Mining for the Source:

Identifying the origins of prehistoric raw muscovite through XRF analysis

Emma Richardson

Warren Wilson College

Spring 2008

Sociology/Anthropology Department

Abstract

This research explores the prehistoric trade of mica in the eastern United States with the purpose of determining the possible production sources of raw sheet muscovite. X-ray fluorescence spectrometry was used to detect whether trace elemental analysis is effective in determining regionally specific patterns of chemical characteristics in muscovite. While this initial analysis shows no distinctive regional characteristics of the material, more work is necessary before a conclusion is reached on whether geochemical analysis is a viable method of sourcing muscovite.

TABLE OF CONTENTS

ABSTRACT 2

ACKNOWLEDGEMENTS 4

THE SIGNIFICANCE OF MUSCOVITE 5

EXAMINING THE POSSIBILITY OF TRADE 5

EXCHANGE SYSTEMS 7

A SOCIETAL BACKGROUND 9

THE VALUE OF MICA 17

MICA SOURCES 19

MICA MINING IN NORTH CAROLINA 23

PRODUCTION SITES 29

THE ORIGINS OF MICA: A GEOLOGIC PERSPECTIVE 33

A BACKGROUND IN MICA GEOLOGY 34

METHODS 37

DATA 41

THE FUTURE OF SOURCING MUSCOVITE 43

CONCLUSION 45

NON-NATIVE MICA ARTIFACTS FROM SELECTED SITES 46
SOUTHERN APPALACHIAN PREHISTORIC MICA MINES 47
TRILINEAR DIAGRAMS 48
ANALYZED SAMPLES 51
XRF RESULTS 54
X-RAY FLUORESCENCE SPECTROMETRY DETAILS 55

REFERENCES 56

Acknowledgements

I owe a great debt of gratitude to the Dean of Warren Wilson College, John Casey. Without his financial support I would not have been able to complete my sampling and analysis. I would also like to thank Rodney Snedeker of the US Forest Service and Kenneth Whittaker for helping me to sample the Franklin/Sylva district and the Shelby district respectively. Samples from outside of North Carolina were supplied by the State Geologic Surveys of New Hampshire, Virginia, Alabama, and South Carolina. For this, I am very grateful to Lee Wilder, Amy K. Gilmer, Gary L. Taylor, and Lewis S. Dean. In addition, I would like to thank Dr. Doug Dvoracek of the University of Georgia's Center for Applied Isotope Studies not only for his willingness to analyze my samples, but for his patience in explaining chemistry and his understanding of a tight student budget. Most of all, I'd like to thank Dr. David Moore and Robert Hastings for their constant guidance, support, and enthusiasm. I could never have begun to understand the geology behind this project without Robert Hastings, and I could never have struggled through it without Dr. David Moore.

The Significance of Muscovite

A piece of mica no bigger than a postcard is found on a Hopewellian site in Ohio. It is not visibly worked by human hand, has no ornamentation, yet it is an exceptionally significant piece of archaeological material. Mica artifacts and material are commonly excavated from archaeology sites in places such as Ohio and Illinois where mica does not occur naturally. Here lies its significance. If a material is not local, then it was an imported commodity; one that was valued enough by a culture to have it carefully mined from the parent rock and transported hundreds of miles. This paper will study the prehistoric trade of mica in the eastern United States so as to determine the possible production sources of raw sheet muscovite.[1] By doing so, the exchange systems of the Adena, Hopewell and the Mississippian cultures can be better understood.

Examining the Possibility of Trade

Exchange studies commonly focus on the array of exotic raw materials[2] from a site or population and attempt to identify the geologic sources of each raw material. Researchers interested in prehistoric North Carolinian muscovite trade have done this by using historic documents to complement the incomplete archaeological record. The lucrative business of modern mining has largely destroyed traces of prehistoric mica, leaving historical records as the primary source of qualitative information regarding mining of the material.[3] Twentieth century Smithsonian documents on ancient mica mining, current geologic data on potential sources in the area, commercial mining

---

[1] *Muscovite* is the geologic term for mica that is colorless, or clear, in appearance.
[2] *Exotics* refer to materials that do not naturally occur in the area.
[3] Leland G. Ferguson, "Prehistoric Mica Mines in the Southern Appalachians," *South Carolina Antiquities 6*, no. 2 (1974): 212.

reports, and archaeological and historical accounts of Native American trails in the country have been useful to this area of study.[4]

The growing range and accuracy of analytical methods available for characterization and sourcing of raw material now allows for a more in-depth examination of the interaction spheres[5] of the Adena, Hopewell, and Mississippian cultures. Studying the intricate connection of mica's production, trade, and consumption within these exchange systems is now possible. Innovative scientific techniques have created new possibilities for recognizing differences in raw materials from various sources. Now, the mechanism of trade and the role of mica within that system may be better interpreted by studying the network of production through characterization of the source material of mica mines.

According to Renfrew and Bahn, exchange systems are reconstructed by studying the materials with which traded and procured artifacts are made.[6] To do this, the material must be sufficiently distinctive according to its source. Only after determining the possible sources for archaeological material can the methods of procurement and the organization of trading systems be understood and reconstructed. If non-native material is found, it can be assumed that the material was imported, whether through exchange or direct procurement. Non-native mica found on Middle Woodland sites in Ohio or on a

---

[4] Peter R. Margolin, "The Sink Hole at Bandana: An Historic Blue Ridge Mica Mine Reveals Its Past," *North Carolina Archaeology, 49* (2000): 43.
Charles Hudson, *The Southeastern Indians* (University of Tennessee Press 1976), 110.
Chapman, Jefferson and Bennie C. Keel, "Candy Creek-Connestee Components in Eastern Tennessee and Western North Carolina and Their Relationship with Adena-Hopewell," in *Hopewell Archaeology: The Chillicothe Conference*, ed. David S. Brose and N'omi Greber (Kent, Ohio: Kent State University Press, 1979), 161.
[5] The term *interaction sphere* refers to the shared social and material exchange network of a culture. *Exchange sphere* refers solely to the material exchange network of a culture.
[6] Colin Renfrew and Paul Bahn, *Archaeology: Theories Methods and Practice* (New York: Thames & Hudson Inc, 2004), 357.

Mississippian site in Illinois can therefore be understood to be an indication of the importation of muscovite from an outside source.

Exchange Systems

Archaeologists studying exchange systems examine non-native material from sites and populations to determine the extent of a culture's interaction throughout the region, and to understand the commerce and structure of early societies. Qualitative and quantitative techniques are employed to identify the geologic source(s) of each exotic material found on a site or associated with a specific culture.[7] After establishing the production site(s), archaeologists must then determine who controlled and exported the material, and whether goods were raw at the time of exchange, or were manufactured before leaving the site.[8] Understanding each of these variables is essential to understanding the exchange spheres of cultures.

Exchange involves the production, distribution, and consumption of material goods.[9] If the population importing the material good has direct access to the source of the material, an exchange transaction between individuals or groups is not required. *Direct access* allows the user to acquire goods directly from the source, without need for intervening parties.[10] According to American anthropologist Karl Polanyi, trade between groups can occur through three different modes of exchange: reciprocity, redistribution,

---

[7] Sharon I. Goad, "Middle Woodland Exchange in the Prehistoric Southeastern United States," *Hopewell Archaeology: The Chillicothe Conference*, ed. David S. Brose and N'omi Greber, (Kent, Ohio: The Kent State University Press, 1979), 239.
[8] *Production site* refers to the location where raw material is mined or turned into a finished product. See Renfrew and Bahn, "The Study of Production," in *Archaeology: Theories, Methods, and Practice* (New York: Thames & Hudson Ltd., 2004), 382.
[9] Renfrew and Bahn, 357.
[10] Renfrew and Bahn, 375.

and market exchange.[11] Reciprocity occurs when both the producer and consumer are political equals. In this case, exchange is used as a means of reinforcing relationships between groups by way of gift giving. Bronislaw Malinowski describes this method of exchange in his 1922 study of the *kula* system in Melanesia. He suggests that reciprocal exchange of valuable goods obligates each party to continue the giving of gifts, and in doing so, continues the relationship between the parties.[12] Redistribution occurs only in chiefdoms and states where a central organization is present. Material goods are imported to the center before being reallocated throughout the power's network, allowing for a wide distribution of goods.[13] Market Exchange, like its name infers, requires a specific location where trade occurs such as a marketplace or city center. Traders travel to the organizing center from different areas in order to take part in exchange.[14]

American archaeologist George Dalton suggests that separate spheres of exchange exist according to the type of material that is being traded.[15] Everyday goods are only traded for ordinary items, and similarly, valuable commodities are only traded for high-prestige items. Mica, being traded as an exotic material or manufactured good, would be exchanged in a prestige interaction with an equally valuable item traded in return. According to Dalton, prestigious exchange spheres can include *competitive exchanges* that are used as a show of power to settle rivalries.[16] Groups can surpass rivals by giving a more prestigious gift, or destroying valued commodities to show wealth.[17] The

---

[11] Renfrew and Bahn, 360.
[12] Bronislaw Malinowski, *Argonauts of the Western Pacific: An Account of Native Enterprise and Adventure in the Archipelagoes of Melanesian New Guinea* (New York: E.P. Dutton & Co., 1922).
[13] Renfrew and Bahn, 360.
[14] Renfrew and Bahn, 360.
[15] George Dalton, "Aboriginal Economies in Stateless Societies," in *Exchange Systems in Prehistory*, ed. T.K. Earle and J.E. Ericson (New York: Academic Press, 1977): 200.
[16] Dalton, 201.
[17] Renfrew and Bahn, 364.

Hopewell of Ohio included purposefully broken pipes in grave good offerings. This practice has been documented both at the Mound City Group and at Tremper Mound, where a cache of 136 broken pipes was discovered.[18] However, destruction of exotic goods may have instead played a more ritual role. William C. Mills describes the practice in his 1922 study of the Hopewellian site of Mound City as a "killing ceremony," suggesting that it symbolized the "release of the spiritual essence of the object."[19]

Whether mica was traded through reciprocity, redistribution, or as a show of wealth is yet to be known. To understand the modes and purposes of exchange for the Adena, Hopewell, and Mississippian cultures, an understanding of the politico-economic structures of the cultures is required.

A Societal Background

In the eastern United States, non-native mica artifacts and material have been found on sites associated with the Adena, Hopewell, and Mississippian cultures. In the early 1930's, Emerson F. Greenman loosely defined the Adena as the mound-building culture of Ohio. As archaeologists began to discern distinct cultural differences in the mound-building and burial customs of the people of the Ohio Woodland period, Greenman's categorization lost favor and the disparate groups became known as the Adena and the Hopewell.[20] Today, the Adena culture is defined as an Early Woodland Period society (circa 1,000 B.C. to A.D. 100) concentrated in the Scioto River Valley of Ohio. The Adena people lived in "small, widely scattered hamlets," and boasted a

---

[18] Susan L. Woodward and Jerry N. McDonald. *Indian Mounds of the Middle Ohio Valley: A Guide to Adena and Ohio Hopewell Sites* (Newark, Ohio: The McDonald & Woodward Publishing Company, 1986), 109.
[19] William C. Mills, "Exploration of the Mound City Group, Ross County, Ohio," *American Anthropologist, New Series 24*, no. 4 (1922): 404.
[20] William S. Webb and Charles E. Snow, *The Adena People* (University of Tennessee Press, 1974), VII.

territory stretching from southeastern Indiana to southwestern Pennsylvania and from north central Ohio to central Kentucky.[21] Though mainly a hunter-gatherer society, the Adena people were regional pioneers of horticulture and mound building and had an extensive trade network based on reciprocity. Adena artifacts have been found in the Chesapeake Bay area and as far north as Vermont and New Brunswick.[22]

Imported exotic goods in the form of tools and personal adornments have been found in Adena burial mounds, indicating their widespread trade. High-prestige items such as projectile points made from exotic materials, tubular pipes, stone gorgets, stone tablets, and non-native mica have been excavated from Adena sites.[23] The small amounts of reported mica found on sites associated with the Adena are rarely visibly worked. In fact, mica is so scarce on Adena sites that the material has been used as a characteristic for dating sites to the Late Adena, verging on the advent of the Hopewell.[24]

Before its destruction, work on Baird Mound in Ohio exposed muscovite, but the amount and the provenience of the mica are unknown due to the method of excavation.[25] In Ross County Ohio, Mound I of the Adena Renick Group included "a few mica fragments."[26] However, a burial at the Adena Law Site mound included worked mica that Ben J. Morris describes as "several crescent-shaped strips of muscovite mica...each containing multiple 'pin holes'...matted together in a single cluster."[27] Other worked mica has been found on sites dated as Late Adena, however, there is a small amount of mica associated with the Adena when compared to the large amount of mica artifacts

---

[21] Woodward and McDonald, 7,11.
[22] Woodward and McDonald, 15.
[23] Woodward and McDonald, 11, 15, 58.
[24] Webb and Snow, XV.
[25] Woodward and McDonald, 58.
[26] Robert A. Kercher "Notes on the Adena Aspect," *American Antiquity 15,* no. 1 (1949): 62.
[27] Ben J. Morris, "An Archaeological Survey of Randolph County, Indiana," *Archaeological Reports,* no. 7, ed. B.K. Swartz Jr. (Muncie, Indiana: Ball State University, 1970), 9-10.

excavated from Hopewell mounds. Nevertheless, as with any record of material consumption, what has been found is unlikely to be a completely accurate representation of what was once traded. Mica is easily destructible, and there remains a bias towards the excavation and study of valued materials placed in burials.[28] This bias is increased with the Adena culture as grave goods are few in number when compared with that of their Hopewell successors.

