A comparison of temper characteristics between Virgin Anasazi black-on-gray bowl rim sherds and plain gray jar rim sherds from Yama-2 and Yama-3

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A COMPARISON OF TEMPER CHARACTERISTICS BETWEEN

VIRGIN ANASAZI BLACK-ON-GRAY BOWL RIM SHERDS

AND PLAIN GRAY JAR RIM SHERDS

FROM YAMA-2 AND YAMA-3

by

Laureen M. Perry

Bachelor of Arts
San Jose State University, California
1983

A thesis submitted in partial fulfillment
of the requirements for the degree of

Master of Arts

in

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Department of Anthropology and Ethnic Studies
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Laureen M. Perry

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ABSTRACT

A Comparison of Temper Characteristics Between
Virgin Anasazi Black-on-gray Bowl Rim Sherds
and Plain Gray Jar Rim Sherds
from Yama-2 and Yama-3

by

Laureen M. Perry

Dr. Margaret Lyneis, Examination Committee Chair
Professor of Anthropology
University of Nevada, Las Vegas

Comparative analyses of Virgin Anasazi black-on-gray
bowl and plain gray jar rim sherds from the sites of Yama-
2 and Yama-3 show weak associations between those vessel
forms and each of the following temper characteristics:
temper sorting; temper percentage; temper angularity; and
temper size. Black-on-gray bowl rim sherds mostly contain
quartz and olivine temper and plain gray jar rim sherds
contain more mixed sand, sherd and quartz/feldspar temper.
Dates of A.D.1050-1100 (mid-Pueblo II) with mixing from
earlier periods are suggested for Yama-2 and Yama-3 with
evidence of usage of the sites for habitation and storage.

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CHAPTER 1

INTRODUCTION

Pottery plays a major role in the study of prehistoric archaeology. Clay, temper and water combined and fired produces artifacts that last a very long time. As archaeological methodologies have developed through the years, studies of pottery have also developed providing valuable information for the studies of prehistoric cultures. Ceramic artifacts are mainly thought to provide what Orton, Tyler and Guilford call the "big three": dating evidence, distributional evidence, and evidence of function and/or status (1993:23). Dating evidence is of major importance as critical time periods are often separated into pre-pottery and post-pottery periods. When pottery was made and used has been divided into finer time frames by comparisons with other dating methods (tree-ring dating, for example) in the same contexts. Distributional evidence is based on where the pottery was made and where it is.
found away from that source whether through trade, population movements, etc. Evidence of function and/or status is based on the usages of pottery through contexts, ethnographical comparisons and/or inferences. The production of pottery itself provides evidence of human behaviors through studies of the technical and artistic aspects of pottery. Numerous other sources of information can also be gained through pottery studies, such as group size, subsistence patterns, gender roles, and so on. This paper is concerned with relationships between manufacturing behaviors involved in pottery production and the functions of that pottery.

Some of the decisions to be made in producing pottery include what materials to use, under what conditions to make the pottery, what end-products (vessel forms) are desired, and so forth. "Real-life production behavior involves complex decision making in the face of uncertainty regarding variables and outcomes; it aims to minimize risk and accommodate any number of tangible and intangible considerations" (Rice 1987:207). Prehistoric peoples certainly used decision-making processes in the production of prehistoric pottery. In pottery used for domestic and
culinary purposes "the full spectrum of cultural and technological factors underlying the choices involved in manufacturing a vessel is brought into play" (Rice 1987:208). By examining the pottery left by prehistoric peoples at what are now archaeological sites, a better understanding of their prehistoric behaviors involving pottery making can be gained. One method used is to examine the selection of materials themselves as reflected in the composition of vessels and potsherds.

Ethnographic studies, experimental archaeological studies, inferences, and archaeological contexts combine to provide an approach to ascertaining prehistoric vessel functions (Rice 1987:211). How vessels were used prehistorically is of great importance to studies of human behavior as it provides insight into broader cultural behavioral patterns. In the prehistoric southwestern United States, one major division of vessel functions is between bowls which were used for serving and jars which were used for cooking, storage and transport. The ratios of vessel forms found at a site are used to determine whether or not prehistoric people were actually living at a site or just using it for storage. Vessel forms are
thought to indicate vessel function (see Rice 1987:207-242; and Henrickson and McDonald 1983, for examples). Whole vessels are most desirable for vessel form studies but are not always available as the majority of pottery artifacts are found in pieces. Braun based his study of vessel functions and forms on the rim and neck pieces (1980). Often, not even this much of a pot is found and vessel form is indicated by the curvature of the rims, painted surfaces, and overall smoothing of surfaces. Differences in prehistoric uses of vessels defined through vessel forms cannot be well-understood but these labels provide a "descriptive and predictive framework for establishing what a particular class of prehistoric vessels look like and how they may have been used" (Rice 1987:211).

Vessel form and function analyses are very important in studies of the prehistoric Southwest. In his early studies of prehistoric pottery of the Arizona Strip, Harold S. Colton noticed differences in the temper found in Anasazi- made Tusayan Gray Ware vessels and Tusayan White Ware vessels in which the plain grayware vessels contain different temper sizes than the painted whiteware vessels (1952:19,39-46). In his studies of Black Mesa Anasazi
pottery, Hill suggests that temper differences between Tusayan White Ware and Tusayan Gray Ware at Black Mesa indicate different functional usages of these two pottery types (1994:50-51). Studies of technical aspects of pottery may be related to functional usages. This paper presents hypotheses developed about two different Virgin Anasazi vessel forms and differences in temper characteristics found in the pottery from two sites located in the Moapa Valley of Nevada. Pottery from archaeological research conducted at these sites is examined and used to test the hypotheses. Statistical analyses are performed on the data to test for associations between the variables. A discussion and conclusion follows, interpreting the implications of this research.
CHAPTER 2

BACKGROUND RESEARCH

Puebloan Pottery Manufacturing Techniques

Before analyzing bits and pieces of an artifact, it is helpful to understand how those bits and pieces fit and work together. With potsherds, knowing the steps and processes involved in the manufacture of the pot greatly aids in the development of analytical methods that can tell the most about those processes. Fortunately, modern Puebloan pottery making, in the "traditional" way, has produced pottery similar to prehistoric Puebloan (including the Anasazi peoples) pottery. Replication experiments and examinations of prehistoric pottery have also been most helpful in understanding the production methods used in the past. When relating modern ceramic practices with prehistoric ones, cultural change must be taken into account (Hill 1994:38). Over time, changes in the pottery technology occur, especially evident in functional changes
from actual cooking and serving usages to marketable usages. "However, the basic technology has remained virtually unchanged" (Hill 1994:38). Clay, temper and water are worked together to make coils that are put together to form pots that are then fired.

Clay, the most important resource in pottery manufacture, is a sedimentary deposit resulting from the weathering and decomposition of older rocks. Clays can be found either at the source of their formation or in a secondary location being moved by such natural forces as wind and water. Clays vary in composition and suitability for use in pottery manufacture, a point that prehistoric potters were obviously fully aware of. With different clays having different characteristics, particularly when being used for making pottery, the choice of clays can depend on the intended function of the vessel, especially cooking or non-cooking functions (Hill 1994:38). Clays also were selected for color as evidenced in redwares and whitewares. Ethnographically, clay sources are sometimes kept secret with the collection process involved in ritual (Rice 1987:115). The following clay preparation account is based on San Juan and Santa Clara pottery methods (Hill
1994:39). After the clay is collected, lumps are spread to dry. After drying, the clay is mashed and pounded on stone slabs with small stones and other particles being picked out and discarded. The pulverized clay is sifted or winnowed to obtain more evenness in particle size. The clay is then used or stored.

Clay by itself is "too plastic" meaning it tends to shrink and crack during pottery making and firing. Non-plastic particles improve workability and prevent cracking during drying and heating stages. Some clays naturally contain enough non-plastic particles (inclusions), generally rocks and minerals, for successful pottery making while other clays need to have them added. The term "temper" will be used when referring to non-plastic particles added to clay. Tempers, like clays, have different characteristics that cause different reactions in pottery manufacture and usage. Some of the kinds of tempers used include sand, crushed rock, shell, plant materials and crushed potsherds. "Temper is considered highly (indeed probably excessively) important in archaeological studies, because the materials added are often distinctive of particular cultures and time periods"
and are therefore useful in dating sites and tracing trade relationships" (Rice 1987:118). For example, the mineralogy of a crushed rock temper can be used to located the source of that particular temper. Like clay, tempers may also need to be processed by sorting, pounding, crushing, etc.

The prepared clay, temper and a liquid (usually water) are mixed together, proportions measure by "feel" (Oppelt 1991:20), and the forming process begins. Oppelt describes a coil and scrape forming technique based on combined information from modern Puebloan ethnographic accounts, replication experiments and examinations of prehistoric pottery (1991:21-37). A concave, circular slab of clay or a tight coil is used to form the base. Clay is rolled into coils (modern Puebloans use thick coils while prehistoric pottery seems to have been made using thin ones). The first coil is placed on an upturned edge of the base slab and successive coils are placed on top. Coils are overlapped with seams staggered to make stronger bonds. When thinner coils are used, the vessel can be formed as the coils are added. Modern Puebloans using thicker coils form the vessel during scraping. Sherds or gourds are used
for scraping the vessel while counterpressure is applied to the opposite side. After the body is shaped, the rim is finished and handles or other attachments are added. Replicators add one more coil in height which is then scraped and the excess clay removed to form a rim. Vessels are then polished, rubbed with a smooth stone, or slipped, adding a thin layer of clay to the surface, if desired. Corrugated pottery is scraped on the inside leaving the coils, which may be pinched in patterns, visible on the exterior of the vessel. Prehistorically, paint was applied to dried vessels before firing. Mineral and organic paints were applied with yucca brushes in designs without using patterns. "Some modern Pueblo potters say they have no preconceived design; they allow the form of the vessel and the spirits in the clay to determine the design" (Oppelt 1991:37). The design elements and patterns are used by archaeologists to indicate particular cultures and time periods.

Drying vessels before firing them is a very important step and must be done carefully to prevent flaws from the drying itself or later in the firing process. Drying vessels "typically takes several days or even weeks" (Rice
1987:152) with Oppelt reporting a time frame of ten days, or more for thicker vessels, on Mesa Verde (1991:36). Prehistoric Puebloans did not use kilns but used an open firing method instead. This method today consists of a bed of fuel laid on the ground or in a prepared shallow pit with the vessels placed on this bed, supported by thin sandstone slabs or large potsherds (Oppelt 1991:39). More fuel is placed around the vessels. The fire is lit and burns a relatively short time, only fifteen to twenty minutes (Rice 1987:154).

The type of fuel used has an effect on the finished pots, for example, dung is used to produce the black Santa Clara pottery made today. Prehistorically, whatever wood was available was probably used by potters to fire their vessels. The open firing method produces a low fired pottery with the temperatures of the fires ranging from 600 to 850 degrees Celsius with considerable variation (Rice 1987:156). Controlling the temperature and duration of the fire is very difficult under these conditions. This results in uneven firing of vessels even within a single vessel. Fireclouds, or carbon spots, are the result of pots in direct contact with the fire. Rather than timing
the firing, potters use the color of the pots to determine when firing is complete (Oppelt 1991:40; Rice 1987:157-8). The vessels are then cooled and ready for use.

Vessel Form and Function

Classes of vessel forms generally used for common purposes have been developed through ethnographic studies, experimental archaeology and personal experiences. As vessels are made, the intended function of the vessel is considered which influences the desired form. Some of the factors influencing a container's design include whether contents will be wet or dry; whether contents will be cold or hot (require heating); how contents will be accessed; how often contents will be accessed; how far the vessel will be moved; and the volume of the contents (Rice 1987:208). Such factors are taken into consideration as the vessel's overall size, shape, opening size, appendages, decorations, etc., are produced. Ethnographically, particular vessel features have been shown to be desired with particular intended vessel functions. This can be used as a guideline in studying prehistoric vessels but should be used with caution as the jump is made from the present
to the past. As with vessels of the present, prehistoric vessels were not necessarily limited to one purpose and were sometimes used for a variety of functions.

The largest division between vessel forms and functions is that between jars and bowls. Bowls are generally thought to be used for serving while jars are used for storage, cooking, and transport. The differences between the forms and functions of vessels classified as jars and bowls is "not well understood and are often contradictory" but "provide a descriptive and predictive framework for establishing what a particular class of prehistoric vessels look like and how they may have been used" (Rice 1987:211). Classes of vessel forms with particular functions can be used as a "framework" for archaeologists to predict how vessels may have been used with the understanding that these are not exclusive functions.

Henrickson and McDonald developed general vessel form and function categories based on ethnographic data from a number of cultural groups (1983:631-633). Serving and eating vessel forms were dominated by an "open bowl with a flat bottom" and were "quite often decorated". Cooking
pots were generally "short and squat with a large basal surface for efficient heat transfer, but usually with a somewhat restricted mouth to prevent rapid evaporation from boiling foods". Dry storage vessels usually had an "opening wide enough to scoop from" with the overall shape varying with the length of storage. Liquid storage vessels showed "considerable morphological variation" with rounded or everted rims. Water transport vessels and canteens were "roughly globular" with a small orifice and handles on vessels used for short distances. Henrickson and McDonald then applied these categories to two early sites in Iran and found that even though they had a relatively small sample size, "functional correlations with the ethnographic categories could be made" (1983:640). They also found independent archaeological evidence supporting the inferences made on vessel functions.

In a study published slightly earlier, Braun (1980) used ethnographic data from historic and modern Yuman, Piman and Puebloan cultures to develop generalized vessel forms for particular kinds of domestic activities applying this to two sites in the Navajo Project area. Braun found the "selection of particular vessel forms for particular
ranges of domestic activities, then, appears to be based primarily on gross attributes of rim and neck size and shape" (1980:173). Braun's study using the rim and neck portions of vessels concluded that a high proportion of very narrow and narrow necked vessels suggested concern for secure storage containment with food processing and consumption based on other orifice sizes (1980:188).

Ethnographically, vessel form classes can be developed to include general purposes of those forms. Application of these classes to prehistoric situations seems to work although caution must be used in generalizing too much about prehistoric behaviors. Different vessel forms being used for different purposes provides only a guideline for archaeologists.

**Virgin Anasazi Pottery**

The Puebloan manufacturing techniques previously described seem to be close to those used prehistorically in the Anasazi region. Pottery in the prehistoric Southwest is used to distinguish different cultural groups based on the premise that methods of pottery making were passed down within that group. The pottery can be grouped into types
based on common characteristics that can be further grouped into wares when the types have enough in common to do so (Colton 1952:1). "Pottery wares are one of the best indicators of prehistoric Indian tribes, which Gladwin called branches, and persisted often for a thousand years, while pottery types change every few generations" (Colton 1952:2). The characteristics of a ware are "very generalized and depend on basic methods of manufacture" while types are based on more details such as design styles and time of manufacturing differences (Colton 1952:1-2). Colton points out that "a pottery ware is a conception" meaning that it is just a method used now to group what are seen as common characteristics in pottery made in the past (1952:2). These concepts are the basis of Colton's classifications of pottery of the prehistoric Arizona Strip and adjacent areas developed in the 1930's and 1950's that are still very much in use today. When Colton was developing his classification of pottery across the Arizona Strip and southern Utah and into southeastern Nevada, he noticed enough differences between the pottery made in the eastern part of this area and that made in the western part to name a Virgin Branch of Anasazi for the westernmost area
of Anasazi occupation (1952:3). Colton lists seven wares "indigenous to the Arizona Strip and Southern Utah":

[Tusayan White Ware-Virgin Series-light colored paste, clay probably of sedimentary origin, and quartz sand temper]
Tusayan Gray Ware-light paste
Shinarump Gray Ware-dark gray paste, clay probably residual in origin
Moapa Gray Ware-olivine temper, clay probably residual in origin
Moapa White Ware-olivine temper, clay probably residual in origin
Logandale Gray Ware-limestone temper
(Colton 1952:3)

The white wares have painted surfaces. The gray wares have unpainted surfaces that can be plain, corrugated, or have a fugitive red coating. Types within these wares are further divided using more detailed characteristics. In 1992, Margaret Lyneis described another kind of Virgin Anasazi made pottery, Shivwits Plain, distinguishable by the presence of sherd temper along with olivine grains (Lyneis 1992:45). (Shivwits Plain is not placed in a ware since it does not seem to fit that definition (Lyneis 1992:45).)

These descriptions, along with the coil and scrape method of pot making, provide a guideline to distinguish Virgin Anasazi made pottery from pottery made elsewhere.
Virgin Anasazi Pottery in the Moapa Valley

Virgin Anasazi pottery types found in the Moapa Valley to date fall mostly within descriptions in the typology developed by Harold S. Colton for Tusayan Gray Ware and Tusayan White Ware and for Moapa Gray Ware (Colton and Hargrave 1937; Colton 1952 and 1955). Colton's typology is based on methods of construction, surface treatments, temper characteristics, and painted design styles. Although Colton's keys to pottery types appear easy to use, actual sherds often do not "fit" nicely into the typology. Modifications of type descriptions made throughout time by numerous researchers are not always consistent and often are not published.

