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A Geomorphological Lithic Provenance Study at the Oklahoma Geological Survey

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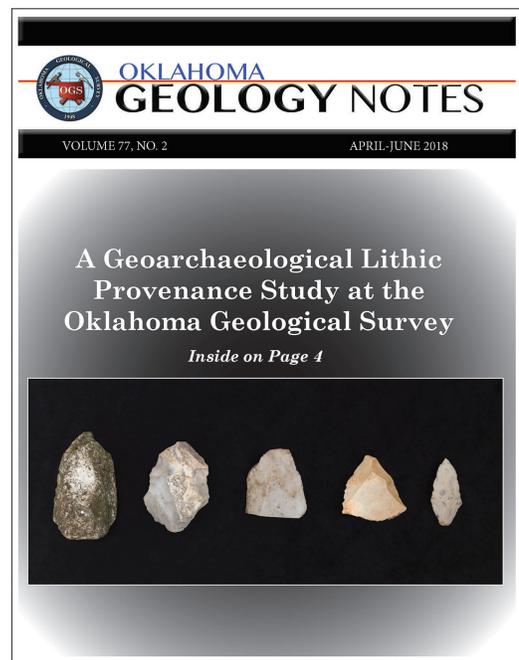
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The Oklahoma Geological Survey is a state agency for research and public service, mandated in the State Constitution to study Oklahoma's land, water, mineral and energy resources and to promote wise use and sound environmental practices.

IN THIS ISSUE

✿ Richie Tarver, OGS Data and Collections Manager, presents an article about how an OGS geoarchaeological examination into the intersection of prehistoric human activity and the natural resources of Oklahoma could expand our understanding of the lifeways of North America's indigenous cultural groups.

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Cover Design by Ted Satterfield

From The Director

Looking at Oklahoma's Ancient History

This issue of the Oklahoma Geology Notes is devoted to Richie Tarver's article on the archaeological application of geological and geochemical characteristics of rock materials worked and used by native cultures. Characterizing the sources of these "lithics" provides an enhanced understanding of their cultures, especially gathering and trading behavior and a view of technology evolution through time. Richie's article also provides many of us as non-archaeologists with an interdisciplinary view we may not encounter that often. We are mostly habituated to our own terminology, and we see other disciplines as jargon-rich. A quick swim in that other terminology should give us pause to think about our own use (and overuse?) of technical terms in explanations to people outside our field.

But Richie also includes some terms I had not encountered that highlighted fundamental ideas about how we do research, once I looked up the definitions! He refers to the use of geological methods as part of an effort to "bolster the use of nomothetic tenets of the scientific method into the discipline (archaeology)." Nomothetic refers to the scientific tradition of trying to generalize and define rules or laws from the observed patterns of objective phenomena in a given subject area. Science explanations are commonly uncertain and incomplete. This tradition is contrasted to the idiographic tradition typical of the humanities, which tends to focus on the unique and subjective features, and those contingent upon prior events.

Geologic phenomena sometimes partake of a bit of both. Geologists make interpretations that can be derived from surprisingly subjective judgements that focus on complete understanding of a very specific instance. They deal in a world of events that have already happened along a unique trajectory. The only way to run the experiment again is in analogous examples. Still, especially in the analytical arenas of geochemistry and petrography, there are specific data and general relationships that can be deduced.

Richie's article describes his current project to gather chert from as many available sources as possible in Oklahoma, characterize them geochemically and by other analytic means, and then to work with the archeological community (specifically our counterparts at the Oklahoma Archeological Survey) to connect sources of raw material to artifacts in collections here, and perhaps elsewhere. He starts with an archeological tour of North America and Oklahoma, then focuses in on lithic technology and artifacts. He describes the general sedimentology of chert, and of chert in Oklahoma. Because of its strength,



Jeremy Boak
OGS Director

brittleness and cryptocrystalline nature, which allows it to be worked into remarkably sharp tools, chert was much favored by hunter-gatherers on the Southern Plains, and Oklahoma has a wealth of sources in chert nodules contained within limestone, dolomite and shale.

Studies like this support better understanding of Oklahoma's ancient history and build collaboration with related state research groups. The University has committed to the development of the Corix Plains Institute, an interdisciplinary hub for environmental research and education, with Archaeological, Biological, Climatological, Geological and Water Surveys as crucial elements.