The Hopewell culture arose during the Middle Woodland Period (circa 150 B.C. to A.D. 500) in the Scioto River Valley of Ohio and the Havana region of Illinois.[29] Like the Adena, the Hopewell people were hunter-gatherers. Both mound building cultures represent what American Archaeologists describe as a "mortuary cult," however the Hopewell expanded on the Adena culture by increasing their reliance on horticulture and broadening their trading network.[30]

Based on the archaeological record preserved in grave goods, the Hopewell Interaction Sphere stretched from the Rocky Mountains to the Atlantic Ocean and from the Great Lakes to the Gulf of Mexico.[31] This extensive exchange system allowed for the importation of exotic prestige goods such as freshwater pearls, hammered copper and gold, galena, conch shells, grizzly bear teeth, fossil shark teeth, obsidian, and mica.[32] Archaeologists Bennie C. Keel and Jefferson Chapman both suggest that the principal element in Hopewell interaction with the Appalachian area was the mica trade.[33]

---

[28] Renfrew and Bahn, 384
[29] Renfrew and Bahn, 390.
[30] Woodward and McDonald, 5.
[31] Renfrew and Bahn, 390.
[32] Woodward and McDonald, 19.
[33] Chapman and Keel, 161.

Cut mica "bird-claw" from the Mound City Group, Ohio.[34]

Compared to the Adena, the Hopewell people were better patrons of the mica trade. This is seen in the archaeological record left behind in the exotic goods associated with burials from both cultures. As shown above, the Adena were involved in the trade of mica and held the material in high esteem. However, along with the emergence of the Hopewell culture came a sharp increase in mica artifacts and material (See Appendix 1). This rise may have been the result of stronger trade ties with groups in control of mica production sites, an incorporation of the material into Hopewell cultural practices, or simply a greater interest in the material itself. Just as shell beads were highly regarded by some groups, mica may have merely been in fashion.

The Hopewell Interaction Sphere was made up of two centers located in what is now Ohio and Illinois. Hopewell sites in Illinois are centered in the lower and middle Illinois River Valley and in the adjacent Mississippi Valley. While the Illinois Hopewell had a wider geographic influence, both the Ohio and Illinois Hopewell have parallel

[34] Ohio Historical Society, *Virtual First Ohioans*, http://ohsweb.ohiohistory.org/gallery2/main.php?g2_itemId=279&g2_page=3.

ceramic styles, subsistence resource utilization, settlement patterns, access of exotic raw materials.[35]

Nonetheless, the Ohio Hopewell exhibit the greatest distribution of mica artifacts in mounds and burials within the Scioto Valley. The Mound City Group of Ohio has provided an abundance of both worked and unworked mica from its series of Hopewell mounds. Early excavation of the mounds produced cut mica in the form of human torsos, disks, a bird-claw, a hand, a projectile point, and many other figures.[36] Outside of Ohio, a stone mound in Georgia associated with the Ohio Hopewell was found to have interred a "mica-covered extended burial" with sheets of mica lying over the face and chest of the individual.[37]

The presence of mica artifacts and material in the Hopewell sites has been attributed to trade with the Southern Appalachians and more specifically with western North Carolina. Other sheet mica sources have been excluded as feasible source sites. However, other source sites beyond the Southern Appalachians are possible. The Hopewell Interaction Sphere has been said to have stretched westward to what is now Yellowstone National Park in Wyoming and into North Dakota. Artifacts found both in the Ohio Hopewell site of Mound City, and Illinois Early Woodland mounds in southwest Wisconsin have been associated with this source.[38] If this is the case, it is certainly possible that sheet mica was being traded from the Rocky Mountain deposits or the Black Hills pegmatites in South Dakota.

---

[35] Ronald J. Mason, "Hopewell, Middle Woodland, and the Laurel Culture: A Problem in Archaeological Classification," *American Anthropologist, New Series 72*, no.4 (1970): 802-3.
[36] Margolin, 54.
[37] A.J. Waring Jr., "Hopewellian Elements in Northern Georgia," *American Antiquity 11,* no. 2 (1945): 119.
[38] James B. Stoltman and Richard E. Hughes, "Obsidian in Early Woodland Contexts in the Upper Mississippi Valley," *American Antiquity 69,* no. 4 (2004): 751; Warren B. DeBoer, "Little Bighorn on the Scioto: The Rocky Mountain Connection to Ohio Hopewell," *American Antiquity 69,* no. 1 (2004): 85.

The Hopewell's exchange of prestige goods was associated with the cultural and symbolic similarities between the Ohio and Illinois Hopewell. Although local cultural differences are evident, prestige goods in both areas were ritually consumed for mortuary uses by destroying the exotic items. According to Dalton, this illustrates the "competitive emulation" between the two Hopewell centers.[39] Exotic goods, such as the mica artifacts found both in Ohio and Illinois Hopewellian burials, could very well be an indication of this competitive nature. Not only would one group need to obtain the same prestige items as their competition, but they may take part in competitive exchanges or attempt to surpass rivals by destroying valued commodities to show wealth.

Mica "Mirror" from the Mound City Group, Ross County, Ohio.
(Photo taken by the author.)

As Hopewell influence began to wane, the abundance and size of mica diminished.[40] With the transition to a sedentary, corn-based agricultural society, the

[39] Renfrew and Bahn, 390.
[40] Warren R. DeBoer, "Little Bighorn on the Scioto: The Rocky Mountain Connection to Ohio Hopewell," *American Antiquity 69*, no. 1 (2004): 97.

Hopewellian Period came to a close and the Mississippian culture was born. The Mississippian Period (circa A.D. 1000-1600) is distinguished by their agriculture, large flat-topped earthen mounds, and a multi-tiered settlement hierarchy.[41] Status differentiation is partially indicated by exotic materials and other high-prestige goods seen in burials.

The Mississippian trade spread primarily by way of major waterways from the Great Plains to the South Atlantic Coast through interregional interactions between the main Mississippian centers. The largest of all polities was Cahokia in present day Illinois, but other large centers existed at Spiro in Oklahoma, Moundville in Alabama, and Etowah in Georgia.[42] These Mississippian sites have been described as *complex chiefdoms* with local chieftains acting under larger political and social units.[43] According to Polanyi, exchange systems of these chiefdoms follow the redistribution model, however many archaeologists argue that Mississippian societies had their start in a reciprocal long-distance exchange system.[44]

The Illinois Mississippian center of Cahokia is considered the largest North American center before European contact. Its influences spanned from Minnesota to Oklahoma, and from Louisiana into Tennessee, with the spread of exchange going beyond direct political influence.[45] Mica artifacts have been found in the notable Monk's

---

[41] Timothy Pauketat and Thomas Emerson, *Cahokia: Domination and Ideology in the Mississippian World,* (Lincoln, NE: University of Nebraska Press, 1997), 5.
[42] Pauketat and Emerson, 19.
[43] Pauketat and Emerson, 3; Mary Beth D. Trubitt, "Mound Building and Prestige Goods Exchange: Changing Strategies in the Cahokia Chiefdom," *American Antiquity 65*, no. 4 (2000): 671. *Complex chiefdoms* are described as elaborate nonstate political organizations devoid of formal bureaucracies.
[44] Renfrew and Bahn, 360; Trubitt, 670.
[45] Pauketat and Emerson, 1.

Mound and in a burial within Mound 72.[46] Mica fragments not associated with mounds have been found mainly in elite homes at Cahokia, suggesting that it was a high-prestige material that was not being worked by artisans at the site.[47]

Outside of Illinois, the centers of Spiro, Moundville, and the Georgia site of Mandeville also contain mica artifacts. On the Mandeville site in southwestern Georgia, "large quantities" of cut and unworked mica were excavated from Mound A.[48] At the prominent Mississippian polity of Moundville in west central Alabama, 109 occurrences of mica were found associated with two mounds.[49] The close proximity of Moundville to mica deposits in Alabama suggests that these sources were being mined rather than the western North Carolina deposits.[50] At the Spiro site in Oklahoma, Robert Bell proposes that mica fragments found are more likely from sources of mica in southwestern Arkansas.[51] Of particular interest are the three pieces of biotite mica excavated from the Brown mound fill of Spiro.[52] Biotite mica is not common in Mississippian trade goods, and Spiro's close proximity to the Arkansas biotite and muscovite deposits suggest that material was being mined from that area.

---

[46] Timothy R. Pauketat, *The Ascent of Chiefs: Cahokia and Mississippian Politics in Native North America,* (Tuscaloosa, AL: University of Alabama Press, 1994): 84; George R. Milner, "Social and Temporal Implications of Variation among American Bottom Mississippian Cemeteries," *American Antiquity 49,* no. 3 (1984): 482.
[47] Pauketat, 163.
[48] James H. Kellar, A.R. Kelly and Edward V. McMichael, "The Mandeville Site in Southwest Georgia," *American Antiquity 27,* no.3 (1962): 346.
[49] Vernon James Knight, Jr., "Characterizing Elite Midden Deposits at Moundville," *American Antiquity 69,* no. 2 (2004): 311.
[50] James A. Brown, *The Spiro Ceremonial Center: The Archaeology of Arkansas Valley Caddoan Culture in Eastern Oklahoma,* (Ann Arbor: University of Michigan, 1996), 645. Brown lists possible mica sources in Chilton, Jefferson, Coosa, Clay, Randolph, and Cleburn Counties in Alabama.
[51] Robert E. Bell, "Trade Materials at Spiro Mound as Indicated by Artifacts." *American Antiquity 12,* no. 3 (1947), 182.
[52] Brown, 645.

Data now suggest that contact between western North Carolina and the Midwest occurred before the Hopewell period with exported material such as mica, quartz crystal, aventurine, and chlorite traded from the southern Appalachians.[53] Artifacts found in Adena mounds are evidence of that connection of exchange. The Hopewell Interaction Sphere marked the peak of the mica trade, with elaborate cut mica figures and shapes used as a status display in burials. According to the archaeological record, mica use declined as the Hopewell's influence declined, and by the Mississippian Period, fewer and smaller pieces of non-native mica were being imported and used. Whether this is due to waning interest in the material, a change in the use of the material which is not seen in the archaeological record or a difficulty getting sheet mica from production sources is unknown.

The Value of Mica

Material exchange occurs through offerings of gifts and manufactured goods, and through the trade of everyday goods and exotics that are valued by the consumer group.[54] In trade, high-prestige items of value are crafted from raw exotic materials such as sheet mica.[55] Prestige items are goods that are subjectively valuable and in most cases are not for common use, but are instead acquired to display status and power. Gary M. Feinman refers to individual prestige and wealth accumulation as part of the "network mode."

---

[53] Chapman and Keel, 161; John A. Walthall, *Prehistoric Indians of the Southeast: Archaeology of Alabama and the Middle South* (Tuscaloosa, Ala.: University of Alabama Press, 1980), 106.
[54] Renfrew and Bahn, 358.
[55] Renfrew and Bahn, 362.

This strategy of leadership uses long-distance exchange, exotic wealth exchange, and personal networks to build social hierarchy.[56]

According to Renfrew and Bahn, materials are given intrinsic value if they are rare, durable, and visually conspicuous, making mica a high-prestige item.[57] Therefore, the allure of muscovite may have rested in its appearance and scarcity. Sheet mica is found in various isolated regions throughout the southeast, but is nonetheless a rare material. Furthermore, exotic materials are symbols of status and therefore must be visually appealing much like sheet mica. According to the archaeological record, it is clear that mica was used for personal adornment and to show elite status. This is evident by the "pierced" small holes for attachment found on cut sheets of mica found in burials.[58] In particular, a burial in Ohio contained a "headdress" made from cut strips of mica with holes for attachment, and in South Carolina, a mantle possibly made of deerskin was found covered with thirty mica disks.[59]

Although not as durable as high-prestige items such as flint or shell, worked sheet mica can easily remain intact depending on its quality. Dalton argues that variance in quality enhances the level of prestige of materials. Differences in the quality of raw and worked materials allows for high-status individuals to attain goods of better quality than materials acquired by the less powerful.[60] Sheet mica is difficult to mine in large

---

[56] Gary M. Feinman, "The Emergence of Inequality: A Focus on Strategies and Processes," in *Foundations of Social Inequality*, ed. T.D. Price and G.M. Feinman (New York: Plenum Press, 1995), 268.
[57] Renfrew and Bahn, 362.
[58] W.H. Holmes, "Handbook of Aboriginal American Antiquities," *Bureau of American Ethnology*, Bulletin No. 60 (1919): 241-2. In Wheeling, West Virginia, a burial was found to contain 150 sheet mica disks with one to two perforations each.
[59] Joffre Lanning Coe, *Town Creek Indian Mound: A Native American Legacy* (Chapel Hill: The University of North Carolina Press, 1995), 238.
[60] Renfrew and Bahn, 364; James B. Griffin, "Adena Pottery," *American Antiquity 7*, no. 4 (1942): 346.

sheets and is found with a wide range of durability and pureness of color, allowing for an array of mica quality and for mica's distinction of being an "exotic good."