An easier approach to identifying types of pottery in an area is to review previous reports of sites in the vicinity and to use those pottery descriptions as a starting place for expected characteristics. Researchers also need to be aware of variations in these descriptions, the presence of intrusive wares, and yet to be described types. Since the focus of this research project is to identify temper characteristics, the temper descriptions in
previous reports are of particular interest.

In Shutler's descriptions of Pueblo sites of southern Nevada based on M.R. Harrington's findings and notes of his expeditions in the 1920's and 1930's, Colton's ceramic types are used to distinguish pottery found at numerous sites referred to as Pueblo Grande de Nevada along the Muddy and Virgin Rivers (1961). Shutler reports finding a variety of Virgin Anasazi pottery types in these collections including plain gray wares, corrugated gray wares, and painted wares.

The kinds of temper based on type descriptions from Colton found in the utility wares (plain and corrugated pottery) include carbonate (limestone), quartz sand, and olivine sand. Quartz sand tempered pottery was found in the dominant utility wares from these sites (Shutler 1961:28). These pottery types fall under Colton's Tusayan Gray Ware in which the temper is described as "abundant quartz sand, with occasional opaque fragments, gray or tan; temper usually conspicuous" (1952:15). Two other kinds of temper observed in utility wares by Shutler are the distinctive olivine temper of Moapa Gray Ware and limestone temper of Logandale Gray Ware (Shutler 1961:28). The temper types of
the Virgin Anasazi painted pottery are basically the same as that of the utility wares, quartz and olivine, although other characteristics of the temper seem to vary, such as more rounded quartz grains, more grains of the same size, etc.

Kathryne Olson reports in "An Attribute Analysis of Muddy River Ceramics" numerous difficulties involved when using a typology developed from southern Utah potsherds (Colton's) for potsherds found in southern Nevada and proposes that a "basic change" is needed based on attributes of the pottery itself (1979:308-311). Olson then examines pottery from three separate Virgin Anasazi sites in the lower Moapa Valley reporting on various attributes observed and measured. Twenty-one different kinds of temper are listed although many of them contain one primary mineral along with various amounts of other temper present, for example, quartz and olivine, quartz and carbonate, quartz and rock, and so on (Olson 1979:331). This study alerts researchers that defining kinds of temper from a relatively small area can get quite complex.

At Adam 2, a late Pueblo II Virgin Anasazi site located within one mile of the Yamashita sites, the same
kinds of temper that Shutler observed for Virgin Anasazi pottery were found with one variation. The dominate temper reported at Adam 2 is "sand-tempered" rather than quartz sand tempered with the sand in jars found to be "of quite mixed lithology" (Lyneis et al 1989:26). This mixed sand tempered pottery is still considered by the authors to belong to Tusayan Gray Ware Virgin Series as described by Colton.

One other kind of temper found in Virgin Anasazi pottery in the Moapa Valley is the sherd temper of Shivwits Plain first identified by Lyneis (1988). A description of Shivwits Plain is in the report on Main Ridge by Lyneis (1992:45). The temper is described as primarily crushed olivine tempered sherd with crushed sand tempered pottery sometimes present along with the presence of individual olivine grains that are difficult to see because of their small size and the darkness of the clay in this pottery. Although identified in this report of Main Ridge, Shivwits Plain had been noticed before by others but the temper had been misidentified due to the difficulties in identifying sherd temper using methods available and sometimes placed in the wrong type because of similarities in the clay
(Lyneis 1992:44).

Based on these reports on Virgin Anasazi pottery found in the Moapa Valley, some of the temper types expected to be found at other Moapa Valley sites include limestone, quartz sand, mixed sand, olivine, and sherd. Further divisions and combinations may be made of these temper types. This list is not to be considered exhaustive particularly because so few Virgin Anasazi sites in the lower Moapa Valley have had thorough pottery analyses reported. Also, variability seems to have been a characteristic of the Virgin Anasazi and should be expected in their pottery.

The Virgin Anasazi in the Moapa Valley

The Muddy River, fed by clear warm springs at the north end of the valley, winds its way down through the valley gathering sediment and alkali and for this reason it is called Muddy. George Perkins, a student of early Nevada history, says the river gets its name from the Mesquite bean, "Moudy". The valley is truly an oasis in the desert, surrounded by mesas and flanked on the north, south, and east by beautiful mountains. At sunrise and sunset they reflect gorgeous colors of blues, reds, purples, lavenders, and pinks, blended and glowing from the towering peaks to cover the valley below, bathing it in a riot of color. The native growth of mesquite, mascrew tree, greesewood, quail bush, arrow weed, and sorrel, replaces orchards and gardens in many
places. There are three valleys, the first being circular, two miles long and one and a half miles wide. The upper end is covered with springs, some cold and some warm, and covered with a luxurient growth of grass where travelers along the "old Spanish Trail" stopped to rest and feed their cattle.

From 100 Years on the Muddy
(Hafner 1967:26)

This colorful description of the Muddy Valley, now called the Moapa Valley, presents a picture of paradise, certainly a view not shared by many of the early Mormon settlers who endured extreme hardships, mainly from the climate and environment, during initial settlement attempts. In spite of these difficulties, the Moapa Valley, located in southern Nevada approximately 50 miles northeast of Las Vegas, has been occupied for a very long time by people who farmed the floodplains of the Muddy River. The earliest of these farmers were prehistoric Puebloans.

The Muddy River, which runs through the Moapa Valley, originates from several large springs as a perennial stream flowing southerly and emptying into the Overton Arm of Lake Mead. In 1880, severe floods of the Muddy River lead to incising of 20-30 feet into valley fill (Gardner 1968:60). Prior to that time, the Muddy River wandered over a
Figure 1 Location of the Moapa Valley in Nevada.
USGS Map of Las Vegas, Nevada; Arizona; California, Scale 1:250,000, Revised 1969
relatively flat plain surface. Gardner suggests the
floodplain was an "uninhabitable marshy area which probably
supported a thick growth of phreatophytes" (1968:60).
Although "uninhabitable", the floodplain provided farming
opportunities with the perennial flow of the Muddy River.
Springs in the terrace cuts also were a source of water.
The majority of Puebloan sites are found on terraces along
the eastern side of the valley near the floodplain. This
area, commonly called Anasazi Bench or Sand Bench, is
covered in reddish wind-blown sand derived from the Aztec
sandstones of the Valley of Fire formation located in the
direction prevailing winds come from. Gravels underlying
the sand are presently quarried in several places and
natural cuts in the surfaces would have made these gravels
available to prehistoric people, too. These prehistoric
inhabitants are called Virgin Anasazi by researchers.

The Virgin Anasazi were the western branch of the
prehistoric Anasazi people who occupied portions of the
Southwest in the United States. Much more is known about
other branches of the Anasazi of southern Colorado,
northern New Mexico, northeastern Arizona, and southeastern
Utah than is known about the Virgin branch who occupied the
western Colorado Plateaus and river valleys of the Mojave Desert in Utah, Arizona and Nevada. The large pueblos and cliff dwellings of the Anasazi to the east are not found in the west where smaller groups of people lived in diverse environmental conditions using mixed subsistence, including cultivation. Occupation of the Virgin area probably began before A.D.1 lasting through about A.D.1200 (Lyneis 1995:1) with these dates being understood as flexible as more research is done here.

Some of the westernmost Virgin Anasazi occupations are found in the Moapa Valley. Archaeological evidence of Virgin Anasazi occupation followed by (or concurrent with) Southern Paiute occupation from Basketmaker II (?300BC-AD500) through European contact appears throughout the valley with most Anasazi sites located along lower terraces overlooking the Muddy River floodplain. These sites have been known to exist for many years with archaeological research, including excavation, taking place since the 1920's. Mark Harrington excavated sites such as Lost City (Main Ridge) in the early 1920's. R. F. Perkins also worked on many of these sites with relatives and friends for almost forty years. More recent work through the
University of Nevada, Las Vegas has produced publications and numerous master's theses about these early Moapa Valley inhabitants. The ongoing research in the valley by Dr. Margaret Lyneis and her students has provided valuable information about this little known branch of Anasazi.

Virgin Anasazi sites are generally indicated by structures that changed through time. Pit houses appeared in Basketmaker II times (?300B.C.-A.D.400) and continued in usage throughout Virgin Anasazi occupation of the Moapa Valley. Above ground structures for both habitation and storage purposes came into use during early Pueblo II times (A.D.1000-1050) and continued through the end of occupation. In late Pueblo II times (A.D.1050-1150) the attached rooms formed arcs around a courtyard area (Lyneis 1995:210-217). Many of these sites with structures have evidence of multiple occupations based on such evidence as structures found below other structures and artifacts of different time frames. Although occupation length has not been determined, Lyneis makes a "good guess" at length of occupation of a household at a specific location as being 10 to 15 years at the most (1992: 80). Structures found usually consist of remnants of adobe floors and the lower...
portions of walls and/or stones used as foundations. Structural damage from looting occurred with the knowledge of a Virgin Anasazi practice of burying the dead along with grave goods in the floor of structures. Trash deposits are found outside the structures and in courtyard areas. Numerous artifacts are scattered around the sites including groundstone, lithic and ceramic remnants.

Even though the settlement patterns of the Virgin Anasazi in the Moapa Valley resemble those of the Virgin Anasazi across the Colorado Plateau of small, dispersed settlements situated near arable land, the sites in the Moapa Valley demonstrate some differences from other Virgin Anasazi to the north and east. These differences were probably due to the differences in environment (Lyneis 1989). The Moapa Valley Virgin Anasazi lived in a desert environment rather than the upland Colorado Plateau environment where most Virgin Anasazi lived. The Moapa Valley Anasazi raised their crops near springs and along the floodplains of the Muddy River while the Virgin Anasazi on the Colorado Plateaus raised their crops in upland areas depending on rainfall for moisture. Building material for the masonry structures built by the upland Virgin Anasazi
was not available to the Moapa Valley Anasazi who used adobe for building structures. The pottery found in the Moapa Valley closely resembles the Virgin Anasazi pottery from other areas. Differences found in general living patterns due to environmental differences might be expected to be reflected in the pottery. Pottery in the Virgin Anasazi area plays a valuable role in understanding these people.

The Yamashita Sites

Approximately six acres of land belonging to the Kio Yamashita family contain eight of the many prehistoric sites found along a strip of land commonly known as Sand Bench, or Anasazi Bench, along the terraces overlooking the Muddy River in the lower Moapa Valley of southern Nevada. These sites on the Yamashita property have been known to exist for quite some time but the exact locations of these sites (recorded 26CK-2039 through 26CK-2044 at the southern Nevada repository at the UNLV Museum of Natural History) have not really been verified in the field. Larry Alexander, who worked in conjunction with the Lost City Field School under the direction of Dr. Claude Warren of
the UNLV Department of Anthropology, conducted a survey of
the terraces along Anasazi Bench in 1973. He gave the
eight sites on the Yamashita property field numbers
prefixed MRS-73 for "Muddy River Survey 1973". These were
not formally recorded. In 1979, site sheets filed at the
Nevada State Museum repository in southern Nevada were made
up on these sites with assigned Smithsonian site numbers
based on information from Chick Perkins who knew these
sites as Keo 1 through Keo 6. The sites were not field
checked. Mary Rusco of the Nevada State Museum, in 1979,
re-surveyed Anasazi Bench in an effort to clarify records
and site locations. The sites on the Yamashita property
still were not ground surveyed and some errors on actual
locations of these sites still remained. In 1989, Dr.
Margaret Lyneis of the University of Nevada, Las Vegas
(UNLV) Anthropology Department used Alexander's sketch map
records to locate eight sites on this property. She
renamed the eight sites choosing not to use the formal site
numbers because of the confusion with their actual
locations. Site boundaries were based on artifact
concentrations and evidence of adobe structures. With Mr.
Yamashita's generous consent, she then began directing
surveys and excavations of these sites through an UNLV archaeological field class and a volunteer program.

The Yamashita sites lie within a layer of reddish-brown aeolian sand, approximately 50-60 centimeters deep, that overlays Pleistocene gravels. Yama-2, Yama-3, Yama-4 and Yama-5 are located on an upper terrace with Yama-6, Yama-7 and Yama-8 on a lower terrace nearer the floodplain of the Muddy River which lies toward the west of the sites (Figure 2). All of Yama-1 and a portion of Yama-2 were destroyed by gravel quarrying in the gravel pit located to the south of the sites. Some artifacts and samples were collected from Yama-1 before it was completely lost. Through the years, these sites have been disturbed through natural and human causes which combined with a sandy fill results in a lack of good stratigraphy for chronological purposes. Whole pots and the greater portions of the adobe structures are long gone. Some complete projectile points have been collected. Evidence shows mostly prehistoric occupation by the Virgin Anasazi (during mid- to late-Pueblo II) with some evidence of Southern Paiute occupation (probably post-Anasazi). The dating of the sites is based on the architectural styles and types of pottery found.
Figure 2 Sketch Map of the Yamashita Sites. The locations of the eight Yamashita sites are shown on two terraces east of the Muddy River floodplain. This sketch map was drawn by Margaret Lyneis in 1989.
Fieldwork began in 1989. A grid system was laid out over the Yamashita sites with base lines surveyed in by Russ Avery of Avery Engineering. A fence post with a formally surveyed survey point at its base was designated as 300N120W. The baselines were set at 20 meter intervals running north-south and east-west. This grid system was used to name excavation units and locations on the sites throughout the fieldwork.

Surface collections were made on Yama-1, Yama-4, Yama-5, Yama-6, Yama-7 and Yama-8. Yama-8 had been previously excavated and the location of artifacts and other data is unknown. Both Yama-2 and Yama-3 have been excavated. Both of these sites contain the remains of adobe structures. These structures include habitation rooms with storage structures, some attached forming an arc of rooms. Destruction of the structures due to weathering and vandalism left layers of adobe wash and adobe rubble with only the bases of walls and floors intact. Old and newer looters' holes were found in the center of many of the structures where burials were probably found along with burial goods. The looters removed the goods without regard for the preservation of the sites scattering artifacts and
confusing provenience. Artifacts and site records collected during fieldwork are stored in the Archaeology Laboratory, Department of Anthropology, University of Nevada, Las Vegas. The archaeological research on the Yamashita sites is expected to help answer questions asked about Virgin Anasazi occupation in the Moapa Valley. Also important are questions about the Moapa Valley Virgin Anasazi and their relationships with other groups of Anasazis and other prehistoric peoples of the time. Also, relationships between the Anasazi and the Paiutes are under investigation.

Yama-2 and Yama-3

Yama-2 is one of two sites with adobe structures that has been systematically excavated. Figure 3 shows exposed adobe and architectural remains. One larger structure (approximately 3x4 m) was found, the center of which had been looted, along with a mass of adobe rubble with indiscernible structures. An isolated storage sized structure with a subfloor of rounded rocks was also found. Both of these structures were made of adobe, readily available in the floodplain, in the sand, lacking sandstone.
Figure 3 Exposed Architecture at Yama-2 and Yama-3. This map shows the excavated architectural remains of Yama-2 and Yama-3 during the 1989-1996 field seasons. The 220North gridline marks the general boundary between the two sites. This map was compiled by Margaret Lyneis.
slabs. Only the bases of walls and remnants of floors are present. A vast majority of artifacts indicate Virgin Anasazi occupation with lesser amounts of Southern Paiute associated artifacts such as brownware pottery, projectile points and surficial hearths.

Richard Peterson conducted an investigation of cists found at Yama-2 (1992). He excavated several different cists that were dug into the Pleistocene gravels beneath the sand layer forming the site surface. Four burnt corn cobs were found in cists. Peterson concluded that most of the cists were used for storage and probably were contemporaneous with the Pueblo II structures although some of the cists may have been used earlier in Basketmaker III times. Richard Peterson, along with Susan Peterson, also conducted a systematic probe survey in 1990 of Yama-2 to attempt to locate cists and/or possible pit structures. Richard Peterson generated a contoured map with elevations of probe penetration depths for Yama-2.

Yama-3 also has been excavated and adobe structures have been found. Figure 3 shows the structures exposed and units excavated. The boundary line between Yama-2 and Yama-3 at about the 220N line is based on a thinning of the
distribution of artifacts on the surface. An arc opening southward of two habitation rooms with clay rimmed hearths and a row of attached storerooms between them has been uncovered at Yama-3. Looter's holes, even one with a leftover screen, have been found throughout the structures. The habitation room on the west end of the arc appears to have been looted at least twice but a clay-rimmed hearth was left relatively intact. To the south of this arc of rooms a straighter row of attached storerooms was excavated in 1993. Next to these was a deeper pit structure, later determined not to be associated with the storerooms. Construction of these rooms is similar to the rooms found at Yama-2. One store room had a row of cobbles placed around the bottom of two of the walls. Generally, artifact counts are greater from courtyard units (those located inside the arc) than from units with adobe.

Rich Peterson's probe survey was extended from Yama-2 to Yama-3 in 1992. He located a depression about 2.5 meters in diameter. He then excavated a test unit at 226.8N61.2W to explore a portion of this depression. He found evidence of a pit structure with an adobe floor and possible mud-plastered walls. To the west of this pit
structure is the straight row of storerooms. The pit structure may be from an earlier occupation than the other adobe structures on the site.

