No.	Previous Recommendation	SRI's Recommendation
	San Andres Group	
LA 144349	not eligible	not eligible
LA 161046	not eligible	not eligible
Meadow Hill Survey Area	none	not eligible
	Upper Pecos River Group	
LA 29500	eligible	not eligible
LA 146857	eligible	eligible
LA 163991	eligible	not eligible
	Artesia Group	
LA 119804	eligible	not eligible
LA 121969	not eligible	not eligible
LA 130417	eligible	not eligible
LA 150383	eligible	not eligible
LA 155867	eligible	eligible
Adobe Draw Survey Area	none	not eligible
	Lower Pecos River Group	
LA 43423	eligible	eligible
LA 122842	eligible	eligible
	Isolated Sites Group	
LA 149992	eligible	not eligible
LA 169668	eligible	not eligible

Key: NRHP = National Register of Historic Places; SRI = Statistical Research, Inc.

LA 161046

The site was originally recorded by the BLM-CFO in 2008. It measured approximately 230 by 110 m and covered an area of just over 25,000 m^2. It was described as a small lithic workshop consisting of chert artifacts, mostly cores and debitage as well as one biface. Many of the chert nodules were small and had weathered into small, angular pieces. The site is currently in the same general condition as previously described. It occupies a hilltop with a large limestone outcrop on top and thin soils along the sides. Most of the artifacts were situated in the northern and southern sections of the site, where the bulk of the natural chert outcrops are. No subsurface deposits are possible at the site because of the widespread limestone outcrops and thin soils.

The site was originally classified as a BLM Category 1 site and recommended not eligible by Stein and Robinson (2008) based on the lack of diagnostic artifacts. Likewise, during the current study, no diagnostic artifacts or features were present that might be used to date the site. The geologic setting suggested that there is little potential for buried deposits. Although there is some spatial patterning at the site, this seems to be due to the location of natural chert nodules and not resulting from human agency. Because of the lack of artifacts, the site has no research potential and is not eligible under Criterion d. Therefore, SRI recommends the site not eligible for listing in the NRHP (see Table 40).

Meadow Hill Survey Area

A small survey was conducted at locations in which artifacts had been noted in the past. The survey area measured approximately 220 by 220 m and covered an area of 42,000 m^2. A small number of artifacts were present within the survey area and were located primarily along the edges of the hilltop. There were few chert nodules larger than 15 cm each, and the chert, particularly the chert containing fusulinid fossils, has eroded into blocky, angular forms. The artifacts were mixed together with the natural spalls, and some of the angular debris may have resulted from lithic reduction. A single piece of obsidian was found on the surface.

The obsidian nodule found on the surface was the only artifact that could potentially be used to date this location. Because of the thin soils, subsurface deposits are not present. There is some patterning, but the assemblage is so small that it is difficult to make conclusions about the location. Because of the small number of artifacts and the lack of any diagnostic artifacts and variation in the artifact assemblage, the location has no research potential and is not eligible under Criterion d. Therefore, SRI recommends the location not eligible for listing in the NRHP (see Table 40).

Sites in the Upper Pecos River Group

LA 29500

The site was originally recorded by the ENMU AFCA (1981). The site was revisited by Mesa Field Services in 2001, by the BLM-CFO in 2008, and by Boone Archaeological Services in 2011. The site measured 250 by 223 m and covered 55,750 m^2. In all cases, the site was described as a small lithic-procurement site containing cores, tested material, and debitage. No features or diagnostic artifacts were recorded during any previous site visit. SRI located only 34 total artifacts, spread diffusely across the area. Raw material was only available in very limited quantities, and most of the chert and quartzite cobbles were less than 10 cm each in length.

The site was originally classified as a BLM Category 2 site and recommended eligible by Smith and Hermann (2001) based on the fact that the site may retain additional data potential. However, during the current study, only a small surface assemblage was found at the site, and it did not feature any spatial patterning. No diagnostic artifacts or features were present that might be used to date the site. No subsurface artifacts were found in the two 1-by-1-m test pits excavated at the site, and the geologic setting suggested that there is little potential for buried deposits. Because of the small number of artifacts and the lack of any diagnostic artifacts and variation in artifact assemblage, the site has no research potential and is not eligible under Criterion d. Therefore, SRI recommends the site not eligible for listing in the NRHP (see Table 40).

LA 146857

The site was originally recorded in 2005 by Southern New Mexico Archaeological Services, Inc., and was revisited by Boone Archaeological Services, LLC, later that same year. It measured 170 by 150 m and covered 25,500 m^2. The site was described as a large lithic scatter containing thousands of quartzite and chert artifacts, including cores, tested cobbles, and debitage. No diagnostic artifacts or features were observed at the site. The current survey observed a large number of cobbles spread across the surface of the site, and the site boundaries could be mapped onto this scatter of cobbles; few artifacts were found beyond the scatter. The artifact density was quite high, with over 1,200 artifacts recorded on the surface.

The site was originally classified as a BLM Category 2 site and recommended eligible by Rein (2005) based on the large artifact assemblage and potential for subsurface deposits. During the current study, a large surface assemblage was found at the site, including debitage, cores, and tools, although no subsurface artifacts were found in the two 1-by-1-m test pits excavated at the site. Spatial analyses of surface artifacts at the site showed that there was some patterning to the artifact distributions at the site (see Chapter 9). For example, although tested cobbles were concentrated in the center of the site and also found in smaller quantities toward the edges, platform cores were primarily concentrated in the center of the site and nearly absent elsewhere, with the exception of some found at the margins of the site. The platform cores found at the margins were not associated with tested cobbles. This pattern suggests that although early-stage cobble testing mapped onto the distribution of raw materials at the site, later-stage reduction activities were carried out in specific parts of the site. Also, there was some patterning in terms of the distribution of chert and quartzite artifacts at the site; areas with higher frequencies of quartzite artifacts were located around the margins of the areas with high frequencies of chert artifacts. Because the cobbles should have been relatively randomly distributed across the site, this patterning is likely the result of human activities, although it is not clear what the patterns represent.

Although there were no subsurface deposits at the site, some artifact clustering was present and could be used to address future research questions. Therefore, SRI recommends the site eligible for listing in the NRHP, under Criterion d (see Table 40).

LA 163991

The site was originally recorded in 2009 by Southern New Mexico Archaeological Services, Inc., and was revisited by APAC in 2011. It measured 295 by 165 m and covered an area of 48,000 m^2. It contained a dispersed lithic scatter of at least 100 artifacts that consisted of cores, tested cobbles, hammerstones, and debitage. No features or diagnostic artifacts were present. The current study recorded a total of 172 artifacts, spread mostly across the central and northern portions of the site. The artifacts, as well as the cobble formation containing the lithic raw materials, were sitting directly on top of a sterile sandstone formation.