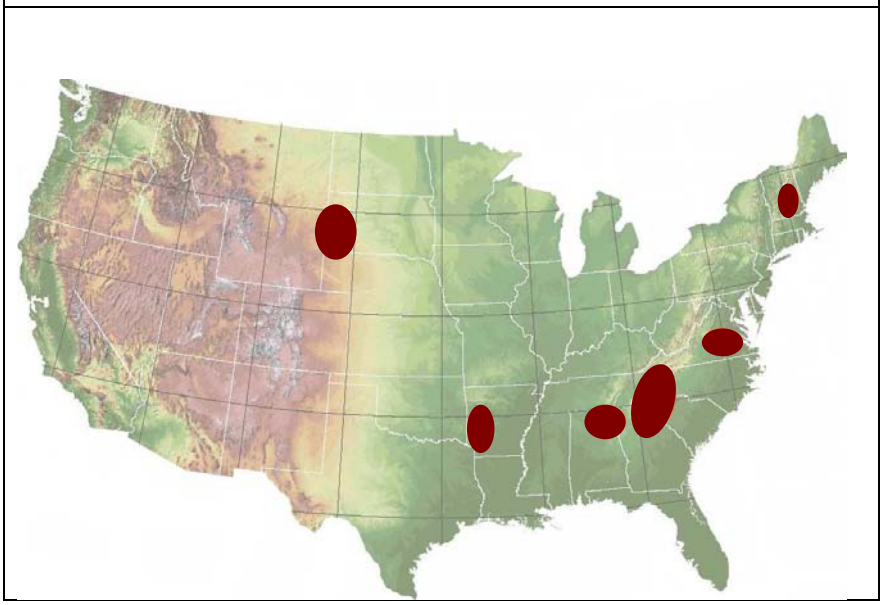
Archaeologists examine mortuary treatment to determine status differential in societies, theorizing that status during life is reflected by treatment at death. High-prestige items such as exotic goods are commonly found in burials, indicating high status of the individuals. The burials of the Turner mounds in Ohio held figures cut from thin sheets of mica in the shape of serpents, birds, and other forms, and Mound 13 of the Mound City Group included a large deposit of cut sheet mica overlaying a cremation pit.[61] Other mica artifacts found are speculated to have been used as mirrors.[62] Non-native mica found on archaeology sites in the eastern United States have primarily been found in burials, signifying its value as an exotic material (See Appendix 1).

Mica Sources

If there is more than one available source for a particular resource, it is necessary to identify material differences between the sources in order to determine the source of an individual exotic good. It has long been assumed that mica found at Hopewell sites in Ohio was imported from the mica-rich regions of western North Carolina. However, other mica belts in the eastern United States can be seen to be possible source sites as well. A close study of potential mica production sources is therefore required.

[61] Holmes, 242; Mills, 410.
[62] Holmes, 242.

Sheet Mica Deposits



James B. Griffin summarized the nature and extent of Ohio Hopewell trade as being "the acquisition of nonlocal raw materials by trading parties, a significant activity in Late Archaic and Early Woodland times, [that reached] striking proportions particularly in Ohio Hopewell." [63] Keel and Chapman propose that contact between the southern Appalachian region and Hopewell culture was prompted by sheet mica interest. After examining maps of historic Indian trails compiled by Myer in 1928, Chapman and Keel suggest that the trails had been used for more than 3000 years, linking the Appalachian Summit area and southeastern sites with the northern Hopewell centers.[64] This would have created a trade network of resources and exotics between the southern Appalachian region and areas as far north as the Hopewell centers in Ohio. However, archaeological evidence for trading and exchange systems in the area is lacking. Without written records of exchange, it is difficult to discern which materials were traded from

[63] Walthall, 106.
[64] Chapman and Keel, 161.

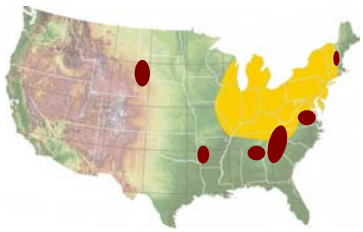
each area. Therefore, it is a slow, but necessary process to continue to piece together evidence of sources and distribution to more fully understand exchange systems in the area.

Despite claims of exotic muscovite originating from prehistoric western North Carolina mica mines, a thorough examination of raw muscovite sources in the region has been largely overlooked, and testing on the archaeological material remains incomplete. Yet muscovite is still largely assumed to have been prehistorically traded from the western North Carolina region's mica bands. Mica fragments found at the Spiro site in Oklahoma have been reported as being from the North Carolina mica belts, however, the source of the material remains in question.[65]

According to Bishop and Canouts, archaeologists studying traded raw materials rely chiefly on "the criteria of abundance and fall-off models" to identify material sources. Areas of origin are then narrowed using geologic maps to determine the ability and likelihood of access to each source site or area.[66] With the help of historical documents, mica quarries in North Carolina have been known for some time, but there can be questions as to a definite source, or sources, of the material(s). According to fall-off analysis, the quantity of a traded material declines as the distance increases between the source site and the site of consumption.[67] This theory suggests that mica traded from sources closer to the final consumption site, such as the Alabama mica deposits, may be a more likely production source for Hopewell groups in Illinois.

---

[65] Laura Kozuch, "Olivella Beads from Spiro and the Plains," *American Antiquity 67*, no. 4 (2002): 700.
[66] Ronald L. Bishop and Veletta Canouts, "From *Archaeometry,"* in *The Development of Southeastern Archaeology*, ed. Jay K. Johnson (Tuscaloosa: The University of Alabama Press, 1993), 162.
[67] Renfrew and Bahn, 376.

Mica Deposits Overlying Adena Trade	*Mica Deposits Overlying the Hopewell Interaction Sphere*	*Mica Deposits Overlying Mississippian Trade*
		

Robert Bell suggests that despite long term knowledge of mica quarries in North Carolina, these mines "seem questionable as a source for the material."[68] Workable forms of mica are found in southwestern Arkansas, and although it is not known to have been mined, this would be a more logical source of supply for the Spiro specimens.[69] Sources in Virginia are reported to have been prehistorically mined, as well as sources in Alabama.[70] Qualitative evidence points to the Alabama River system as a major trading route into the "interior highland crystalline area" of the mica-rich west-central counties of Alabama.[71] According to John Walthall, the Alabama River Valley area was mined beginning in the Archaic period, and was exploited by the Tennessee Valley middle Woodland Copena peoples who obtained raw materials from the area, either through trade or direct procurement. Walthall asserts that the peoples inhabiting this community controlled the Alabama River system through which it acquired raw materials and

[68] Bell, 182.
[69] W.H. Holmes, "Handbook of Aboriginal American Antiquities." *Bureau of American Ethnology,* Bulletin No. 60 (1919): 241.
[70] Holmes, 101; Walthall, 161.
[71] Brown, 645.

finished products.[72] I would argue that this information alone is enough to justify a re-evaluation of the possible sources of mica-procurement and trade especially for artifacts found at archaeology sites in Oklahoma.

Mica Mining in North Carolina

Apart from the sources in Alabama, the western North Carolina region contains three primary mica deposits: the Spruce Pine, Franklin-Sylva, and Shelby districts.[73] These bands of mica stretch into multiple counties of North Carolina and from the late 19th Century through the mid-20th Century have provided the United States with over 75 percent of the nation's supply of mica. In the case of the Franklin-Sylva deposit, its northeast trending mica-rich pegmatite belt extends for 72.4 km and is as wide as 22.5 km.[74] Mica occurs in sporadic clusters in Franklin-Sylva pegmatites and therefore is harder to follow than the mica veins of the Spruce Pine area.[75] For prehistoric miners this quality would be problematic.

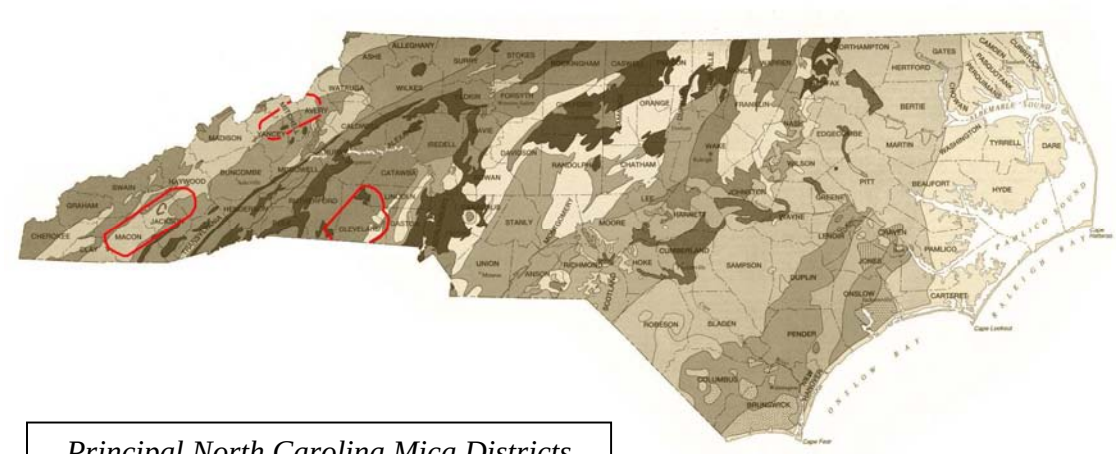
The Shelby district lies in the Piedmont region of the state and covers approximately 700 square miles. Like the Franklin-Sylva district, mica deposits are unpredictable. However, unlike the Franklin-Sylva and Spruce Pine, Shelby deposits seldom are visible at the surface, making mining for quality sheet mica difficult.

From 1868 until the 1950's, the Spruce Pine district was the nation's primary sheet mica producer. Its mica-rich pegmatites have provided the modern mica industry, and possibly the prehistoric mica industry, with 250 square miles of workable micaceous

---

[72] Walthall, 161.
[73] Sam D. Broadhurst and Lewis J. Hash, "The Scrap Mica Resources of North Carolina," *North Carolina Department of Conservation and Development,* Bulletin No. 66 (1953): 2.
[74] Chapman and Keel, 161.
[75] J.C. Olson, "Economic Geology of the Spruce Pine Pegmatite District, North Carolina," *North Carolina Department of Conservation and Development,* Bulletin No. 43, (1944): 10.

pegmatites.[76] Spruce Pine mica is known for its clusters of rich, high quality crystals. Such a characteristic would make the area exceptionally valuable to prehistoric miners. One crystal mined from the region was reported to have weighed 4,300 pounds. Furthermore, surface outcrops are common in the Spruce Pine district, providing many near-surface possibilities for prehistoric mining.[77]



Principal North Carolina Mica Districts

In 1868, General T.L. Clingtings of North Carolina began to mine for silver in previously worked rock. What he stumbled upon instead was a prehistoric mica mine, thereby initiating the mica economic boom of the western North Carolina region.[78] Clingtings was not alone in his confusion. In the sixteenth century, Spanish explorer Hernando de Soto was on a similar quest that led to a similar disappointment. Through the help of a young Indian trading boy named Perico, Soto was led to believe that silver

[76] Olson, "Economic Geology," 9, 10.
[77] Olson, "Economic Geology," 29.
[78] Holmes, 242.

lay near the town of Cofitachequi in present day South Carolina. Once there, he found that the "silver" was in truth large slabs of silvery mica.[79]

Though the area was a disappointment to both Soto and Clingtings, North Carolina and its surrounding area is a rich center of sheet mica. In western North Carolina alone, Leland Ferguson has been able to document seventeen separate prehistoric mica mines, compared to five in Alabama.[80] The majority of these mines are located in Mitchell, Macon, and Yancey counties in the Franklin-Sylva and Spruce Pine mica districts.[81] (See Appendix 2).

Large prehistoric mines, such as the Silvers Mine near Bandana, North Carolina, have been described in historical documents as "being made by some ancient race of people," and judging by the excavations there, early mining operations necessitated "a series of years and a large force to have accomplished such results."[82] In an 1875 geologic study of Mitchell County, W.C. Kerr described:

> "Hundreds of old pits and connecting tunnels among the spurs and knobs and ridges of this rugged region…there remains no doubt that mining was carried on here for ages, and in a very systematic and skillful way; for among all the scores of mines recently opened, I am informed that scarcely one has turned out profitably which did not follow the old workings, and strike the ledges wrought by these ancient miners."[83]

Mines in the area are described as having "large amphitheatral cuts" or "small tunnels and shafts where the formations were soft," and are said to have contained stone tools used by the prehistoric miners as well as "immense dump heaps" of waste material.[84]

---

[79] Charles Hudson, *The Juan Pardo Expeditions: Exploration of the Carolinas and Tennessee, 1566-68.* (Washington: Smithsonian Institution Press, 1990), 161.
[80] Ferguson, 214-216.
[81] Brown, 45.
[82] Ferguson, 213.
[83] W.C. Kerr, *Report of the Geological Survey of North Carolina, Vol. 1,* Josiah Turner, Printer (Raleigh: 1875): 300.
[84] Ferguson, 213-215.

This material included scraps of unwanted material, and "cut forms" of mica.[85] Kerr's descriptions of western North Carolina mica mines is particularly important as it is the one of the few records of prehistoric mica working. Shortly after his account, modern miners destroyed the prehistoric workings as they searched for the same valued mineral as the earlier miners.