The evidence found indicates that the Virgin Anasazi lived on the Yamashita sites during Pueblo II times and possibly earlier. Relationships between these Anasazi and other prehistoric people during Pueblo II times are suggested by the artifacts found even without detailed analysis. Shell beads found here probably originated along the coast of California and the Gulf of California where different groups of prehistoric peoples lived (Lyneis 1989). Olivine-tempered Moapa Grayware and sherd-tempered Shivwits Plain ceramics originating north of the Grand Canyon in Virgin Anasazi areas have been found here (Lyneis 1988). Also, black-on-gray painted pottery and redwares indicate contact north and east of the Moapa Valley with other branches of Anasazi people. Some of the black-on-red painted pottery may have come from as far east as northeastern Arizona and the Four Corners area. Exchange and contact in these directions seemed to have been at a peak during middle Pueblo II times (Lyneis et al 1989:iv). The design styles of black-on-gray painted pottery found in
the Virgin Anasazi region resemble Kayenta Anasazi styles for which a chronology has been developed. That chronology is used as a guideline for dating Virgin Anasazi black-on-gray painted pottery and using this comparison, the painted styles seen at Yama-2 and Yama-3 place the sites in a Pueblo II time period. The presence of corrugated pottery at Yama-2 and Yama-3 suggests a mid-Pueblo II date (post A.D.1050) when corrugated pottery was in use in the Moapa Valley (Lyneis et al 1989:iv). The differentiation in room sizes at both Yama-2 and Yama-3 suggest middle to late Pueblo II dating (Lyneis 1986).
HYPOTHESIS AND METHODOLOGY

Hypothesis Development

Potters use clay and temper to make vessels. "The use of different clays and tempers for different form or function classes of pottery is widely known ethnographically" (Rice 1987:226). Prehistoric potters may have also selected different materials such as using certain tempers to be added to clays for vessels used for certain functions. The materials and techniques used during manufacturing of pottery vessels reflects these decisions and can be useful for archaeological interpretation (Rye 1976:106).

Based on ethnographic, archaeological and technical information, Rice compiled a "simplified, idealized" summary of the relation of form, function and technology (1987:237-238). In the functional category of serving vessels, the materials may be fine; storage vessel
materials would be variable; cooking pot materials would be coarse and porous; food preparation vessel materials would be relatively coarse; and transport vessel materials would be dense and hard. Although Rice urges the use of caution when generalizing these relationships, she does show variations in technical aspects of pottery related to function.

In a technological analysis of the temper used in Anasazi pottery from Black Mesa, it was observed that both Tusayan White Wares (painted wares) and Tusayan Gray Wares (plain wares) contained a crushed sandstone temper that could have been from the same source (Hill 1994:26-27). The differences between the tempers of the two wares was in the particle size believed to be a result of differential processing of the tempers. Tusayan White Wares had smaller particle sizes than those in Tusayan Gray Ware with a very slight overlap in the ranges. The different wares are presumed to have different functional categories. "Potters appear to have recognized that different functional classes of vessels, expressed as Tusayan Gray and White wares, were best made using different particle sizes of crushed sandstone temper" (Hill 1994:50). Vessels with smaller
particles would be better suited for serving, transport, short-term storage or trade since the smaller particles would not expand enough during heating to affect the paste (Hill 1994:50-51). The larger particle size of the gray wares would help the vessels withstand the repeated heating and cooling of cooking allowing for expansion of the paste without damage to the vessel.

Black Mesa was repeatedly occupied by the Kayenta Branch of Anasazi and contained evidence of on-site ceramic production of pottery that was both used locally and traded throughout the entire Anasazi region. At Black Mesa, the functions of white wares and gray wares appear to have been distinct. In the Virgin Anasazi areas where the people seemed to have lived in smaller groups and evidence of centralized or specialized pottery production has yet to be found, painted wares and plain gray wares may have also had different functions. In an analysis of ceramics from the Steve Perkins site, a Virgin Anasazi site located in the lower Moapa Valley of Nevada, Keith Myhrer proposes that "sherds from storage vessels should exhibit poorly sorted temper, and sherds from food consumption vessels should exhibit finely sorted temper" (1989:45). Myhrer tested
this proposal on 81 sherds from an excavation unit with the results that the temper of corrugated sherds from storage vessels had the largest range of grain size and poorest sorting while the temper of painted sherds had the smallest and finest size range and were well-sorted (1989:45). According to Myhrer, this study implies that functional associations can be inferred from temper characteristics (1989:45). This suggests that the Virgin Anasazi at the Steve Perkins site selectively chose and/or prepared tempers for particular vessel forms with different functions much like the Kayenta Anasazi of Black Mesa.

Based on these two studies, hypotheses can be developed that prehistoric Virgin Anasazi potters made vessel forms with selected temper based on the intended functions of the vessels. The temper characteristics include tempering material, temper sorting, percentage of temper in relation to amount of clay, temper angularity, and temper size. Different temper types may have been chosen for different vessel forms and functions. Finer sorted temper would have been preferred for serving vessels than for heating or storage vessels. Smaller percentages of temper would have been needed for serving vessels than
for vessels requiring temper to control expansion during heating. For similar reasons, more angular temper shapes and larger temper sizes would have been used in cooking jars than in serving bowls. These can be tested at individual sites.

A set of four hypotheses are tested at the Virgin Anasazi sites of Yama-2 and Yama-3:

1. Virgin Anasazi black-on-gray bowls have better sorted temper than Virgin Anasazi plain gray jars;
2. Virgin Anasazi black-on-gray bowls have smaller percentages of temper than Virgin Anasazi plain gray jars;
3. Virgin Anasazi black-on-gray bowls have more rounded temper grains than Virgin Anasazi plain gray jars;
4. Virgin Anasazi black-on-gray bowls have smaller temper particle sizes than Virgin Anasazi plain gray jars.

Black-on-gray bowl rim sherds and plain gray jar rim sherds used in this study are recognizable as different vessel forms that were used for different functions. Black-on-gray bowls were used for serving and plain gray jars were
used for cooking and storage.

Methodology

The set of four hypotheses about Virgin Anasazi temper characteristics and black-on-gray bowls and plain gray jars is tested at the Yamashita sites, a group of Virgin Anasazi sites located in the lower Moapa Valley of southern Nevada. Pottery collected during the 1989 through 1993 field seasons from Yama-2 and Yama-3 is used for data. Only identifiable Virgin Anasazi pottery is used to help control variations due to pottery making methods between cultural groups.

As is the case in virtually all southwestern archaeological sites excavated in present times, whole vessels have not been found at the Yamashita sites; therefore, pottery rim sherds are used. Rim sherds exhibit different degrees of eversion, or outward curvatures, that when combined with surface treatment and smoothing provide information to determine whether the sherd was part of a bowl or jar. Bowl sherds with paint, usually found on the interior surfaces, and jar sherds without paint are assumed to have had different functions. Corrugated jars often
have an uncorrugated (smoothed) band from the rim downward before corrugation begins. This can lead to broken rims without corrugation that actually are from corrugated vessels. Unpainted smoothed jar rim sherds and corrugated jar rim sherds are included in the plain (referring to "not painted") gray jar category. Temper characteristics of the rim sherds are recorded and compared within these two vessel forms. The temper characteristics measured and recorded include mineralogy, degree of sorting, percentage of temper, angularity, and size. Statistical analyses determine the amount of association between the vessel forms and the temper characteristics.

Yama-2 and Yama-3 potsherds from the 1989 through 1993 field seasons are used since these two sites have been systematically excavated and provide a sample size that includes different vessel forms and variability in temper characteristics for the test. A sample of 1,117 rim sherds are chosen for examination for this research. Virgin Anasazi pottery types are defined as by other researchers along with any other sherds that fall within those general descriptions. Even though olivine tempered and olivine sherd tempered pottery are believed to be made in a
localized area outside of the Moapa Valley (Lyneis 1988),
these vessels are included in this study because they are
believed to be Virgin Anasazi-made.

Virgin Anasazi pottery types are distinguished from
other prehistoric pottery types using construction
techniques and temper characteristics. With active trade
networking in Pueblo II times, tradewares, especially from
other Anasazi branch areas, are expected at the Yamashita
sites. Anasazi pottery was constructed using coils and
scraped to smooth the surfaces. This method of
construction is often evident as striations on the
surfaces, especially on the interior, of sherds. Other
construction methods leave different finished surfaces,
such as, rounded impressions formed with the paddle-and-
anvil technique. Scrapemarks are a first indication that
the pottery is Anasazi. Plain pottery, corrugated pottery
(with textured exterior surfaces), pottery with a reddish
granular coating (fugitive red), and black-on-gray (painted
on a plain surface without other preparation, i.e. not
slipped) pottery is assumed to be Virgin Anasazi-made.
Redwares; other painted pottery with a white slip; paddle-
and-anvil made pottery; and dark colored sherds made with
coarsely textured often crumbly clay, especially with mica present, are all considered non-Virgin Anasazi pottery and are excluded from this study.

Variables and Methods of Measurement

Rim sherds. Rim sherds are first identified by a smooth, rounded or flattened edge formed before firing. Body sherds have exposed unfired edges on all sides. Worked sherds have smoothed edges formed from grinding or abrading, and are distinguishable from rim sherds because the smoothed edge is formed after firing often leaving the core exposed on the worked edge.

Rim Eversion. Rim eversion is the amount of curvature of the rim in respect to the wall of the sherd. Eversion categories will be based on Colton's "lip direction" types (Colton and Hargrave 1937:11). Figure 4 shows the chart of expected rim eversions. The exterior of the sherd is determined by comparative smoothing and visible scrapemarks with jars having smoother exteriors and bowls having smoother interiors. This information is compared with the overall curvature of the sherd with the concave surface generally being the interior surface. Rim eversion is
Figure 4 Rim Eversion Chart.
(From the "lip direction" chart in Colton and Hargrave 1937:11.)

Figure 5 Lip Form Chart. The exterior surface of the sherd faces to the right of the diagram. (From the "rim form" chart in Colton 1952:14).
viewed with the sherd held in profile with the rim up and the exterior surface on the right side.

**Vessel form.** Surface smoothing and curvature are combined to determine the type of whole vessel a sherd represents. Generally, jars are smoother on their exterior surfaces than on their interior surfaces. Bowls generally have well-smoothed interior surfaces. The curvature of the sherd is used to determine interior and exterior surfaces. In this study, vessel form is identified as either jars or bowls. More specific identification of vessels, such as, ollas and seed jars, are not used. Some sherds are not big enough or the surfaces cannot be distinguished enough to determine the whole vessel's form. These sherds are not used.

**Surface Treatment.** The surface treatment of interest in this study is painting. Sherds are coded either plain for no paint or black-on-gray for sherds with paint. Corrugated sherds are coded in the same way and included in either the plain or black-on-gray categories.

**Lip.** The lip of the vessel is the very tip or smoothed edge of the rim and is identified using Colton's "rim form" chart (Figure 5) (1952:14). Lip form, wall width
and rim width are used primarily for helping to identify vessels that tend to thicken at the lip, one characteristic of the paddle-and-anvil technique of pottery manufacture.

Wall Width. This measurement of the thickness of the sherd is taken parallel to the rim using calipers below the point where eversion begins and recorded in millimeters.

Rim Width. This measurement, in millimeters, is taken with calipers at the lip or edge of the sherd and is used with lip form to identify paddle-and-anvil pottery.

Orifice Diameter. The orifice of sherds is measured in the interior of the sherd parallel to the rim at the point where the most constriction would be if the vessel was whole. A Formaguage is used with a curvature chart that gives the diameter of the curvature in centimeters. Only sherds with enough rim and wall present to find the measurement point and with at least 3 cm of curvature are used. Sherds smaller than this would not provide accurate enough measurements because of the very slight curvature present.

Rim Diameter. The rim diameter is measured along the exterior edge of the rim using the same technique as with the orifice diameter. These sherds must also be at least 3
cm wide along the rim circumference.

**Microscopic Examinations**

All microscopic examinations of the temper are done under a binocular microscope at 15x power on a "fresh" break of each sherd. A portion of the sherd is broken with pliers to expose the interior of the sherd. This helps to see the temper and clay of the sherd more clearly and helps eliminate misinterpretations of temper as rocks and minerals adhere to the exterior of the sherd through the many years of deposition.

**Temper.** The temper compositions previously observed at Moapa Valley sites include limestone, quartz sand, mixed sand, olivine and olivine-tempered sherd temper. Temper content and mineralogy categories for this study are determined with a pretest on a sample of sherds from Yama-2 and Yama-3.

**Temper Sorting.** A chart used for sand grain sorting from Pettijohn, Potter and Siever (1972:585) is used to determine the degree of temper sorting in each sherd. The following terms are used for the categories: very well sorted (VW), well sorted (W), moderately sorted (M), and
Very well-sorted  Well-sorted  Moderately-sorted  Poorly-sorted

Figure 6  Temper Sorting Chart. This temper sorting chart is based on charts used for sorting sand grains. (Pettijohn, Potter and Siever 1972:585)

10%/90%  20%/80%  30%/70%  40%/60%  50%

Figure 7  Temper Percentage Chart. These charts are visual references for the percentage of temper within a clay body.

Very well rounded  Well rounded  Subrounded  Subangular  Angular

Figure 8  Temper Angularity Chart. This chart is from a chart for determining the angularity of sand grains. (Pettijohn, Potter and Siever 1972:586)
poorly sorted (P) as shown in Figure 6.

Temper Percentage. The percentage of temper in comparison to the amount of clay is estimated at 0%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90% and 100% using visual comparisons as shown in Figure 7.

Temper Angularity. The angularity of the temper is compared to the chart in Figure 8 (from Pettijohn et al 1972:586). The angles of the circumferences of temper particles are observed. The following major categories are used: well-rounded (WR), rounded (R), subrounded (SR), subangular (SA), and angular (A). More than one code is used when the temper particles demonstrate more than one kind of angularity, for example, SA-A for sub-angular to angular temper particles.

Temper Diameter. The diameters of the temper grains are measured as an "up to" measurement. The diameters of the largest grains are measured in millimeters using a clear ruler placed directly over the grains under the microscope. The measured diameters are then grouped into the following categories based on the Udden-Wentworth scale for rock grain size (Adams et al 1984:3): very fine (>0.06-0.1 mm), fine (>0.1-0.25 mm), medium (>0.25-0.5 mm),
coarse (>0.5-1.0 mm), very coarse (>1.0-2.0 mm), granules (>2.0-4.0 mm), and pebbles (>4.0-64.0 mm).

Pretest for Temper Types

The potsherds from the Yamashita sites had not been previously formally analyzed to determine what kinds of temper are present. Observations in the field and occasionally through the microscope in the lab indicated the presence of at least three different temper compositions for sherds fitting within Virgin Anasazi pottery types. Reports on sherd analyses from other sites in the Moapa Valley indicate that several Virgin Anasazi types with different temper compositions could be expected at the Yamashita sites. Before beginning analysis of all of the Virgin Anasazi rim sherds from Yama-2 and Yama-3, a pretest was done to test the proposed categories of analysis and to describe expected temper types.

A sample of approximately 10% of the Virgin Anasazi rim sherds from Yama-2 and Yama-3 was used in the pretest. Following the proposed procedure for the overall study, a cross-section of each sample sherd was observed on a fresh break at 15x under a binocular microscope. The focus of
this pretest was on the kinds of minerals, rocks or other inclusions making up the temper in the sherd with other characteristics recorded as a test to see if the proposed categories were reasonable for this research. To verify the mineralogy observed under the microscope, each temper category underwent a petrographic analysis of thin-sections cut from the sherds which enables more accurate mineral identification to be made. Adams, McKenzie and Guilford's Atlas of Sedimentary Rocks under the Microscope (1984) was used as a guide to mineral identification of thin-sections.

Making thin-sections of sherds requires cutting the sherd with a gem saw into at least two pieces, one for reference and one that can be sliced into a very thin piece or section. Basically, the piece is coated with a resin that keeps the sherd together when cut into very thin slices. Polarized light shone through the thin-section produces distinct observable patterns for different minerals. Rim sherds from selected units were first observed at 15x and temper type categories were defined by descriptions of the temper composition. Body sherds with those temper types were then used to make the thin-sections needed for the next phase of the pretest. The temper
TEMPER CATEGORIES OF SAMPLED RIM SHERDS
FROM YAMA-2 AND YAMA-3

Quartz sand:
Inclusions are primarily quartz (more than 50%), usually clear, rounded to subangular, ranging in size up to 1 mm but generally 0.5 mm. Sorting varies but is generally well- to moderately-sorted. Other rock fragments and grains are present in minor amounts. Further divisions of this category follow.

Q1:
Inclusions are mostly clear quartz grains.; well- to moderately-sorted; mostly 0.5 mm up to 1 mm; angularity varies.

Q2:
Subangular to subrounded clear and whitish quartz grains; well- to moderately-sorted; up to 1 mm but mostly 0.5 mm. Also present throughout the clay are tiny dark flecks. Other assorted fragments are also present in minor amounts.