A similar multi-disciplinary project here that is beginning to recruit partners in-state and beyond is the Bridging Local Outreach & Seismic Signal Monitoring (BLOSSM) project. This OGS project is installing inexpensive seismometers in classrooms, museums, and other learning facilities to help students learn about earthquakes and the world around (and beneath) them, as well as gathering seismic data to enhance our tracking of earthquakes in Oklahoma. I expect to see an issue of the Notes dedicated to this program and its accomplishments in the future. The Survey is committed to building multi-disciplinary research programs and the integrated data structure to link and manage them to maximize the benefit to the state of Oklahoma.

On a more personal note, congratulations and thanks are due to Tom Stanley for 20 years of service to the Oklahoma Geological Survey.

A Geoarchaeological Lithic Provenance Study at the Oklahoma Geological Survey

By Richie Tarver

OGS DATA AND COLLECTIONS MANAGER
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ABSTRACT

A geoarchaeological lithic provenance study being developed at the Oklahoma Geological Survey (OGS) will enable the characterization of discrete chert typologies to be used in the identification of raw source materials for lithic tool industry procured within the state of Oklahoma. The resulting data will provide an empirical basis by which to determine the origin and distribution of chert-derived lithics throughout the Southern Plains region of North America. Lithic sourcing studies represent an important aspect of material culture that can provide a pathway to learning more about prehistoric cultural groups, including: the economics, mobility, and socio-cultural dynamics of hunter-gatherer communities.

INTRODUCTION

Anyone who has ever spent a significant amount of time exploring the Oklahoma outdoors might have chanced upon their own unique archaeological discovery in the form of an arrowhead or other similar stone tool. The feel of the smooth

glassy stone, the sharp, pressed edges honed by human hands from the distant past — hundreds, or even thousands of years ago — fills the observer with wonder. Much more than a curious antiquity, these seemingly simple tools are the keys to unlock a doorway into the prehistory of humanity as it spread into the New World.

Such artifacts, known as lithics, represent an important aspect of material culture that allow a glimpse into the lifeways of prehistoric humans; the choice of materials, treatment of the stone, and diversity of tool types are just a few aspects of lithic fabrication that provide clues for learning about how prehistoric North Americans lived. For many non-western indigenous cultures who lived for tens of thousands of years prior to the colonial occupation of North America, their stone tools might be the only surviving trace of their existence that stood the test of time. In order to learn more about human activity within the prehistoric landscape, it is essential to determine the origin and distribution of lithic artifacts by locating the naturally occurring raw material sources of the tools themselves.

GEOARCHAEOLOGY

A geoarchaeological examination into the intersection of prehistoric human activity and the natural resources of Oklahoma introduces the potential for a more nuanced understanding of the lifeways of North America's indigenous cultural groups (i.e., Arco et al., 2006; Haynes, 1991; Mandel, 2000; Mandryk et al., 2001; Sherwood and Kidder, 2011).

As a burgeoning discipline that combines geology and archaeology, the strengths of geoarchaeology as an interdisciplinary field of research continue to be demonstrated — especially in the context of lithic provenance studies. This is due in large part to the utilization of consistent lithic typologies linked explicitly to well-defined source materials defined by geologists, and the emphasis on canonical nomenclature of geological formations (Mandel, 2000; Wyckoff, 2005).

According to geoarchaeologist Rolfe Mandel (2000), during the latter half of the 20th century, many adherents to the processual movement within archaeology — who also saw an increase in federally funded cultural resource management work — were quick to recognize the advantages of incorporating a more in-depth geological perspective into their work. This was done both in an effort to bolster the use of nomothetic tenets of the scientific method into the discipline, as well as to more efficiently detect deposits of cultural resources within ever increasing survey areas (Mandel, 2000). This was particularly the case for Southern and Central Plains archaeologists, and early geoarchaeologists studying in Oklahoma, Kansas, Arkansas, and Texas — sites of some of the highest concentrations of chert deposits in North America.

While lithic provenance studies have been conducted in Oklahoma, they have typically been isolated to a particular region (e.g., Ozark Uplift) or cultural period (e.g., PaleoIndian, Archaic, Woodland, etc.). Due to the diverse array of lithic typologies and discrete cultural units located throughout the project area, it is decidedly advantageous to develop a research design that

reflects the widespread, comprehensive nature of the subject's temporal and geographical breadth. OGS staff expertise and legacy of research and publications relating to Oklahoma geology will provide added strengths to this study.