Sink Hole Mine in Mitchell County, North Carolina is one of the better-documented prehistoric mines in western North Carolina. When first recorded by North Carolina State Geologist W.C. Kerr in 1880, the once productive mica mine appeared to be no more than overgrown pits in the hillside. However, closer study revealed the remains of a prehistoric mine thirty to forty feet deep and running for a distance of 300 to 400 feet.[86]

Sink Hole Mine. Photograph by Joffre L. Coe (1936).[87]

[85] Kerr, 300-1.
[86] Margolin, 46; Holmes, 246.
[87] Margolin, 50.

Not long after the discovery of Sink Hole Mine and other prehistoric mica mines in the area, the market for mica opened wide and prehistoric mines began to be worked by modern miners.[88] This sudden commercial interest in mica destroyed any evidence of prehistoric mica mining. In many cases sadly, prehistoric mica mines were favored. They were easy to find, tended to contain quality mica, and could be easily worked from the rock matrix.

This was not a coincidence. Prehistoric miners were selective in picking the sources of sheet mica. Once exposed mica was found, miners worked with stone implements and chipped away at feldspar and schist that had been softened by the atmospheric chemistry to carefully remove the fragile material.[89] Tunnels followed the mica as bands of muscovite branched off from the primary vein, and stopped or veered off at the sight of harder rock masses of schist and quartz.[90] The sheet mica that was mined and kept appears to have been of the highest quality. As seen in the archaeological record, sheet mica deemed worthy of working and trading was large in size and light in color. Inferior mica was discarded and left behind in refuse piles near the mine site. Nineteenth century miners later salvaged this substandard material.[91]

Such high quality standards were hard to maintain with the stone tools. This limiting factor sometimes required mining to stop or branch off in search of more material in another vein when the parent rock got too difficult to work through. In Spruce Pine, Kerr stated that in many cases tunnels stretch fifty to a hundred feet before

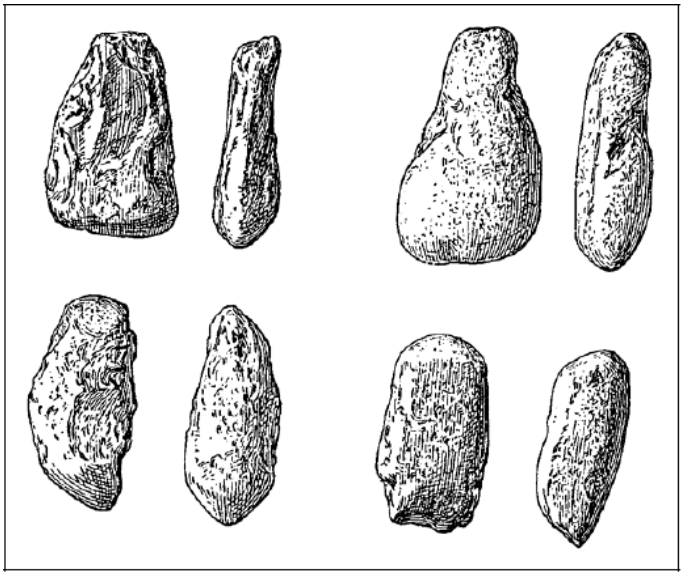
[88] Holmes, 242-3.
[89] Margolin, 47.
[90] Holmes, 245-6.
[91] Holmes, 249.

abruptly stopping when the rock proved too hard for their method of extraction.[92] Instead, prehistoric mines tend to follow the weathered rock or mica outcrops, making their mines appear as "diggings" rather than mine shafts.[93]

The scarcity of stone tools associated with prehistoric mines led Holmes to believe that "friable and easily worked" formations were commonly mined with wood and buckhorn tools.[94] However, it could just as easily be that stone tools were overlooked when mines were examined, or that they were destroyed when the mica mining business was revived. This seems to be a more plausible reason, since the country rock surrounding mica deposits require working through feldspar, quartz, gneisses, and schists. Near the surface, weathered schistose rock would be easily excavated, however prehistoric mines were reported at depths exceeding forty feet below the surface.[95] Wood or buckhorn tools would simply be inadequate. Furthermore, the tool markings found along the walls of tunnels were reported to resemble that of a "pick or chisel" stroke.[96]

---

[92] Kerr, 302.
[93] Kerr, 300.
[94] Holmes, 243-44.
[95] Holmes, 244.
[96] Kerr, 301.



Drawings of prehistoric mining implements excavated from Sink Hole Mine.[97]

Even with stone tools, sheet mica extraction requires exceptionally skilled miners. Mica is a particularly fragile mineral. Despite its resiliency to weathering, its plate structure makes the material extremely vulnerable to splitting and breaking. Mica found on sites associated with the Adena, Hopewell, and Mississippian societies show a preference to large unbroken sheets.[98]

Production Sites

After being mined, the route of mica becomes less clear. Mica "workshops," or places where sheet mica is worked or otherwise readied for trade, are not well documented or researched. Yet the information that can be gathered from such sites would greatly help the understanding of mica exchange. Was mica directly procured by

[97] W.H. Holmes, "Handbook of Aboriginal American Antiquities." *Bureau of American Ethnology*, Bulletin No. 60, (1919): Figure 115.

[98] When sampling mica districts in North Carolina, I learned the difficulty of extracting mica when I attempted to remove a four-inch by four-inch sheet of muscovite out of feldspar using a stone implement. I crushed the piece after a few minutes. I then tried to do the same with a similar piece using a metal chisel and hammer. The piece that I finally extracted was partially crushed and considerably smaller than when it had been originally while in situ, showing just how skilled prehistoric miners had to be to extract large mica sheets.

the consuming group and worked by artisans in a separate location? Was material worked on by a mining and trading group centered in the mine area and then traded after being worked? Were specific settlements built near mica mines to accommodate for this need? To understand who controlled the mica trade, this information is necessary.

In 1876, C.D. Smith recorded a mica storage site in North Carolina. He describes "several cart-loads" of buried mica "packed down with great regularity" in an area approximately one hundred feet away from a prehistoric mine.[99] His report fails to mention an exact location, yet his description is intriguing. If it was laid down with care as Smith illustrates, it is unlikely that it was mica refuse from the mine. Was mica there for safe-keeping until being worked or traded? Since the exact location of this storage area is unknown, it is impossible to study the site for small cut fragments that would suggest a production site.

According to Roy S. Dickens Jr., raw material was mined as irregular sheets and was cut into *preforms* or finished artifacts at towns nearby using worked lithic flakes.[100] One such site has been found at the Mulberry site, a Mississippian town in what is now South Carolina, where hand-sized pieces of unworked mica and cut mica disks have been found.[101]

If a site is to be considered a mica trading center, one that works and exports material, then the site should appear as a large trading center that is reaping the benefits

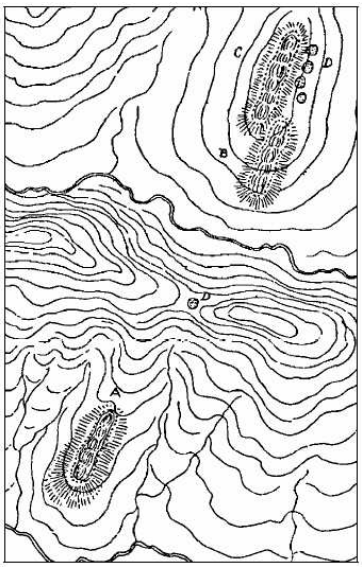
---

[99] C.D. Smith, "Ancient Mica Mines in North Carolina," *Smithsonian Institution Annual Report* (1876): 442.

[100] Roy S. Dickens Jr., *Cherokee Prehistory: The Pisgah Phase in the Appalachian Summit Region* (Knoxville: University of Tennesee Press, 1976): 143; In this case, *preforms* are incomplete forms of mica that are cut roughly to prepare for working.

[101] Coe, 238; The Mulberry Site is currently considered to be the site Cofitachequi. The town was visited by Hernando de Soto in 1540 after being led there under the impression that there was silver there. Much to his dismay, he was shown slabs of mica instead (see page 161 of Charles Hudson's *The Juan Pardo Expeditions*).

of being in control of part of a larger exchange sphere. According to Margolin, the only mica-working sites in North Carolina have been identified near the Sink Hole Mine.[102] However, at the Warren Wilson Site in Buncombe County, North Carolina, Burial 7 included fifteen small solid disks and six large disks with holes.[103] With sheet mica deposits nearby, this site may well have been a site for working mica. Mica disks identical to those found at the Warren Wilson Site were found at the Town Creek Site, and similar disks were found at a site on Hiwassee Island in Tennessee and at the McCollum Mound in South Carolina.[104] In 1875, Kerr stated that worked mica forms similar to forms found in Ohio mounds had been found at the Sink Hole Mine in Bandana, North Carolina.[105] At the very least, similar patterns suggest interaction between the groups. It is possible that a site close to a sheet mica source, such as the Warren Wilson Site, was the site where mica was worked into disks before being traded.



Sketch map of the Robinson (A) and Sink Hole (B and C) mines and their relation to mica workshops (D).[106]

[102] Margolin, 51.
[103] Dickens, 143-4.
[104] Dickens, 144.
[105] Kerr, 300.
[106] Holmes, 246.

Another possibility is that mica was being traded to consumption centers as preforms and then being cut into finished forms. At Brown's Bottom #1, a Hopewell site in central Ohio, a large piece of mica cut on all sides was exposed in a feature associated with production of goods, suggesting that mica was being worked after importation.[107] Fourteen mica fragments have been found in mounds in four mounds in Kentucky and approximately two hundred fragments were discovered by Emerson Greenman in his study of seventy mounds. According to William S. Webb and Charles E. Snow, this suggests that the Adena cut their own mica forms instead of importing them as finished products.[108] Due to its planar structure, mica breaks and splits easily. Therefore, more research needs to be done on reported "unworked" mica fragments found on sites to determine whether or not fragments are refuse from cutting mica forms.

In addition, it is possible that mica was being used both in the form of cut sheet mica and as powdered mica used as a type of body ornamentation to take advantage of its luster. This last application is nearly impossible to examine, since crushed mica would be difficult to discern in the archaeological record without possible confusion with native micaceous soils.

Sadly, many prehistoric mines and possible signs of production sites were disturbed by historical mines, and are now destroyed beyond identification. Therefore, due to the lack of qualitative evidence regarding muscovite mining in North Carolina,

---

[107] Paul J. Pacheco, Jarrod Burks, and Dee Anne Wymer, "Investigating Ohio Hopewell Settlement Patterns in Central Ohio: A Preliminary Report of Archaeology at Brown's Bottom #1 (33Ro21)," *Ohio Archaeological Council* (2005). http://www.ohioarchaeology.org.
[108] Webb and Snow, XV.

archaeologists must combine qualitative research with quantitative research in order to determine the source(s) of raw muscovite.

The Origins of Mica: A Geologic Perspective

The desire to understand prehistoric exchange in the United States has produced a vast array of archaeological research regarding raw material sourcing and exotic raw material trade. Traditionally, this work has been speculative as to the source of material and trade diffusion; however, with the recent availability of geologic and trace element analysis, research is broadened to more definitively answer questions regarding the sources of exotic raw materials found at prehistoric sites.

Western North Carolina is a region rich with mica deposits and has been long assumed by archaeologists to be the source for prehistoric sheet mica trade. Through this preliminary research, the range of muscovite elemental diversity in the southeast will be studied to facilitate future researchers determine which mica source(s) were used prehistorically. Physical and elemental traits compiled from this research will allow for further discernment of trade routes and a better assessment of the North Carolina region's control of exportation of sheet mica.

This research attempts to distinguish the characteristics of muscovite source(s) found in the western North Carolina region, as well as muscovite from mines in Alabama, Virginia, South Carolina, and New Hampshire in order to help further research to determine which source(s) were used prehistorically. It introduces the methodology of macroscopic analysis and trace elemental analysis of muscovite material, and provides a preliminary indication of the range of diversity of muscovite in the southeast. After examining potential sources of muscovite, mica was analyzed to determine regionally

specific elemental characteristics to aid future sourcing of archaeological material. This information indicates whether a specific region or mine can be isolated as the raw material source for a specific artifact, and provides a background with which mica artifacts and refuse material may be compared to areas that were involved in mica mining and trade. Muscovite characterization of the southeast leads to a better understanding of the nodes of prehistoric exchange spheres by pinpointing sites of nonlocal raw materials.

