Multi-analytical Residue Analysis of the Trihedral Adze: A case Study for the Introduction of new Methodologies in Boreal Forest Archaeology

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Submitted to the Faculty of Graduate Studies in Partial Fulfillment of the Requirements for the Degree of Masters of Environmental Studies in Northern Environments and Cultures

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ABSTRACT

This thesis aims to evaluate the use of multi-analytical residue analysis in archaeological investigations in the Boreal Forest through the examination of a specific artifact class – the trihedral and related adze tool types recovered from the Thunder Bay District and surrounding regions. The trihedral adze has not yet been confidently attributed to any specific cultural period in the pre-history of the Thunder Bay region. It is hoped that a detailed analysis of this artifact type may provide insight into tool use, and allow it to be attributed to a specific culture. This work also addresses the feasibility of the analytical approach.

Methods employed include microscopy, biochemical and analytical chemical techniques with the research being approached using the *Archaeological Biomarker Concept* and the *Artifact as Site Concept*. Combining these approaches involves examining the artifact independent of the site using the methods noted above to determine the chemical nature of any residues, thereby allowing for an identification of residue source.

The methods employed were successful in identifying tool use. The findings of this research indicate the adzes were employed in the processing of conifer trees, at least some of which were treated with a controlled use of fire. This practice is consistent with the production of dugout canoes. At least one secondary tool use as a butchering tool was noted on one artifact. In addition to determining tool use these findings allow for the determination of site activities at archaeological sites which have not yet been excavated.

ACKNOWLEDGMENTS

I must begin this by thanking my supervisor, Dr. Carney Matheson (Dept. of Anthropology, Lakehead University). I arrived at Lakehead with a very narrow view of the possibilities available to me. You not only introduced me to a world of new research potential but also a plethora of unforeseen directions life could take me, and for that I will always be in your debt.

My committee members Dr. Scott Hamilton (Dept. of Anthropology, Lakehead University) and Dr. Matthew Boyd (Dept. of Anthropology, Lakehead University) also deserve a great deal of the credit (and a lot of thanks) for helping me see this thesis through to completion. Scott, you helped me grasp the true implications of my work and provided me with some needed perspective as well as lending moral support during times of doubt. Matt, your feedback helped me understand the importance of focus and refinement while producing this thesis. I also must thank my external committee member, Jean-Luc Pilon (Canadian Museum of History), for his guidance and input.

I must also thank all the faculty of Lakehead University's Anthropology Department and the NECU program for the countless instances of assistance you granted me throughout my time at Lakehead. A special thanks must go to Clarence Surette (Dept. of Anthropology, Lakehead University) for his tireless assistance in locating collections, accessing equipment and providing feedback.

Thank you to the avocational archaeologists Harold Alanen, Oliver Anttila, Terry Wilson and Brad Hyslop for making your personal collections available for my research. I appreciate the trust you showed me in placing your collections in my stewardship. I also must thank Paige Campbell for providing me access to artifacts in the possession of the Ministry of Tourism,

Culture and Sport. I hope these kinds of partnerships can continue to grow to the benefit of all archaeologists.

A huge thank you to all my fellow students, both graduate and undergraduate students alike. So many of you offered friendly advice, encouragement and commiseration or at the very least listened patiently to my ramblings and complaints. It is because of your support and sense of community that I leave with my sanity (mostly) intact.

The final group I need to thank are all my friends and family back home. Regardless of how stressful or overwhelming things seemed I always had an amazing group of people backing me. Vic, thanks for the walks, the talks and all the parallels. A final and very profound thank you goes to my parents, Jill and David Cook. Regardless of what 'great' idea I came up with you always supported me (including that time near the supposed end of my undergraduate degree that I suddenly decided I wanted to be an archaeologist). There is no way I would have made it half this far without you.

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Chapter 1 INTRODUCTION

1.1 BACKGROUND

Since the 1960s, with the beginning of Processualist Archaeology, there has been a growing acceptance and use of scientific methods in addressing archaeological problems. This has involved the adoption of conceptual testing frameworks involving 'null and alternate' hypotheses, the widespread use of sampling and statistics, and extended to the utilization of scientific methodologies and instrumentation. This has been a crucial factor in the development of the field of Archaeology and will likely continue.

Unfortunately the introduction of new methods can be plagued by uncritical integration of incompletely understood methodologies and over-enthusiastic interpretations of data without due regard to inherent limitations of the methods. Any application of new and innovative methods to a discipline must involve a critical evaluation of its efficiency and resolution of precision as part of its acceptance as a standard analytical approach.

This thesis aims to evaluate the introduction of multi-analytical organic residue analysis utilizing the *Archaeological Biomarker Concept* (Evershed 2008) and the *Artifact as Site Concept* (Loy 1993) into archaeological investigations in the Boreal Forest context. *The Archaeological Biomarker Concept* (Evershed 2008) will use microscopic, biochemical and analytical chemical methods to characterize organic residues based on their specific chemical composition. This study is not the first example of residue analysis undertaken in the Thunder Bay region (e.g., Newman and Julig 1989), but will focus on evaluating the methods to show both the use and limitations that must be considered. The research will also be conducted using the theoretical model of the *Artifact as Site Concept* (Loy 1993), using all available evidence gained from artifact analysis to assist in interpreting sites where only surface collections have

been gathered as well as gaining analytic insight into artifacts with lost or compromised provenience.

This will be accomplished through a case study involving the organic residue analysis of trihedral and related adzes recovered from the Thunder Bay District and surrounding regions. The tool type has not yet been recovered from a securely dated context and no direct evidence as to the specific use of the tool type has yet been discovered. This has resulted in a lack of evidence to place it within the cultural historical context of the region (Arthurs 1997). Fox (1980) proposed a hypothesis that the trihedral adze may reflect the development of a dugout canoe industry related to the arrival of *Pinus stobus* (Eastern White Pine) during the Hyspithermal, a period of climactic warming which began approximately 6,000 cal yr BP. Because we have a sense of when such tree species entered the pollen record, the successful speciation of organic residues deriving from such tools might help refine our understanding of the time frame for the production and use of this form of stone adze tool.

The artifacts examined, primarily collected as surface finds, have remained in private, university or government collections for years, and have been subjected to various degrees of cleaning and handling. Combined with the harsh taphonomy of the region this means that the tools examined in this study represent a kind of worst case scenario for residue analysis, and will help to further highlight the limitations and utility of the methodology.