Brief Archaeological History of North America

Towards the end of the Pleistocene, North America had already become an established home of *Homo sapiens*. Previously inaccessible to humans, due primarily to geographic circumscription, the New World had begun to open up in the wake of the Last Glacial Maximum (LGM), which exposed the Bering Strait land bridge through an ice-free corridor that connected Siberia to Alaska.

Although there is a great deal of debate on the precise timeline, the preponderance of data suggests a series of successive migrations beginning as recently as 24kya from a divergent Siberian/proto-Native American population originating in Asia (Fagundes et al., 2008; Llamas et al., 2016; Waters and Stafford, 2007).

As the ice sheets retreated over Beringia after the LGM, nomadic Pleistocene hunter-gatherers likely migrated south along the Pacific coast, following the retreating glaciation and migrating megafauna such as mammoths, ground sloths, camelids, and bison (Waters et al., 2015). As the migrations moved further south, the Rocky Mountains may have acted as a natural partition to the migratory route for game and hunter-gatherers alike, opening the path to the Pacific coast to the west and the interior North Central Plains to the east.

Recent genetic analyses have demonstrated that the descendants of these nomadic progenitors would later inhabit South and Central America as well as proliferating into modern Native American groups endemic to North America (Dillehay et al., 2008; Horai et al., 1993; Waters and Stafford, 2007).

Early Cultural Groups of Oklahoma

Archaeologists classify prehistoric cultural groups according to discrete temporal phases

Period	Epoch	Cultural Period	Years BP
Quaternary	Holocene	Proto-Historic	500-Present
		Plains Village	1,200-500
		Woodland	2,000-1,200
		Archaic	8,000-2,000
	PaleoIndian	12,000-8,000	
Pleistocene		Pre-Clovis	35,000-12,000

Figure 1. Composite geological time scale with archaeological cultural periods. Source for dates adapted from Bell (1980).

denoted by the presence of unique cultural traditions preserved by material remnants left behind within the archaeological record. These cultural periods, as they are significant to cultural groups that inhabited the Southern Plains region of North America, are as follows: PaleoIndian, Archaic, Woodland, Plains Village, and Proto-Historic (See Figure 1).

Evidence for the Paleoamerican occupation of what would later become Oklahoma can be seen in the archaeological record as early as 12,000 years ago (Bement and Carter, 1999; Gilbert and Brooks, 2000; Llamas et al., 2016; Waters and Stafford, 2007). Many sites in Oklahoma representative of Paleoamerican groups, such as the Clovis and Folsom cultures, have been identified throughout the western portion of the state. Some of the more prominent sites representative of these prehistoric groups include the Cooperton and Domebo (Clovis) mammoth kill sites located in Kiowa and Caddo

counties, respectively, and the Cooper bison kill site (Folsom) located in Harper County.

The Domebo site is of particular significance in that it represents one of the earliest sites in Oklahoma where stone tools were discovered *in situ* with the skeletal remains of a mammoth (Gilbert and Brooks, 2000). The stratigraphic association of both the mammoth remains and the stone tools at the site provide a context that allow archaeologists to glean information regarding the lifeways of these ancient individuals (See Figure 2).

In the eastern portion of the state, another Paleoamerican group known as the Dalton people lived in smaller, regionally circumscribed hunting territories where, in a marked transition from megafauna kill sites — a departure that is also reflected in their lithic technology, they subsisted on wild plants and smaller game animals (Driskell

Lithics

As noted archaeologist and southern plains lithics expert Don Wyckoff (2005) has indicated: discrete cultures would have exhibited an array of concomitantly discrete behaviors associated with procurement as well as the preference of materials for certain tool types.

Further, it should also be noted that lithic technology, like any fabricated technology, would ostensibly have to endure a heuristic development unique to the adaptive needs of the cultural group manufacturing the tools. These unique expressions of culture make for difficult elements of comparison on the basis of complexity. Although lithics can potentially tell us a great deal about the cultural groups to which they belong, they are only one aspect of material culture, and culture should not be ranked on a stadial scheme from simple to complex due to the implicit ethnocentrism required of such an endeavor. Although there may exist certain commonalities between cultural groups, it is important to utilize the archaeological record to tell the story of each culture in its own unique context.