A Background in Mica Geology

Muscovite, or "isinglass," is the most common member of the Mica group of minerals which includes biotite, phlogopite and lepidolite.[109] The mica group is distinguished as "six-sided crystals with angles . . . of 60 to 120 degrees," with highly developed basal cleavage.[110] This cleavage, often considered the most perfect observed on any minerals, allows mica to be split into thin sheets.[111] Muscovite, $H_2KAl_2(SiO_4)_3$, is a hydrous aluminum and potassium silicate. Unlike other micas, muscovite is light in color and ranges from colorless, to yellowish white or brownish white.[112] The best-known muscovite in North America occurs in North Carolina, Virginia, and South Dakota in granite, pegmatite, gneiss and mica-schist bands. Crystals are often large and rough, and can measure up to several feet in diameter.[113] All muscovite has a hardness of 2 to 3, has a specific gravity of 2.8 to 3.1, is transparent to translucent, and has a pearly to vitreous luster.[114] Despite its apparent vulnerability, muscovite is remarkably stable and

---

[109] George L. English, *Getting Acquainted with Minerals* (New York: McGraw-Hill Book Company, Inc, 1934), 228.
[110] English, 228-9.
[111] Kraus, Edward H., Hunt, Walter F., and Lewis Stephen Ramsdell, *Mineralogy: An Introduction to the study of Minerals and Crystals* (New York: McGraw-Hill Book Company, 1959), 396.
[112] Kraus, Hunt, and Ramsdell, 636.
[113] English, 229.
[114] Kraus, Hunt, and Ramsdell, 398.

among silicate minerals, is the most resistant to weathering.[115] Because of this resiliency, muscovite native to the soil is difficult to distinguish when compared to material carried in by humans by way of trade or through direct procurement.

Different classes of muscovite mica allow determination of the area in which the mineral formed. *Ruled*, *ribbon*, or *A mica* is distinguished by partings seen running perpendicular to the cleavage of the mineral. *Wedge mica*, which usually occurs in "scaly, foliated, and plumose aggregates," is muscovite that forms with one end thicker than the other. [116] In certain areas, muscovite has visible inclusions, allowing for more specific sourcing of material due to its regional rarity and therefore distinct characterization. The only other difference between mica that can be seen macroscopically is color. Though it is not a viable way to source muscovite, the color of mica has been reported to show regional distribution patterns according to the country rock.[117]

Muscovite exhibits more variability geochemically. Muscovite can form in different country rocks, through different processes, and at different speeds. This broad range of variables leads to a wide array of elemental structures. All muscovite has the same basic chemical composition of major elements (Hydrogen, Potassium, Aluminum, Silica, and Oxygen), however, in the process of formation suspended trace elements are included in the mineral's structure. Depending on the country rock and the formation

---

[115] F.C. Loughnan, *Chemical Weathering of the Silicate Minerals* (New York: American Elsevier Publishing Company, Inc, 1969), 11-13.
[116] Kraus, Hunt, and Ramsdell, 397.
[117] Patricia Wood, "Petrogenesis of the Spruce Pine pegmatites, North Carolina," 1996. Master's thesis, Virginia Polytechnic Institute, 30; Frank G. Lesure, "Mica Deposits of the Blue Ridge in North Carolina," *Geological Survey Professional Paper 577* (1968): 16; Broadhurst and Hash, 1-66.

process, muscovites can incorporate a broad range of trace elements. These minor elements can be clues to the mineral's place of origin.

In the case of the North Carolina muscovite veins, each district formed separately in disparate parent rocks, making the discovery of distinguishable characteristics using X-ray fluorescence spectrometry probable. Wood's theory of systematic variation of trace elements in Spruce Pine muscovites was the basis for this study. Her examination found that color variation of muscovite in the Spruce Pine district is due to the charge transfer interaction between differing amounts of Fe^{3+} and Fe^{2+}.[118] If patterns of trace elemental differences of muscovite exist, then characterization and sourcing of mica is conceivable. But first, an understanding of muscovite formation is necessary.

Muscovites in the Spruce Pine District of North Carolina occur in pegmatites that intrude kyanite grade metamorphic rocks of the Ashe metamorphic suite and the Alligator Back formation. These pegmatites occur both in the granodiorite country rock as well as in eight granodiorite plutons.[119] Mineralogically, the plutons and pegmatites of Spruce Pine are "virtually identical" leading to the theory that the pegmatites formed during a late phase of the magma from the plutons, or that the pegmatites and plutons are the product of partial melting of the country rocks. Both theories of formation result in similar levels of major and trace elements in muscovites found in the pegmatites and plutons.[120]

Like the Spruce Pine district, Franklin-Sylva was formed during the Devonian Period. The district's country rock is primarily composed of micaceous and hornblendic

---

[118] Wood, 30; Large amounts of Fe^{3+} result in "green" muscovite, whereas red samples correspond to high amounts of Fe^{2+}.
[119] Wood, 3, 7, 10.
[120] Wood, 6.

schists and gneisses, with feldspathic gnessies interspersed. The micaceous schist and gneiss are primarily of sedimentary origin, whereas the interlaying hornblendic rocks are either sedimentary or volcanic in origin.[121]

The Shelby district stretches between the Inner Piedmont and Kings Mountain Belt, consequently varying from the Spruce Pine and Franklin-Sylva mica deposits in its origin. Pegmatites genetically associated with large granite bodies intrude into the primary rock of gneiss and schist. Mica occurs within these pegmatites and along the contact zones of granites.

Outside of North Carolina, muscovite is found throughout the Appalachian Mountain Range. Concentrations of workable sheet mica are found in New Hampshire, South Carolina, Virginia, and Alabama. Of these, only sources in Virginia are reported to be prehistorically mined.[122] Because they are all part of the same geologic formation, the Appalachian deposits have similar parent rock and therefore have similar geochemical composition. Beyond the Appalachians, sheet mica occurs in southwestern Arkansas and in South Dakota. There have been no reports of prehistoric mines in Arkansas. However, based on fall-off theory, the Woodbine Formation of the state is a more logical source of mica for the Mississippian site of Spiro than Appalachian sources.[123]

Methods

In order to explore prehistoric mica mining in the eastern United States, information was gathered regarding possible prehistoric mica mines in the region by studying historic maps, written accounts, and the locations and characteristics of

---

[121] J.C. Olson, "Mica Deposits of the Franklin-Sylva District, North Carolina," *North Carolina Department of Conservation and Development*, Bulletin No. 49, (1946): 5.
[122] Holmes, 101.
[123] Bell, 182.

prehistoric and historical muscovite mines. An understanding of the regional elemental characteristics of muscovites was then required. To begin, two of the three primary muscovite veins in North Carolina: Franklin-Sylva in Macon, Jackson and Haywood counties, and the Shelby source in Cleveland, Lincoln, and Gaston counties were sampled. Dr. Patricia Wood previously studied the third source in her 1996 study of trace elements of muscovite in the Spruce Pine district of Yancey, Mitchell and Avery counties.[124] Two samples from Buncombe County were collected to determine if distinguishing characteristics remain the same within a mica band. Wood's analyses of 53 separate Spruce Pine samples were also used as a base for regional comparison.

In case the outcome of the study resulted in the ability to pinpoint specific source sites, areas that were known as prehistoric mining sites were sampled when possible. Archaeological material that has previously been excavated from Adena, Hopewell, and Mississippian sites suggests that Native American miners and traders preferred large clear sheets of muscovite. For that reason, when possible samples were taken from areas that produced sheet muscovite larger than 15cm in length.

This study is based on research done by Wood and incorporates her work on Spruce Pine muscovites. Therefore, her analytical methodology was followed closely, which determined the way samples were prepared and analyzed. The total weight of samples from each collection site was required to be a minimum of 15 grams to ensure accurate X-Ray Fluorescent Spectrometry (XRF) analysis. At every sample collection point, the location was recorded using a GPS unit, the collection area was photographed, a number was assigned to the sample and the parent rock was recorded. This process was continued beyond the western North Carolina region to provide outliers in the project that

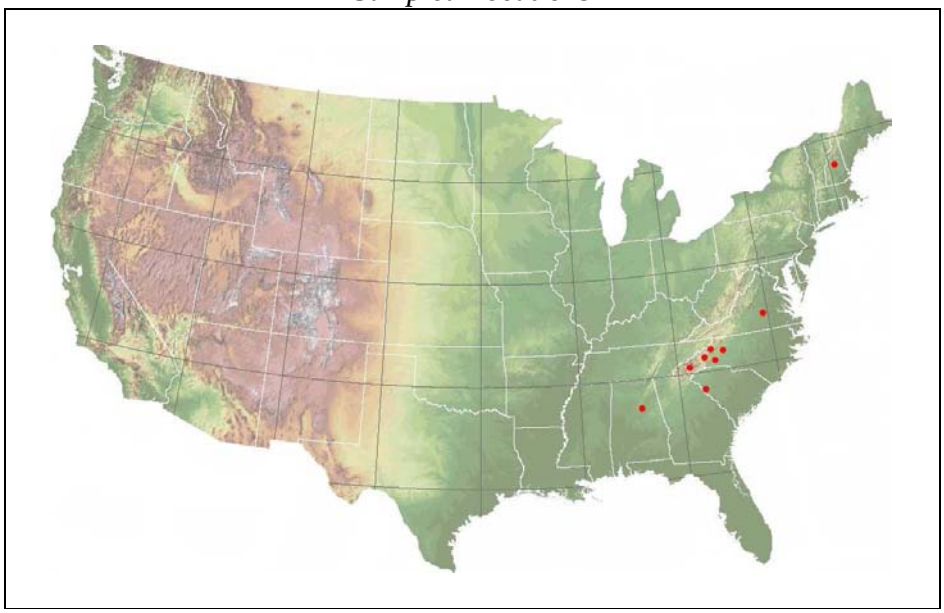
[124] Wood.

will help to determine the amount of variation within each muscovite vein. A greater variation within a region rather than between regions would suggest that no distinctive geographic characteristics are visible using XRF spectrometry.

Sheep Mountain Mica Mine, Franklin-Sylva District, North Carolina. (Photo taken by the author)

Samples from outside of North Carolina were obtained through the state geology survey offices of Alabama, New Hampshire, Virginia, and South Carolina. Samples of archaeological material from surface collections of the Berry Site (31Bk22) in Burke County, North Carolina were incorporated into analysis as a preliminary assessment of the possibility for production source trace elemental analysis and archaeological material to be compared to each other. During analysis, one sample from the Berry site (NCBK1) was lost when a bolt sheared off in the grinding apparatus, sending the grinding container flying. VAAm1, was duplicated to determine the accuracy of analysis by comparing the results of the identical material.

Sampled Locations



Analyzed Samples				
ID	State	County	Collection Site	Lat/Long When Available
ALCo1	AL	Coosa	Pond Mica Mine	N32°89 W86°25
NHGr1	NH	Grafton	Old Palermo Mica Mine	N43°45'03" W71°53' 24"
VAAm1	VA	Amelia	Morefield Mine	near town of Winterham N37°22'5" W 77°55'51"
NCBn1	NC	Buncombe	Walker Creek River Site	N35°45.395' W82°21.316'
NCBn2	NC	Buncombe	Walker Creek Road Site	N35°45.212' W82°20.580'
NCCl1	NC	Cleveland	Yates Brooks Farm	N35°20'37" W71 °41'17.7"
NCJk1	NC	Jackson	Old Sheep Mountain Mica Mine	N35°20'22" W83°6'13"
SCAn1	SC	Anderson	Galliard Mine	N34°21'36" W82°47'59"
NCBk1*	NC	Burke	31BK22 Beck Surface Survey	N35°49'27" W81°44'2"
NCBk2	NC	Burke	31Bk22 2002 Surface Survey	N35°49'27" W81° 44'2"

*sample lost during X-ray fluorescence analysis

Each sample was analyzed both macroscopically and microscopically based on geologic methods. Muscovite samples were washed, photographed with a scale, and then studied for distinct variations in color and inclusions.

After macroscopic analysis, samples were studied using an X-Ray Fluorescent Spectrometer. XRF spectrometry provides trace elemental results that are uniquely characteristic of each samples' geochemical composition. Electrons in the inner shells of

the atom are irradiated with a beam of X-rays. This beam excites the electrons, causing them to jump up to a higher shell and then return to their original position. The energy emitted in this reaction is measured and compared to the reaction for specific elements. Measurements taken show not only the presence of the element, but the level in parts per million (ppm) in the sample.[125] Dr. Doug Dvoracek of the Center for Applied Isotope Studies of the University of Georgia completed the XRF analysis. A Phillips (Panalytical) 2400 series wavelength-dispersive XRF spectrometer with a total power of 2.4 kW and a 170 position robotic multisampler was used. Wood's work was completed on a Philips 1400 series machine with major elements analyzed at 40kV and 60mA and trace elements at 80kV and 30mA.[126] Samples were cleaned, crushed, sieved, and pressed into pellets before analysis. Wavelength-dispersive XRF analysis was chosen instead of energy-dispersive XRF because muscovite's planar structure could lead to polar biases when samples are not sufficiently crushed. Despite the differences in XRF machine models, Wood's study was carefully reconstructed in order to accurately correlate between studies. After analysis of the samples, the results were combined to create a series of Trilinear Diagrams to compare multiple sets of three elemental variables. (See Appendix 3).

Data

The color of mica samples was determined using the Munsell Rock Color Chart commissioned for the Geological Society of America Rock-Color Chart. Muscovite color is fairly homogenous, however, slight color differences in mica that have led to terms such as "green," "brown," "ruby" and "rum." These color variations correspond to

[125] Renfrew and Bahn, 368.
[126] Wood, 28.

chemical disparities. According to Wood, color variation occurs systematically throughout pegmatites surrounding plutons in the Spruce Pine district.[127] However, this information is useless without first being able to isolate the district the mica originated from.