The Boreal Forest can, to some degree, be considered an archaeological nightmare. The sheer size of the region, harsh taphonomic conditions, poor stratigraphy and a lack of development and funding have severely impeded archaeologist's efforts to resolve the cultural history of the region. This is most prominent with regards to the pre-ceramic Paleoindian and Archaic cultures for which only a limited collection of stone artifacts has been recovered. This

has, for many years, acted as an additional barrier to the research efforts of regional archaeologists.

Residue analysis has the potential to provide information not previously available to researchers and can be employed on artifacts already recovered and currently part of collections. The use of these methodologies has in the past allowed for the confirmation or rejection of archaeological hypothesis based on previously unattainable data (Evershed et al 1997; Buckley and Evershed 2001; Craig *et al.* 2003; Colombini *et al.* 2005; d'Errico *et al.* 2012). This case study may provide us with a similar opportunity. Using the *Archaeological Biomarker Concept* (Evershed 2008) I will attempt to identify the source of any identified residues to the highest resolution possible. This will be accomplished by determining the specific chemical composition of any identified residues, and using the occurrence of order/genus/species specific compounds to assign as specific a source for the residue as is possible.

The *Artifact as Site Concept* (Loy 1993) will be used to assign site and regional level interpretations of the data collected through residue analysis. The majority of tools in this study were recovered as surface finds from archaeological sites that will likely remain unexcavated for the foreseeable future. The *Artifact as Site Concept* (Loy 1993) operates on the knowledge that an extensive investigation of recovered artifacts can provide detailed information on site function regardless of whether a traditional excavation has been conducted.

1.2 THE TRIHEDRAL AND RELATED ADZES TYPOLOGIES

1.2.1 Physical description

These stone artifacts are generally interpreted as coarsely flaked tools that were either employed as hand tools or hafted to handles with a unifacially chipped working edge. The ventral surface is generally flat, with the ventral surface of some examples being formed from a fault plane within the original stone block from which the tool blank was detached. This

generally has the effect of creating a nearly flat surface for hafting (see figure 1.1 A). The ventral surface of other examples were formed via flaking with the manufacturer attempting to create a flat surface to facilitate hafting. The dorsal surface was formed through bifacial flaking, leaving a dorsal ridge that varies in distinctiveness between artifacts. Some examples have had a single long flake removed from the dorsal surface, obliterating the top most portion of the dorsal ridge. The cross section of the tools ranges from trihedral (examples with distinct dorsal ridges) to quadrahedral (examples with flake removing the dorsal ridge) (see figure 1.1). It is yet unclear if this morphological range represents varying tool roles or an evolution of the tool over time (McLeod 1978).

This study focused on adzes that loosely fit within the description for trihedral adzes recovered from the Thunder Bay District and some surrounding area. All adzes analyzed exhibit clearly defined dorsal and ventral surfaces. The majority of the tools are typically long and thin, with a few exceptions deviating from this trend. The majority of examples examined by Arthurs (1997) and Fox (1980) tend to cluster between 8.5 and 16.5cm in length, although a small number are extremely long (26cm and 21cm) by comparison (Arthurs 1997).

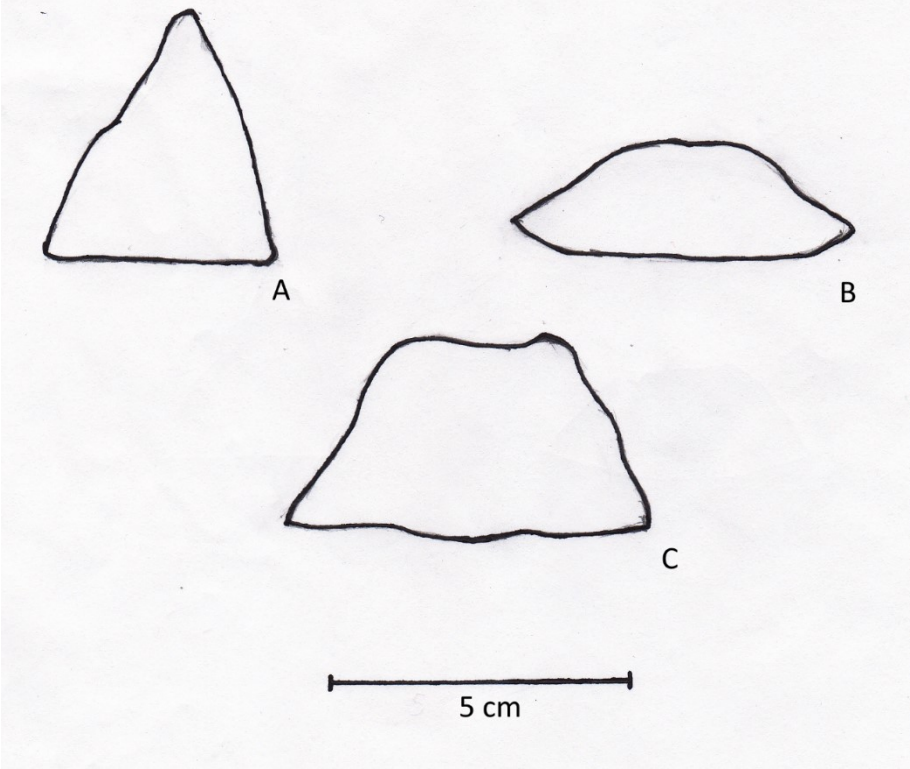

Figure 1.1 Variation of cross sections of adzes examined in this study
A) Artifact DeJj-2(3), a trihedral adze as defined by Fox (1980), B) Artifact DeJj-4(4), a quadrahedral adze as described by McLeod (1978) with the dorsal ridge removed by a single flake. C) Artifact DeJj-4(5), a quadrahedral like adze with dorsal ridge removed by multiple flakes.

1.2.2 Current Published Interpretations

Fox (1980) published the first report dealing almost exclusively with the trihedral adze. In it, he hypothesized that its appearance may coincide with the northern maximum extent of *P. strobus* that is thought to have occurred during the rise of temperature and decrease in precipitation during the Early Holocene. Other interpretations (Buchner 1980; Arthurs 1997; Mcleod 1980) generally come to the same conclusion as Fox (1980), with the presence of the tool type being attributed to the appearance of a watercraft industry, potentially utilizing *P. strobus* as a natural resource. Although these interpretations seem plausible, there is no direct association observed within the archaeological record.