The tools discovered at the Domebo site included an assemblage of projectile points and debitage (lithic debris and discards found at the sites where stone tools and weapons were made) thought to be emblematic of the Clovis mammoth hunting culture. Other later sites at Cooper, representative of the Folsom culture, also exhibit tools and faunal remains associated together within the site stratigraphy (Bement and Carter, 1999). Comprised of chert, these projectile points were wielded on spear tips, often in conjunction with the use of atlatls — a handheld lever used to generate energy for greater speed and distance in order to fell larger prey.



Figure 2. Clovis points (above) and scrapers (below) recovered from the Domebo mammoth kill site in Oklahoma. Photo originally published in Czaplewski et al., (1997).

and Walker, 2007). Many Dalton sites located in the Ouachita Mountains of southeastern Oklahoma are dated to the Late-PaleoIndian period, circa 10,000-9,000 years BP (Ballenger, 2001).

These early groups were among the first peoples in the Southern Plains to utilize raw material sources such as chert to produce their tool industry. Evidence of continued occupation among lithic procurement sites throughout Oklahoma demonstrate the utilization of chert as a lithic source material from the end of the Pleistocene through the historic era of the late 17th and early 18th centuries (Banks, 1990; Drass et al., 2012; Vehik, 1990).

Archaeologically, one of the most significant features common to each of the aforementioned sites is the associated context of stone tools and faunal remains. Although behavior is difficult to discern within the archaeological record, the choice of materials used and the diversity of lithics exhibited by hunter-gatherer groups within North America can reveal a great deal about the socio-cultural dynamics of these cultures, with particular emphasis on economics, mobility, and subsistence.