Macroscopic Analysis			
Sample ID	**Color*		*Inclusions*
	Munsell	Description	
ALCo1	10YR4/2	Dark Yellowish Brown	no
NHGr1	5Y5/2	Light Olive Gray	no
VAAm1	5Y6/1	Light Olive Gray (appears as "rum mica")	yes
NCBn1	10YR4/2	Dark Yellowish Brown	no
NCBn2	10YR4/2	Dark Yellowish Brown	no
NCCl1	10YR5/4	Moderate Yellowish Brown	no
NCJk1	5Y5/2	Light Olive Gray ("green mica")	no
SCAn1	5Y5/2	Light Olive Gray	yes
NCBk1	5Y5/2	Light Olive Gray	no
NCBk2	5Y5/2	Light Olive Gray	no

**Sample color based off of the Geological Society of America Rock-Color Chart*

Inclusions were visible in two samples collected for this study: Virginia (VAAm1) and South Carolina (SCAn1). This information was recorded in case the inclusions caused the samples to appear as outliers in trace elemental analysis. Moreover, if mica artifacts or material with inclusions are found on archaeology sites it would be helpful to have a record of what muscovite deposits include this characteristic.

Trace elemental levels were combined in a series of five Trilinear Diagrams to compare multiple sets of three elemental variables. (See Appendix 3). Six of Wood's Spruce Pine samples were included in this study to provide a base for regional comparison. Patterns and outliers according to origin were of particular interest.

[127] Wood, 30.

However, the samples analyzed and compared showed no regional geochemical patterns. In the diagram comparing K, Rb, and Sr, no outliers or distinctive characteristics were present. In the Y, Zn, and Cu diagram, all samples were grouped together, representing similar levels of each element. In the diagram comparing levels of Ce, Pb, and Zr for each sample, muscovites showed more diversity. This held true for the Ni, Na, Cr diagram and the V, Nb, Ba diagram. However, this diversity did not follow a regional pattern. Spruce Pine samples did not track each other. Instead they showed just as wide a geochemical range as the other samples. The same occurred for the two samples taken from Buncombe County. Only the Virginia samples tracked each other throughout the series of Trilinear Diagrams. Since they were duplicates, this is to be expected. The remainder of the tested samples provided no evidence for regional geochemical similarity. This suggests that distinctive trace elemental characteristics cannot be seen through XRF analysis and therefore XRF cannot be used to determine specific mining locations for muscovite. However, all samples in this study were from the Appalachian and Piedmont regions. It is possible that X-ray fluorescence spectrometry could show distinctive regional characteristics between samples from this study and muscovites from Arkansas or the Black Hills in South Dakota.

The Future of Sourcing Muscovite

Sourcing muscovite requires samples to exhibit distinct characteristics according to its origin. The results of this study showed no regional patterns in trace elemental composition. However, this preliminary study was limited by time and money to a small amount of samples in a narrow geographic range. Access to the technology required for trace elemental analysis, as well as the cost of using the equipment, limited the number of

samples taken from each source. This maximized the margin of error in the results. In future studies, more samples from each mica district need to be collected and analyzed to determine regional geochemical patterns. Patricia Wood's study of Spruce Pine is an example of this concentrated approach. In addition, the narrow geographic range of this study only provides a basic understanding of the differences in trace elemental levels of the Appalachian region. A broader study is necessary to determine whether mica deposits associated with the Appalachian Mountains differ from muscovites outside of the area. In particular, samples should be taken from southwestern Arkansas and from South Dakota. Southwestern Arkansas muscovite sampling is needed, as it is a viable prehistoric source of sheet mica for sites in the vicinity such as Spiro, and Black Hills muscovites are needed as it is a probable source for Hopewellian artifacts and material.

Reassessment of possible analysis methodology is also required. XRF spectrometry is currently the most accepted approach to determine trace elements in geologic samples, but wavelength-dispersive XRF analysis requires a minimum of fifteen grams per single sample. If multiple pieces are used for archaeological material to reach this minimum weight, there is a possibility that the mica may be from separate source locations, thereby falsifying the results. Energy-dispersive XRF analysis (ED XRF) could possibly be used, but research needs to be done to determine whether the planar structure of muscovite creates polar biases. If no biases are caused, ED XRF would be a preferred analytical method as it does not require samples to be crushed. This would allow archaeological artifacts to be analyzed.

Conclusion

In archaeology, social and political complexity has often been directly linked to exchange systems involving the long-distance trade of exotics. To better understand a prehistoric society such as the Hopewell, a basic understanding of the movement of mica from mine site to point of consumption is necessary. While ethnographic research and macroscopic analysis is helpful in doing this, geologic knowledge of muscovite within the exchange sphere and geochemical analysis is required to understand what groups were in control of mica and what groups were importing it. This study is a preliminary attempt to analysis muscovite characteristics using XRF Spectrometry with the intent of locating mica production sources. While this initial analysis shows no distinctive regional characteristics of the material, more work is necessary before a conclusion is reached on whether geochemical analysis is a viable method of sourcing muscovite.

Appendices

Appendix 1

Non-Native Mica Artifacts from Selected Sites

State	*Mica Material*	*Cut Material*	*Muscovite*	*Biotite*	*Adena*	*Hopewell*	*Mississippian*	*Burial*	*Mound*	*Elsewhere*
OH	?*	?*	x		x			?*	x	
OH	x		x		x			?*	x	
OH		x	x		x			x	x	
GA	x		x			x		x	x	
OH	x		x			x				x
OH		x	x			x		x	x	
OH		x	x			x				x
OH		x	x			x		x	x	
OH		x	x			x		x	x	
OH		x	x			x		x	x	
OH		x	x			x		x	x	
OH		x	x			x		x	x	
OH	x	x	x			x		x	x	
OH		x	x			x		x	x	
OH		x	x			x		x	x	
IN	?*	?*	x			x		x	x	
OH		x	x			x		x	x	
OH		x	x			x		x	x	
IL	x	x	x				x	x	x	
IL	x	x	x				x		x	
IL	x		x				x			x
IL	x		x				x			
IL	x		x				x			
AR	x		x	x			x	?*	?*	?*

*Site reports do not include this information

Appendix 2

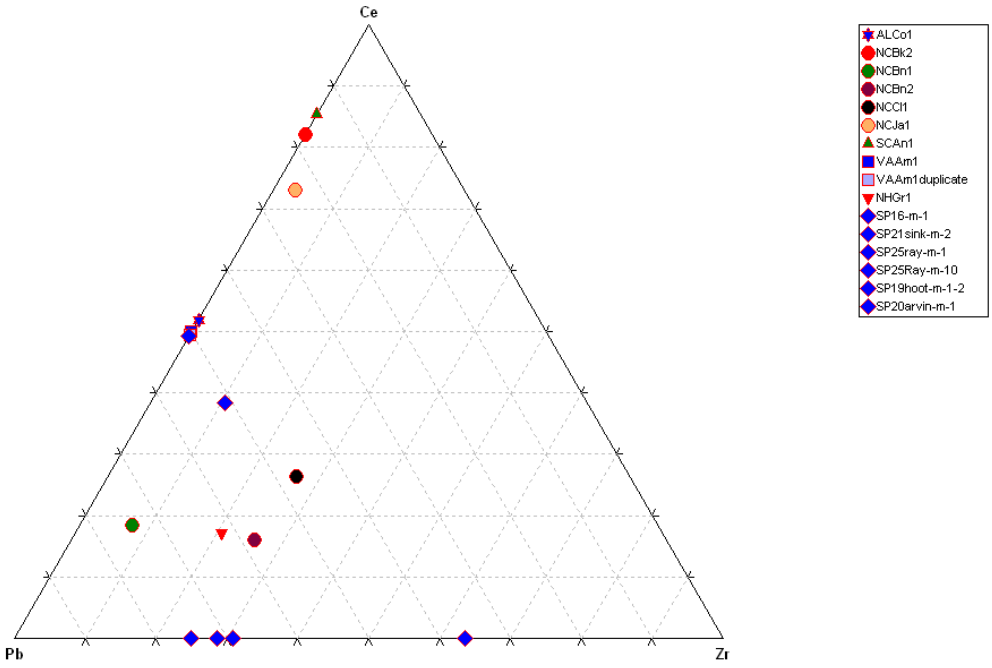
Southern Appalachian Prehistoric Mica Mines [128]

State	*County*	*Name*	*Description*
Alabama	Clay		
Alabama	Randolph	The Curley Mine	1.75 miles north by east of Pinetucky, AL Remnants of ancient pits and dumps
Alabama	Randolph	Miller Mines	2.5 miles north by west of Pinetuckey, AL 75 ft. long, 40 feet wide, and 10 feet deep
Alabama	Randolph	Mine No.5 of the Great Southern Mica Company	2 miles north 35°east of Pinetuckey, AL 60 feet across and 5-12 feet deep
Alabama	Talladega		
Georgia	Gordon		Whitepath, GA
North Carolina	Ashe	Little Phoenix Mine	2.25 miles north 60°east of Jefferson pegmatite worked along the quartz outcrop
North Carolina	Ashe	Walnut Knob Mine	2 miles north 40°west of Elk Crossroads and .75 miles south of Black Mountain
North Carolina	Buncombe	W.H. Burnett Mine/Conally Mine	4 miles north of Black Mountain east of theSwannanoa River North Fork
North Carolina	Cherokee		near Colnard's Creek 5 miles above Murphy, NC
North Carolina	Jackson	Ocher Hill Mine	1.75 miles east of Beta on Ocher Creek
North Carolina	Macon		5 miles below Franklin, NC on Iola Creek
North Carolina	Macon	Smith/Baird Mine	a mile west of Franklin, NC
North Carolina	Macon	Winecoff Mine/Old Jacobs Mine	2.5 miles northwest of Franklin, NC
North Carolina	Macon	N.L. Barnard Mines	3.25 miles north, 60°west of Franklin, NC
North Carolina	Mitchell	Clarissa Mine	2.5 miles east of Bakersville, NC
North Carolina	Mitchell	Buchannan Mine	.33 miles north 25°west of Ledger, NC stone implements found in pits
North Carolina	Mitchell	Sink Hole Mine	extensive tunnels and shafts following the soft parent rock near Bandana, NC
North Carolina	Mitchell		Little Yellow Mountain
North Carolina	Yancey	Hensley Mine	Pigpen Creek, near Green Mountain, NC
North Carolina	Yancey		Hurricane Mountain, near Burnsville, NC on a small headwater of Bowlen's Creek
North Carolina	Yancey		1.5 miles east of Burnsville
North Carolina	Yancey		1 mile north of Crabtree Creek 5 miles northeast of Burnsville, NC

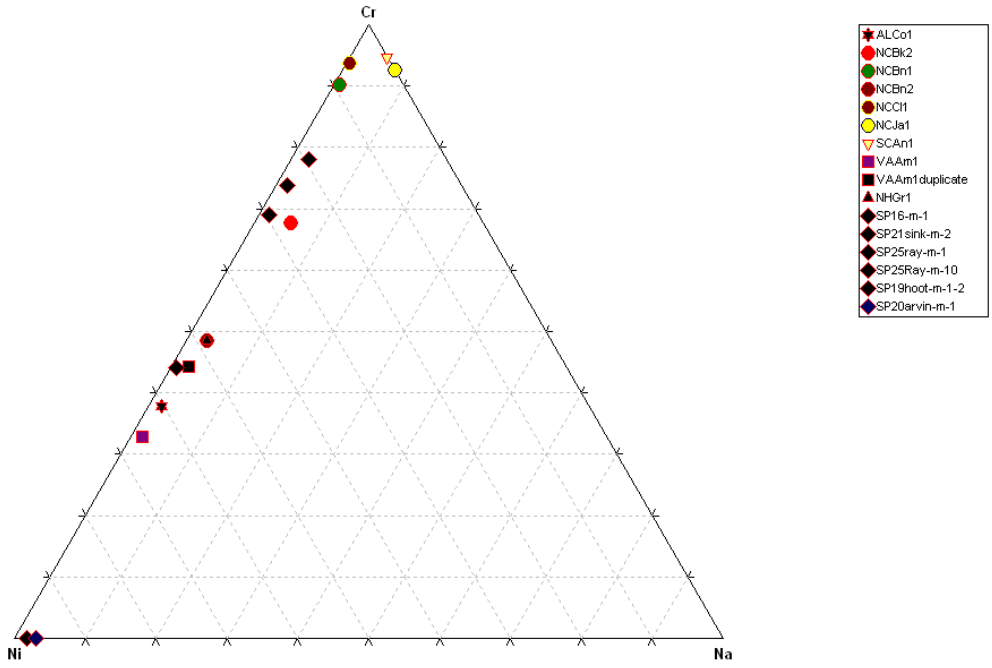
[128] Leland G. Ferguson, "Prehistoric Mica Mines in the Southern Appalachians," *South Carolina Antiquities 6*, no. 2 (1974): 211-217.