1.2.3 Dating

In the Thunder Bay and surrounding regions no trihedral or related adze has yet been recovered from a dated context. Most have been found as surface collections, while the remainder were recovered from unstratified multicomponent sites, or contexts not associated with any identifiable tool tradition.

In Manitoba the trihedral adze has been identified as a diagnostic object associated with the Caribou Lake Complex, which Buchner (1984b) associates with a Late Paleoindian/Early Archaic transitional culture. Radiocarbon dates from Caribou Lake Complex sites have been inconsistent (Buchner 1984b) but it is still possible to assign an approximate date to the complex, using a deductive 'process of elimination' approach. Artifacts are always recovered on or above lacustrine clay deposits, indicating that they were deposited as Glacial Lake Agassiz was declining. This suggests a date no later than approximately 9,000 yr BP. Stratigraphically, Caribou Lake Complex artifacts are directly below those of the Oxbow Complex which has been dated to 4,900-4,700 yr BP, providing a minimum age. The morphology of Caribou Lake Complex points indicates they may directly pre-date those of the Logan Creek type, assigning an average age of approximately 7,000 yr BP. Based on these associations, Buchner (1979) assessed the age of the Caribou Lake Complex as existing sometime between 9,000 and 5,000 yr BP.

The majority of the Caribou Lakes Complex sites are located at low elevations, with the central regions of many large sites inundated with water, indicating they were inhabited during a period of low water levels. The common association between sites and water levels indicates the Caribou Lake Complex inhabited the region during the period of peak temperature and aridity in the Early Holocene (Buchner 1979). This is essentially consistent with Fox's (1980) proposed time frame for the introduction of the trihedral adze.

A similar 'process of elimination' approach has been attempted in Thunder Bay and surrounding regions (McLeod 1978). This approach primarily relied on artifact distributions in relation to known glacial and hydrological features which will be discussed in greater detail in Chapter 2. The minimum age determined in this dating is based on the fact that no trihedral adze has been recovered from a secure context within a Lake Minong beach. While several have been recovered at sites associated with Minong beaches, they have either been collected as surface finds or found in an unsecure context. These beaches are dated to 9,500-8,500 BP, providing an apparent minimum age similar to the Caribou Lake Complex (McLeod 1978). However a lack of association is not definitive, as the absence of evidence should not be considered as evidence. No adzes have yet been recovered from the shores of Nipissing phase beaches, apparently providing a minimum age of approximately 5,500 yr BP (McLeod 1978). However, this once again does not explicitly prove a minimum age as a lack of data cannot be used as data in such an interpretation. As a result, this tool type has not at this point been assigned a confident date range in Ontario.

The best current date given to the trihedral adze in Ontario comes from the Allen Site (EcJs-1), located on the shores of Fairchild Lake, north east of Lac Seul (Pilon and Bona 2004). Several trihedral adzes and adze fragments were recovered from surface collections along the lake shore. Excavations of the area identified two periods of habitation. The most recent occupation included ceramic artifacts while a much earlier stratigraphic later contained only lithic artifacts including lanceolate point fragments. Charcoal fragments from this layer dated to 8, 050 ± 80 yr BP and 8160 ± 80 yr BP (Pilon and Bona 2004). While this charcoal was not directly linked to the earliest occupation it is considered a confident indicator of the age of the stratigraphic layer from which the tools were excavated. The adzes cannot be directly associated

with these dated lithics due to their recovery during surface collections, however the only other cultural component identified at the site contained ceramics (Pilon and Bona 2004). The use of flaked stone wood working tools are known to pre-date the introduction of ceramics, eliminating any chance of association between the adzes and this occupation. It has been proposed that the adzes may represent a portion of the site which was eroded due to rising water levels and are therefore potentially associated with the dated layer (Pilon and Bona 2004). If this association proves true and if the dated charcoal is indicative of the early occupation it would assign an approximate date of 8, 000 yr BP to the tool type.

If these tools can be directly associated with the arrival of *P. strobus* it may be possible to assign a directly associated approximate date. Pollen records suggest *P. strobus* entered the region approximately 6, 500 yr BP (Bjork 1984). While this is not a precise system of dating it would provide a greater level of resolution than has been previously attainable.

1.3 DISTRIBUTION/AREA OF STUDY

The study area reflects the presently reported distribution of the trihedral and related adzes in the Thunder Bay District and surrounding regions. In Ontario, these adzes have been found as far west as Lac Seul, but it likely the distribution continues to the border with Manitoba, due to their association with the Caribou Lake Complex (Buchner 1984). The artifact type has also been recovered north east of Lac Seul from the shores of Fairchild Lake, marking the northern most known example in Ontario (Pilon and Bona 2004). The tool type has been found as far east as French River, north of Georgian Bay (Arthurs 1997). A single adze has been recovered from Turkey Lake, east of Lake Nipigon and appears to extend the distribution of this tool to include the eastern Lake Nipigon watershed (Arthurs 1997). Dog Lake, located

approximately 50km north of Thunder Bay, has the highest concentration of adzes in the region. McLeod (1981) reportedly collected 53 adzes from 11 sites located on the lake.

The high concentration of artifacts at this single location may be the result of sampling bias given the relatively recent erosion of the lake shore due to hydroelectric development and a local tradition of artifact surface collection. Other finds have been generally scattered with relatively few adzes being attributed to single sites. It is possible that a high concentration of adzes may be located in the Lake of the Woods region due to its central placement along the regional watercourse and the existence of lithic sources related to many adze specimens (Arthurs 1997). It is proposed that concentrations of adzes may be associated with available tree resources, especially given their functional association as woodworking tools (Arthurs 1997).

Outside of Ontario the trihedral adze is found as a diagnostic component of the Caribou Lake Complex of Eastern Manitoba. Other examples of tools matching the description of the trihedral adze have been identified at sites in Northern Manitoba and Nunavut, associated with the AgateBasin and Paleoeskimo tool traditions (Nash 1969; Wright 1976). A single artifact of similar description was recovered from Blood Falls Nunavut, approximately 10km from shore of the Arctic Ocean (McGhee 1970). The trihedral adze has also been identified in Minnesota as a component of the Reservoir Lakes Complex with dates possibly similar to that of the Caribou Lakes Complex.