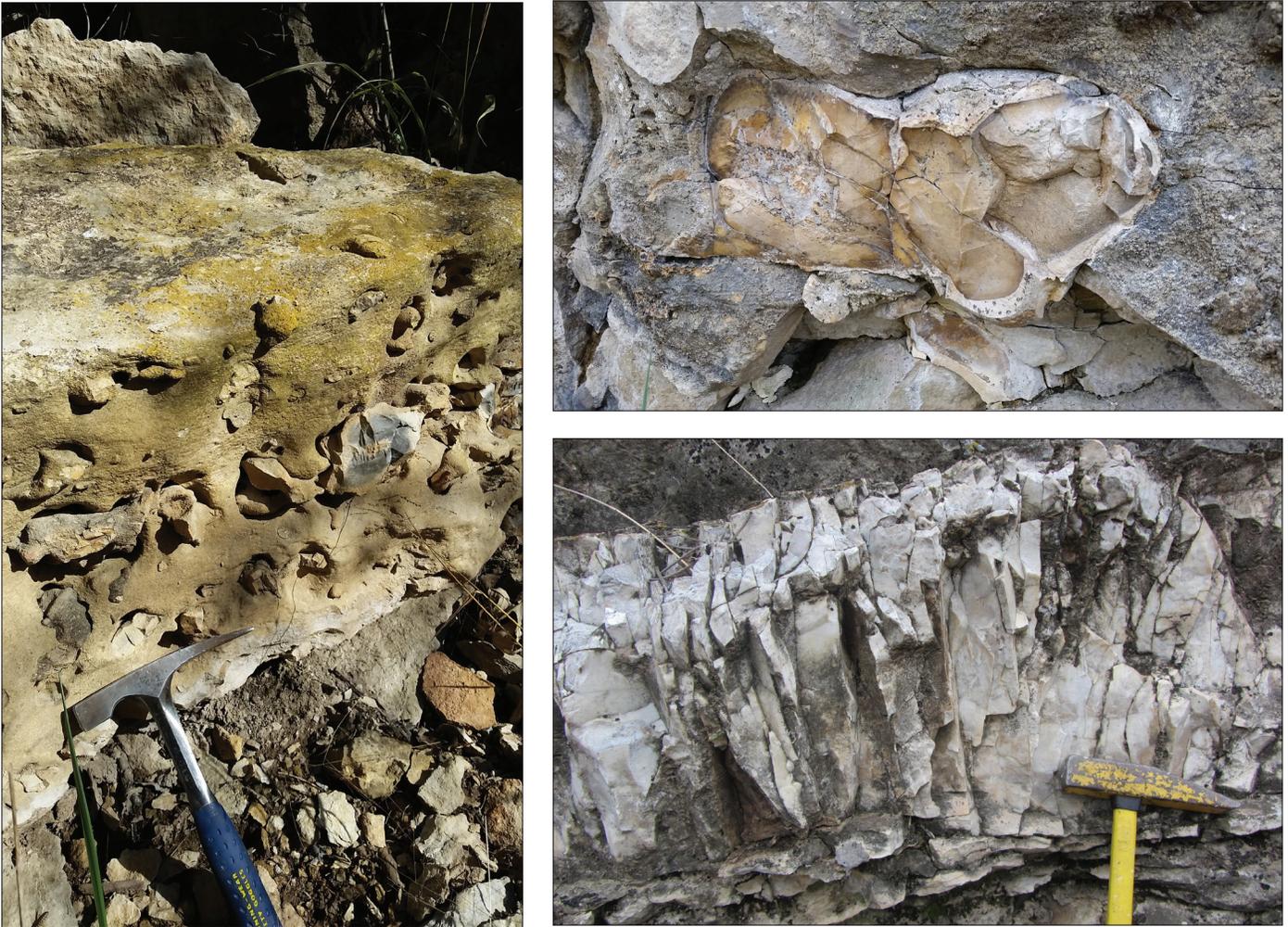


Figure 3. Examples of the occurrence of chert in nodular forms (left and upper right) and bedded forms (lower right).

As in the case of the examples of the aforementioned prehistoric sites, the predominate lithic source material used was chert, which is the primary focus of the study. Other less common lithic sources in Oklahoma include siliceous sandstone, jasper, and novaculite (Banks, 1990).

Chert Sedimentology

Where it is present on the landscape, chert has been widely observed as a favored material for use in the fabrication of lithic technology among many prehistoric and non-industrial hunter-gatherer societies throughout the world. In an archaeological context, this common sedimentary rock is often found beneath shallow limestone pits, and naturally occurring outcrops where it was quarried from dedicated procurement sites.

Chert is a siliceous, cryptocrystalline

sedimentary rock, composed primarily of silicon and oxygen (SiO_2), commonly containing microfossils such as radiolarians or spicules. Other trace elements, organic matter, water, and minor metals such as iron, can be incorporated into the diagenesis and deposition of chert as inclusions, which influence its coloration, generally ranging from white to black (Folk and Weaver, 1952; Ham, 1942). Typically associated with limestones, dolomites, and shale, chert most commonly occurs as nodules or concretions, and less commonly as thick-bedded deposits (Folk, 1980). Nodular chert (See Figure 3), is typically formed as calcium carbonate replacement with silica derived from the skeletal material of organisms such as sponges, diatoms, and radiolarians, whereas bedded chert is formed through biochemical precipitations of siliceous oozes into deposits of dissolved siliceous organisms (Folk, 1980; Nichols, 2009; Maliva and Siever, 1989).

Chert was likely prized among hunter-gatherers of the Southern Plains because of both its accessibility and malleability; it can be easily manipulated into a variety of tools including knives, scrapers, drills, awls, and projectile points. Chert core stones, also known as cobbles, will fracture easily into a conchoidal pattern when hit with a hammerstone — a process known as flint knapping. The concussive force of the hammerstone sends a shockwave (i.e., Hertzian cone) through the core stone, where it fractures into smaller flakes known as debitage, most often with a sharp edge. Once the decorticated material is cleaved from the core stone, the materials are refined through processes of heat treatment, micropressing, and pressure flaking in order to arrive at a finished product.

Chert Distribution in Oklahoma

According to the USGS, there are over 11 geological units in Oklahoma containing chert bearing formations (Mineral Resources On-Line Spatial Data, n.d.). The distribution of chert within Oklahoma is mostly concentrated within the Ozark Uplift in the northeast portion of the state, and also the north central Flint Hills region of Kay and Osage counties (Banks, 1990; Gould, 1921; Huffman, 1955). Other secondary deposits have been identified in the Arbuckle and Ouachita Mountains (Banks, 1990; Wyckoff, 2005).

RESEARCH DESIGN

Reference Collection

In order to determine the location of raw source materials for discrete lithic industries, it is necessary to first develop a reference collection of chert samples taken from known procurement locales such as quarries and workshops sites, as well as naturally occurring outcrops from chert bearing geological formations that would have been available to hunter-gatherers on the landscape (See Figure 4).