Q3:
Clear to white quartz grains, fragments containing quartz grains, unidentified softer, white 'stuff', some red staining and occasionally attached mica. Quartz grains in the fragments are smaller than free quartz. Temper is generally poorly-sorted with grains up to 2 mm. Mica present is coppery.

Q4:
Very sparse, tiny, subrounded quartz grains that look like they are from the clay rather than added. Clay resembles fired mud.

Mixed sand:
Inclusions are a variety of rock fragments and mineral grains including clear quartz (less than 50%). Sorting, angularity and size vary. Following are further divisions of this group.

M1:
Inclusions are a variety of rock fragments and clear quartz grains with white coating. Rock fragments are generally rounded to subrounded and gray, black, and
purplish in color. Quartz grains often have angular breaks. Inclusions tend to be poorly-sorted and measure up to 2 mm. Clays seem to divide into two categories: reddish-brown and light grayish-brown to gray.

**M2:**

Rock fragments are found in less variety than M1. Subrounded rock fragments are white, gray and black with an absence of the purplish rocks. Clear quartz grains are broken angularly. Inclusions are moderately-sorted with few grains as big as 1 mm.

**M3:**

Dark gray rock fragments with clear quartz grains are present along with dark gray, vesicular fragments.

**M4:**

These inclusions are very well-sorted, fine mixed rock fragments and quartz grains.

**Quartz/feldspar:**

Inclusions are clear quartz and white feldspar in abundant amounts. Mica and other fragments are also present in minor amounts.

**QF1:**

Quartz and white feldspar are present in abundant amounts with mica. The clay is grainy.

**QF2:**

Quartz and white feldspar are present along with sherd temper with olivine.

**Olivine:**

Inclusions are translucent green olivine, sometimes red, with occasional black rock.

**Sherd:**

Sherds from previously fired pottery are used as inclusions. The temper of the sherd temper is olivine. Free olivine is also present.

**Table 1** Initial Temper Categories for Yama-2 and Yama-3 Rim Sherds From a Sample under 15X Magnification.
categories were then modified as needed and used for the major observations for this research.

Sherds from particular units were used rather than an overall sample. Three units from Yama-2 and four units from Yama-3 were selected based on the units' location in respect to architecture. The following units were selected: Yama-2: 202N74W-habitation structure; 204N70W-no architecture, possibly a courtyard; 206N74W-adobe rubble; Yama-3: 230N72W-storeroom; 236N70W-courtyard, no architecture; 236N84W-habitation room; and 242N76W-adobe rubble. (Refer to the map in Figure 3 for the unit locations.) The Virgin Anasazi rim sherds (a total of 126) from these units were analyzed noting the surface treatment, rim eversion, lip type, temper type, temper sorting, temper angularity and temper diameter. Table 1 lists the temper categories developed from these observations. Quartz sand temper and mixed sand temper were each divided into four subcategories. The quartz/feldspar category was divided into two subcategories. Olivine and sherd temper categories did not need further divisions into subcategories. Initially, other temper characteristics, such as angularity, size and
percentage, were used with temper type to define the temper categories.

With the exception of the quartz/feldspar temper, these temper groups are those expected to be present at these sites. A quartz/feldspar temper has not been previously identified in Virgin Anasazi pottery in the Moapa Valley. This kind of temper is found in Paiute pottery but the construction methods and clay characteristics are different from those quartz/feldspar tempered sherds found at Yama-2 and Yama-3. Mica also seems to be more abundant in the Paiute pottery. These Virgin Anasazi sherds were made from a lighter colored gray firing, finer clay with a smoother surface finish than the Paiute sherds. Scrapemarks and the lack of circular indentations on the surfaces indicate that the pottery was made using the coil and scrape technique identified as a Virgin Anasazi pottery characteristic.

To verify the temper compositions defined in the temper categories, a representative sample of sherds of the proposed categories were made into thin-sections for more detailed petrographic analysis. To keep the rim sherds usable, body sherds with the same temper were used to make
thin-sections. A total of twenty sherds were made into thin-sections. The olivine category was not included since it is readily distinguishable. Duplicate thin-sections were made of the other categories for comparison purposes. The sherd thin-sections were then observed under plane and cross-polarized light with the following observations being recorded: temper type, temper sorting, temper angularity and temper percentage. A table in Appendix I shows the recorded observations for these sherds.

On the basis of the thin-section analysis, the temper type categories were revised as shown in Table 2. Temper sorting, temper angularity and temper percentage were recorded to be compared with the binocular examinations to be used in the overall analyses.

In the thin-section analysis, the quartz sand subcategories were re-evaluated. Q3 with quartz grains and unidentified white 'stuff' is actually quartz/feldspar temper. The subcategory Q4 is noticed to be used for a few very small vessels that appear to be hand-molded and most likely not a part of the general assemblage of vessels. These vessels without added temper are excluded from this study. The tiny dark flecks in Q2 that seemed to appear
TEMPER TYPE CATEGORIES FOR ANALYSIS OF YAMA-2 AND YAMA-3 RIM SHERDS

Limestone (L):
This temper was not observed in the pretest of sherds but is known to exist in the Moapa Valley. Limestone is the predominant temper with very minor amounts of other grains.

Quartz Sand (Q):
This temper is predominantly (more than 50%) quartz grains varying in coloring including clear, white, gray, and red-stained. Quartz sandstone cemented with a white matrix may also be present. Other minerals and rocks are present in smaller, minor amounts.

Mixed Sand (M):
This temper is an assortment of rock fragments varying in color and composition. Occasional clear quartz grains and quartz sandstone are seen with possible quartz/feldspar intergrowths and sparse mica.

Quartz/feldspar (Q/F):
This temper has quartz and whitish feldspar as the main components. Quartz and feldspar sometimes are together as an intergrowth with cuppery mica attached. Free mica is rare. Fewer other rocks and minerals are present.

Olivine (O):
The major inclusion seen in this temper is olivine ranging in color from clear to green to deep red. Also present are black rocks in which an occasional green olivine grain can be seen. Minor amounts of quartz and other grains are also present.

Sherd (SH):
Sherd temper is used, usually olivine tempered, with free olivine, quartz and other rock fragments in sparse amounts. Quartz tempered sherd sometimes is present.

Unidentified (U):
This category is added for unknown temper types.

Table 2  Temper Type Categories for an Analysis of Yama-2 and Yama-3 Rim Sherds.
regularly are actually voids in the clay that appear dark under the microscope. Two overall differences in quartz sand were observed. One group includes rounded, well-sorted individual quartz grains while the other group includes quartz sandstone appearing both aggregated and as individual quartz grains sometimes coated in white. The second group also has a lot of variability in the amounts of quartz sandstone and free quartz. These two groups could either be left as separate groups or combined into a quartz temper group. If the groups were left separated, problems in categorizing sherds could come from a range of the types grading into each other. It was decided to combine these subcategories into a single quartz sand tempered category.

The four mixed sand subcategories are also combined into a single mixed sand temper category. In the thin-section analysis, ranges of inclusion composition overlap the subcategories. Further divisions may have been possible but it was decided that dividing this mixed sand category into smaller groups was not necessary for this study. No individual rock fragments seem to dominate and the temper appears quite mixed in composition.
The quartz/feldspar temper with minor amounts of mica was not an expected Virgin Anasazi temper type. The thin-section analysis confirmed that this temper was correctly identified. The quartz/feldspar tempers are combined into one category after the thin-section analysis using the same reasoning as for the quartz and mixed sand categories.

The sherd temper category is left as defined except to note that quartz tempered sherd can occasionally be present along with the olivine tempered sherd. One of the sherd tempered thin-sections has only olivine tempered sherd while the other one has a few quartz tempered and olivine tempered sherd fragments.

These temper types are used for the tests on all rim sherds as proposed. A limestone category is added although not seen in the sample pretest because it is known to occur in the Moapa Valley. An unknown category is added to allow for different tempers that could still be present and not in the sample. The observations of the thin-sections are compared to the observations on the reference sherd pieces, cut pieces of the same sherds used for thin-section, viewed at 15x power. Temper sorting, percentage and angularity comparisons between thin-section pieces and reference
pieces confirm consistency by the researcher in recording these categories.

Recording of Data

The previously assigned catalog numbers are used to identify each sherd with the prefix A229- for Yama-2 sherds and A230- for Yama-3 sherds. All measurements and observations are recorded as previously described and entered into a database using the MacIntosh Panorama II program.

Statistical Analysis

Descriptive statistics in the form of tables and graphs using counts and percentages are used to present the data from Yama-2 and Yama-3 combined. The focus of this research are bivariate analyses comparing vessel form with temper type; vessel form with temper sorting; vessel form with temper percentage; vessel form with temper angularity; and vessel form with temper size. The vessel forms compared are black-on-gray bowls and plain jars since these forms are assumed to have the most distinct functions. Orifice diameter and rim diameter information is used to indicate sizes of vessels. Since only a small number of
sherds are expected to provide orifice diameter measurements, this information is not used for statistical purposes but is presented as a characterization of vessel assemblage for these sites. Complete counts of temper characteristic categories for each vessel form is presented in tabular and graphic forms.

A non-parametric statistic, Goodman and Kruskal's Tau, is used to test for one-way associations between vessel forms and temper characteristic categories. A non-parametric statistic is indicated because this sample cannot be assumed to be random since the units excavated were chosen judgmentally. Also, the original size of the potsherd collection is not known. The same statistical test is used for each of the four hypotheses to compare the results of these tests. Goodman and Kruskal's Tau test for association is used because of its sensitivity to all cells of data and because small counts are expected in some cells. Tau varies from zero to one, with values closer to zero indicating the weakest associations and values closer to one indicating stronger associations. Calculations are shown in Appendix III.
CHAPTER 4

OBSERVATIONS AND RESULTS

The analyses described in the methodology section are performed on a total of 1,117 rim sherds from Yama-2 and Yama-3. Of this total number, 167 rim sherds are excluded from this study because all measurements cannot be taken on them, primarily due to the small sizes of the sherds. No paddle-and-anvil made sherds are in this sample. When separated into vessel forms, the remaining 950 rim sherds include 270 black-on-gray bowl rim sherds, 93 plain gray bowl rim sherds, 1 black-on-gray jar rim sherd, and 586 plain gray jar rim sherds. Four unpainted jar rim sherds and one black-on-gray bowl rim sherd have corrugation on the exterior. The corrugated jar rim sherds are included in the plain gray jar rim category and the corrugated black-on-gray bowl rim sherd is included in the black-on-gray bowl rim category. Only the black-on-gray bowl rim sherds and the plain gray jar rim sherds, 856 sherds in
all, are used to test the proposed hypotheses. The black-on-gray bowl rim sherds represent 31.5% of this sample and the plain gray jar rim sherds represent 68.5%.

**Wall Width and Rim Width**

The average wall width for the Yama-2 and Yama-3 black-on-gray bowl and plain gray jar rim sherds is 4.3 mm with a minimum width of 2.0 mm and a maximum width of 7.0 mm. These rim sherds have an average rim width of 3.1 mm with a minimum width of 1.2 mm and a maximum width of 5.6 mm. These measurements show that the Virgin Anasazi rim sherds from Yama-2 and Yama-3 have a tendency to be thinned toward the edge during formation.

**Inner Orifice Diameter and Rim Diameter**

Inner orifice diameters are measured on rim sherds with enough of a profile present to determine where the narrowest opening at the neck of the vessel would be and that are at least 3 cm wide at this point. Measurements of the diameters of the rims are also taken using the same method on rim sherds from Yama-2. Appendix II lists the inner orifice diameter and rim diameter measurements taken...
on black-on-gray bowl and plain gray jar rim sherds from Yama-2 and Yama-3.

David Braun did a study on ceramic vessel use based on rim and neck attributes separating vessel orifice measurements into the following categories: very narrow (3-6 cm); narrow (7-12 cm); medium (13-25 cm); and wide (26-39+ cm) mouthed (1980:182). The sizes of the openings for the vessels are equated with usage of the vessels. Measurements of the inner orifices of black-on-gray bowl and plain gray jar rim sherds from Yama-2 and Yama-3 show 1 very narrow mouthed jar, 1 narrow mouthed bowl, 16 narrow mouthed jars, 14 medium mouthed bowls, 75 medium mouthed jars, 17 wide mouthed bowls, and 8 wide mouthed jars. Rim diameter measurements on Yama-2 plain gray jar rims add 1 narrow mouthed jar, 5 medium mouthed jars, and 7 wide mouthed jars. This information is shown in Table 3 and Chart 1.

Rim sherds that fit the criteria for measuring orifice diameters are the largest ones in the collection. The larger sherds may have different characteristics than the smaller sherds. The walls of the larger sherds are slightly wider than those of the smaller sherds with an
Table 3 Orifice Sizes of Rim Sherds from Yama-2 and Yama-3. The sizes are shown of the openings for selected black-on-gray bowl rim and plain gray jar rim sherds. Percentages are based on the totals for each vessel form. N=145

Chart 1 Orifice Sizes of Black-on-gray Bowl Rim Sherds and Plain Gray Jar Rim Sherds from Yama-2 and Yama-3. VN=Very narrow, N=Narrow, M=Medium; and W=Wide. N=145
average width of 4.6 cm (range 2.8-7 cm) compared to 4.3 cm (range 2-7 cm). More plain gray jars are represented by the larger sherds (78%) than with the smaller sherds (68.5%) and conversely, fewer black-on-gray bowls with larger sherds (22%) than smaller sherds (31.5%). This is also reflected in the lower number of larger rim sherds with rim eversion A. Rim eversion C is found slightly more in the larger sherds. Olivine and mixed sand temper are the most dominant temper types found in the larger sherds. Olivine temper is found in a higher percentage of the larger sherds than in the smaller sherds. Temper sorting and temper angularity categories are very similar in both the sizes of sherds. More very coarse temper sizes are found in the larger sherds than in the smaller sherds probably due to the higher percentage of olivine tempered sherds.

**Rim Eversion**

The rim eversions found on the rim sherds from Yama-2 and Yama-3 are shown in Table 4 as total counts and converted into percentages of the total rim sherds used from these sites (Chart 2). Rim eversions coded as A, B, C,
Table 4 Counts for Rim Eversions for Black-on-gray Bowl Rim Sherds and Plain Gray Jar Rim Sherds from Yama-2 and Yama-3. Percentages are based on the totals for each column. N=856

<table>
<thead>
<tr>
<th>RIM EVERSION</th>
<th>ALL RIM SHERDS</th>
<th>BLACK-ON-GRAY BOWL RIM SHERDS</th>
<th>PLAIN GRAY JAR RIM SHERDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>COUNT</td>
<td>PERCENT</td>
<td>COUNT</td>
<td>PERCENT</td>
</tr>
<tr>
<td>A</td>
<td>278</td>
<td>32.5%</td>
<td>267</td>
</tr>
<tr>
<td>B</td>
<td>334</td>
<td>39.0%</td>
<td>3</td>
</tr>
<tr>
<td>C</td>
<td>161</td>
<td>18.8%</td>
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</tr>
<tr>
<td>D</td>
<td>71</td>
<td>8.3%</td>
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<tr>
<td>E</td>
<td>12</td>
<td>1.4%</td>
<td>0</td>
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<tr>
<td>TOTALS</td>
<td>856</td>
<td>100.0%</td>
<td>270</td>
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</table>

Chart 2 Percentages of Rim Eversion Categories for Black-on-gray Bowl Rim Sherds and Plain Gray Jar Rim Sherds from Yama-2 and Yama-3. N=856
Figure 9  Rim Profiles of Selected Sherds from Yama-2 and Yama-3. The exterior surface of each sherd faces to the right of the diagram. Profiles A-E have rim eversion A. Profile A is a black-on-gray corrugated bowl rim sherd. Profiles B-D are black-on-gray bowl rim sherds. Profile E is a plain gray jar rim sherd. Profiles F-I have rim eversion B. Profile F is a black-on-gray bowl rim sherd. Profiles G-I are plain gray jar rim sherds. Profile J-L have rim eversion C. Profiles J and K are plain gray jar rim sherds. Profile L is a corrugated jar rim sherd. Profiles M and N have rim eversion D and are both plain gray jar rim sherds.
D and E are recorded as previously described.

The slight rim eversion A is found in 32.5% of the sampled sherds which is very close in percentage to the total of 31.5% black-on-gray bowl rim sherds. As expected, the largest majority of black-on-gray bowl rim sherds (98.9%) have rim eversion A and a very small percentage (1.9%) of the jar rim sherds have eversion A. The largest percentage (39%) of total rim sherds have the slight eversion B which is represented by 56.5% of the plain gray jar rim sherds and only 1.1% of the black-on-gray bowl rim sherds. Rim eversions C, D and E are found only on plain gray jar rim sherds from this sample. Rim eversion C is on 27.5%, rim eversion D is on 12.1%, and rim eversion E is on 2% of the plain gray jar rim sherds.