Figure 1.2 Known distribution of trihedral and related adzes in Ontario (Image modified from Google Earth, 2015)

1.4 REGIONAL LIMITATIONS

This study seeks to assess the utility of new methodologies to help overcome some of the limitations inherent in Boreal Forest archaeological investigations. The primary restriction is the limited amount of archaeological research and publication. This derives from the enormity of the region, coupled with logistical difficulties and a lack of development stemming from low population density. The issue is exacerbated by the poor organic preservation inherent to the region's podzolic soils coupled with slow sediment accumulation that are subjected to severe bioturbation. These daunting challenges have contributed to a primary focus upon exploratory research and have produced a severe sample bias. Not surprisingly these difficult challenges tend to be persistent.

1.4.1 Regional Size and Sample Bias

Much of the region surrounding the Thunder Bay District is underdeveloped and as a result difficult to access. This is a problem common to the Boreal Forest environment. In many cases archaeological sites are inaccessible by road, creating a unique set of logistical challenges compounded by rugged topography, dense forest cover and abundant wetlands (Hamilton 2013). The isolation and under developed of the region has led to limited research and documentation of the archaeological record.

The Boreal Forest region of Canada also suffers from sampling bias. It has been assumed in the past that sites in the Boreal Forest as a whole (including the Thunder Bay region) tend to be both sparsely distributed along the region's water ways. This created a situation where, for many years, archaeologists only looked for shoreline occupations and as a result found only that (Reid 1988). This paradigm unfortunately dominated the region for several decades (Reid 1988; Hamilton 2013). These practices, combined with the difficult conditions resulted in sparse data collection and publication, creating a void in the information that would generally help the analyses of the region to move forward (Reid 1988; Hamilton 2013). Most regional archaeologists have moved away from this paradigm and are beginning to develop methods of investigation tailored to the specific needs of the region. It is hopeful that the methods proposed in this thesis will offer another tool to assist researches in making up for the lack of data.

1.4.2 Taphonomy

The Boreal Forest archaeological record experiences some of the harshest taphonomic conditions in Canada. Subarctic Canada (included the Boreal Forest) experiences an intense continental climate, with generally severe freeze/thaw cycles further compounded by strongly acidic soils and repetitive and cyclical forest fires which commonly occurred before modern fire

control practices. Most Boreal Forest soils are classified as podzolic (Natural Resources Canada 2014). These soils are created by the decomposition of tree litter in cool and damp conditions, and are strongly acidic under coniferous forest litter. These acidic breakdown products are leached through the soil by water, altering the pH of the underlying matrix, and consuming organic materials as well as some mineral compounds (Spaargaren 2014). Thus, macroscopic organic remains are often subjected to rapid post burial decomposition, leaving only lithic, ceramic or cupric artifacts. This chemical degredation is particularly severe with Paleoindian and Archaic sites with a few limited exceptions (Hinshelwood and Webber 1987).

1.5 SUMMARY

This research evaluates the capabilities of multi-analytical organic residue analysis in Boreal Forest contexts through the analysis of the trihedral adze artifact type. This tool type has been recovered from the Thunder Bay District and some surrounding regions but has not yet been clearly associated with a specific archaeological context. The combination of harsh taphonomy and sampling bias means that the archaeological record of the Thunder Bay region is poorly understood. One strategy for addressing and resolving some of these problems might involve innovation and adaptation of methods, including organic residue analysis.

Chapter 2 DEGLAGICATION, HYDROLOGICAL AND ENVIRONMENTAL HISTORIES OF NORTHWESTERN ONTARIO

2.1 DEGLACIATION

The deglaciation of Northwestern Ontario began after the post-Valderan advance phase that marked the end of the last glacial maximum. At this point the Laurentide Ice Sheet (LIS) began a process of recession and re-advance that would eventually lead to the full deglaciation of Northwestern Ontario (Farrand and Drexler; 1985). It is difficult to confidently provide a chronology of early glaciation due to a lack of associated organic material available for dating (Brackenridge *et al.* 2004; Loope 2006). The glacial movements dating to the early Holocene have proven easier to document due to the deposition of associated recessional or end moraines. These have been dated using basal organic remains recovered from lake cores directly associated with the moraines (Lowell *et al.* 2009; Björck 1985; Loope 2006) and have been used in tandem with data collected from the cutbanks of several rivers (Loope 2006). These data appear to indicate that approximately 12,000 cal yr BP, prior to the Marquette re-advance, a large area to the north and west of Thunder Bay was deglaciated.

Around 11,500 cal yr BP the Marquette re-advance cause a re-expansion of the LIS (Teller and Thorleifson 1983). At this time the ice sheet re-occupied a large portion of the Lake Superior Basin, extending as far south as Duluth, Minnesota and east into Wisconsin and Michigan (Farrand and Drexler 1985). The timing of this re-advance and subsequent recession is indicated by the position of end moraines (Farrand and Drexler 1985) and dated by organics obtained at Gribben Lake Forest, an ancient forest buried by glacial action in Northern Michigan (Lowell et al 1999).

The relatively intact nature of this forest, and the means by which it was buried, indicates that it is likely the furthest southerly extent of the Marquette re-advance in Michigan. The Grand Marais I moraine has been directly associated with the burial of Gribben Lake Forest and can be traced from Marquette, Michigan, east and north to the vicinity of Sault St. Marie (Lowell et al 1999). In Northwestern Ontario the extent of the Marquette re-advance is identified by the location of the Marks, Lac Seul and Kaiash moraines (Lowell et al 2009). At this time Thunder Bay was likely covered by the glacier related to the advance. Any evidence indicating whether the area has been previously de-glaciated has been destroyed (Phillips 1993). An analysis of cutbanks from the Kaministiquia and Whitefish Rivers, and lake cores from Echo and Mokomon lakes, indicate that the area directly west of Marks morain may have been glacier free prior to the Marquette re-advance (Loope 2006). While still hypothetical, if these results prove accurate this may indicate that the LIS only advanced 50km in the Thunder Bay region, potentially due to the depth of Lake Superior hindering its expansion (Loope 2006).