To date, chert sample specimens have been taken from outcrops as well as workshop and quarry sites from six counties throughout the state (See

Figure 5).

In Kay County, numerous samples were taken of Florence-A and Wreford chert at quarry sites located near Hardy, OK. Guided by representatives of the Nature Conservancy's Pontotoc Ridge Preserve, samples of Frisco chert and decorticated materials were taken near a workshop procurement site located in Pontotoc County near Fittstown, OK. Jackfork chert samples were taken near known workshop sites located in Choctaw County near Redden, OK, assisted by consultants of the Choctaw Nation Forestry department.

Additional collections of outcrop samples from chert bearing formations have been taken from Delaware, Mayes, and Tulsa counties (Blackfork, Reeds Spring, and Keokuk cherts). Future chert sampling will be necessary to complete the reference collection in order to accurately represent the broad geographic range of various raw material sources located throughout Oklahoma.

Analytic Profiles

Once the prerequisite sample population of source materials are present within the reference collection, an analytic profile will then be developed for each discrete chert typology. Analytic profiles will be comprised of both macroscopic and microscopic petrographic descriptive characteristics, combined with elemental instrument analyses. The resulting amalgam provides the basis for comparative analysis via observable characteristics such as color, hardness, and the presence of fossils, as well as the elemental constituents of the rock itself by which to establish trace element and minor metal heterogeneity and homogeneity of chert types.

Analytical techniques such as inductively coupled plasma mass spectrometry (ICPMS), X-ray fluorescence (XRF), and neutron activation analysis (NAA) have been demonstrated to be successful in chert material provenance studies (Speer, 2014; Tykot, 1999; Younger-Mertz et al., 2015). The resulting profile would provide a means to compare typed-chert raw material specimens against known



Figure 4. A range of coloration within the OGS chert reference collection as seen among Florence-A (bottom left), Frisco (top left), Reeds Spring (top right), and Jackfork (bottom right) cherts.

lithic tool industry to establish provenance.

Comparative Analysis

Various collections of known lithic industry are available for comparative analysis, and some degree of destructive and non-destructive analysis would ostensibly be required in order to establish a proof of concept for sourcing lithics. In particular, the Sam Noble Museum of Natural History and the Oklahoma Archeological Survey maintain collections of lithic artifacts representative of various cultural groups throughout the project area.

Database

A final portion of the study will be to generate a publically searchable, spatially driven

database that will include chert types represented in the OGS reference collection, as well as GIS coordinates for source materials and related sites.

SUMMARY

OGS is in the initial stages of developing a geoarchaeological lithic provenance study, which is comprised of four essential phases:

- 1) **Reference Collection** - the development of a comprehensive reference collection of all known chert lithic source materials within the state of Oklahoma. This phase will require extensive fieldwork for sample collection and GIS mapping. The collection will be stored at OGS and made available to the public for educational and research purposes.
- 2) **Analytic Profiles** - characterization of chert