The site was originally classified as a BLM Category 2 site and recommended eligible by Pangburn (2011) based on the large artifact assemblage. During the current study, a moderately sized surface assemblage was found at the site, including debitage, cores, and tools, although no subsurface artifacts were found in the four 1-by-1-m test pits excavated at the site. However, spatial analysis showed that there was no patterning to the distribution of artifacts at the site, and only one grid cell contained more than six artifacts. Because of the lack of diagnostic artifacts and variation in the artifact assemblage, the site has no research potential and is not eligible under Criterion d. Therefore, SRI recommends the site not eligible for listing in the NRHP (see Table 40).

Sites and Survey Areas in the Artesia Group

LA 119804

LA 199804 is a small scatter of lithic artifacts covering a low rise. It measured 200 by 115 m and covered an area of 23,000 m^2. A small number of chert nodules were present on the site surface, but few showed any evidence of human modification. A 1-by-1-m test pit was excavated in the location of the southern artifact scatter and was placed over a small number of artifacts on the surface. The test pit was excavated to a depth of 20 cm, where the soil became too rocky to continue excavation. No artifacts were found below the ground surface. A number of rodent burrows and other evidence for bioturbation were present at the site. The site's location on an eroding limestone ridge seems to preclude the possibility of significant subsurface deposits.

The site was originally classified as a BLM Category 2 site and recommended eligible by Fredine and Allen (1997) based on the possibility that subsurface deposits were present. However, during the current study, only a very small surface assemblage was found at the site, and it contained no variability in its artifact assemblage. No diagnostic artifacts or features were present that might be used to date the site. No subsurface artifacts were found in the 1-by-1-m test pit excavated at the site, and the geologic setting suggested that there is little potential for buried deposits. Because of the small number of artifacts and the lack of any diagnostic artifacts and variation in the artifact assemblage, the site has no research potential and is not eligible under Criterion d. Therefore, SRI recommends the site not eligible for listing in the NRHP (see Table 40).

LA 121969

The site was originally recorded by ASC in 1998 as a small lithic scatter consisting of a handful of silicified-limestone artifacts, primarily lithic debitage. The site measured just 12 by 3 m and covered an area of 37 m^2. It was located near a recently constructed oil well and associated pad. SRI was unable to relocate artifacts within the previously recorded site boundaries. Given the small size of the site and the site's location near a large oil well, it could have been destroyed or misplotted. The original recorders also noted that at least some of the artifacts at the site may not, in fact, have been real, because they were composed of limestone, which is plentiful as a bedrock outcrop.

The site was originally classified as a BLM Category 2 site and recommended not eligible by Sciscenti and Griffiths (1998) based on the lack of diagnostic artifacts. Likewise, during the current study, no diagnostic artifacts or features were present that might be used to date the site. The geologic setting suggested that there is little potential for buried deposits. Because of the lack of artifacts, the site has no research potential and is not eligible under Criterion d. Therefore, SRI recommends the site not eligible for listing in the NRHP (see Table 40).

LA 130417

The site was originally recorded by DWAS (2000), and test excavations were carried out by Mesa Field Services later that same year. The site as originally recorded occupied the southern margin of the terrace as well as the southern low areas. In addition to the artifacts, three features were noted: two small concentrations of burned caliche and FCR and a large, low ring midden composed of approximately 300 pieces of limestone FCR.

The current site boundary measured 700 by 600 m and covered just over 410,000 m^2. SRI was able to identify 263 artifacts on the surface of the site—nowhere close to the thousands of artifacts recorded in 2000. Most of the artifacts identified at the site were located on top of the terrace and in the low areas south of the terrace. Very few artifacts were found north of the terrace. None of the three previously recorded features (the two FCR features and the ring midden) could be relocated during the current survey.

The site was originally classified as a BLM Category 2 site and recommended eligible by Straight and Hermann (2000) based on the possibility that subsurface deposits were present and based on the presence of the possible ring midden. However, during the current study, only a small surface assemblage was found at the site, and the artifacts were spread across the central and southern portions of the site and showed little spatial patterning. No diagnostic artifacts or features were present that might be used to date the site. The recorded location of the ring midden was in the middle of a large field of limestone cobbles, and no discernable features could be identified in the area. No modern disturbances were present in that part of the site; so, it was not clear what the original recorders had described as a ring midden. No subsurface artifacts were found in the eight 1-by-1-m test pits excavated at the site, and the geologic setting suggested that there is little potential for buried deposits. Although the site is classified as a BLM Category 2 site and there is a relatively large artifact assemblage, little spatial patterning was present at the site, it has no research potential, and it is not eligible under Criterion d. Therefore, SRI recommends the site not eligible for listing in the NRHP (see Table 40).

LA 150383

LA 150383 was originally recorded in 2005 by ASC as a large artifact scatter measuring approximately 300 by 280 m and covering an area of more than 86,000 m^2. Artifacts included numerous chert cores, tested nodules, and flakes from various stages of lithic reduction as well as bifaces, unifaces, and retouched flakes. No features or diagnostic artifacts were identified by ASC. The site is U-shaped, with the open end to the south, corresponding to the location of a large oil-well pad. During the survey, SRI was not able to relocate many of the plotted artifacts depicted in the previous site record. The site featured a sparse scatter of small chert cores, core-reduction flakes, and tested nodules as well as a few bifaces, unifaces, and retouched tools. There appeared to be a greater concentration of artifacts at the northwestern end of the site, particularly along the lower terrace.

The site was originally classified as a BLM Category 2 site and recommended eligible by Sciscenti and Griffiths (2005) based on the fact that it may retain additional data potential. However, during the current study, only a small surface assemblage was found, concentrated primarily near the northwestern end of the site. No diagnostic artifacts or features were present that might be used to date the site. No subsurface artifacts were found in the three 1-by-1-m test pits excavated at the site, and the geologic setting suggested that there is little potential for buried deposits. Because of the small number of artifacts and the lack of any diagnostic artifacts and variation in the artifact assemblage, the site has no research potential and is not eligible under Criterion d. Therefore, SRI recommends the site not eligible for listing in the NRHP (see Table 40).

LA 155867

The site was originally recorded in 2007 by the BLM-CFO. The site measured 245 by 55 m and covered an area of 13,475 m^2. It was described as a lithic scatter with 24 features, 22 of which were thermal features. The remaining 2 were a small stone alignment and a small artifact concentration. During the current survey, nearly 400 lithic artifacts were recorded on the surface of the site, and 23 of the 24 previously recorded features were relocated. The only feature that was not relocated was Feature 21, a short alignment of limestone cobbles. The 23 features identified at the site included 22 FCR concentrations and an artifact concentration. The thermal features contained between 5 and 205 pieces of FCR each, with an average of about 40. Most of the features were sitting on the surface and had been disturbed to varying degrees. Trowel tests were excavated into all the features, but no charcoal was found and no soil changes were noted at any of them. They all appeared to be deflated and to lack any potential for subsurface components. The artifact concentration was also relocated, but slightly fewer artifacts were noted.