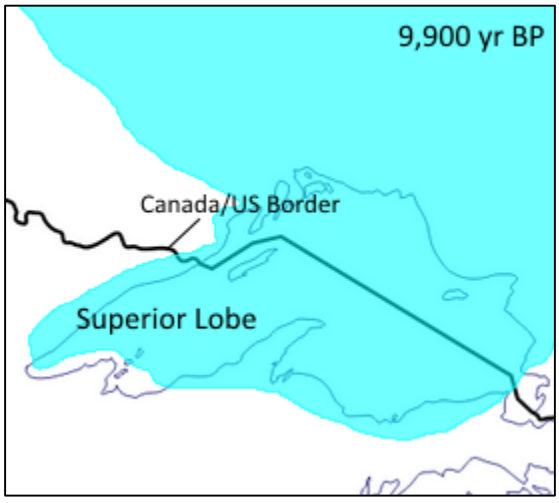

Figure 2.1 Extent of the Marquette Re-advance (modified after Farrand and Drexler 1985: 21)

The LIS retreated rapidly following the Marquette re-advance (Slattery *et al.* 2007; Loope 2006). It appears the ice sheet may have retreated from the southern portion of the Lake

Superior Basin, in Michigan, Wisconsin and Minnesota, to the northern extent of the basin, east of Lake Nipigon, in approximately 500-1500 years (Clayton 1983; Farrand and Drexler 1985). The Thunder Bay region appears to have been exposed by approximately 10,700 cal yr BP. This conclusion is based on radiocarbon dates recovered from wood samples found at the base of a relic Lake Minong beach which formed as the LIS receded north (Julig *et al.* 1994). By 9,200-8,900 cal yr BP the LIS had vacated Northwestern Ontario, stalling briefly during periodic advances and retreats (Prest 1970).

2.2 PALEOHYDROLOGY

2.2.1 Lake Agassiz

The process of de-glaciation produced an abundance of melt water. This resulted in the creation of a series of glacial lakes that corresponded with the stages of the retreating LIS. Lake Agassiz, began forming approximately 14,000 cal yr BP (Bajc *et al.* 2000). Lake Agassiz persisted for approximately 5,000 years and covered a large expanse including Northeastern Saskatchewan, a large portion of Manitoba and Northwestern Ontario, and extended as far south as Minnesota and North Dakota (Teller *et al.* 2005; Boyd 2007). The extent of Lake Agassiz shifted as the LIS retreated, creating different avenues for water to drain. One possible avenue, which may have persisted until Lake Agassiz water level began to recede, was the Lake Superior Basin (Teller *et al.* 2005).

Figure 2.2 Lake Agassiz Drainage.
NW= Northwest outlet, S= Southern outlet, HB= Hudson Bay outlet, KIN= Kinjevis outlet, E= Eastern outlet through the Nipigon basin, K= Eastern outlet through Thunder Bay region (modified after Leverington and Teller 2003)

2.2.2 Post Marquette Lake Superior Basin Phases

Following the Marquette re-advance the Lake Superior Basin underwent a series of glacial lake phases. The first, Lake Duluth, was situated in the southwestern arm of the Lake Superior Basin. The western basin underwent a series of successive phases with Lake Duluth being replaced by Lake Washburn that was, replaced by Lake Beaver Bay; the first glacial lake to reach Northwestern Ontario.

Perhaps the most well-known of the post-Marquette glacial lake phases was Lake Minong. It formed initially in the southeastern portion of the Lake Superior Basin approximately 11,300 cal yr BP, and eventually became the first glacial lake to occupy the entire Lake Superior Basin. Radiocarbon dates have been recovered from the base of a core from Cummins Pond (approximately 10,500 cal yr BP) in Northwestern Ontario (Julig *et al.* 1990), from the base of a

relic Minong beach near Rosslyn village (approximately 10,700 cal yr BP) in Northwestern Ontario (Zoltai 1965) and the base of a Lake Minong beach (approximately 10,600 cal yr BP) at Grand Marais in Minnesota (Drexler *et al.* 1983). All dates indicate the initial establishment of the Lake Minong beach ridges occurred prior to 10,500 cal yr BP. The Lake Minong shoreline is approximately 40m above modern day Lake Superior, with this level varying due to the effects of isostatic rebound (Booth *et al.* 2002) and likely underwent fluctuations throughout its existence, primarily due to changes in drainage and landscape alteration through isostatic rebound (Julig *et al.* 1990). Archaeologically, Lake Minong may be considered the most important of the glacial lakes due its association with the earliest presently recorded human occupation within Northwestern Ontario.

2.2.3 Houghton Low Phase

At about 9,000 cal yr BP the water levels in the Lake Superior Basin reached their lowest point, known as the Houghton Low Phase. The timing of the phase is identified by radiocarbon dating performed on organic samples from Lakes Crozier and Fenton in the eastern basin (Saarnisto 1975), samples recovered from cutbanks of the Kaminisitqua River (Loope 2006) and deltaic deposits near Marathon Ontario in the western basin (Bajc *et al.* 1997). All dates indicate that the water levels reached their lowest point around or slightly before 9,300 cal yr BP. This age appears to be supported by the cessation of varve deposits in the western basin approximately 9,000 cal yr BP (Brackenridge 2007). It appears a number of factors impacted both the inflow and outflow of water in the Lake Superior Basin, leading to the Houghton Low. A discharge of water from Lake Agassiz into the Lake Superior Basin may have eroded the Nadoway Point Sill, connecting the Superior and Huron Basins, causing an increased flow of water out from the Lake Superior Basin. Lake Agassiz's drainage appears to have then shifted

away from the Lake Superior Basin and begun flowing north of the Great Lakes (Farrand and Drexler 1985). Declining lake levels in the Superior Basin appear to have been further impacted by the onset of a more arid climate (Boyd et al 2012).

The special extent of the lake deriving from these low water levels is not confidently known in all parts of the basin. Estimates of the total reduction vary from 13m (Fisher and Whitman 1999) to 1m (Yu et al 2010). Radiocarbon dates recovered from submerged organic materials in the Thunder Bay region indicate that Lake Superior ceased draining approximately 8,900-9,000 cal yr BP (Boyd et al 2012). In the southern portion of the basin it appears water levels may have been much lower than the modern shoreline. A buried deposit from the Apostle Islands in Wisconsin suggests the water level there was approximately 16.5m below modern levels while radiocarbon dates from deposits on the Keweenaw Peninsula indicate water levels that far south may have been up to 60m below current levels (Farrand 1960). This large discrepancy is likely due to uneven rates of isostatic rebound (Farrand 1960).