Chert Samples

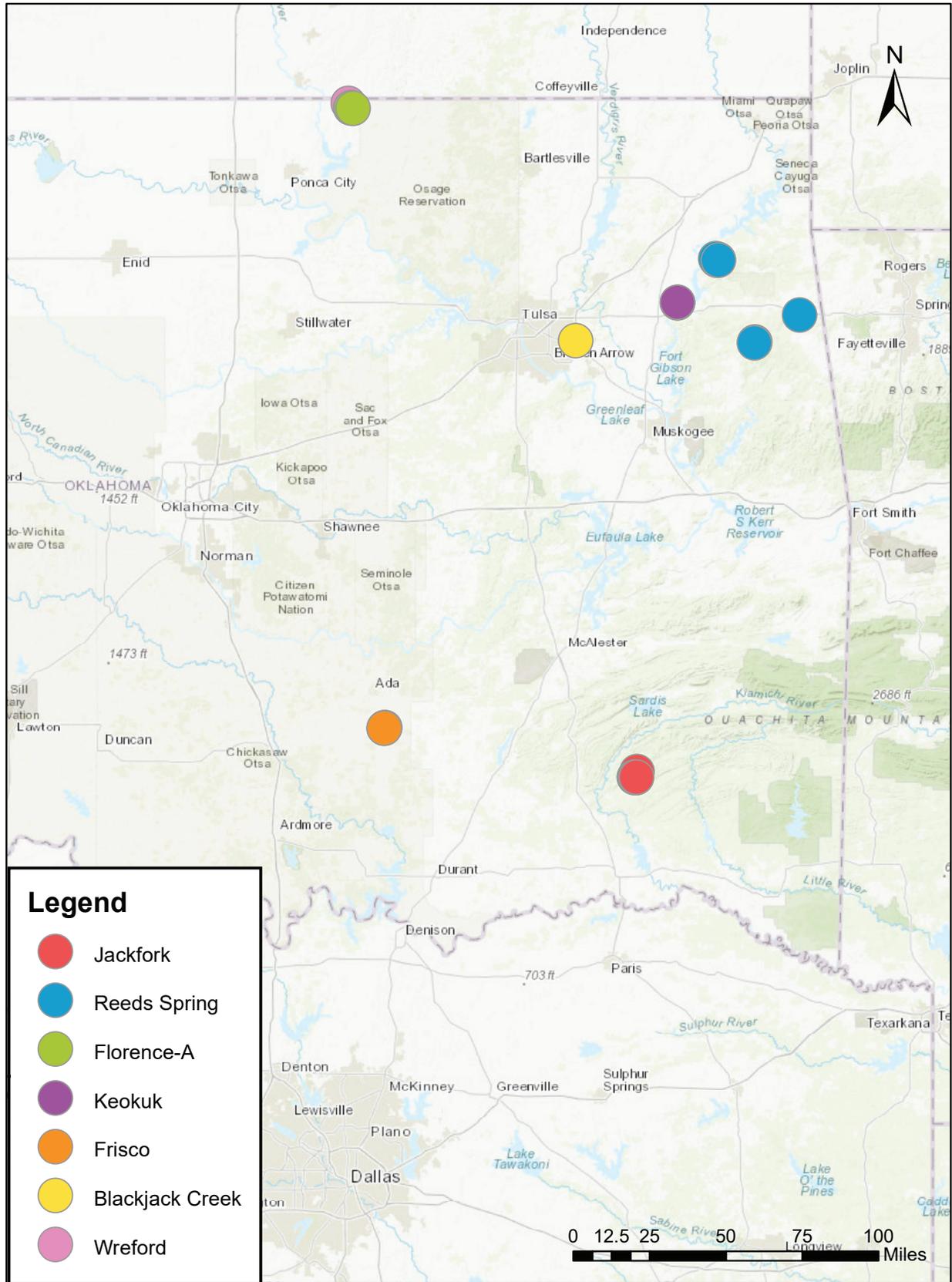


Figure 5. Map of chert samples in OGS reference collection.

typologies by ascertaining the minimum threshold of micro/macro-level petrographic descriptions and elemental analysis of samples necessary to establish distinct analytic typologies and reference profiles.

- 3) **Comparative Analysis** - comparison of typed-chert raw material specimens against known lithic tool industry to establish proof of concept.
- 4) **Database** - development of searchable database of chert typologies, locales, and associated lithic industry within project area.

CONCLUSION

As stakeholders of Oklahoma's natural resources and cultural heritage, the public will benefit from a wealth of information pertaining to the role and significance that lithic technologies played in the lives of Oklahoma's indigenous peoples — of which, relatively little is known. The study further

provides an opportunity to examine the procurement of raw material sources for lithic fabrication among distinct cultural groups in order to arrive at a greater understanding of indigenous, non-western cultures with particular emphasis on economics, mobility, and socio-cultural dynamics of communities on the prehistoric landscape.

This effort will have many positive impacts to the state by facilitating the dissemination of information to scientists, researchers, native communities, and everyday citizens of Oklahoma, in order to promote the archaeological history of the state and its natural resources through best practices and environmental stewardship.

The societal benefits conferred by the comprehensive scope of the project have the potential to enhance our understanding of indigenous lifeways as they intersected with the natural resources of Oklahoma, contributing to the greater overall anthropological understanding of the human species.

ACKNOWLEDGMENTS

Special thanks to David Brown, Neil Suneson, Brittany Pritchett, Stacey Evans, and Julie Chang of the OGS for helping to collect samples and verify corresponding geological formations. Thanks to Jona Tucker of The Nature Conservancy's Pontotoc Ridge Preserve for spending an afternoon guiding us through difficult terrain, and James Briscoe of Briscoe Archaeology for providing access to Choctaw lands on behalf of the Choctaw Nation. Additional thanks to Richard Drass, Susan Vehik, and Don Wyckoff of the University of Oklahoma Anthropology Department and Oklahoma Archeological Survey for their data sharing, correspondence, and guidance.