The site was originally classified as a BLM Category 2 site and recommended eligible by Smith (2007) based on the presence of features and a large artifact assemblage. During the current study, a relatively large surface assemblage was found at the site, including debitage, cores, and tools, although no subsurface artifacts were found in the 1-by-1-m test pit excavated at the site. Spatial analysis showed that there was some patterning to the distribution of artifacts and features at the site. It appeared that domestic activities were concentrated in the center and northwestern portions of the site and that lithic-reduction activities were more common in the southeastern third of the site (see Chapter 9). The northwestern and central parts of the site contained the majority of the thermal features at the site and also contained most of the platform cores and finished tools. In contrast, tested cobbles and debitage were more common in the southeastern third of the site.

The 22 thermal features recorded at the site were all disturbed, and trowel tests did not find any charcoal or other datable materials. Although there were no subsurface deposits at the site and the features were all disturbed, artifact clustering at the site was present and could be used to address future research questions. Therefore, SRI recommends the site eligible for listing in the NRHP, under Criterion d (see Table 40).

Adobe Draw Survey Area

This location consists of a number of reduction loci scattered across a low ridge, interspersed between unmodified chert nodules. The survey parcel measured 100 by 50 m and covered 5,000 m^2. Much of the raw material is very poor quality, having many inclusions, voids, and other imperfections. However, a few loci that contained a high-quality, fine-grained chert were identified at the location. Several cores, pieces of debitage, and tested nodules were associated with these loci, and a single 1-by-1-m test pit was excavated at one of these loci. There is virtually no soil development at this location, and the unit extended only a few centimeters below the ground surface.

No diagnostic artifacts or features were present that might be used to date the location. No subsurface artifacts were found in the 1-by-1-m test pit excavated, and the geologic setting suggested that there is little potential for buried deposits. There was some patterning, but the assemblage was so small that it was difficult to make conclusions about the location. Because of the small number of artifacts and the lack of diagnostic artifacts and variation in the artifact assemblage, the location has no research potential and is not eligible under Criterion d. Therefore, SRI recommends the Adobe Draw Survey Area not eligible for listing in the NRHP (see Table 40).

Sites in the Lower Pecos River Group

LA 43423

The site was originally recorded in 1968 for an unknown oil or gas project. It measured approximately 630 by 440 m and covered an area of 270,000 m^2. The site was revisited several times beginning in 1974, as part of the El Paso Natural Gas Clearance project. It was revisited again in 1998 by Southern New Mexico Archaeological Services, Inc., and in 2010 and 2011 by Boone Archaeological Services, LLC. These previous studies described the site as a large lithic scatter of variable density. Artifacts numbered in the thousands, and the collections consisted primarily of cores, tested cobbles, and flakes. A single projectile point was found, but ceramic artifacts were absent. The site was tentatively dated to the Middle to Late Archaic period. Two FCR concentrations were also identified in the center of the site.

The current study found the site to be quite large, and the density of artifacts varied greatly around the site. The densest parts of the site were located on several low ridges that run through the center of the site. The gravel- and cobble-lag deposits were concentrated at these ridges, and artifacts were mixed with unmodified cobbles and rocks. The northern and eastern portions of the site as well as the disturbed areas along the graded rock featured few artifacts.

The site was originally classified as a BLM Category 2 site and recommended eligible by Rein (2010) based on the large artifact assemblage. During the current study, a large surface assemblage was found at the site, including debitage, cores, and tools, although no subsurface artifacts were found in the six 1-by-1-m test pits excavated at the site. Although most of the artifacts mapped onto the low ridges that ran through the site and contained cobble-rich lag deposits, spatial analysis showed that there was patterning to the distribution of artifacts at the site. Tested cobbles were more evenly distributed throughout the site, and platform cores were concentrated in areas with higher artifact frequencies. Also, as with LA 146857, there was some spatial patterning to the distribution of chert and quartzite artifacts across the site. Quartzite artifacts were fairly evenly distributed, but chert artifacts were concentrated in two areas on the western side of the site. Because the cobbles at the site should have been relatively randomly distributed across the site, this patterning likely resulted from human activities, although it is not clear what the patterns represent.

Although there were no subsurface deposits at the site, artifact clustering was present and could be used to address future research questions. Therefore, SRI recommends the site eligible for listing in the NRHP, under Criterion d (see Table 40).

LA 122842

The site was originally recorded by Southern New Mexico Archaeological Services, Inc., in 1998 and was revisited by Mesa Field Services in 2001. The site measured 400 by 300 m and covered just over 120,000 m^2. It was described as large lithic scatter of variable density. The surface of the site was covered with cobbles of quartzite, chert, chalcedony, and other materials, which were the sources of the artifacts at the site. Artifacts were recorded as numbering in the thousands and included cores, tested cobbles, and debitage, which consisted primarily of flakes from the early stages of reduction. Most of the artifacts identified were located on the top of the hill. Despite the large number of artifacts, no features or diagnostic artifacts were noted. It was originally proposed that the site may in fact be several smaller sites clustered together, but Mesa Field Services determined that there was a continuous, albeit sparse, scatter of artifacts across all of those areas.

As recorded during SRI's survey, the surface of the site was covered in chert and quartzite cobbles; some other materials were also present. Most of the artifacts were located at the summit of the hill and consisted of tested cobbles, cores, and debitage. Fewer artifacts were found on the slopes and base of the hill, but a small concentration was identified on the eastern slope of the hill.

SRI identified two features at the summit of the hill: a large rock ring (Feature 1189) and a smaller FCR cluster (Feature 1192). The dating of these two features was ambiguous. Neither of the previous investigators had mentioned them, although it was clear from their documentation that they had visited the summit of the hill. It is possible that both features were modern, or at least historical period, and not related to the prehistoric occupation of the site.

The site was originally classified as a BLM Category 2 site and recommended eligible by Saunders (1998) based on the large artifact assemblage. During the current study, a large surface assemblage was found at the site, including debitage, cores, and tools, although no subsurface artifacts were found in the four 1-by-1-m test pits excavated at the site. Spatial analysis showed that there was patterning to the distribution of artifacts at the site and that the summit of the hill represented the primary focus of prehistoric lithic procurement. This patterning was not studied in the same detail as the patterning at LA 43423, LA 146857, and LA 155867 in Chapter 9; so, further research should be conducted at this site (see Chapter 11).

Although there were no subsurface deposits or diagnostic artifacts at the site, artifact clustering was present and could be used to address future research questions. Therefore, SRI recommends the site eligible for listing in the NRHP, under Criterion d (see Table 40).