Appendix 3
Trilinear Diagrams

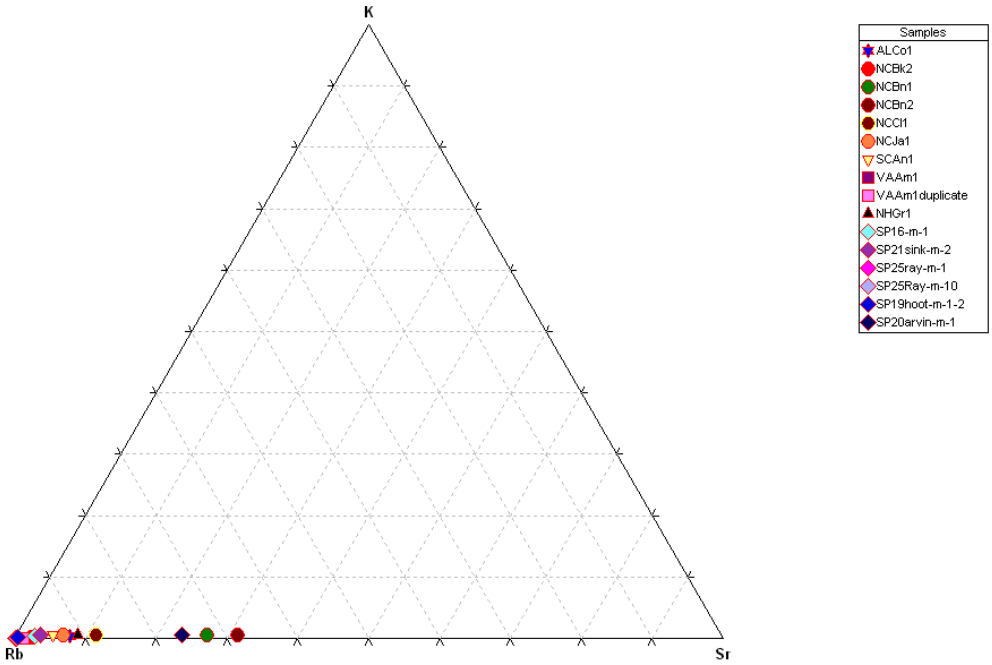
Ce/Pb/Zr



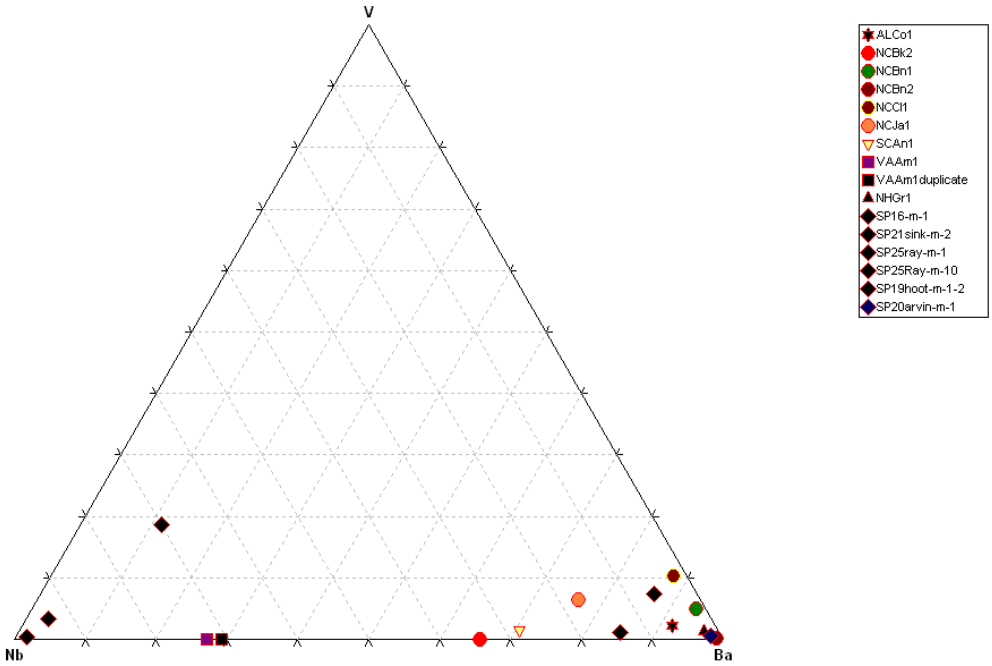
Cr/Ni/Na



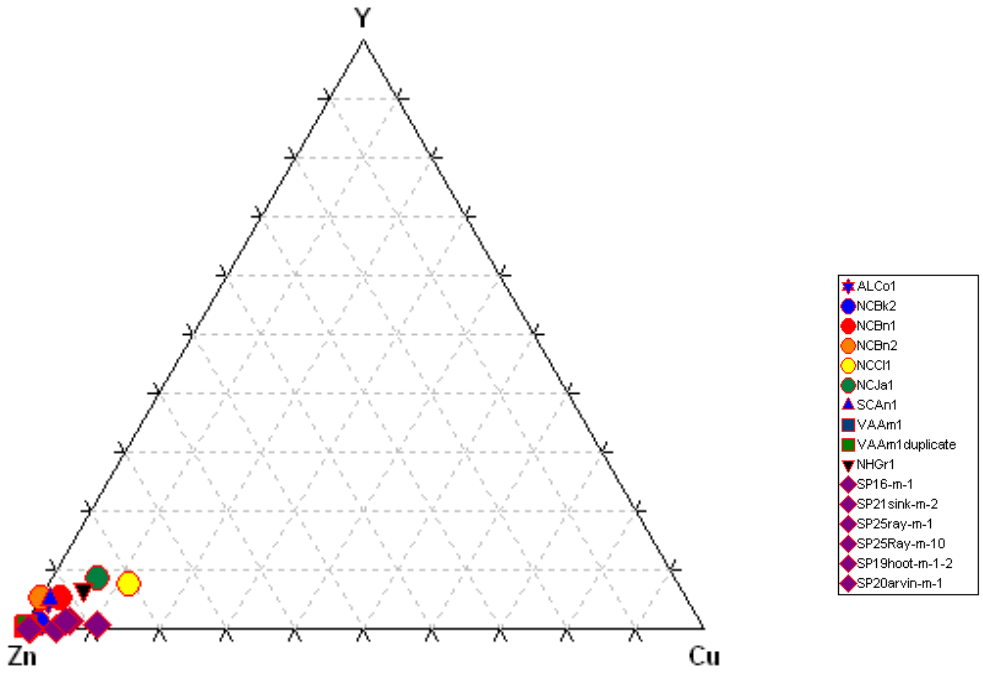
K/Rb/Sr


K
Rb
Sr
Samples
ALCo1
NCBk2
NCBn1
NCBn2
NCCl1
NCJa1
SCAn1
VAAm1
VAAm1duplicate
NHGr1
SP16-m-1
SP21sink-m-2
SP25ray-m-1
SP25Ray-m-10
SP19hoot-m-1-2
SP20arvin-m-1

V/Nb/Ba

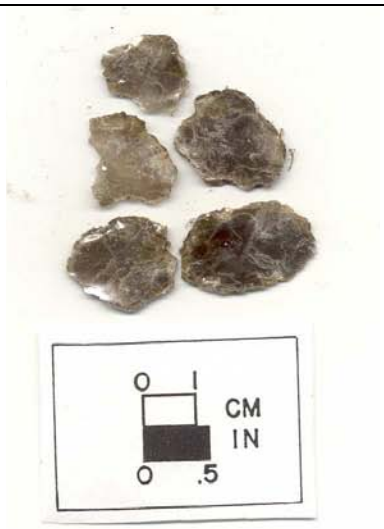
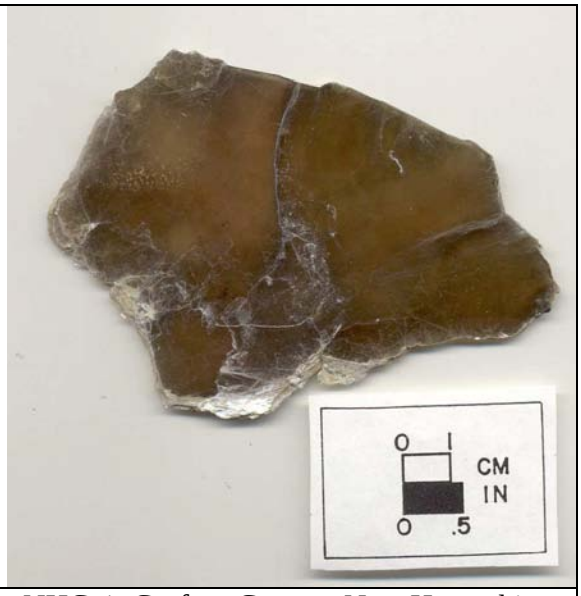

V
Nb
Ba
ALCo1
NCBk2
NCBn1
NCBn2
NCCl1
NCJa1
SCAn1
VAAm1
VAAm1duplicate
NHGr1
SP16-m-1
SP21sink-m-2
SP25ray-m-1
SP25Ray-m-10
SP19hoot-m-1-2
SP20arvin-m-1

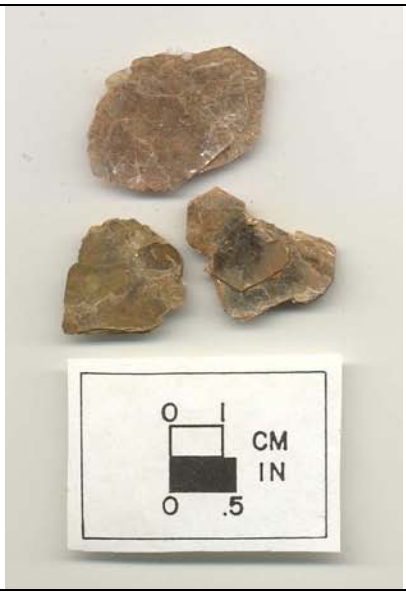
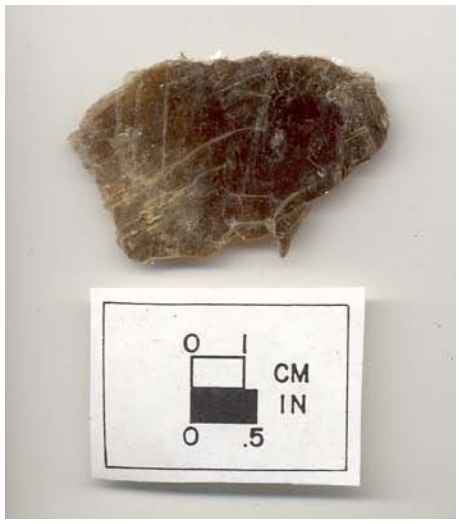
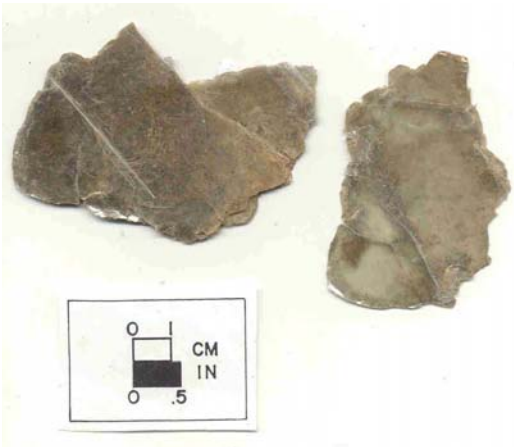
Y/Zn/Cu

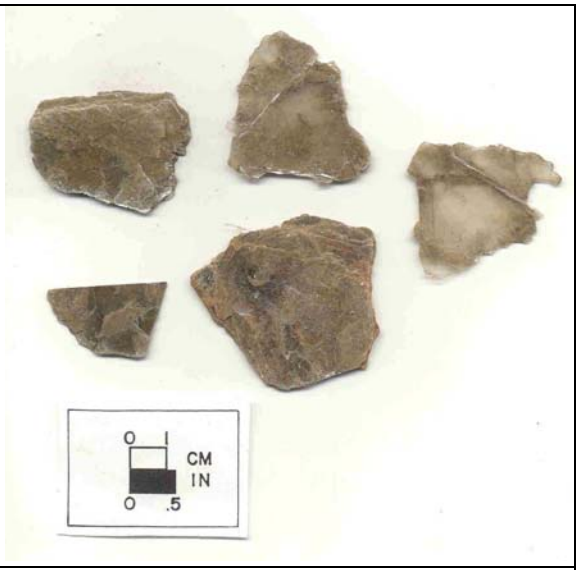

Y
Zn
Cu
ALCo1
NCBk2
NCBn1
NCBn2
NCCl1
NCJa1
SCAn1
VAAm1
VAAm1 duplicate
NHGr1
SP16-m-1
SP21sink-m-2
SP25ray-m-1
SP25Ray-m-10
SP19hoot-m-1-2
SP20arvin-m-1

Appendix 4

Analyzed Samples

	
NCBk1 Buncombe County, North Carolina	NHGr1, Grafton County, New Hampshire
NCBk2 Buncombe County, North Carolina	ALCo1, Coosa County, Alabama

	
NCCl1, Cleveland County, North Carolina	VAAm1, Amelia County, Virginia *Sample Duplicated*
	
SCAn1, Anderson County, South Carolina	NCBk2, Berry Site (31Bk22) 2002 Surface Survey, Burke County, North Carolina

	
NCJa1, Jackson County, North Carolina	NCBk1, Berry Site (31Bk22) Beck Survey, Burke County, North Carolina *Sample Lost*