**Temper Type**

The temper types found in the sample rim sherds are presented in Table 5 and Chart 3. With the exception of a few limestone tempered sherds, the tempers found in the pretest are also found in the overall sample of sherds. The criteria of greater than 50% quartz for sand temper to be considered as quartz sand proved to be unnecessary since
### TEMPER TYPES OF YAMA-2 AND YAMA-3 RIM SHERDS

<table>
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<tr>
<th>TEMPER</th>
<th>ALL RIM SHERDS</th>
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<th>BLACK-ON-GRAY BOWL RIM SHERDS</th>
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<th>PLAIN GRAY JAR RIM SHERDS</th>
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<td>74</td>
<td>12.6%</td>
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<tr>
<td>TOTAL</td>
<td>856</td>
<td>100.0%</td>
<td>270</td>
<td>100%</td>
<td>586</td>
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</table>

*Table 5* Temper Types of Yama-2 and Yama-3 Black-on-gray Bowl Rim Sherds and Plain Gray Jar Rim Sherds. Percentages are based on total counts within each column. N=856

Goodman and Kruskal's Tau=0.1

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![Chart 3](image)

**Chart 3** Percentages of Temper Types for Black-on-gray Bowl Rim Sherds and Plain Gray Jar Rim Sherds from Yama-2 and Yama-3. L-Limestone; M-Mixed sand; Q-Quartz; Q/F-Quartz/Feldspar; O-Olivine; S-Sherd temper. N=856
the quartz sand tempered sherds are composed predominately of quartz grains with only minor amounts of other grains present. Sandstone grains formed of quartz are sometimes recognizable with these sherds included in the quartz temper category. Mixed sand tempered sherds contain primarily a mixture of assorted rocks and minerals with quartz grains often present in minor amounts. The quartz and feldspar temper is distinguishable from both of these temper types. The sherd temper appears to be from olivine tempered pottery although this was sometimes difficult to determine at the magnification used. Some of the sherd temper may be quartz tempered. The sherd tempered pottery always contains a small number of individual grains which fits the description of Shivwits Plain pottery.

Limestone (0.3%), quartz/feldspar (8.9%), and sherd (8.6%) are present only in the plain gray jar rim sherds. Mixed sand (32.4%), quartz (22%), and olivine (27.8%) tempers are present in both black-on-gray bowl and plain gray jar rim sherds. Mixed sand temper is found in more plain gray jar rim sherds (44.2%) than in black-on-gray bowl rim sherds (6.7%). Olivine temper is found in 19.3% of
the plain gray jar rim sherds and in 46.3% of the black-on-gray bowl rim sherds. Quartz temper is found in more black-on-gray bowl rim sherds (47%) than in plain gray jar rim sherds (10.4%). Goodman and Kruskal's Tau has a value of 0.1 for the association between vessel form and temper type.

**Temper Sorting**

Table 6 shows the counts and percentages (also in Chart 4) for the temper sorting categories for the black-on-gray bowl rim sherds and the plain gray rim sherds. By far the most rim sherds (72.8%) fall within the poorly sorted category. This is also reflected in the high percentages of black-on-gray bowl rim sherds (56.7% of these sherds) and plain gray jar rim sherds (80.2% of these sherds) with poorly sorted temper. In plain gray rim sherds, only 13.8% of the sherds have moderately sorted temper; 5.1% of the sherds have well sorted temper; and 0.9% of the sherds have very well sorted temper. A higher percentage of black-on-gray bowl rim sherds (21.5%) have moderately sorted temper, with 16.3% having well sorted temper and 5.5% having very well sorted temper. A value of
Table 6 Temper Sorting of Yama-2 and Yama-3 Black-on-gray Bowl Rim Sherds and Plain Gray Jar Rim Sherds. Percentages are based on total counts within each column. N=856. Goodman and Kruskal's Tau=0.04

Chart 4 Percentages of Temper Sorting for Black-on-gray Bowl Rim Sherds and Plain Gray Jar Rim Sherds from Yama-2 and Yama-3. VW-Very well; W-Well; M-Moderately; P-Poorly sorted. N=856
0.04 is calculated for Goodman and Kruskal's Tau for association between vessel form and temper sorting.

**Temper Percentage**

The percentages of temper in relation to clay are shown in Table 7 and Chart 5 for the black-on-gray bowl rim sherds and the plain gray jar rim sherds. All of the sherds used in this study contain temper although none of them contain more than fifty percent temper. A vast majority (66%) of the rim sherds contain 20% temper. In black-on-gray bowl rim sherds, 90.7% of the sherds have 20% temper with smaller percentages of the sherds having 30%, 10%, and 40% in descending order. Most of the plain gray jar rim sherds also have 20% temper (54.6%) with 22.7% of the sherds with 10% temper, 18.8% of the sherds with 30% temper, 3.6% of the sherds with 40% temper, and only 0.3% of the sherds with 50% temper. Goodman and Kruskal's Tau has a value of 0.08 for the association between vessel form and temper percentage.
<table>
<thead>
<tr>
<th>TEMP</th>
<th>ALL RIM SHERDS</th>
<th>BLACK-ON-GRAY BOWL RIM SHERDS</th>
<th>PLAIN GRAY JAR RIM SHERDS</th>
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<tbody>
<tr>
<td></td>
<td>COUNT</td>
<td>PERCENT</td>
<td>COUNT</td>
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<td>10%</td>
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<td>40%</td>
<td>23</td>
<td>2.7%</td>
<td>2</td>
</tr>
<tr>
<td>50%</td>
<td>2</td>
<td>0.2%</td>
<td>0</td>
</tr>
<tr>
<td>TOTAL</td>
<td>856</td>
<td>100.0%</td>
<td>270</td>
</tr>
</tbody>
</table>

Table 7 Temper Percentage of Yama-2 and Yama-3 Black-on-gray Bowl Rim Sherds and Plain Gray Jar Rim Sherds. Percentages are based on total counts within each column. N=856. Goodman and Kruskal's Tau=0.08

Chart 5 Percentages of Temper Percentage for Black-on-gray Bowl Rim Sherds and Gray Jar Rim Sherds from Yama-2 and Yama-3. No sherds were found with 0% or greater than 50% temper. N=856

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Temper Angularity

The totals for the temper angularity categories for the rim sherds from Yama-2 and Yama-3 are shown in Table 8 with Chart 6 showing the percentages. The temper in most of the rim sherds examined falls within ranges of temper angularities which is reflected in the distribution of sherds over all combinations of angularity types. In all of the rim sherds in the sample, the highest percentage found in any category is only 24.4% of sherds with subangular to angular temper. The other categories are all represented by smaller percentages of the total rim sherds.

The largest percentage of black-on-gray bowl rim sherds (30.7%) also have subangular to angular temper. The next largest percentages of black-on-gray bowl rim sherds also include subangular and angular temper shapes in the categories. Only 6.6% of the black-on-gray bowl rim sherds have only rounded to subrounded temper shapes. None of the amorphous shape of sherd temper is in black-on-gray bowl rim sherds which is not surprising since none of these sherds have sherd temper. The temper shapes found in plain gray jar rim sherds are more evenly distributed in the categories including subrounded, subangular to angular
### Table 8
Temper Angularity of Yama-2 and Yama-3 Black-on-gray Bowl Rim Sherds and Plain Gray Jar Rim Sherds. Percentages are based on total counts within each column. The percentages do not total 100% due to rounding of values. N=856

Goodman and Kruskal's Tau=0.02

<table>
<thead>
<tr>
<th>TEMPER ANGULARITY</th>
<th>ALL RIM SHERDS</th>
<th>BLACK-ON-GRAY BOWL RIM SHERDS</th>
<th>PLAIN GRAY JAR RIM SHERDS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>COUNT</td>
<td>PERCENT</td>
<td>COUNT</td>
</tr>
<tr>
<td>ROUNDED</td>
<td>6</td>
<td>0.7%</td>
<td>2</td>
</tr>
<tr>
<td>ROUNDED-SUBROUNDED</td>
<td>39</td>
<td>4.6%</td>
<td>16</td>
</tr>
<tr>
<td>ROUNDED-SUBANGULAR</td>
<td>48</td>
<td>5.6%</td>
<td>14</td>
</tr>
<tr>
<td>ROUNDED-ANGULAR</td>
<td>69</td>
<td>8.1%</td>
<td>17</td>
</tr>
<tr>
<td>SUBROUNDED</td>
<td>20</td>
<td>2.4%</td>
<td>6</td>
</tr>
<tr>
<td>SUBROUNDED-SUBANGULAR</td>
<td>121</td>
<td>14.1%</td>
<td>57</td>
</tr>
<tr>
<td>SUBROUNDED-ANGULAR</td>
<td>120</td>
<td>14.0%</td>
<td>16</td>
</tr>
<tr>
<td>SUBANGULAR</td>
<td>61</td>
<td>7.1%</td>
<td>43</td>
</tr>
<tr>
<td>SUBANGULAR-ANGULAR</td>
<td>209</td>
<td>24.4%</td>
<td>83</td>
</tr>
<tr>
<td>ANGULAR</td>
<td>90</td>
<td>10.5%</td>
<td>16</td>
</tr>
<tr>
<td>AMORPHOUS</td>
<td>73</td>
<td>8.5%</td>
<td>0</td>
</tr>
<tr>
<td>TOTAL</td>
<td>856</td>
<td>100.0%</td>
<td>270</td>
</tr>
</tbody>
</table>

**Chart 6** Percentages of Temper Angularity for Black-on-gray Bowl Rim Sherds and Plain Gray Jar Rim Sherds from Yama-2 and Yama-3. R-Rounded; SR-Subrounded; SA-Subangular; A-Angular. N=856

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shapes. Only 4.6% of the plain gray jar rim sherds have rounded and subrounded shapes only. A value of 0.02 is calculated for Goodman and Kruskal's Tau for association between vessel form and temper angularity.

**Temper Size**

Table 9 shows the counts and percentages (Chart 7) of the temper size categories for the rim sherds in this study. Slightly more than half (51.1%) of the rim sherds contain coarse (>0.5-1.0 mm) temper. Very coarse (>1.0-2.0 mm) temper is in 38.7% of the rim sherds. The other size categories are represented in smaller percentages. This distribution is reflected in both the black-on-gray bowl and plain gray jar rim sherds. The two sherds with very fine sized temper are black-on-gray bowl rim sherds and the one sherd with pebble sized temper is a plain gray jar rim sherd. Goodman and Kruskal's Tau has a value of 0.01 for the association between vessel form and temper size.

**Re-evaluation of Temper Types Used to Test the Hypothesis**

During the analysis of the rim sherds from Yama-2 and Yama-3, it seemed that the olivine temper was consistently larger, more angular and more poorly sorted than the other
Table 9 Temper Size of Yama-2 and Yama-3 Black-on-gray Bowl Rim Sherds and Plain Gray Jar Rim Sherds. Percentages are based on total counts within each column. N=856. Goodman and Kruskal’s Tau=0.01
temper types. While 27.8% of the sherds used to test the proposed hypotheses have olivine temper, 46.3% of all of the black-on-gray bowl rim sherds and 19.3% of all of the plain gray jar rim sherds have olivine temper. An evaluation of the other temper characteristics of the olivine tempered sherd confirms that these sherds have large, angular, poorly sorted temper.

More than one-half (56.8%) of the rim sherds with very coarse sized temper have olivine temper. Four of the granular sized temper rim sherds have olivine temper (44.4%) and the one sherd with pebble sized temper has olivine temper. Large portions of the temper angularity categories with angular temper have olivine tempered sherds: 86.7% angular; 53.6% subangular-angular; and 22.5% subrounded-angular. Of the total rim sherds with poorly sorted temper, 37.1% of them have olivine temper. Olivine tempered rim sherds also account for 34.7% of the sherds with 20% temper percentage. Perhaps the use of olivine temper in Virgin Anasazi sherds is different than the use of sand tempers.

Both Hill's (1994) and Myhrer's (1989) research were on quartz sand tempered pot sherds. The data for sand
tempered (mixed sand, quartz, and quartz/feldspar temper types) Virgin Anasazi black-on-gray bowl and plain gray jar rim sherds from Yama-2 and Yama-3 are separated from the other temper types. Goodman and Kruskal's Tau for association is applied to these data.

A total of 541 rim sherds with mixed sand, quartz, or quartz/feldspar temper, 145 black-on-gray bowls and 396 plain gray jars, are tested for the same associations as with all rim sherds. The counts for black-on-gray bowls and plain gray jars with temper types of mixed sand, quartz, and quartz/feldspar are shown in Table 10 with a Tau of 0.3. Table 11 shows the temper sorting categories for the vessel forms with a value of 0.1 for Goodman and Kruskal's Tau. Temper percentages in black-on-gray bowl rims and plain gray jar rims are shown in Table 12 with Goodman and Kruskal's Tau calculated at 0.06. Table 13 shows temper angularity categories for vessel forms with a Tau of 0.04. Temper size categories for vessel forms are shown in Table 14 with a value of 0.04 for Goodman and Kruskal's Tau.
SAND TEMPER TYPES OF YAMA-2 AND YAMA-3 RIM SHERDS

<table>
<thead>
<tr>
<th>TEMPER</th>
<th>ALL RIM SHERDS</th>
<th>BLACK-ON-GRAY BOWL RIM SHERDS</th>
<th>PLAIN GRAY JAR RIM SHERDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIXED SAND</td>
<td>277 51.2%</td>
<td>18 12.4%</td>
<td>259 65.4%</td>
</tr>
<tr>
<td>QUARTZ</td>
<td>188 34.7%</td>
<td>127 87.6%</td>
<td>61 15.4%</td>
</tr>
<tr>
<td>QUARTZ/FELDSPAR</td>
<td>76 14.1%</td>
<td>0 0.0%</td>
<td>76 19.2%</td>
</tr>
<tr>
<td>TOTALS</td>
<td>541 100.0%</td>
<td>145 100.0%</td>
<td>396 100.0%</td>
</tr>
</tbody>
</table>

Table 10 Temper Type Counts for Black-on-gray Bowl Rim Sherds and Plain Gray Jar Rim Sherds with Mixed Sand, Quartz, and Quartz/feldspar Temper from Yama-2 and Yama-3. Percentages are based on the total counts within each column. N=541. Goodman and Kruskal's Tau=0.3

Chart 8 Percentages of Temper Types for Black-on-gray Bowl Rim Sherds and Plain Gray Jar Rim Sherds with Mixed Sand, Quartz, and Quartz/feldspar Temper from Yama-2 and Yama-3. M-Mixed sand; Q-Quartz; and Q/F-Quartz/Feldspar. N=541

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<table>
<thead>
<tr>
<th>TEMPER SORTING</th>
<th>ALL RIM SHERDS</th>
<th>BLACK-ON-GRAY BOWL RIM SHERDS</th>
<th>PLAIN GRAY JAR RIM SHERDS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>COUNT</td>
<td>PERCENT</td>
<td>COUNT</td>
</tr>
<tr>
<td>VERY WELL</td>
<td>20</td>
<td>3.7%</td>
<td>15</td>
</tr>
<tr>
<td>WELL</td>
<td>72</td>
<td>13.3%</td>
<td>43</td>
</tr>
<tr>
<td>MODERATELY</td>
<td>120</td>
<td>22.2%</td>
<td>54</td>
</tr>
<tr>
<td>POORLY</td>
<td>329</td>
<td>60.8%</td>
<td>33</td>
</tr>
<tr>
<td>TOTAL</td>
<td>541</td>
<td>100.0%</td>
<td>145</td>
</tr>
</tbody>
</table>

Table 11 Temper Sorting Counts for Black-on-gray Bowl Rim Sherds and Plain Gray Jar Rim Sherds with Mixed Sand, Quartz, and Quartz/feldspar Temper from Yama-2 and Yama-3. Percentages are based on the total counts of each column. N=541

Goodman and Kruskal's Tau=0.1

Chart 9 Percentages of Temper Sorting for Black-on-gray Bowl Rim Sherds and Plain Gray Jar Rim Sherds with Mixed Sand, Quartz, and Quartz/feldspar Temper from Yama-2 and Yama-3. VW-Very well sorted; W-Well sorted; M-Medium sorted; P-Poorly sorted. N=541

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Table 12 Temper Percentage Counts for Black-on-gray Bowl Rim Sherds and Plain Gray Jar Rim Sherds with Mixed Sand, Quartz, and Quartz/feldspar Temper from Yama-2 and Yama-3. No sherds were found with 0% or greater than 50% temper. Percentages are based on total counts for each column. N=541. Goodman and Kruskal's Tau=0.06