Isolated Sites

LA 149992

The site was previously recorded by Ecosystem Management (2006). It was described as a large lithic scatter consisting of thousands of artifacts composed primarily of silicified sandstone, which was readily available at the site. It measured 185 by 124 m and covered 22,940 m^2. Most of the artifacts were unidirectional and multidirectional cores, debitage, and hammerstones. No formal tools or diagnostic artifacts were noted. SRI was able to relocate the site but does not believe it to be as extensive as previously recorded. There were many opalized-caliche nodules present on the site, concentrated in the shallow washes that run south from the sandstone outcrop outside the site boundary. An examination of these nodules showed that the vast majority were rocks that had broken as a result of natural processes that created curved spalls, ecofacts that superficially resemble cores and flakes. Only small numbers of artifacts were noted at the site, including chert artifacts and a few pieces of opalized-caliche debitage that had platforms, bulbs of percussion, and other diagnostic attributes.

The site was originally classified as a BLM Category 2 site and recommended eligible by Shine and Shine (2005) based on the large site assemblage and the fact that the site may retain additional data potential. However, during the current study, only a small surface assemblage was found at the site. No diagnostic artifacts or features were present that might be used to date the site. No subsurface artifacts were found in the 1-by-1-m test pit excavated at the site, and the geologic setting suggested that there is little potential for buried deposits. Because of the small number of artifacts and the lack of any diagnostic artifacts and variation in the artifact assemblage, the site has no research potential and is not eligible under Criterion d. Therefore, SRI recommends the site not eligible for listing in the NRHP (see Table 40).

LA 169668

The site was originally recorded by Lone Mountain Archaeological Services in 2011. They described the site as a large, sparse scatter composed of lithic debitage, hammerstones, cores, and a small number of ceramic sherds. The site measured 537 by 452 m and covered 242,724 m^2. Most of the recorded artifacts were located at the northern edge of the site, in the small washes that run from the ridgetop to the floor of the draw. Approximately 150 pieces of FCR were noted throughout the site, though not in any significant concentrations.

During SRI's survey, the site appeared to conform generally to the earlier recording. However, SRI was not able to relocate a number of the artifacts, particularly the hammerstones, ceramics, and FCR. A number of fist-sized quartzite cobbles were noted on the site surface, but only a few showed modifications typical of use as hammerstones. FCR, primarily burned caliche, was noted throughout the site but in only roughly half the quantities previously recorded. As noted in the previous site record, the majority of the artifacts were concentrated in the shallow washes leading from the ridgetop to the floor of the draw. It appeared that prehistoric visitors to the site selected cobbles found in these washes and tested them to check their suitability as tool-stone material. One deflated concentration of FCR was found in the center of the site.

The site was originally classified as a BLM Category 2 site and recommended eligible by Schultheis and Francisco (2011) based on the large site assemblage and the fact that the site may retain additional data potential. However, during the current study, the surface assemblage was found to be smaller than previously recorded. No diagnostic artifacts were present that might be used to date the site. No subsurface artifacts were found in the six 1-by-1-m test pits excavated at the site, and the geologic setting suggested that there is little potential for buried deposits. There was no significant patterning of artifacts at the site. Because of the small number of artifacts and the lack of any diagnostic artifacts and variation in the artifact assemblage, the site has no research potential and is not eligible under Criterion d. Therefore, SRI recommends the site not eligible for listing in the NRHP (see Table 40).

Summary

Twelve of the sites had fewer artifacts than originally recorded, and testing revealed little chance of subsurface deposition; most of the sites revealed little evidence of surface spatial artifact patterning. Several specific issues were discerned concerning the initial recording of the sites. First, it appeared that the recorders tended to inflate the number of lithic artifacts present, probably because they counted natural debris as debitage. Second, they tended to equate a large artifact assemblage with eligibility, whether or not there was artifact patterning present. Third, they tended to overstate the possibility for subsurface materials, even though the geological setting indicated that the possibilities for subsurface deposition were minimal. No testing was done to support the conclusion that no subsurface deposits were present.

Of the 16 locations in the study area, SRI recommends 4 sites eligible for listing in the NRHP. These sites all meet the eligibility requirements described earlier in the chapter. That is, they contain evidence of surface artifact patterning in a relatively large surface assemblage that could be used to address future research questions. They were not necessarily recommended eligible because there were intact features, diagnostic artifacts, or subsurface deposits. The other 12 locations either had assemblages that were too small or had no spatial patterning or diagnostic artifacts. This study can be viewed as a method of eligibility determination, because it incorporates detailed surface recording, spatial analysis, and subsurface testing, along with geological observations, to support eligibility determinations. This type of project has implications for future work in the Permian Basin Programmatic Agreement area. In the next chapter, we explore some avenues for future research at these locations and in the wider research area.

CHAPTER 11

Future Research Directions

Scott H. Kremkau, Kate E. Ziegler, Bradley J. Vierra, and Phillip O. Leckman

Introduction

In the introduction to this report, we outlined some of the research agendas called for in the SENMRRD (Hogan 2006). The SENMRRD, as well as the Synthesis of Excavation Data for the Permian Basin Mitigation Program (Railey et al. 2009), stated that identifying the sources of lithic raw materials in the region and understanding the cultural behaviors associated with lithic-raw-material acquisition are important steps if we are to understand precontact lifeways in the region. This study has been a first step in addressing those questions. In this chapter, we present some avenues of future research that were beyond the scope of the current project as well as some recommendations for data collection in the region. Because cultural resource management (CRM) archaeology—along with the budgetary issues, project footprints, and other factors often associated with it—influences much of the archaeological research in southeastern New Mexico, we outline areas for future research that would provide meaningful data and therefore could be used throughout the region.

Future Geologic Research in Southeastern New Mexico

The present study of potential lithic-procurement locales in southeastern New Mexico is an interesting start to what can become a larger-scale endeavor. Questions that arose during the course of fieldwork include:

1. *What other bedrock sources, or "quarries," could be identified in the Permian Basin region, aside from the exposures on the Pecos Slope*?
2. *How do changes in sediment input from major tributaries to the Pecos River alter the suite of knappable materials available for use*? and
3. *Can the relationships between different Quaternary and Holocene geomorphic surfaces (terraces, pediment surfaces, and the retreating Llano Estacado) be refined in terms of statistically significant differences in pebble and cobble lithologies*?

In order to answer the first question, it would be useful to identify and visit exposures of bedrock of Permian, Triassic, and Neogene strata to the east of the Pecos Slope in order to assess potential contributions of knappable materials. For example, outcrops of the Cretaceous Edwards Formation have been identified along the Texas state line. These outcrops should be visited, their extent confirmed, and any potential knappable materials identified and described. Outcrops of the Ogallala Formation could also be visited and their gravel lithologies described in order to determine whether gravel types along the extent of Ogallala exposures vary significantly.