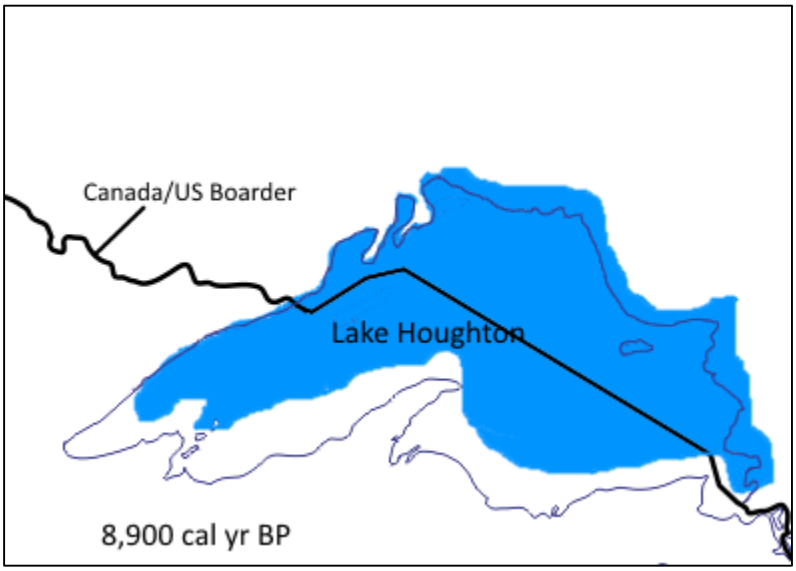

Figure 2.3 Estimated Lake Houghton water levels at 8,900 cal yr BP (modified after Hamilton 1996)

2.2.4 Nipissing Transgression

As isostatic rebound continued to raise the elevation of northern latitudes, the North Bay outlet flow ceased, creating a new high water phase in the Upper Great Lakes (Fisher and Whitman 1999; Tellar 1985). Uneven rates of rebound caused a backup of water in Lakes Superior, Michigan and Huron as the Port Huron outlet was not yet able to drain into Lake Erie (Farrand and Drexler 1985).

Researchers have divided the transgression into two stages, the Nipissing I and Nipissing II. There is some discussion regarding the exact dating of the Nipissing I with researchers placing the transgression between 5,500-4,700 cal yr BP (Larson 1985) and 6,800-5,700 cal yr BP (Booth *et al.* 2002) with water levels similar to modern elevations or approximately 13m above modern respectively (Larson 1985; Booth et al 2002). The Nipissing II is thought to have occurred between 4,700-4,200 cal yr BP with a slight increase in water levels (Larson 1985). Regardless of the timing and levels of the initial rise, the influx of water would have been enough to submerge shorelines established in the Houghton Phase (Farrand 1960).

The Nipissing Transgression ended approximately 4,500 cal yr BP, with water levels decreased as Lake Huron began to drain into Lake Erie (Johnson *et al.* 2004).

2.2.5 Post Nipissing

Two additional phases, the Algoma and Sault, have been identified post Nipissing. The Algoma phase, which occurred approximately 3,500-2,300 cal yr BP saw a further decrease in water, from Nipissing levels, of approximately 4m (Baedke *et al.* 2004). The Sault Phase occurred approximately 2,200 cal yr BP and marks the point at which Lake Superior and Huron separated. Isostatic rebound raising the Sault St. Marie outlet, leaving the St. Mary River channel as the outflow of Lake Superior. (Farrand 1960; Farrand and Drexler 1985; Johnston *et al.* 2004).

2.3 ENVIRONMENTAL HISTORY

An understanding of the paleo-environmental history of Northwestern Ontario is important as this thesis seeks to assign an approximate date range to the production and use of flaked stone adzes in Northwestern Ontario based on organic residues associated with the exploitation of a specific tree species. The climatic and environmental history of the region is marked by a series of fluctuations as the global climate stabilized in the wake of the Pleistocene-Holocene transition. The majority of this fluctuation appears to be related to a 1,500 year long climate cycle causing global temperature fluctuations as recorded in Greenland ice cores (Broecker 2000).

The global climate began to warm following last glacial maximum, becoming warmer, damper and eventually resembling modern climates (Broecker 2000; Jackson *et al.* 1997). Isotope records of sediment cores taken from Crawford Lake in Southern Ontario indicate that the warming trend began between 14,400-12,900 cal yr BP (Yu and Eicher 1998). With post-glacial warming, spruce (*Picea*) populations went into decline when warm-adapted plant species began to appear (Wright 1974; Birks 2003). In Northwestern Ontario deciduous tree pollen from the ash (*Fraxinus*), oak (*Quercus*) and elm (*Ulmus*) genera begin to appear in lake and pond core records (Baker 1963; Birks 2003). The concentration of these species is low, but is consistent over the time period. However, this pollen may represent long-distance transport since no macroscopic remains related to these genera have been recovered and pollen has been shown to travel great distances by air current (Yu 2003). Perhaps the regional climate remained too cold for them to survive (Birks 2003).

Around 12,900 cal yr BP the Younger Dryas period began. This was marked by a decline in temperature of approximately 3°C and was likely the cause of the Marquette glacial re-advance (Farrand and Drexler 1985; Teller and Thorleifson 1983; Yu *et al.* 1998). In

northwestern Ontario pollen from deciduous genera disappears from the pond and lake core records and there is a marked rise in the Cyperaceae and Graminae families of grasses as well as the Compositae family of wildflowers and the *Picea* and *Salix* genera of tree/shrub. This would appear to indicate that the region transitioned into a shrub tundra environment (Björck 1985). As the LIS retreated from the region we again see a decline in grass pollen and the rise in *Picea* and *Betula* both boreal related tree genera, beginning approximately 10,100 cal yr BP. This is consistent with a rise in temperature and precipitation that would again bring climatic conditions to essentially modern levels (Bjorck 1985).

This period was eventually followed by the Hypsithermal, suggested by pollen recoveries which indicate a notable increase in temperature and a decline in precipitation. This drying period appears to have begun in the High Plains around 17,200 cal yr BP before time-transgressively spreading to the region's peripheries (Williams *et al.* 2010). The trend suggests shifting conditions spreading from west to east, finally occurring in the Mid-West between 6,300-3,200 cal yr BP (Webb III *et al.* 1983; Baker *et al.* 1992). At its peak, the temperature may have increased by as much as 6°C, although fluctuations likely occurred throughout the period (Yu *et al.* 1997).

The presence of the LIS meant that northern latitudes experienced a delay in the onset of the Hyspithermal, limiting the timeframe in Northeastern Ontario to 7,800-3,200 cal yr BP (Wright 1983; Liu 1990). Influence from the LIS also altered the overall effect of the Hypsithermal with summer temperatures likely remaining cool (Wright 1983). The warmer average temperatures during the Hypsithermal allowed many southern species to reach their furthest northern extent. Pollen records indicate that the Great Lakes-St. Lawrence forest may have penetrated as far as 140km past its current limits into Northwestern Ontario (Liu 1990).