Chart 10 Percentages of Temper Percentages for Black-on-gray Bowl Rim Sherds and Plain Gray Jar Rim Sherds with Mixed Sand, Quartz, and Quartz/feldspar Temper from Yama-2 and Yama-3. No sherds were found with 0% or greater than 50%. N=541
<table>
<thead>
<tr>
<th>TEMPER ANGULARITY</th>
<th>ALL RIM SHERDS</th>
<th>BLACK-ON-GRAY BOWL RIM</th>
<th>PLAIN GRAY JAR RIM SHERDS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>COUNT</td>
<td>PERCENT</td>
<td>COUNT</td>
</tr>
<tr>
<td>ROUNDED</td>
<td>6</td>
<td>1.1%</td>
<td>2</td>
</tr>
<tr>
<td>ROUNDED-SUBROUNDED</td>
<td>38</td>
<td>7.0%</td>
<td>15</td>
</tr>
<tr>
<td>ROUNDED-SUBANGULAR</td>
<td>46</td>
<td>8.5%</td>
<td>13</td>
</tr>
<tr>
<td>ROUNDED-ANGULAR</td>
<td>60</td>
<td>11.1%</td>
<td>8</td>
</tr>
<tr>
<td>SUBROUNDED</td>
<td>20</td>
<td>3.7%</td>
<td>6</td>
</tr>
<tr>
<td>SUBROUNDED-SUBANGULAR</td>
<td>114</td>
<td>21.1%</td>
<td>51</td>
</tr>
<tr>
<td>SUBROUNDED-ANGULAR</td>
<td>95</td>
<td>17.6%</td>
<td>0</td>
</tr>
<tr>
<td>SUBANGULAR</td>
<td>56</td>
<td>10.4%</td>
<td>38</td>
</tr>
<tr>
<td>SUBANGULAR-ANGULAR</td>
<td>95</td>
<td>17.6%</td>
<td>12</td>
</tr>
<tr>
<td>ANGULAR</td>
<td>11</td>
<td>2.0%</td>
<td>0</td>
</tr>
<tr>
<td>TOTALS</td>
<td>541</td>
<td>100.1%</td>
<td>145</td>
</tr>
</tbody>
</table>

Table 13 Temper Angularity Counts for Black-on-gray Bowl Rim Sherds and Plain Gray Jar Rim Sherds with Mixed Sand, Quartz, and Quartz/feldspar Temper from Yama-2 and Yama-3. Percentages are based on the total counts in each column and do not equal 100% due to rounding of values. N=541. Goodman and Kruskal’s Tau=0.04

Chart 11 Percentages of Temper Angularity for Black-on-gray Bowl Rim Sherds and Plain Gray Jar Rim Sherds with Mixed Sand, Quartz, and Quartz/feldspar Temper from Yama-2 and Yama-3. R-Rounded; SR-Subrounded; SA-Subangular; and A-Angular. N=541
<table>
<thead>
<tr>
<th>TEMPER SIZE</th>
<th>ALL RIM SHERDS</th>
<th>BLACK-ON-GRAY BOWL RIM SHERDS</th>
<th>PLAIN GRAY JAR RIM SHERDS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>COUNT</td>
<td>PERCENT</td>
<td>COUNT</td>
</tr>
<tr>
<td>VERY FINE</td>
<td>2</td>
<td>0.4%</td>
<td>2</td>
</tr>
<tr>
<td>FINE</td>
<td>7</td>
<td>1.3%</td>
<td>4</td>
</tr>
<tr>
<td>MEDIUM</td>
<td>63</td>
<td>11.6%</td>
<td>41</td>
</tr>
<tr>
<td>COARSE</td>
<td>347</td>
<td>64.1%</td>
<td>85</td>
</tr>
<tr>
<td>VERY COARSE</td>
<td>122</td>
<td>22.6%</td>
<td>13</td>
</tr>
<tr>
<td>TOTALS</td>
<td>541</td>
<td>100.0%</td>
<td>145</td>
</tr>
</tbody>
</table>

Table 14 Temper Size Counts for Black-on-gray Bowl Rim Sherds and Plain Gray Jar Rim Sherds with Mixed Sand, Quartz, and Quartz/feldspar Temper from Yama-2 and Yama-3. Percentages are based on the total counts for each column. N=541

Goodman and Kruskal's Tau=0.03

Chart 12 Percentages of Temper Size for Black-on-gray Bowl Rim Sherds and Plain Gray Jar Rim Sherds with Mixed Sand, Quartz, and Quartz/feldspar Temper from Yama-2 and Yama-3. VF-Very fine; F-Fine; M-Medium; C-Coarse; and VC-Very coarse. N=541

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CHAPTER 5

DISCUSSION

Testing the Hypothesis

A set of four hypotheses are proposed for Virgin Anasazi pottery at Yama-2 and Yama-3. Black-on-gray bowls have better sorted temper than plain gray jars. Black-on-gray bowls have smaller percentages of temper than plain gray jars. Black-on-gray bowls have more rounded temper grains than plain gray jars. Black-on-gray bowls have smaller temper particle sizes than plain gray jars. These hypotheses are tested by examining each of these temper characteristics in Virgin Anasazi-made black-on-gray bowl rim sherds and plain gray jar rim sherds from the combined sites of Yama-2 and Yama-3. Goodman and Kruskal's Tau is applied to the data to test the amount of association between the two vessel forms and the temper characteristics. The four temper characteristics in the hypotheses are discussed along with the types of temper
found in the sherds.

Six different temper types are found in the rim sherds used for this study: limestone, mixed sand, quartz, quartz/feldspar, olivine, and sherd. When Goodman and Kruskal's Tau is applied to test for an association between the vessels forms of black-on-gray bowls and plain gray jars and all of these temper types, a value of 0.1 is calculated indicating a weak association. A value of 0.3 is calculated for Goodman and Kruskal's Tau test for association between black-on-gray bowls and plain gray jars and rim sherds with mixed sand, quartz, or quartz/feldspar temper types only. Although this value shows a stronger association between the vessel forms and these tempers, this is still a weak to moderate association. The distributions of temper types shows trends toward occurrences in black-on-gray bowls or plain gray jars.

Limestone, quartz/feldspar, and sherd tempers are found only in plain gray jar rim sherds. Although mixed sand is found in both vessel forms, a much higher percentage of the plain gray jar rim sherds have mixed sand temper than the black-on-gray bowl rim sherds. In contrast, a much higher percentage of black-on-gray bowl
rim sherds have quartz temper than plain gray jar rim sherds along with more than double the percentage of black-on-gray bowl rim sherds with olivine temper than plain gray jar rim sherds. The purposes for using different temper mineralogies warrants further research beyond the scope of this study.

The temper sorting categories for this test are divided into very well, well, moderately, and poorly sorted temper. Goodman and Kruskal's Tau applied to black-on-gray bowls and plain gray jars with these temper sorting categories with all temper types yields a value of 0.04, a very weak association. When the same statistic is applied to sherds with mixed sand, quartz, or quartz/feldspar temper, a value of 0.1 is calculated which still shows a weak association. Both vessel types have sherds with each of the degrees of temper sorting.

One vessel form contains certain temper sorting categories more than in the other even though Tau is a low value. Plain gray jar rim sherds have poorly sorted temper more often than black-on-gray bowl rim sherds. As the degree of sorting gets finer, the percentages of black-on-gray bowl rim sherds becomes increasingly greater than
those of plain gray jar rim sherds. This suggests that there is a tendency for the black-on-gray bowl rim sherds to have finer sorted temper than plain gray jar rim sherds in the sherds from Yama-2 and Yama-3.

At Yama-2 and Yama-3, the degree of temper sorting cannot be predicted for vessel forms because of the presence of all sorting categories in both vessel forms. The hypothesis that Virgin Anasazi black-on-gray bowls have finer sorted temper than plain gray jars is not supported at Yama-2 and Yama-3. The differences Myhrer proposed in temper sorting between storage vessels and food consumption vessels at the Steve Perkins site (1989:45) are not found at the sites of Yama-2 and Yama-3 which have overlapping sorting categories in these vessel forms.

The amount of temper in relation to clay is measured in increments of 10 percent. No rim sherds are found without temper and none are found with greater than 50% temper. The highest percentage of rim sherds have 20% temper in both black-on-gray bowls and plain gray jars. In the black-on-gray bowl rim sherds, 90.7% have 20% temper. The remaining plain gray jar rim sherds are mostly split between 10% and 30% temper. These counts are comparable to
those in the sand tempered rim sherds.

The hypothesis that black-on-gray bowls have different temper percentages than plain gray jars is not supported at Yama-2 and Yama-3. When Goodman and Kruskal's Tau is applied to vessel form and temper percentage, a value of 0.08 is calculated for rim sherds with all temper types and a value of 0.06 is calculated for rim sherds with mixed sand, quartz, or quartz/feldspar temper types. This shows very weak associations between vessel forms and temper percentages at Yama-2 and Yama-3. There is not much difference in the association values for the two major temper groups.

Basically no association is demonstrated between the vessel forms of black-on-gray bowls and plain gray jars and temper angularity at Yama-2 and Yama-3. The rim sherds from Yama-2 and Yama-3 have a wide range in temper angularity. Many of the rim sherds have more than one kind of angularity in the temper grains. This is demonstrated in the distribution of temper angularities within each vessel form. Although most of the sherds appear to have more subangular and angular temper than rounded temper, this basis could not be used to separate the sherds because
of the shape varieties found within individual sherds. This wide distribution is evident in the values of Goodman and Kruskal's Tau calculated as 0.02 for rim sherds with all temper types and 0.04 for rim sherds with mixed sand, quartz, and quartz/feldspar temper.

Temper size is grouped according to measurements of the diameters of the largest temper grains. Most of the rim sherds from Yama-2 and Yama-3 have coarse or very coarse sized temper in both vessel forms. Both black-on-gray bowl rim sherds and plain gray jar rim sherds have all temper size categories with the exception of the two black-on-gray bowl rim sherds with very fine temper and the single plain gray jar rim sherd with the largest pebble sized temper. Higher percentages of black-on-gray bowl rim sherds have smaller temper sizes than in plain gray jar rim sherds but not in considerable amounts.

In the sand tempered rim sherds, there are differences in the medium and very coarse size categories. Approximately five times as many black-on-gray bowl rim sherds have medium sized temper than plain gray jar rim sherds. Slightly more than three times as many plain gray jar rim sherds have very coarse size temper than black-on-
gray bowl rim sherds. Most of the sherds in both categories have coarse size temper in roughly comparable percentages.

The hypothesis that black-on-gray bowls will have smaller temper particle sizes than plain gray jars is not supported by Yama-2 and Yama-3 rim sherds. Goodman and Kruskal's Tau for association between vessel form and temper size has a value of 0.01 for all rim sherds and a value of 0.03 for sand tempered rim sherds at Yama-2 and Yama-3. This demonstrates a very weak association between vessel forms of black-on-gray bowls and plain gray jars at Yama-2 and Yama-3 and temper sizes that is reflected in the wide distributions found in these temper size categories. Hill's findings of differences in temper sizes between painted bowls and plain jars (1994:26-27) is not found at the sites of Yama-2 and Yama-3. The temper sizes found in the rim sherds from Yama-2 and Yama-3 overlap from fine to granular sizes while the temper sizes found in the Black Mesa pottery used by Hill separates into two different ranges with very little overlap.

The suggestions that food serving vessels, i.e. black-on-gray bowls, have better sorted temper, more rounded
temper grains, and smaller temper sizes than plain gray jars does not appear to be supported here based on the presence of olivine temper in a large percentage of painted bowl sherds. Although the differences between the characteristics of olivine temper and the other temper types are not thoroughly investigated here, the poorly sorted, angular, large grains of olivine alone do not support the proposed hypotheses. Further research should be done on the characteristics of these temper types, especially between olivine and quartz, and their usage in serving vessels.

Predicting Temper Characteristics From Vessel Form

Keith Myhrer tested a proposition that "sherds from storage vessels should exhibit poorly sorted temper, and sherds from food consumption vessels should exhibit finely sorted temper" with 81 sherds from the Steve Perkins site (1989:45-46). Myhrer used 64 corrugated sherds (from storage vessels) and 17 decorated sherds (from food consumption vessels) to find that the corrugated sherds have a large range in temper size and poor sorting while the decorated sherds have smaller and finer well-sorted
grains. Myhrer then concluded, "implications are that because sherds from corrugated vessels at the Steve Perkins site contain temper composed of poorly-sorted sand, other regional Virgin Anasazi collections with large quantities of similar sherds, whether evidence of corrugation is present or not, can be used to indicate functional associations" (1989:45). A comparison of the temper types found at the Steve Perkins site and the Yamashita sites of Yama-2 and Yama-3 shows that similar pottery types are found at these sites.

The strong distinction found by Myhrer between temper sorting in the two vessel forms he used is not found at Yama-2 and Yama-3. The sample size used from Yama-2 and Yama-3 is larger and more variable in vessel forms than the sample used in the Steve Perkins study. The larger number of sherds and wider variety of vessel forms in the non-consumption vessel category may account for the wider, overlapping ranges of temper sorting found in the sherds of Yama-2 and Yama-3.

Hill's findings of temper size differences between painted vessels and plain vessels at Black Mesa (1994:26-27) also are not found at Yama-2 and Yama-3. Comparisons
between the pottery of Black Mesa and the pottery of Yama-2 and Yama-3 cannot be easily made because of the many differences between these sites and their pottery. These sites are considered to belong to different branches of Anasazi people. These sites are located in two separate areas with numerous differences that are reflected in the pottery. For example, Black Mesa is thought to have been a production locale for tradewares, a fact that must have influenced pottery manufacturing.

In a general discussion of Virgin Anasazi pottery, Thompson states that "(t)he view today would suggest that, for much of the time, the temper in plain and painted sherds is much the same. Where differences do occur, the tendency would be to find the temper of painted sherds to be slightly finer" (Walling, et al, 1986:360). The analysis of rim sherds from Yama-2 and Yama-3 seem to support this statement with some additional differences in temper types. There is a slight tendency for Virgin Anasazi black-on-gray bowl rim sherds from Yama-2 and Yama-3 to have better sorted temper than plain gray jar rim sherds with fewer differences in temper percentage, size and angularity.
Vessel Assemblage

Data from this analysis of Yama-2 and Yama-3 rim sherds provide information on the overall vessel assemblage from these sites. Referring to the 950 rim sherds that were large enough for all measurements required in this research, 270 black-on-gray bowls, 93 plain gray bowls, 1 black-on-gray jar, and 586 plain gray jars are represented. Overall, bowls are represented by 38.2% of the sherds and jars are represented by 61.8%. At the mid-Pueblo II site of Main Ridge, 30.5% bowls and 69.5% jars are found (Lyneis 1992:Tables 19,20). Adam 2, a late Pueblo II site, has 40.6% bowls and 59.4% jars (Lyneis, et al 1989:44). This information is not available from the Steve Perkins site.

The presence of a relatively high percentage of serving vessels or bowls at Yama-2 and Yama-3 indicates that these sites were used for everyday living purposes. This is supported by the presence of habitation rooms with fire hearths and other information from the sites. It is not clear if the painted bowls served different purposes than the plain bowls from this information. The orifice diameter data provide clues to the uses of the jars.
Table 3 and Chart 1 include mouth opening sizes from black-on-gray bowl and plain gray jar rim sherds only. As expected, the highest percentage of bowl rim sherds have wide mouths followed by medium mouths with a much smaller percentage of narrow mouthed vessels. The largest majority of jar rim sherds have medium mouthed openings with smaller percentages of narrow and wide mouthed openings and a very small percentage of very narrow mouthed openings. Braun equates mouth opening sizes to function: very narrow for most permanent storage and water carrying; narrow for permanent storage and water carrying; medium for temporary storage, water coolers, cooking vessels, and for small-moderate sized groups; and wide for temporary storage and food preparation for large numbers of people (1980:182). These functions are based mainly on the concerns for spillage, access frequencies and access methods (Braun 1980:183).

Comparing this information to the Yama-2 and Yama-3 data for mouth opening sizes, the presence of wide and medium mouthed bowls suggests that these vessels were needed to serve both larger groups and small to moderate sized groups. The high percentage of medium and wide sized
mouth openings in the plain gray jar group suggests the need for temporary storage vessels, water coolers and cooking vessels. The presence of narrow and very narrow mouthed jars indicates that some water carrying vessels and/or some more permanent storage vessels were needed, too. These vessel forms also suggest that living activities were taking place at Yama-2 and Yama-3 while permanent storage was not a major concern. A reminder of Rice's cautions about using such functional categories as exclusive (1987:211) should be kept in mind here. A study into variable functional usages of Virgin Anasazi vessels would be very interesting.

**Chronological Indications Based on the Rim Sherds**

The data gathered during this research provides some chronological information about Virgin Anasazi occupation of Yama-2 and Yama-3. Painted design styles are used most often to date Virgin Anasazi sites but this kind of analysis was not done for this research. The degree of rim eversion in jars is used for general dating purposes in the Virgin Anasazi region. "The eversion or outcurve of the rim is very slight in Basketmaker III but somewhat more
pronounced in Pueblo I. The eversion is, however, fully
developed early in Pueblo II" (Thompson 1988:230). The rim
eversion categories found at Yama-2 and Yama-3 indicate use
of the sites during Pueblo II times because of the 39.6% of
plain gray jar rims with more pronounced curvatures. There
is still a high percentage (58.4%) of jar rims with a
slight or no eversion. This could indicate a mixture of
sherds from repeated occupations at Yama-2 and Yama-3
during Basketmaker III through Pueblo II times which is
also suggested by other information from the two sites.