To answer the second question, it would be important not only to review the existing literature regarding Pecos River gravel lithologies (e.g., Bretz and Horberg 1949) but to examine the river-gravel bedload at the northern end of the field area and at the entrance of each major tributary to determine what materials are being introduced into the river. The third question is, to some extent, intertwined with the first two questions. Examinations of Ogallala outcrops will refine our understanding of the contributions of different gravel lithologies to the more modern land surface, and a better understanding of tributary contributions to the Pecos River may also be translatable to the terrace deposits of the Pecos River. Working on even just one of these questions would clarify the distribution of knappable materials on the landscape and allow us to more clearly relate human use to known sources.

Future Archaeological Research in Southeastern New Mexico

As noted in Chapter 10, studying quarries and procurement locales can be difficult because of a lack of features and diagnostic artifacts that can help to date them. Moreover, because of the specialized tasks carried out at quarries and procurement locales, there is often a lack of artifact variability, particularly in terms of finished tools. As a result, many investigators have focused on regional analyses when trying to understand and, particularly, to date quarries and procurement locales.

In Chapter 8, we compared the artifact collections from the study locations to those from a number of other sites in southeastern New Mexico, including habitation sites and other quarries and procurement sites. We identified some patterns, particularly contrasting the habitation sites with quarries and procurement sites. Although some general comparisons could be made, the regional analysis was somewhat limited, because the comparison sites were spread across southeastern New Mexico. The comparisons presented a general, regional overview but obscured any variations within the region. For example, most of the habitation sites examined were located in the eastern part of the region and were not associated with locations in the Artesia and San Andres Groups, which occupy very different geologic and biologic settings. This also made temporal comparisons difficult, because sites were occupied over a broad period of time, and diachronic changes were not easily represented.

In future studies, research should focus on groups of sites in different parts of the region, examining quarries and procurement sites, habitation sites, and sites of other types that would have been occupied by the same groups of people, presumably over the same periods of time. When we laid out our criteria for site evaluations in Chapter 10, many of the evaluations of quarries and procurement locales were based on comparing artifact collections from quarries and procurement locales to those of nearby habitation sites. At Fort Irwin, California, Bergin and Warren (1983); Byrd et al. (2005); and Byrd et al. (2009) were able to address many research issues at quarries and procurement sites by comparing artifacts from procurement sites with those from various nearby habitation sites that had been excavated. Through this holistic approach, they were better able to understand not only changes in technology but also changes in regional settlement patterns and strategies of lithic procurement. Moreover, this type of analysis allows investigators to study diachronic changes in technology and settlement patterns.

Obviously, this type of analysis is predicated on the presence of a number of well-documented sites within a given area, and because of the focus on CRM projects in the area, sites are generally recorded in piecemeal fashion, based on the footprints of various development projects. This situation makes consistent data collection and analysis a priority in the region, because the data needed to address the above issues will likely come from a number of smaller projects carried out over a number of years. Thus, we present some recommendations for data-collection methods below, reiterating those called for by Hogan (2006).

Spatial Studies

In Chapter 9, we presented some spatial analyses of the 13 archaeological sites and 2 survey areas at which surface artifacts were recorded. The beginning of that chapter focused on all 15 locations and discussed some general patterns seen there. Three of the sites, LA 43423, LA 146857, and LA 155867, were analyzed in further detail because they contained relatively large and diverse artifact assemblages. Analyses at these three sites showed that there were some potentially interesting patterns in artifact distributions across the sites that seemed to result from human action instead of natural processes. At LA 155867, for example, two different activity areas were identified: a domestic area and a lithic-reduction area. At the gravel-procurement sites LA 43423 and LA 146857, some differences in the distributions of cores and tested cobbles were noted, as well as differences in the distributions of chert and quartzite artifacts.

Some intermediate-sized locations that were part of the current study, such as LA 122842, should be analyzed, as well, to see if similar patterns are present there. Additionally, these patterns should be statistically analyzed to see if they are actually significant. As discussed in Chapter 10, Haynes (1996) was able to conduct similar studies in Nevada to understand how surface lithic scatters were structured. Methods similar to those used in this study have recently been used at Fort Bliss, Texas (Leckman 2010, 2012). In these studies, investigators have been able to look at artifact distributions at nonsite, intersite, and intrasite levels. This type of spatial analysis should also be conducted at other sites in southeastern New Mexico, so that the organization and use of space at habitation and lithic-procurement sites can be compared across the region. Previous discussions of the spatial distributions of artifacts at the sites were absent from many of the case studies examined in Chapter 8.

The difficult questions to answer are in regard to who visited the locations, and when. If we assume that hunter-gatherers seasonally resided at these locations, then maybe the large campsite was occupied by these groups. In contrast, if we suppose that farmers from the Pecos River valley periodically visited the area, then maybe locations with one or two artifact clusters were temporarily occupied by a few individuals while they collected rocks. Lastly, locations characterized by dispersed scatters of artifacts could represent people who briefly traversed through the area during any time period. These are important issues that are in need of continued research.

Data-Collection Recommendations

As part of the current study, SRI examined 14 archaeological sites, primarily quarries and lithic-procurement sites; 2 survey areas; and 3 raw-material locations. The methods employed at the locations were developed by the BLM and SRI to follow recommendations outlined in the SENMRRD. During fieldwork and subsequent analyses, SRI identified additional studies that could be conducted as part of future projects. These studies could help to increase our understanding of how the locations were used.

Cobble Studies

In Chapter 4, we examined the cobbles collected from the study sites and survey areas. Generally, the chert and quartzite cobbles collected and analyzed from sites in the Upper and Lower Pecos River Groups were nearly identical in size. These two material types were, by far, the most commonly utilized materials in those areas. Although the frequencies of those materials changed somewhat from location to location, prehistoric peoples had access to the same sizes of cobbles. What is not clear is whether those people selected cobbles of different sizes based on the kinds of tools they were making from different materials. Future studies may include the dimensions of complete cores and tested cobbles to examine whether size was an important factor for selecting different material types.

Source-Provenance Studies

Obsidian has been the focus of most Southwestern provenance studies because it is easily identified by XRF analysis (Shackley 2005). Chert has been studied more rarely because of the difficulties of distinguishing separate sources. Banks (1990:8) identified seven analytical techniques for the identification and discrimination of chert: comparative analysis, petrographic analysis, scanning electron microscopy, and three different processes of trace-element analysis (XRF, neutron activation, and proton-induced X-ray emission), and ultraviolet-light fluorescence (UV) (also see Church 1994; Hess 1996; Luedtke 1992). Church et al. (1996:49–62) provided a review of potential source techniques, including natural radioactivity emissions, UV, bioclast (fossil), and low-field magnetic susceptibility. Each of these techniques is not without its problems and limitations for identifying distinctive chert sources (also see Thacker and Ellwood 2002). UV has received more attention, with studies by Hillsman (1992), Hofman et al. (1991), and Church et al. (1996). However, as Church et al. (1996:53) pointed out, that method is also prone to error because of differences between specific light sources, objective identification of luminescence intensity, the presence of secondary minerals, limitations in human perception, and the effect of burning on samples. They suggested that a regional UV study needs to be conducted that involves the systematic collection of rock samples that identify the variability within broad source areas and that determines ways to limit the effects of human subjectivity. A recent study of Tecovas and Alibates chert sources conducted by Quigg et al. (2011) was relatively successful in distinguishing the geochemical signature between and within source variations by using Instrumental Neutron Activation Analysis. At least two chert samples from New Mexico sources that could be segregated from their Texas counterparts (Dockum Group and Baldy Hill) were included in the study. Again, systematic collections from well-defined geologic contexts are needed to further evaluate the potential of this technique for identifying chert provenance in southeastern New Mexico.