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About the Author

Richie Tarver joined the Oklahoma Geological Survey in 2011 as a Lab/Research Technician III at the Oklahoma Petroleum Information Center, where he currently works as Data and Collections Manager.

Mr. Tarver has nearly a decade of collections management experience with emphasis on the digital preservation and curation of archival collections for research loans.

Richie received his undergraduate and graduate education in Anthropology at the University of Oklahoma.

As the recipient of several United States



Geological Survey-Department of the Interior-(USGS-DOI) grants for data preservation, one of Richie's principle objectives at the OGS is to foster the digital infrastructure of

data holdings within the OGS-OPIC repository.

In Memoriam

James Russell Chaplin was born on July 16, 1937 in Onslow, Iowa to parents Russell and Harriet Chaplin. Jim's hobbies included reading, comic book collecting, gardening, and exploring the outdoors, particularly fishing and hunting. He loved investing in people and ideas. He loved the oceans. He especially enjoyed spending time with his family. He used the gifts he'd been given to bless others.

Jim was a graduate of Onslow High School, one of seven students in the class of 1955, where he played baseball and basketball. He attended Cornell College in



James Chaplin

Mt. Vernon, Iowa from 1955-1959, graduating with a B.S. in geology and Spanish. Jim then attended the University of Houston from 1959-1961 where he received his M.S. degree in geology. In the summer of 1960, he attended the Institute of Marine Science at Port Aransas, Texas where he completed coursework in marine geology, marine chemistry, marine microbiology, and marine ecology. He began a professorship in 1961 at Morehead State University in Morehead, Kentucky where he taught numerous courses in geology and oceanography. While at MSU, he organized and led numerous field trips to marine stations located in Lewes, Delaware, the Dauphin Island Sea Lab in Alabama, and the Gulf Coast Research Laboratory in Ocean Springs, Mississippi.

In 1967, Jim was granted a faculty sabbatical

from Morehead State University to continue his doctoral studies at Virginia Polytechnic Institute. While at VPI, he served as a research scientist on several cruises aboard Duke University's research vessel, Eastward, collecting geological and biological data along the western margin of the Atlantic Ocean. He returned to MSU in 1969 to continue teaching until taking early retirement in 1982. Jim met his wife, Barbara Lowry-Chaplin at MSU in 1978, and they married in College Park, Maryland on December 31, 1983.

In 1982, Jim moved to Arlington, Texas where he taught geology at Tarrant County Junior College and helped manage Lonestar Comics. In 1983, he accepted a position as geologist with the Oklahoma Geological Survey at the University of Oklahoma where he was employed until his retirement in 2011. He authored and coauthored more than 150 publications including peer reviewed journal papers, abstracts, guidebooks, and education materials for K-12 students and teachers. He extends to his students at MSU and OU his heartfelt appreciation, respect, and gratitude for focusing the passions of his mind to problem solving.

Jim is survived by his wife Barbara Lowry Chaplin of Noble, OK, his daughter Abigail Chaplin-Kyzer and her husband Daniel Kyzer of Corinth, TX, his daughter Kathleen Grzybowski and her husband Dawid Grzybowski of Moore, OK, his sister Kay Chaplin Saelens of Loveland, CO, his mother-in-law Aileen Lowry Allison of Norman, OK, his son Steve Chaplin of Indiana, and his son Kevin Chaplin of Kentucky in addition to many beloved in-laws and nieces and nephews. In lieu of flowers, the family requests that donations be made to the Hobart W.C. Furbunch Award for Outstanding Field Research in Geology at the University of Houston, a scholarship fund founded by Jim Chaplin and his colleagues to encourage and promote field research by the next generation of young geologists and scholars.

*Text was taken from a handout from James Chaplin's funeral



Oklahoma Geological Survey

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Looking Down the Road

Coming up next in *The Oklahoma Geology Notes*

Natural Falls State Park

In the next issue of the Oklahoma Geology Notes, OGS geologists take a look at the geology and history of Natural Falls State Park in Northeast Oklahoma.