Appendix 5

XRF results

Sample	ALCo1	NCBK2	NCBN1	NCBN2	NCCl1	NCJa1	SCAn1	VAAm1	VAAm1 duplicate	NHGr1
SiO2	46.2	46.12	47.53	52.54	45.9	46.68	46.05	46.08	46.19	49.29
Al2O3	31.89	35.33	35.83	30.48	34.44	34.25	32.4	29.63	29.65	30.36
Fe2O3	5.26	2.01	2	2.14	2.34	2.88	5.34	7.02	7.01	4.25
FeO	0	0	0	0	0	0	0	0	0	0
MgO	1.46	0.87	1.26	1.06	1.15	1.26	1.17	0.32	0.31	1.25
CaO	0	0.03	0.01	0.06	0.02	0.02	0	0	0	0.06
Na2O	0.48	0.74	0.8	0.61	0.53	0.78	0.54	0.5	0.52	0.56
K2O	10.83	10.45	10.62	9.22	10.7	10.28	10.79	10.48	10.48	9.94
TiO2	0.41	0.19	0.61	0.42	0.76	0.26	0.47	0.25	0.25	0.39
MnO	0.04	0.02	0.01	0.01	0.02	0.01	0.04	0.49	0.5	0.03
CalcTotal	96.57	95.77	98.67	96.55	95.86	96.43	96.8	94.77	94.91	96.13
Mineral formulae based on 22 Oxygens										
OxNum	22	22	22	22	22	22	22	22	22	22
Si	6.163	6.113	6.114	6.793	6.099	6.157	6.129	6.3	6.305	6.514
Al	5.014	5.519	5.432	4.645	5.394	5.325	5.082	4.775	4.77	4.729
Fe3	0.528	0.2	0.194	0.208	0.234	0.286	0.535	0.722	0.72	0.423
Mg	0.29	0.172	0.242	0.204	0.228	0.248	0.232	0.065	0.063	0.246
Ca	0	0.004	0.001	0.008	0.003	0.003	0	0	0	0.008
Na	0.124	0.19	0.2	0.153	0.137	0.199	0.139	0.133	0.138	0.143
K	1.843	1.767	1.743	1.521	1.814	1.73	1.832	1.828	1.825	1.676
Ti	0.041	0.019	0.059	0.041	0.076	0.026	0.047	0.026	0.026	0.039
Mn	0.004	0.003	0.002	0.001	0.002	0.001	0.005	0.057	0.057	0.003
Total Cat	14.008	13.987	13.986	13.576	13.986	13.976	14.001	13.906	13.905	13.781
Trace element Abundances (ppm)										
V	27	-1	120	5	161	51	7	-6	-2	32
Cr	<5	<5	25	<5	40	<5	<5	<5	<5	<5
Ni	4	1	<5	<5	<5	0	0	5	3	<5
Cu	<2	2	<2	0	6	3	<2	<2	4	4
Zn	61	112	34	71	42	39	58	1380	1383	65
Rb	377	631	213	179	339	326	368	2988	2994	305
Sr	31	15	79	82	43	23	20	39	39	29
Y	3	1	2	4	4	4	3	4	7	5
Zr	<1	<1	1	4	9	2	<1	<1	<1	3
Nb	78	88	33	23	28	137	128	289	291	48
Ba	1160	168	2258	2657	1371	604	322	108	120	2297
Hf	6	6	6	7	6	6	6	6	6	6
Th	44	75	24	20	39	38	43	361	362	35
Ce	27	46	<5	<5	9	46	47	47	45	<5
Pb	25	10	10	9	16	15	8	47	46	9

Appendix 6

X-Ray Fluorescence Spectrometry Details

XRF Spectrometer Channels							
Type	Line	X-tal	Collimator	Detector	Tube filter	kV	mA
Gonio	KA	PX1	700 µm	Flow	None	24	100
Gonio	KA	PX1	700 µm	Flow	None	24	100
Gonio	KA	PE 002	700 µm	Flow	None	24	100
Gonio	KA	PE 002	700 µm	Flow	None	24	100
Gonio	KA	Ge 111	700 µm	Flow	None	24	100
Gonio	KA	LiF 200	150 µm	Flow	None	25	96
Gonio	KA	LiF 200	150 µm	Flow	None	30	80
Gonio	KA	LiF 200	150 µm	Flow	None	40	60
Gonio	KA	LiF 200	150 µm	Flow	None	60	40
Gonio	KA	LiF 200	150 µm	Flow	None	60	40

References

Bell, Robert E. "Trade Materials at Spiro Mound as Indicated by Artifacts." *American Antiquity 12*, no. 3 (1947): 181-184.

Bishop, Ronald L. and Veletta Canouts. "Archaeometry" in *The Development of Southeastern Archaeology* (New York: McGraw-Hill Book Company, Inc, 1934), 160-183.

Brose, David S. "The Everett Knoll: A Late Hopewellian Site in Northeastern Ohio." *The Ohio Journal of Science* (1974): 36-74.

Broadhurst, Sam D. and Lewis J. Hash. "The Scrap Mica Resources of North Carolina." *North Carolina Department of Conservation and Development*, Bulletin No. 66 (1953): 1-66.

Brown, James A. *The Spiro Ceremonial Center: The Archaeology of Arkansas Valley Caddoan in Eastern Oklahoma.* (Ann Arbor: University of Michigan, 1996).

Brown, John L. and Charles I. Rich. "High-Resolution Electron Microscopy of Muscovite." *Science*, New Series, 161, No. 3846, (1968): 1135-1137.

Chapman, Jefferson and Bennie C. Keel, "Candy Creek-Connestee Components in Eastern Tennessee and Western North Carolina and Their Relationship with Adena-Hopewell," in *Hopewell Archaeology: The Chillicothe Conference*, ed. David S. Brose and N'omi Greber (Kent, Ohio: Kent State University Press, 1979), 157-61.

Coe, Joffre Lanning. *Town Creek Indian Mound: A Native American Legacy* (Chapel Hill: The University of North Carolina Press, 1995).

Dalton, George. "Aboriginal Economies in Stateless Societies" in *Exchange Systems in Prehistory*, ed. T.K. Earle and J.E. Ericson (New York: Academic Press, 1977), 191-212.

DeBoer, Warren R. "Little Bighorn on the Scioto: The Rocky Mountain Connection to Ohio Hopewell." *American Antiquity 69*, no. 1 (2004): 85-107.

Dickens Jr., Roy S. *Cherokee Prehistory: The Pisgah Phase in the Appalachian Summit Region* (Knoxville: University of Tennesee Press, 1976).

Elemental Analysis at the Department of Earth Sciences Boston University. *Inductively Coupled Plasma Mass Spectrometer (ICP-MS)*. Boston. http://www.bu.edu/es/Louise/ICP_MS.htm.

English, George L. *Getting Acquainted with Minerals* (New York: McGraw-Hill Book Company, Inc, 1934).

Feinman, Gary M., "The Emergence of Inequality: A Focus on Strategies and Processes," in *Foundations of Social Inequality,* ed. T.D. Price and G.M. Feinman, (New York: Plenum Press, 1995), 259-279.

Ferguson, Leland G. "Prehistoric Mica Mines in the Southern Appalachians." *South Carolina Antiquities 6,* no. 2 (1974): 211-217.

Goad, Sharon I. "Middle Woodland Exchange in the Prehistoric Southeastern United States," in *Hopewell Archaeology: The Chillicothe Conference,* ed. David S. Brose and N'omi Greber, (Kent, Ohio: The Kent State University Press, 1979), 239-246.

Griffin, James B. "Adena Pottery." *American Antiquity 7,* no. 4 (1942): 344-358.

Holmes, W.H. "Handbook of Aboriginal American Antiquities." *Bureau of American Ethnology,* Bulletin No. 60 (1919): 1-387.

Hudson, Charles. *The Juan Pardo Expeditions: Exploration of the Carolinas and Tennessee, 1566-68.* (Washington: Smithsonian Institution Press, 1990).

Hudson, Charles. *The Southeastern Indians*. (University of Tennessee Press, 1976).

Jacquot, Richard James Jr. *Rock, Gem, and Minieral Collecting Sites in Western North Carolina.* (Alexander, North Carolina: Land of the Sky Press, 2003).

Kellar, James H., A.R. Kelly and Edward V. McMichael. "The Mandeville Site in Southwest Georgia." *American Antiquity 27,* no.3 (1962); 336-355.

Kercher, Robert A. "Notes on the Adena Aspect." *American Antiquity 15,* no. 1 (1949): 61-63.

Kerr, W.C. *Report of the Geological Survey of North Carolina, Vol. 1.* Josiah Turner, Printer (Raleigh: 1875).

Knight, Vernon James Jr. "Characterizing Elite Midden Deposits at Moundville." *American Antiquity 69,* no. 2 (2004): 304-321.

Kozuch, Laura. "Olivella Beads from Spiro and the Plains." *American Antiquity 67,* no. 4 (2002): 697-709.

Kraus, Edward H., Hunt, Walter F., and Lewis Stephen Ramsdell. *Mineralogy: An Introduction to the study of Minerals and Crystals* (New York: McGraw-Hill Book Company, 1959).

Legacy Research Associates, Incorporated. "Heritage Resources Survey, Wet Face Project, Nantahala Ranger District, Nantahala National Forest, Compartments 88, 89, 90,

91, 92, 93, and 94 in Jackson County, North Carolina." Draft Report. (Prepared for the USDA Forest Service by Legacy Research Associates, Inc.: Durham, North Carolina, 2008).

Lesure, Frank G. "Mica Deposits of the Blue Ridge in North Carolina." *Geological Survey Professional Paper 577* (1968).

Loughnan, F.C. *Chemical Weathering of the Silicate Minerals* (New York: American Elsevier Publishing Company, Inc, 1969).

Malinowski, Bronislaw. *Argonauts of the Western Pacific: An Account of Native Enterprise and Adventure in the Archipelagoes of Melanesian New Guinea.* (New York: E.P. Dutton & Co., 1922).

Margolin, Peter R. "The Sink Hole at Bandana: An Historic Blue Ridge Mica Mine Reveals Its Past." *North Carolina Archaeology 49I,* (2000): 43-56.

Mason, Ronald J. "Hopewell, Middle Woodland, and the Laurel Culture: A Problem in Archaeological Classification." *American Anthropologist, New Series 72,* no.4 (1970): 802-815.

Mills, William C. "Exploration of the Mound City Group, Ross County, Ohio." *American Anthropologist, New Series 24,* no. 4 (1922), 397-431.

Milner, George R. "Social and Temporal Implications of Variation among American Bottom Mississippian Cemeteries." *American Antiquity 49,* no. 3 (1984): 468-488.

Morris, Ben J. "An Archaeological Survey of Randolph County, Indiana." *Archaeological Reports*, no. 7, ed. B.K. Swartz Jr. (Muncie, Indiana: Ball State University, 1970).

Ohio Historical Society. *Virtual First Ohioans.* http://ohsweb.ohiohistory.org/gallery2/main.php?g2_itemId=279&g2_page=3.

Olson, J.C. "Economic Geology of the Spruce Pine Pegmatite District, North Carolina." *North Carolina Department of Conservation and Development,* Bulletin No. 43, (1944): 1-67.

Olson, J.C. "Mica Deposits of the Franklin-Sylva District, North Carolina." *North Carolina Department of Conservation and Development,* Bulletin No. 49, (1946): 1-56.

Pacheco, Paul J., Jarrod Burks, and Dee Anne Wymer, "Investigating Ohio Hopewell Settlement Patterns in Central Ohio: A Preliminary Report of Archaeology at Brown's Bottom #1 (33Ro21)." *Ohio Archaeological Council* (2005). http://www.ohioarchaeology.org.

Pauketat, Timothy R. *The Ascent of Chiefs: Cahokia and Mississippian Politics in Native North America.* (Tuscaloosa, AL: University of Alabama Press, 1994).

Pauketat, Timothy and Thomas Emerson, *Cahokia: Domination and Ideology in the Mississippian World.* (Lincoln, NE: University of Nebraska Press, 1997).

Renfrew, C. and Paul Bahn. *Archaeology: Theories Methods and Practice.* (New York: Thames & Hudson Inc, 2000).

Smith, C.D. "Ancient Mica Mines in North Carolina." *Smithsonian Institution Annual Report*, (1876): 441-443.

Stoltman, James B. and Richard E. Hughes. "Obsidian in Early Woodland Contexts in the Upper Mississippi Valley." *American Antiquity 69,* no. 4 (2004): 751-759.

Sunderhaus, Ted S. "The Smith Site: A Small Hopewell Site Overlooking the Stubbs Earthworks," *Ohio Archaeological Council* (2001). http://www.ohioarchaeology.org.

Trubitt, Mary Beth D. "Mound Building and Prestige Goods Exchange: Changing Strategies in the Cahokia Chiefdom." *American Antiquity 65,* no. 4 (2000): 669-690.

Walthall, John A. *Prehistoric Indians of the Southeast: Archaeology of Alabama and the Middle South* (Tuscaloosa, Ala.: University of Alabama Press, 1980).

Waring Jr., A.J. "Hopewellian Elements in Northern Georgia." *American Antiquity 11,* no. 2 (1945): 119-120.

Webb, William S. and Charles E. Snow. *The Adena People.* (University of Tennessee Press, 1974).

Wood, Patricia. "Petrogenesis of the Spruce Pine pegmatites, North Carolina." 1996. Master's thesis, Virginia Polytechnic Institute.

Woodward, Susan L. and Jerry N. McDonald. *Indian Mounds of the Middle Ohio Valley: A Guide to Adena and Ohio Hopewell Sites.* (Newark, Ohio: The McDonald & Woodward Publishing Company, 1986).