Archaeological Studies

The bulk of the analyses described in the preceding chapters focused on the artifacts recorded during the field survey and in-field analysis. Although none of the excavation units in the study locations contained any subsurface deposits, artifacts from the first 1–5 cm of the surface were collected and analyzed. This analysis showed that at some locations, several smaller flakes were present that were not immediately visible on the ground surface but hidden within the matrix of soil, larger flakes, and unmodified cobbles and rocks. This was particularly noticeable at LA 122842, where large numbers of small flakes were recovered from the top of the hill, in the densest part of the site. In total, 106 artifacts were collected from the three excavation units there—a much greater density than recorded for any of the grid cells on the hilltop.

Angular debris was more highly represented in the excavated sample than in the in-field analysis. These items are very difficult to distinguish from naturally fractured rock while walking over a procurement locale.

Likewise, a small number of cobbles collected from the two test pits at LA 146857 were found during analysis to be hammerstones. No other hammerstones were recorded as part of the in-field analysis at the site. Hammerstones are a notoriously difficult artifact class to identify, because many cobbles that were used as hammerstones were expedient tools that were not significantly modified. Often, hammerstones can only be identified by analyses that are more detailed than analysis that can reasonably be conducted in the field.

Future studies could include surface collections as part of evaluation programs. Because the locations in the study area have no subsurface deposits, additional surface collections can be easily carried out with a minimum amount of effort. Surface sampling would help to identify smaller flakes and more-specialized core and flake types (e.g., bipolar) that might go unrecorded during surface surveys; surface sampling would thereby provide a more complete picture of the lithic landscape across the study area.

These more detailed studies should also focus on distinguishing potential differences in reduction strategies between bedrock quarries and lithic-procurement sites associated with surface gravel deposits. The reduction of tabular pieces of bedrock vs. cobble or pebble materials should have an effect on the specific reduction tactic used. A close inspection of limestone outcrops that contain beds or nodules of chert could be conducted, to more clearly delineate other potential prehistoric quarrying methods.

Dating

None of the sites visited during the project yielded diagnostic artifacts or organic materials suitable for radiocarbon dating, but a few ceramics were noted at one site during the initial survey. The review of radiocarbon dates by Railey et al. (2009) revealed a peak in regional occupation during the Early Formative period, ca. A.D. 500–1000. There was less evidence of terminal Late Archaic period (ca. A.D. 1–500), Late Formative period (ca. A.D. 1000–1500), and protohistoric/historical-period (post–A.D. 1500) occupations and scant evidence of dates prior to A.D. 1. Certainly, an emphasis needs to be directed toward dating these sites. Placing them within a temporal context would help in identifying possible differences in the procurement strategies used by forager vs. agricultural groups. For example, did foraging groups place their residential sites on or near the outcrop? In contrast, did task groups from nearby agricultural communities visit the area to collect lithic raw materials (e.g., chert)?

Consistency in Field Methods and Reporting

Data Collection

The gridded data-collection method employed by SRI provides a straightforward means of ensuring both data comparability and spatial control in a survey setting. The project area is subdivided into a grid of equally sized cells; in this case, each measured 15 by 15 m. Survey across the gridded project area proceeds cell by cell, each archaeologist walking a row of cells and recording and attributing all cultural manifestations present at the individual-cell level. All observations are thus directly associated with spatial information, permitting their locations to be pinpointed to an area no greater than the dimensions of an individual cell. Likewise, data can be quickly summarized for each individual cell, allowing artifact frequencies to be confidently delineated across a site, survey parcel, or project area. Because all artifact observations and counts are associated with individual GPS units, comparisons can be made between field personnel. In addition, because these data are also associated with individual cells, data sets from multiple projects conducted using the same attribute frameworks and values can be aggregated to facilitate direct comparisons and analyses of multiple projects across a region.

Allowable attributes and attribute values for in-field artifact analyses are customized at the project or regional level, ensuring that all artifacts or features identified during a particular project or within a particular project area are attributed using the same set of variables. Detailed field guides and instructions should be provided that include contexts for and explanations of attribute values and ensure that data are recorded correctly. Together, these steps should go a long way toward standardizing data collection and data entry and permitting data to be confidently compared between projects, with identical sets of customized attributes.

For SRI projects, data quality and consistency during gridded survey are achieved through a customized GIS and data-recording application that allows a user to self-locate relative to the cell grid, to select and tag a cell in ESRI ArcPad, and then to digitally record the attributes of all artifacts and features present within the cell. This customized application permits gridded survey to be conducted efficiently and accurately, but the same process could also be readily carried out using a set of detailed in-field-recording forms for each grid cell.

In the case of the current project, existing site boundaries were encompassed with buffered, site-specific survey grids and loaded onto project GPS units to facilitate site relocation and site-level artifact analysis and recordation. The same methods can also be applied to Class III survey in an area in which no previously identified sites are present. An entire survey parcel can be gridded off and used to guide survey as outlined above, with all observations made at the level of the individual cell. If desirable, cell-level observations can even serve as the basic units for site identification, and project- or agency-specific site criteria can be applied to each individual cell. All cells meeting site criteria are identified, and site boundaries are then generated by aggregating adjacent cells until no additional cells are present within a specified distance threshold. If sites are generated and aggregated in this way, two field visits are typically required, because site boundaries are not generated until all individual-cell data are entered and reviewed for data quality. During the initial pass through the project area, crews record the cell data that will inform site generation. After preliminary site boundaries are generated, crews return to potential sites to assess their boundaries, plant site datums, and correct any data problems or inconsistencies. This second field visit is also frequently an opportune time for test excavation, geomorphic testing, or sample collection.

Several specific issues were discerned concerning the initial recording of the sites. First, it appeared that the recorders tended to inflate the number of lithic artifacts present, probably because they counted natural debris as debitage. Second, they tended to equate a large artifact assemblage with eligibility, whether or not there was artifact patterning present. Third, they tended to overstate the possibility for subsurface materials, even though the geological setting indicated that the possibilities for subsurface deposition were minimal. The SRI study can be viewed as a method of eligibility determination, because it incorporates detailed surface recording, spatial analysis, and subsurface testing, along with geological observations, to support eligibility determinations. This type of project has implications for future work in the Permian Basin Programmatic Agreement area.