Some of the pottery types found at Yama-2 and Yama-3
also act as chronological indicators. The presence of
Logandale Gray Ware (limestone tempered pottery) suggests
earlier usage of the site. Colton states that Logandale
Gray Ware is found during the earlier Basketmaker III time
period then again in the Pueblo II period (1952:85). A
relatively high percentage of limestone tempered pottery is
found at the early Pueblo II site of Bovine Bluff (Myhrer
and Lyneis 1985:18). The small percentage of Logandale
Gray Ware at Yama-2 and Yama-3 suggests that an earlier
occupation (earlier than mid Pueblo II) could be present.

Moapa Gray Ware, made about 110 km east near Mt.
Trumball, is found in the Moapa Valley from Basketmaker III to Late Pueblo II times (Lyneis 1995:229). The presence of olivine tempered pottery peaked in the Moapa Valley in mid Pueblo II times with as much as 20-30% of the total pottery at sites (Lyneis, et al., 1989:26). Moapa Gray Ware and Shivwits Plain (olivine sherd tempered pottery also made in the east) make up 36.4% of the rim sherds studied at Yama-2 and Yama-3. This is a strong indication of a mid Pueblo II date for these sites.

**Virgin Anasazi Pottery Made Outside the Moapa Valley**

As mentioned previously, olivine tempered and olivine sherd tempered pottery was made in the vicinity of Mt. Trumball outside of the Moapa Valley. The presence of this pottery at Yama-2 and Yama-3 indicates contact of some sort between the people in the Moapa Valley and Mt. Trumball. The pottery was either traded to the Moapa Valley or brought directly by people from the east for use here. Lyneis notes that this direction of trade from the east is found in other Virgin Anasazi sites (1995:230).

The exclusion of non-Virgin Anasazi pottery types from this study also tends to exclude other information on
trade. The finding of a quartz and feldspar temper at these Moapa Valley sites proves interesting. At Main Ridge, Lyneis found a quartz and feldspar temper with dark accessory minerals present that she suggests came from the Virgin Valley on the other side of Mormon Mesa (1992:43). She also suggests that this indicates that "substantial exchange of plain ware between communities in the Moapa and Lower Virgin valleys may have contributed to the variety of pottery" at Main Ridge (1992:43). The quartz and feldspar temper found in jar rim sherds from Yama-2 and Yama-3 lacks the dark accessory minerals found at Main Ridge. Further research is needed to determine the source of this quartz/feldspar temper but it does seem to suggest contact or travel to the Lower Virgin Valley.

Comparison of Pottery Types Between Moapa Valley Sites

Table 15 compares percentages of pottery types found at five groups of Virgin Anasazi sites found in the Moapa Valley. Logandale Gray Ware decreases drastically in numbers between early Pueblo II and mid-late Pueblo II times. Moapa Gray Ware increases in numbers in mid Pueblo II times then decreases at the late Pueblo II site of Adam
Table 15: A Comparison of Pottery Types at Virgin Anasazi Sites in the Moapa Valley

The types shown are Virgin Anasazi types with the exception of some non-Virgin Anasazi pottery in the "Other" category.

<table>
<thead>
<tr>
<th>SITE</th>
<th>TIME PERIOD</th>
<th>LOGANDALE GRAY WARE</th>
<th>TUSAYAN GRAY WARE, VIRGIN SERIES</th>
<th>MOAPA GRAY WARE</th>
<th>SHIVWITS PLAIN</th>
<th>OTHER</th>
</tr>
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<tbody>
<tr>
<td>BOVINE BLUFF</td>
<td>EARLY PII</td>
<td>58%</td>
<td>32%</td>
<td>10%</td>
<td>0%</td>
<td>1%</td>
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<tr>
<td>*YAMA-2, YAMA-3</td>
<td>MID PII</td>
<td>&lt;1%</td>
<td>63%</td>
<td>28%</td>
<td>9%</td>
<td>**</td>
</tr>
<tr>
<td>MAIN RIDGE</td>
<td>MID PII</td>
<td>0%</td>
<td>62%</td>
<td>24%</td>
<td>14%</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>STEVE PERKINS</td>
<td>MID-LATE PII</td>
<td>1%</td>
<td>59%</td>
<td>20%</td>
<td>18%</td>
<td>2%</td>
</tr>
<tr>
<td>ADAM 2</td>
<td>LATE PII</td>
<td>0%</td>
<td>94%</td>
<td>3%</td>
<td>0%</td>
<td>3%</td>
</tr>
</tbody>
</table>

*Note that these data for Yama-2 and Yama-3 exclude non-Virgin Anasazi pottery types and are based only on black-on-gray bowl and plain gray jar rim sherds. Steve Perkins data is from the late occupation only, values are rounded for comparison.

Bovine Bluff (Myhrer and Lynes 1984); Main Ridge (Lynes 1992); Steve Perkins (Myhrer 1989); and Adam 2 (Lynes, et al 1989)
2. Shivwits Plain follows suit. Based on the percentages of Virgin Anasazi pottery types, Yama-2 and Yama-3 fits nicely into a mid Pueblo II time frame.
A set of four hypotheses were tested at the Virgin Anasazi sites of Yama-2 and Yama-3:

1. Virgin Anasazi black-on-gray bowls have better sorted temper than Virgin Anasazi plain gray jars;
2. Virgin Anasazi black-on-gray bowls have smaller percentages of temper than Virgin Anasazi plain gray jars;
3. Virgin Anasazi black-on-gray bowls have more rounded temper grains than Virgin Anasazi plain gray jars;
4. Virgin Anasazi black-on-gray bowls have smaller temper particle sizes than Virgin Anasazi plain gray jars.

The low values calculated for Goodman and Kruskal's Tau for association between these vessel forms and temper characteristics do not support these hypotheses at Yama-2
and Yama-3. There appears to be a slight tendency for black-on-gray bowls to have better sorted temper than plain gray jars with both vessel forms having all temper sorting categories represented. There also appears to be a tendency toward the presence of certain temper types in black-on-gray bowls and in plain gray jars at Yama-2 and Yama-3 with Tau showing a weak to moderate degree of association.

Black-on-gray bowls are made primarily with 20% temper while plain gray jars mostly range from 10% to 30% temper. Temper angularity varies greatly and most often shows variability within individual sherds. In the two vessel forms, temper size is fairly evenly distributed. This suggests that none of these temper characteristics could be comfortably predicted from vessel forms at these sites.

Other information gained from this research at Yama-2 and Yama-3 support a mid Pueblo II (A.D.1050-1100) date with indications of some mixing with earlier time periods suggesting some repeated usages of the sites. The vessel assemblage determined from rim sherds indicates usage of these sites for habitation and temporary storage purposes for both larger and smaller to moderate sized groups of
people. The percentages of pottery types from outside the Moapa Valley support contact, possibly through trade, between the people of Yama-2 and Yama-3 and Virgin Anasazi farther to the east near Mt. Trumball and possibly closer east in the Lower Virgin Valley.

This study at Yama-2 and Yama-3 indicates that generalizations made about Anasazi pottery do not necessarily hold true to all Virgin Anasazi sites. Hill's findings of temper preparation differences at Black Mesa differs from both the studies at Steve Perkins and Yama-2 and Yama-3 because his vessel forms seem to have the same temper (1994). Generally divided into two separate cultural branches of Anasazi, too many differences exist between the pottery of the Black Mesa Anasazi and the Yamashita Anasazi to directly apply hypotheses from one area to the other. Virgin Anasazi pottery seems to have such a great amount of variability within its own defined types that researchers need to be cautious about forming generalizations that do not allow for the ranges of characteristics found in this pottery. Such variations found within the Virgin Anasazi provide challenges in the studies of these prehistoric people.
Pottery studies contribute tremendous amounts of information to understanding prehistoric peoples. "The combination of abundance, near indestructibility and the almost unique plasticity of the medium conspire to make the ceramic assemblage one of the most important resources from an archaeological site. Although the questions that we are posing in archeology have altered as ideas in the subject shift and develop, it is often pottery to which we turn to test new hypotheses" (Orton, et al, 1993:228). Newer methodologies involving more complex technological procedures are constantly being developed to analyze pottery down to even an atomic level. However, less technical studies involving unaided observations and the use of a microscope still provide valuable information about the cultures being studied. As pottery studies become more and more "scientific", it must be remembered that these artifacts were made and used by people and strict definitions and rules, for that reason alone, may not be of much use. Variability in pottery itself provides an interesting subject for study that can be linked to variability in prehistoric behaviors.
APPENDIX I

THIN-SECTION ANALYSIS OF A SAMPLE
OF YAMA-2 AND YAMA-3 POTSHERDS
<table>
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<th>TS NO</th>
<th>CAT NO</th>
<th>PROVENIENCE</th>
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<th>THICK</th>
<th>T</th>
<th>TS</th>
<th>TP</th>
<th>TA</th>
<th>DESCRIPTION</th>
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<td>A202-241</td>
<td>A229-0641-01</td>
<td>206N74W/0-20cmd</td>
<td>9.4g</td>
<td>4.0mm</td>
<td>Q</td>
<td>F</td>
<td>P</td>
<td>30</td>
<td>A</td>
</tr>
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<td>A202-242</td>
<td>A229-1080-01</td>
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<td>8.7g</td>
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<td>Q</td>
<td>F</td>
<td>P</td>
<td>40</td>
<td>SA</td>
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<td>F</td>
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<td>20</td>
<td>R-SR</td>
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<td>5.3mm</td>
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<td>F</td>
<td>W</td>
<td>20</td>
<td>SR</td>
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<td>F</td>
<td>M</td>
<td>20</td>
<td>SA-SA</td>
</tr>
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<td>F</td>
<td>P</td>
<td>30</td>
<td>SR</td>
</tr>
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<td>A202-248</td>
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<td>5.2mm</td>
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<td>F</td>
<td>P</td>
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<td>R-SR</td>
</tr>
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<td>9.6g</td>
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<td>Q</td>
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<td>M</td>
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<td>P</td>
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<td>4.4mm</td>
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<td>W</td>
<td>40</td>
<td>R-SR</td>
<td>SOME QF INTERGROWTHS; SOME BLACK SHINY LATHS; R Q LAYERED CLAY</td>
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<td>20</td>
<td>R</td>
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<td>W</td>
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<td>R-SR</td>
<td>WELL-ROUNDED, STAINED Q; SA ROCK FRAGS-MINOR; TINY COPPERY MICA</td>
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<td>M</td>
<td>30</td>
<td>R-SR</td>
<td>SOME POSSIBLE QF; SMALL DARK ROCK FRAGMENTS</td>
</tr>
<tr>
<td>A202-257</td>
<td>A229-0715-01</td>
<td>206N74W/20-30cmd</td>
<td>8.9g</td>
<td>4.8mm</td>
<td>SH</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>SPARSE TEMPER; OLIVINE; FINE CLAY; ORGANICS NOT BURNED OUT</td>
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<td>A230-1440-01</td>
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<td>5.6mm</td>
<td>SH</td>
<td>-</td>
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<td>SH PLUS Q &amp; F7 &amp; Q; MICA; ROUNDED Q</td>
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<td>50</td>
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<td>TINY BLACK FLECKS IN CLAY; B/G; LARGER TEMPER; SANDSTONE?</td>
</tr>
</tbody>
</table>

Table 16 Thin-section Analysis of Sample Sherds from Yama-2 and Yama-3

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APPENDIX II

RIM DIAMETERS AND ORIFICE DIAMETERS
OF YAMA-2 AND YAMA-3 RIM SHERDS

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### RIM DIAMETERS AND ORIFICE DIAMETERS OF YAMA-2 AND YAMA-3 RIM SHERDS

<table>
<thead>
<tr>
<th>RD</th>
<th>IOD</th>
<th>BLACK-ON-GRAY BOWLS</th>
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<td></td>
<td>1</td>
</tr>
<tr>
<td>16-26cm</td>
<td>16-30cm</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>16-30cm</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>18-20cm</td>
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</tr>
</tbody>
</table>
### RIM DIAMETERS AND ORIFICE DIAMETERS OF YAMA-2 AND YAMA-3 RIM SHERDS

<table>
<thead>
<tr>
<th>RD</th>
<th>IOD</th>
<th>BLACK-ON-GRAY BOWLS</th>
<th>PLAIN GRAY JARS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-22cm</td>
<td>18-22cm</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>18-24cm</td>
<td>18-24cm</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>22-30cm</td>
<td>18-24cm</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>18-26cm</td>
<td>18-26cm</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>&gt;18cm</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>18-22cm</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>20cm</td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>22-26cm</td>
<td>20-22cm</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>20-24cm</td>
<td>20-24cm</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>20-26cm</td>
<td>20-26cm</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>18-30cm</td>
<td>20-26cm</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>20-28cm</td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>20-30cm</td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>20-24cm</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>22cm</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>24-32cm</td>
<td>22-24cm</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>22-26cm</td>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>22-28cm</td>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>22-30cm</td>
<td></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>24-32cm</td>
<td>22-32cm</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>&gt;22cm</td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>26-32cm</td>
<td>24-26cm</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>24-28cm</td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>24-30cm</td>
<td></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>24-32cm</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>&gt;30cm</td>
<td>24-34cm</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>24-36cm</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>&gt;24cm</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>24-34cm</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>24-40cm</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>26-28cm</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>26-30cm</td>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>26-32cm</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>&gt;26cm</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>&gt;26cm</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>28cm</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>28-30cm</td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>28-34cm</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>&gt;28cm</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>&gt;28cm</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>&gt;28cm</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>30-34cm</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>28-44cm</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>32-38cm</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>&gt;40cm</td>
<td></td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

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Table 17 Rim Diameters and Inner Orifice Diameters for Rim Sherds from Yama-2 and Yama-3. Note that rim diameters were not measured on bowl rim sherds. N=145.

<table>
<thead>
<tr>
<th>RD</th>
<th>IOD</th>
<th>BLACK-ON-GRAY BOWLS</th>
<th>PLAIN GRAY JARS</th>
</tr>
</thead>
<tbody>
<tr>
<td>32-40cm</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;32cm</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;34cm</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;36cm</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;38cm</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;46cm</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;24cm</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>&gt;26cm</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>&gt;29cm</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>&gt;30cm</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>&gt;34cm</td>
<td></td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX III

CALCULATIONS FOR GOODMAN AND KRUSKAL'S TAU
<table>
<thead>
<tr>
<th>TEMPER TYPES OF VIRGIN ANASAZI RIM SHERDS FROM YAMA-2 AND YAMA-3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>VEssel FORM</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>BLACK-ON-GRAY BOWL RIM SHERDS</td>
</tr>
<tr>
<td>LIMESTONE</td>
</tr>
<tr>
<td>MIXED SAND</td>
</tr>
<tr>
<td>QUARTZ SAND</td>
</tr>
<tr>
<td>QUARTZ/FELDSPAR</td>
</tr>
<tr>
<td>OLIVINE</td>
</tr>
<tr>
<td>SHERD</td>
</tr>
<tr>
<td>TOTALS</td>
</tr>
</tbody>
</table>

Goodman and Kruskal's Tau for Vessel Form and Temper Type

\[
T = \frac{r}{N - \frac{r}{N}}
\]

\[
\sum_{i=1}^{r} \sum_{j=1}^{c} n_{i,j}^2 = 270^2 + 270^2 + 270^2 + 270^2 + 270^2 + 270^2 + 259^2 + 61^2 + 76^2 + 113^2 + 74^2 + 586^2 + 586^2 + 586^2 + 586^2 + 586^2 = 280.6
\]

\[
\sum_{i=1}^{r} n_{i}^2 = 270^2 + 277^2 + 188^2 + 76^2 + 238^2 + 74^2 = 210.3
\]

\[
T = \frac{280.6 - 210.3}{856 - 210.3} = \frac{70.3}{645.7} = 0.1
\]
### Temper Sorting of Virgin Anasazi Rim Sherds from Yama-2 and Yama-3

<table>
<thead>
<tr>
<th>Temper Sorting</th>
<th>Vessel Form</th>
<th></th>
<th></th>
<th>Row Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Black-On-Gray</td>
<td>Plain Gray Jar</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bowl Rim Sherds</td>
<td>Rim Sherds</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very Well</td>
<td>15</td>
<td>5</td>
<td></td>
<td>20</td>
</tr>
<tr>
<td>Well</td>
<td>44</td>
<td>30</td>
<td></td>
<td>74</td>
</tr>
<tr>
<td>Moderately</td>
<td>58</td>
<td>81</td>
<td></td>
<td>139</td>
</tr>
<tr>
<td>Poorly</td>
<td>153</td>
<td>470</td>
<td></td>
<td>623</td>
</tr>
<tr>
<td>Totals</td>
<td>270</td>
<td>586</td>
<td></td>
<td>856</td>
</tr>
</tbody>
</table>

Goodman and Kruskal's Tau for Vessel Form and Temper Sorting

\[
T_r = \frac{\sum_i \sum_j (N_{ij}^2 - \frac{N^2}{N})}{N - \frac{\sum_i N_i^2}{N}}
\]

\[
T_r = \frac{15^2 + 44^2 + 58^2 + 153^2}{856} - \frac{270^2}{856} = 496.9
\]

\[
T_r = \frac{20^2 + 74^2 + 139^2 + 623^2}{856} = 482.9
\]

\[
T_r = \frac{496.9 - 482.9}{373.1} = 0.04
\]
TEMPer percentages of virgin anasazi rim sherds from yama-2 and yama-3