Some individual species, such as *P. strobus* may have moved as far as 150-200km north (Björck 1985).

The history of environmental change in Northwestern Ontario has seen notable fluctuations. The early-mid Holocene saw climatic fluctuations on a global scale that were compounded in Northwestern Ontario by the proximity of the LIS. The first humans occupying the region following the Marquette re-advance would have needed to respond to the climatic and environmental changes, altering their life ways and material culture.

Chapter 3 CULTURE HISTORY

3.1 FIRST HUMAN OCCUPATION – LATE PALEOINDIAN, PLANO TRADITION

While it can be argued that Paleoindian cultures may have occupied Northwestern Ontario prior to 11,500 cal yr BP, the Marquette re-advance likely has obscured any evidence (Phillips 1993; Phillips and Hill 2004). The Plano complex is currently the earliest recorded cultural phase in Northwestern Ontario, entering the region following the post Marquette retreat of the LIS (Dawson 1983a; Wright 1995).

The term Plano is used to describe the unfluted lanceolate style projectile points of the Late Paleoindian period (Mason 1997). A subset of phases, identified by variations in projectile point style, exists within the umbrella of the Plano definition. Projectile points recovered in Northwestern Ontario have been attributed to Plainview, Hell Gap, Agate Basin, Angostura, Scottsbluff, Eden and Minocqua among others (MacNeish 1952; Fox, 1975; Julig 1984; Ross 1995; Hinshelwood 2004).

In an effort to integrate the Late Paleoindian sites of Thunder Bay region into the broader North American situation, Fox (1976) defined the Lakehead Complex on the basis of shared attributes. Typically these sites are located on a series of raised strand lines that represent relic shorelines associated with glacial Lake Minong. Sites are also often directly associated with outcrops of the Gunflint Formation, from which the majority of tools were manufactured. Recent research conducted using the projectile point assemblage of the Mackenzie 1 site has indicated that the morphological variation often also attributed to various neighbouring complexes represent sub-types within the Lakehead Complex (Markham 2013).

Ross (1995) expanded upon Fox's (1976) work by defining the Interlakes Composite, based on attributes shared between the Lakehead, Lake of the Woods/Rainy River,

Quetico/Superior and Reservoir Lakes complexes. A comparison with the projectile point assemblage from Mackenzie 1 has shown that the point types identified in Interlakes Composite are all represented in the Lakehead Complex, demonstrating a further unity throughout the region.

Based on morphological characteristics, 5 primary projectile types (with additional subtypes) were identified at Mackenzie 1 (Markham 2013). These have been attributed to the Lakehead Complex (Markham 2013). A wider examination of the Inter Lakes Composites shows that each of the remaining complexes share at least 3 of these types with the Lakehead Complex (Markham 2013). This intra-assemblage variability has led some researchers to speculate that the Plano tradition identified in Northwestern Ontario represents the influence of multiple cultural groups from both the Plains and Eastern Woodlands of North America (Wright 1972; Hinshelwood 2004). A comparison of the projectile point assemblage from Mackenzie 1 with those from the south and west is consistent with this proposed cultural connection (Markham 2013). It is uncertain if these groups migrated to become permanent residents of the region, or whether the artifacts represent a diffusion of ideas between groups (Kingsmill 2011). Regardless of the reason, the result was a culture complex with no easily identifiable point typology. Instead, typology is comprised of a range of projectile points with attributes shared with multiple complexes.

A strong case has recently been made for this interpretation. Excavations at the Mackenzie 1 site outside of Thunder Bay have recovered 380 projectile points and point fragments, the largest collection yet recovered in the region. These points exhibit features noted with other Plano complexes, but does not reveal technological trends common to any one complex defined elsewhere. They are however unified by their method of manufacture, with

approximately 99% of all projectile points made using parallel oblique flaking, a style not found in any adjacent region. A further commonality is that about 85% of the tools were manufactured from Gunflint Formation materials such as taconite and various local cherts.

Figure 3.1 Lakehead Complex Projectile Points from the Mackenzie 1 Site (Markham 2013)

Several adzes were also recovered during the excavation. While they are clearly identifiable as chopping tools most likely associated with wood working, the form of the adzes differs quite distinctly from those examined in this thesis, with one exception. Most have no clearly identified dorsal ridge and while they are also formed primarily through flaking there appears to be less edge grinding used to refine the final shape of the tool. These tools demonstrate that a technological tradition involving the use of wood working tools existed within Northwestern Ontario, potentially reaching back to the region's first inhabitants.

Figure 3.2 Distribution and Complexes of the Interlakes Composite (Modified After Ross 1995)

3.2 THE SHIELD ARCHAIC

The development of the Archaic culture in Northwestern Ontario appears somewhat delayed when compared to neighbouring regions, and much like the arrival of the first Paleoindian people, its origins have been a source of debate. The Eastern Woodlands was the first region in North America to experience the transition towards the Archaic, beginning as early as 12,500-11,500 cal yr BP and has been interpreted to be a response to changing ecological conditions (closed forest biomes) caused by climatic warming (Ellis *et al.* 1998).

The classic interpretation (Jennings 1989) is that the Archaic transition in the Eastern Woodlands is defined by a shift towards a more generalized subsistence strategy with far less reliance on single food sources such as the supposed focus of Paleoindian populations on big

game hunting. Additionally there is a noted decrease in population mobility and increased seasonal scheduling, resulting in many sites being repeatedly re-occupied. There is also evidence for increased populations and larger band sizes (Jennings 1989). Technologically the Archaic period is marked by a shift away from the finely worked projectile points of the Paleoindian period, with more focus on expedient tool production and a gradual decrease in overall point size. This period also sees the introduction of the first ground stone tools, primarily for the purpose of wood working (Ellis *et al.* 1998).

In Northwestern Ontario the Archaic transition may not have occurred until approximately 7,800 cal yr BP, 3,000 years after its emergence in the Eastern Woodlands with the exact mechanism of this transition remaining unclear (Dawson 1983a). The delay likely reflects the delayed deglaciation and biotic recovery coupled with comparatively lower usable biomass found in sub-arctic taiga forests (Jennings 1989). Unlike in the area to the southeast, this technological shift in the Boreal Forest appears to have not been associated with an appreciable alteration in subsistence, population or settlement patterns. Although evidence is limited, the location of Archaic sites in the Canadian Shield tends to be concentrated at river crossings or other potential choke points useful in large game hunting, a trend also commonly identified at Paleoindian sites (Dawson 1983a). Fish may have played a more important role in subsistence, indicated by the introduction of copper fish hooks and gaffs and the location of Archaic sites on water, but the degree of importance is difficult to determine due to an absence of faunal remains in early archaeological sites in this region (Dawson 1983a).