Debitage Analysis

In Chapter 8, we presented lithic analyses of the locations in the study area at various scales (as a group, by region, and by location). We also attempted to compare the study locations to other sites in southeastern New Mexico, other quarries and procurement sites as well as habitation sites. One of the recurring issues that came up during the regional comparison was the great variability in analytical techniques employed by different CRM companies and federal and state agencies. In many cases, collections from different sites were not comparable to one another.

Debitage analyses were particularly difficult to compare. Debitage analysis has followed several different methods through the years (see Shott 1994), and in the reports examined for this study, two main techniques were the most common: flake-size studies and technological studies. Following Sullivan and Rozen (1985), many investigators who prepared the data recovery reports examined for this study recorded flake portions (complete, distal, medial, proximal, etc.) as the primary debitage types and sometimes, but not always, further divided those by material type. The study by Sullivan and Rozen (1985:758–760) presented the idea that relative frequencies of flake size and type can be indicative of different stages in artifact production. For example, higher frequencies of complete flakes and shatter generally result from the reduction of cores, and high numbers of broken flakes result from bifacial reduction to produce tools. However, subsequent studies have shown that these frequencies do not always represent different reduction strategies, and debitage assemblages can vary considerably between sites because of a number of variables (Amick and Mauldin 1989; Baumler and Downum 1989; Tomka 1989).

In contrast to size analysis, technological analysis uses a classification of flake types (e.g., biface thinning, core reduction, microdebitage, and shatter) that are related to different lithic-reduction techniques. This approach is believed by many analysts to be the most effective in reconstructing lithic technologies and was advocated in the SENMRRD in regard to how lithic collections should be analyzed (Hogan 2006:5–8). This approach is based on model building using the results of experimental stone-tool-replication studies. Types of flakes are identified from experimental reduction via specific technologies and are ultimately compared to archaeological specimens.

The studies used in the comparisons discussed in Chapter 8 involved technological analyses, and they were found to be the easiest to compare to one another. We believe that technological analyses should be used in studies throughout the region, so that studies done at different times by different investigators can be compared to one another. Irrespective of the analysis method used, detailed artifact-type definitions should always be provided or referenced in a report (see Appendix C).

Another common problem in reports is how data are presented. In many studies, counts of artifact types (e.g., cores, bifaces, and debitage) as well as counts of different material types (chert, quartzite, etc.) are presented, but the data are not always presented together, so that it becomes impossible to determine, for example, how many quartzite cores or chert bifaces have been recovered from a given site. This makes any detailed lithic analysis difficult, particularly when trying to study how different material types have been used across the region. If investigators in southeastern New Mexico are to achieve any sort of region-wide understanding, better, more consistent, and more detailed reporting of archaeological analyses should be undertaken by all researchers.

APPENDIX A

Site Location Maps

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

APPENDIX B

Grid-Cell Attributes

Table B.1. Field Headings

Grid Cell
Topography
Visibility (%)
Intact (%)
Presence of UXO (yes/no)

Key: UXO = unexploded ordnance.

Features
General type
Specific type
Length
Width
Depth
Staining (yes/no)
Buried feature (yes/no)
Impact

Flaked Stone
Count
Material
Type

Ground stone
Count
Material
Type
Fire cracked (yes/no)

Ceramics
Count
General type
Specific type
Rim sherd (yes/no)
Reconstructible vessel (yes/no)
Worked sherd (yes/no)

Historical-Period Artifacts
Count
General type
Specific type

Faunal
Count
Animal size
Burned (yes/no)

Table B.2. Topographic Attributes

Topography	Visibility (%)	Intact (%)
Alluvium	0–25	0–25
Arroyo	26–50	26–50
Bedrock	51–75	51–75
Blowout	76–100	76–100
Dune		
Hillslope		
Hill top		
Mesa		
Playa		
Ridge		
Sand sheet		
Talus		

Table B.3. Lithic Attributes

Flaked Stone Material
Andesite
Basalt
Caliche
Chalcedony
Chert
Hornfels
Limestone
Obsidian
Quartz
Quartzite
Rhyolite
Sandstone
Other

Debitage Types
Angular debris
Core flake
Biface flake
Undetermined flake
FCR
Other

Flaked Stone Tools
Projectile
Biface
Scraper
Uniface
Tabular knife
Hammerstone
Core
Tested material
Cobble uniface
Cobble biface
Retouched flake
Other

Ground Stone Material
Basalt
Granite
Limestone
Quartzite
Rhyolite
Sandstone
Other

Ground Stone Types
One-handed mano
Two-handed mano
Undetermined mano
Milling stone
Slab metate
Trough metate
Basin metate
Undetermined metate
Undetermined ground stone
Pestle
Other

Table B.4. Ceramic Attributes

General Types	Specific Types
El Paso	El Paso decorated
	El Paso brownware
	El Paso Brown
	El Paso Bichrome
	El Paso Polychrome
Chihuahuan	Chihuahuan Medio
	Chihuahuan Viejo
	Chihuahuan Undifferentiated
Miscellaneous nonlocal	Chupadero Black-on-white
	Mimbres Black-on-white
	Three Rivers Red-on-terracotta
	textured
	plain ware
	other

Table B.5. Historical-Period Attributes

General Types
Non-SCA Glass
SCA Glass
Building material
Cans
Ceramic
Other metal
Other historical period

Key: SCA = sun-colored amethyst.

Non-SCA Glass
Bottle—whole
Jar—whole
Bottle/jar—neck
Bottle/jar—base
Bottle/jar fragment
Window
Undifferentiated fragment
Other

SCA Glass
Bottle—whole
Jar—whole
Bottle/jar—neck
Bottle/jar—base
Bottle/jar fragment
Undifferentiated fragment

Cans
Lard pail
Meat
Oil
Paint
Tobacco
Hole-in-cap
Hole-in-top
Sanitary
Undifferentiated fragment
Other

Building Materials
Nails—square
Nails—wire
Milled lumber
Bricks
Shingle—wood
Shingle—ceramic
Shingle—asphalt
Concrete
Hardware
Other

Ceramic
Whiteware—table
Whiteware—other
Stoneware—table
Stoneware—other
Other ware—table
Other ware—other

Other Metal
Corrugated sheet metal
Wire
Horseshoe
Ammunition cartridge
Shotgun shell
Bullet
Other

Other Historic
Other

Table B.6. Faunal Attributes

Animal Size
Small
Large

Table B.7. Feature Attributes

General	Specific Feature Types	Impact	Depth
Prehistoric	FCR/BC concentration	Low	0
	FCR midden	Medium	5
	Ring midden	High	10+
	Trash midden		(more can be entered)
	Stain		
	Prehistoric artifact concentration		
	Bedrock mortar		
	Rock art		
	Structure		
	Other		
Linear	Fence		
	Aqueduct		
	Ditch		
	Dam/berm		
	Road		
	Utility		
	Rock alignment		
	Other		
Historical period	GLO Marker		
	Historical-period artifact concentration		
	Cairn		
	Corral		
	Stock tank		
	Rock art		
	Structure		
	Fire pit		
	Well		
	Mine		
	Other		

Key: BC = burned caliche; FCR = fire-cracked rock; GLO = General Land Office.