<table>
<thead>
<tr>
<th>PERCENT OF TEMPER</th>
<th>BLACK-ON-GRAY BOWL RIM SHERDS</th>
<th>PLAIN GRAY JAR RIM SHERDS</th>
<th>ROW TOTALS</th>
</tr>
</thead>
<tbody>
<tr>
<td>10%</td>
<td>5</td>
<td>133</td>
<td>138</td>
</tr>
<tr>
<td>20%</td>
<td>245</td>
<td>320</td>
<td>565</td>
</tr>
<tr>
<td>30%</td>
<td>18</td>
<td>110</td>
<td>128</td>
</tr>
<tr>
<td>40%</td>
<td>2</td>
<td>21</td>
<td>23</td>
</tr>
<tr>
<td>50%</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>TOTALS</td>
<td>270</td>
<td>586</td>
<td>856</td>
</tr>
</tbody>
</table>

Goodman and Kruskal's Tau for Vessel Form and Temper Percentage

\[
T = \frac{\sum_{i=1}^{r} \sum_{j=1}^{c} N_{ij}^2 - \sum_{i=1}^{r} \sum_{j=1}^{c} N_{i}^2}{N - \sum_{i=1}^{r} N_{i}^2}
\]

\[
T = \frac{5 \times 270 + 5 \times 270 + 245 \times 270 + 18 \times 270 + 2 \times 270 + 0 \times 270}{270} = \frac{450.0}{270} = 1.67
\]

\[
T = \frac{0 \times 270 + 133 \times 270 + 320 \times 270 + 110 \times 270 + 21 \times 270 + 2 \times 270}{270} = \frac{414.9}{270} = 1.53
\]

\[
T = \frac{450.0 - 414.9}{856 - 414.9} = \frac{35.1}{441.1} = 0.08
\]
### Temper Angularity of Virgin Anasazi Rim Sherds from Yama-2 and Yama-3

<table>
<thead>
<tr>
<th>Temper Angularity</th>
<th>Vessel Form</th>
<th>BLACK-ON-GREY BOWL RIM SHERDS</th>
<th>PLAIN GRAY JAR RIM SHERDS</th>
<th>ROW TOTALS</th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td>2</td>
<td>4</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>R-SR</td>
<td>16</td>
<td>23</td>
<td></td>
<td>39</td>
</tr>
<tr>
<td>R-SA</td>
<td>14</td>
<td>34</td>
<td></td>
<td>48</td>
</tr>
<tr>
<td>R-A</td>
<td>17</td>
<td>52</td>
<td></td>
<td>69</td>
</tr>
<tr>
<td>SR</td>
<td>6</td>
<td>14</td>
<td></td>
<td>20</td>
</tr>
<tr>
<td>SR-SA</td>
<td>57</td>
<td>64</td>
<td></td>
<td>121</td>
</tr>
<tr>
<td>SR-A</td>
<td>16</td>
<td>104</td>
<td></td>
<td>120</td>
</tr>
<tr>
<td>SA</td>
<td>43</td>
<td>18</td>
<td></td>
<td>61</td>
</tr>
<tr>
<td>SA-A</td>
<td>83</td>
<td>126</td>
<td></td>
<td>209</td>
</tr>
<tr>
<td>A</td>
<td>16</td>
<td>74</td>
<td></td>
<td>90</td>
</tr>
<tr>
<td>AM</td>
<td>0</td>
<td>73</td>
<td></td>
<td>73</td>
</tr>
<tr>
<td>TOTALS</td>
<td>270</td>
<td>586</td>
<td></td>
<td>856</td>
</tr>
</tbody>
</table>

**Goodman and Kruskal’s Tau for Vessel Form and Temper Angularity**

\[ T = \frac{\sum_{i=1}^{r} N_{ij}^2 - \sum_{i=1}^{r} N_i^2}{\sqrt{\sum_{i=1}^{r} N_i^2 \sum_{i=1}^{r} N_{ij}^2} - \frac{1}{r} \sum_{i=1}^{r} N_i^2} \]

\[ T = \frac{128.6 - 115.5}{740.5 - 115.5} = 0.02 \]

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<table>
<thead>
<tr>
<th>TEMPER SIZE</th>
<th>VESSEL FORM</th>
<th>BLACK-ON-GRAY BOWL RIM SHERDS</th>
<th>PLAIN GRAY JAR RIM SHERDS</th>
<th>ROW TOTALS</th>
</tr>
</thead>
<tbody>
<tr>
<td>VERY FINE</td>
<td>2</td>
<td>0</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>FINE</td>
<td>4</td>
<td>3</td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>MEDIUM</td>
<td>41</td>
<td>28</td>
<td></td>
<td>69</td>
</tr>
<tr>
<td>COARSE</td>
<td>117</td>
<td>320</td>
<td></td>
<td>437</td>
</tr>
<tr>
<td>VERY COARSE</td>
<td>102</td>
<td>229</td>
<td></td>
<td>331</td>
</tr>
<tr>
<td>GRANULES</td>
<td>4</td>
<td>5</td>
<td></td>
<td>9</td>
</tr>
<tr>
<td>PEBBLES</td>
<td>0</td>
<td>1</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td><strong>TOTALS</strong></td>
<td><strong>270</strong></td>
<td><strong>586</strong></td>
<td></td>
<td><strong>856</strong></td>
</tr>
</tbody>
</table>

Goodman and Kruskal's Tau for Vessel Form and Temper Size

\[
T = \frac{\sum \sum r_{ij}^2 \cdot N - \sum \sum r_i^2 N}{N - \sum \sum r_i^2 N}
\]

\[
\begin{align*}
\sum \sum r_{ij}^2 &= 2 + 4 + 41 + 117 + 102 + 4 + 0 \\
&= 361.2
\end{align*}
\]

\[
\begin{align*}
\sum \sum r_i^2 N &= 270^2 + 270^2 + 270^2 + 270^2 + 270^2 + 270^2 \\
&= 356.8
\end{align*}
\]

\[
T = \frac{361.2 - 356.8}{856 - 356.8} = \frac{4.4}{499.2} = 0.01
\]
### Temper Types of Mixed Sand, Quartz, and Quartz/Feldspar Tempered Rim Sherds from Yama-2 and Yama-3

<table>
<thead>
<tr>
<th>Temper</th>
<th>Vessel Form</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Black-On-Gray Bowl Rim Sherds</td>
<td>Plain Gray Jar Rim Sherds</td>
<td>Row Totals</td>
</tr>
<tr>
<td>MIXED SAND</td>
<td>18</td>
<td>259</td>
<td>277</td>
</tr>
<tr>
<td>QUARTZ</td>
<td>127</td>
<td>61</td>
<td>188</td>
</tr>
<tr>
<td>QUARTZ/FELDSPAR</td>
<td>0</td>
<td>76</td>
<td>76</td>
</tr>
<tr>
<td>TOTALS</td>
<td>145</td>
<td>396</td>
<td>541</td>
</tr>
</tbody>
</table>

Goodman and Kruskal's Tau for Vessel Form and Temper Types of Sherds with Sand Temper

\[
T = \frac{\sum_{i=1}^{r} \sum_{j=1}^{c} N_{ij}^2 - \left( \sum_{i=1}^{r} N_{i.} \sum_{j=1}^{c} N_{.j} \right) / N}{\sum_{i=1}^{r} N_{i.}^2 / N - \left( \sum_{i=1}^{r} N_{i.} \right)^2 / N}
\]

\[
\sum_{i=1}^{r} \sum_{j=1}^{c} N_{ij} = 18^2 + 127^2 + 0^2 + 259^2 + 61^2 + 76^2 = 306.9
\]

\[
\sum_{i=1}^{r} N_{i.}^2 = 277^2 + 188^2 + 76^2 = 541^2 = 217.8
\]

\[
T = \frac{306.9 - 217.8}{541 - 217.8} = \frac{89.1}{323.2} = 0.3
\]
<table>
<thead>
<tr>
<th>TEMPER SORTING</th>
<th>BLACK-ON-GRAY</th>
<th>PLAIN GRAY JAR</th>
<th>ROW TOTALS</th>
</tr>
</thead>
<tbody>
<tr>
<td>VERY WELL</td>
<td>15</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>WELL</td>
<td>43</td>
<td>29</td>
<td>72</td>
</tr>
<tr>
<td>MODERATELY</td>
<td>54</td>
<td>66</td>
<td>120</td>
</tr>
<tr>
<td>POORLY</td>
<td>33</td>
<td>296</td>
<td>329</td>
</tr>
<tr>
<td>TOTAL</td>
<td>145</td>
<td>396</td>
<td>541</td>
</tr>
</tbody>
</table>

Goodman and Kruskal's Tau for Vessel Form and Temper Sorting of Sherds with Sand Temper

\[
T = \frac{r \sum \sum N_{ij}^2 - (\sum N_i \sum N_j)^2}{N - \frac{\sum N_i^2}{N}}
\]

\[
\sum \sum N_{ij}^2 = 15^2 + 43^2 + 54^2 + 33^2 + 5^2 + 29^2 + 66^2 + 296^2 + 396^2 = 276.4
\]

\[
\sum N_i^2 = 20^2 + 72^2 + 120^2 + 329^2 = 237.0
\]

\[
T = \frac{276.4 - 237.0}{541 - 237.0} = 0.1
\]
TEMPER PERCENTAGES OF MIXED SAND, QUARTZ, AND QUARTZ/FELDSPAR
TEMPERED RIM SHERDS FROM YAMA-2 AND YAMA-3

<table>
<thead>
<tr>
<th>TEMPER PERCENTAGE</th>
<th>VESSEL FORM</th>
<th>BLACK-ON-GRAY BOWL RIM SHERDS</th>
<th>PLAIN GRAY JAR RIM SHERDS</th>
<th>ROW TOTALS</th>
</tr>
</thead>
<tbody>
<tr>
<td>10%</td>
<td></td>
<td>3</td>
<td>98</td>
<td>101</td>
</tr>
<tr>
<td>20%</td>
<td></td>
<td>125</td>
<td>206</td>
<td>331</td>
</tr>
<tr>
<td>30%</td>
<td></td>
<td>16</td>
<td>72</td>
<td>88</td>
</tr>
<tr>
<td>40%</td>
<td></td>
<td>1</td>
<td>18</td>
<td>19</td>
</tr>
<tr>
<td>50%</td>
<td></td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>TOTALS</td>
<td></td>
<td>145</td>
<td>396</td>
<td>541</td>
</tr>
</tbody>
</table>

Goodman and Kruskal's Tau for Vessel Form and Temper Percentage of Sherds with Sand Temper

\[
T = \frac{\sum \sum N_{ij}^2 - \left( \sum \sum N_i \right)^2 / \sum N_i}{N - \frac{\sum \sum N_{ij}^2}{N}}
\]

\[
T = \frac{3^2 + 125^2 + 16^2 + 1^2 + 0^2 + 98^2}{145 + 145 + 145 + 145 + 145 + 396} - \frac{145^2 + 145^2 + 145^2 + 145^2 + 145^2 + 396^2}{145 + 145 + 145 + 145 + 145 + 396}
\]

\[
T = \frac{206^2 + 72^2 + 18^2 + 2}{396 + 396 + 396 + 396} = 254.9
\]

\[
T = \frac{101^2 + 331^2 + 88^2 + 19^2 + 2^2}{541} = 236.4
\]

\[
T = \frac{254.9 - 236.4}{541 - 236.4} = \frac{18.5}{304.6} = 0.06
\]
### Temper Angularity of Mixed Sand, Quartz, and Quartz/Feldspar Tempered Rim Sherds from Yama-2 and Yama-3

<table>
<thead>
<tr>
<th>Temper Angularity</th>
<th>Vessel Form</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Black-on-gray</td>
<td>Plain Gray Jar</td>
<td>Row Totals</td>
</tr>
<tr>
<td>ROUNDED</td>
<td>2</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>ROUNDED-SUBROUNDED</td>
<td>15</td>
<td>23</td>
<td>38</td>
</tr>
<tr>
<td>ROUNDED-SUBANGULAR</td>
<td>13</td>
<td>33</td>
<td>46</td>
</tr>
<tr>
<td>ROUNDED-ANGULAR</td>
<td>8</td>
<td>52</td>
<td>60</td>
</tr>
<tr>
<td>SUBROUNDED</td>
<td>6</td>
<td>14</td>
<td>20</td>
</tr>
<tr>
<td>SUBROUNDED-SUBANGULAR</td>
<td>51</td>
<td>63</td>
<td>114</td>
</tr>
<tr>
<td>SUBANGULAR</td>
<td>38</td>
<td>18</td>
<td>56</td>
</tr>
<tr>
<td>SUBANGULAR-ANGULAR</td>
<td>12</td>
<td>83</td>
<td>95</td>
</tr>
<tr>
<td>ANGULAR</td>
<td>0</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td><strong>TOTALS</strong></td>
<td><strong>145</strong></td>
<td><strong>396</strong></td>
<td><strong>541</strong></td>
</tr>
</tbody>
</table>

Goodman and Kruskal's Tau for Vessel Form and Temper Angularity of Sherds with Sand Temper

\[
\tau = \frac{\sum_{i=1}^{r} \sum_{j=1}^{s} n_{ij}^2 - \frac{\sum_{i=1}^{r} \sum_{j=1}^{s} n_{i.}^2 \sum_{i=1}^{r} \sum_{j=1}^{s} n_{.j}^2}{N}}{N - \frac{\sum_{i=1}^{r} n_{i.}^2}{N}}
\]

\[
\tau = \frac{145^2 + 145^2 + 145^2 + 145^2 + 145^2 + 145^2 + 145^2}{541} - \frac{145^2 + 145^2 + 145^2}{541} = 0.04
\]

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<table>
<thead>
<tr>
<th>TEMPER SIZE</th>
<th>VESSEL FORM</th>
<th>BLACK-ON-GRAY BOWL RIM SHERDS</th>
<th>PLAIN GRAY JAR RIM SHERDS</th>
<th>ROW TOTALS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>MEDIUM</td>
<td></td>
<td>41</td>
<td>22</td>
<td>63</td>
</tr>
<tr>
<td>COARSE</td>
<td></td>
<td>85</td>
<td>262</td>
<td>347</td>
</tr>
<tr>
<td>VERY COARSE</td>
<td></td>
<td>13</td>
<td>109</td>
<td>122</td>
</tr>
<tr>
<td>TOTALS</td>
<td></td>
<td>145</td>
<td>396</td>
<td>541</td>
</tr>
</tbody>
</table>

Goodman and Kruskal's Tau for Vessel Form and Temper Size of Sherds with Sand Temper

\[
T = \frac{\sum_{i=1}^{r} \sum_{j=1}^{c} n_{ij}^2 - \sum_{i=1}^{r} \sum_{j=1}^{c} n_{ij} - \frac{1}{N} \sum_{i=1}^{r} n_{i}^2}{\sqrt{\left(\sum_{i=1}^{r} \sum_{j=1}^{c} n_{ij}^2 - \sum_{i=1}^{r} \sum_{j=1}^{c} n_{ij} - \frac{1}{N} \sum_{i=1}^{r} n_{i}^2\right)}^2}
\]

\[
= \frac{145^2 + 41^2 + 85^2 + 13^2 + 0^2 - (2 + 3 + 63 + 347 + 122) - \frac{3^2}{541}}{\sqrt{\left(145^2 + 41^2 + 85^2 + 13^2 + 0^2 - (2 + 3 + 63 + 347 + 122) - \frac{3^2}{541}\right)^2}}
\]

\[
= \frac{267.3 - 257.5}{\sqrt{283.5}} = \frac{9.8}{16.8} = 0.03
\]
APPENDIX IV

PERMISSION TO CITE
THE STEVE PERKINS UNPUBLISHED MANUSCRIPT
Keith Myhrer
99 ABW/EM
4349 Duffer Drive Suite 1601
Nellis AFB, NV 89191-7007

10 Feb, 1997

Lori Perry
2610 Belcastro Street
Las Vegas, NV 89117

Ms Perry,

This letter concerns your request to reference a manuscript report I completed in 1987, titled *Archaeological Investigations at the Steve Perkins Site*. I provide complete approval to cite or discuss the manuscript. I wish you success on your research project.

Sincerely,

Keith Myhrer
Base Archaeologist
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Myhrer, Keith

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Orton, Clive, Paul Tyers and Alan Vince
Peterson, Richard

Peterson, Richard and Susan Peterson

Pettijohn, F.J., P.E. Potter and R. Siever

Rice, Prudence M.

Rye, O.S.

Shutler, Richard, Jr.

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Thesis Title:
A Comparison of Temper Characteristics Between Virgin
Anasazi Black-on-gray Bowl Rim Sherds and Plain Gray
Jar Rim Sherds from Yama-2 and Yama-3

Thesis Examination Committee:
Chairperson, Dr. Margaret Lyneis, Ph.D.
Committee Member, Dr. Martha Knack, Ph.D.
Committee Member, Dr. Alan Simmons, Ph.D.
Graduate Faculty Representative, Dr. Hal Rothman, Ph.D.