Lithic-Artifact Definitions

Cores and Hammerstones

Cores are nodules that have faceted platforms from which specific kinds of flakes have been removed. They are subdivided into the following types: unidirectional, bidirectional, multidirectional, bipolar, flake core, and undetermined fragment. Flake cores are produced on large flakes, and the remaining core types are produced directly from pebbles or cobbles. *Tested materials* are nodules, each having a single flake removed from an unprepared cortical platform at one or more isolated locations. They probably represent nodules that were tested for material quality and then rejected. *Cobble unifaces* have two or more flakes unifacially removed from each, along a single edge margin, usually at one end of the pebble or cobble. Both tested materials and cobble unifaces appear to reflect the use of local tabular raw materials, with flakes having been removed from flat, unprepared platforms. *Cobble bifaces* have two or more flakes bifacially removed from a single edge at the end of each pebble or cobble. They presumably represent formal, heavy-duty chopping tools (i.e., choppers) but might also have been used as sources of flakes. Cobble bifaces differ from bifacial cores in that bifacial cores are generally made of siliceous materials and have more than one continuous, bifacially retouched edge perimeter each. *Worked cobbles* is a generic term that includes tested materials, cobble unifaces, and bifaces. A *hammerstone* is a nodule that exhibits battering on an otherwise unmodified cortical portion of its surface. This battering usually is located on the end or along the perimeter of the pebble or cobble. In contrast, *anvils* are artifacts that exhibit repeated battering in a specific, isolated location, such that a small, circular depression is created on a planar surface.

Debitage

Debitage consists of the byproducts of core reduction and tool production. *Flakes* are pieces of material that have been detached from a core or tool by percussion or pressure, as opposed to *angular debris*, which consists of pieces that were incidentally broken off during core reduction. These pieces of shatter lack definable flake characteristics, such as platform, bulb of percussion, *eraillure*, ventral/dorsal surfaces, and proximal/distal ends. *Core flakes* are flakes that have been detached from a core. A polythetic set of attributes of a core flake includes a single or dihedral platform, a platform that is approximately as wide as the flake, a platform angle of greater than 75°, cortex on the dorsal surface, dorsal scars that may be absent from or either parallel or perpendicular to the platform, a thickness of greater than about 5 mm, a pronounced bulb of percussion, and an *eraillure* scar. To be classified as a core flake, a flake must exhibit at least six of these eight defining attributes.

Biface flakes are flakes that have been detached from a bifacially retouched artifact. A polythetic set of attributes for a biface flake includes a multifaceted platform, an isolated platform, a lipped platform, a platform angle of less than 75°, a weak bulb of percussion, cortex absent from the dorsal surface, dorsal scars that are roughly parallel to each other and perpendicular to the platform, a thickness of less than 5 mm that is relatively even from the proximal to the distal end, and a pronounced ventral curvature. A flake must exhibit at least six of these nine attributes to be classified as a biface flake. Biface flakes removed from retouched tools tend to exhibit platform angles of less than 50°, whereas flakes removed from bifacial cores generally have platform angles of about 50°–75°.

Undetermined flake fragments are fragments for which flake type cannot be determined.

Retouched Tools

Retouched tools are results of the secondary percussion or pressure flaking of a piece in order to produce a specific tool shape. A *marginally retouched flake* is a piece of debitage with retouch that extends over less than one-third of the surface. This noninvasive retouch is limited to the edge margin but may be unidirectional or bidirectional.

A *uniface* is an artifact that exhibits retouch scars over one-third or more of only one of its surfaces. This type of retouch can be described as invasive. Unifaces exhibit initial edge retouch that lacks a formal overall shape. In contrast, *scrapers* are specialized forms of unifaces that exhibit secondary edge retouch, producing a formally shaped tool with an edge angle of between 60° and 80°.

A *biface* is an artifact that exhibits retouch scars extending over one-third or more of both of its surfaces. Generalized bifaces tend to be ovate or lanceolate in shape and have edge angles between about 30° and 50°. *Drills* and *projectile points* are specialized forms of bifaces. *Drills* are bifacially retouched flakes that are twice as long as they are wide and about as thick as they are wide and often exhibit a diamond-shaped cross section. A *projectile point* is a biface that exhibits hafting modifications that distinguish the stem from the blade.

Ground Stone Tools

Ground stone tools are artifacts that exhibit ground and/or abraded surfaces. *Manos* are cobbles or slabs, each having at least one surface characterized by one or more smooth facets produced through grinding. They are handheld artifacts that were primarily used to crush and grind vegetal foodstuffs against a metate. Polished surfaces on manos may indicate functions other than vegetal processing. *One-handed manos* are typically cobble manos that are less than 170 mm in width, and *two-handed manos* are typically tabular manos that have widths equal to or greater than 170 mm. *Undetermined manos* are fragments from which the projected length of the original artifact cannot be determined. *Pestles* are oblong artifacts that exhibit evidence of grinding and/or crushing on one or both ends.

Metates are characterized by at least one large grinding surface each, upon which vegetal foodstuffs may have been crushed and ground with a mano. They generally have grinding surfaces greater than 450 cm^2 in size. *Milling stones* are informal, unmodified slabs with flat grinding surfaces. Although a milling stone's grinding surface may exhibit some pecking, the slab itself exhibits little in the way of formal shaping. *Basin metates* are slabs with concave, basin-shaped grinding surfaces. These two metate types are usually associated with generalized seed processing and the use of a one-handed mano in a rotary motion, although milling stones can also be used with two-handed manos in a longitudinal grinding fashion.

Slab metates are formally shaped metates with large, flat, prepared grinding surfaces. *Trough metates* have deep, prepared troughs as grinding surfaces. The trough may be open at one or both ends. Both slab metates and trough metates are usually associated with more-specialized corn milling and the use of two-handed manos in a longitudinal back-and-forth motion. *Grinding slabs*, unlike milling stones, measure less than 300 mm and may have been used for a variety of purposes. Grinding-slab fragments are distinguished from undetermined ground stone fragments by having lengths of greater than 100 mm.

*Undetermined metate*s are fragments sufficiently large to determine that they represent portions of metates but for which a specific metate type cannot be determined. *Undetermined ground stone* is any unclassifiable ground stone fragment. This type of fragment often exhibits a single flat grinding surface.

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