The most readily visible change between Paleoindian and Archaic culture is seen in the toolset. Projectile points are manufactured with less fine detail than in the Paleoindian period. There is also transition away from the classic Plano lanceolate forms (and associated lithic

reduction patterns focused largely on bedrock lithic sources) and an emergence corner and side notched traits as well as a growing reliance upon more diverse raw material sources (Wright 1978; Dawson 1983a;). Additionally, the Archaic transition saw the introduction of range of tools formed from native copper (Dawson 1983a).

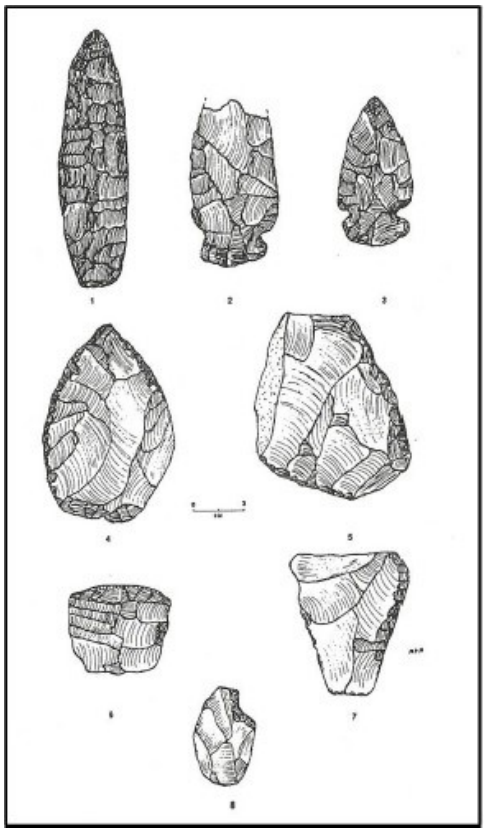

Figure 3.3 Shield Archaic Artifacts

1: Projectile Point from Dog Lake DeJj-32, 2: Projectile point from the Kam River DeJh-2, 3: Projectile point from Dog Lake DeJi-1, 4: biface from Dog Lake DeJh-5, 5: Uniface/knife/scraper from Dog Lake DeJj-22, 6: Spokeshave from Dog Lake DeHh-9. (Taken from Dawson, 1983s)

The distinct nature of the boreal Archaic transition and the existence of trends common throughout the Canadian Shield led to the definition of the Shield Archaic by Wright (1972). Dawson (1983a) further divided the Shield Archaic tradition in the Lake Superior region into Northern and Southern portions. This division relies primarily on the concentration of copper

artifacts in the south, with the Southern Shield Archaic also being referred to as the Old Copper Culture (Dawson 1983a).

In the past the origins of the Shield Archaic have been a source for debate. Initially Wright (1972) proposed that the Shield Archaic originated in the Keewatin District of present day Nunavut and derived culturally from Northern Plano. As ecological conditions changed in the Early Holocene, these populations were thought to have adapted to the developing forest conditions, and then spread south and east throughout the Canadian Shield as glacial lakes receded. The issue with Wright's proposal lay in the volume of data he was basing his claims on. Despite the occupation of the Shield Archaic stretching from the Keewatin District through Northern Ontario and into Northern Quebec, the limited available data forced Wright (1972) to develop his hypotheses from the analysis of only 11 sites with limited inventory.

Buchner (1979) criticized Wright's interpretation, pointing out that many of the apparent similarities between the Keewatin District and Northern Ontario/Quebec were not distinct enough to draw such a comparison. Sites in the Keewatin District and Northern Manitoba generally contained comparatively high numbers of large hide scrapers while such artifacts were either absent or rare in sites from Northern Ontario and Quebec. Additionally, Wright based a large part of his hypothesis on similarities in Early Archaic point types from both regions. Buchner (1979) noted that while both regions contained lanceolate type points this did not prove they were related as that style was found throughout North America and could have come from any other neighboring region.

Dawson (1983a) has proposed that, contrary to Wright's (1972) hypothesis for a Keewatin origin, the Shield Archaic developed *in situ* with influences from the south. As in other parts of the continent, the cultural transition may have occurred as an adaptation to the changing

climate. The northern latitude of the Canadian Shield delayed the shift in local ecology that was experienced thousands of years prior in the south. By as early as 8,900 cal yr BP the region had begun to transition to a closed Boreal Forest environment (Julig *et al.* 1990). The environment continued to undergo a period of warming and drying resulting in the furthest northward penetration of otherwise southerly limited floral species such as *Pinus strobus* (Eastern White Pine) by approximately 6,500 cal yr BP (Björck 1985). Dawson (1983a) speculates that an environmental shift may have led to the new cultural and technological adaptations of the Shield Archaic. While this hypothesis does have merit there is currently a lack of datable Archaic sites to address it.

As was stated above, the primary difference between Paleoindian and Archaic populations is found in the tool sets the two cultures employed. Archaic sites contain far fewer bifaces and more hide scrapers (Wright 1978). They also contain more projectile points but fewer lanceolate type points with an increase in triangular points and the presence of side notching (Wright 1978; Dawson 1983a; Hamilton 2007). The Archaic culture appears to have largely abandoned the use of bedrock taconite sources, instead relying on a diverse range of materials (Wright 1978; Dawson 1983a). At some point in the Shield Archaic we also see the introduction of ground stone tools and, in the Southern Shield Archaic, copper tools such as spears, projectile points, knives, scrapers, fish hooks, gaffs, axes and adzes as well as decorative pendants and bracelets (Dawson 1983). While some wood working tools have been associated with Paleoindian sites (primarily adzes) we see the first widespread introduction of such tools in the Shield Archaic including ground stone and copper adzes, axes, celts, burins and chisels (Dawson 1983a).

The distribution of confirmed Archaic sites in Northwestern Ontario is sparse. Several sites have been found in association with Lake Nipissing paleo-shorelines which have been dated to ~6,300 cal yr BP (Phillips 1993). In the northern extent of the region two sites have been associated with early Archaic occupations including the Wapekeka site, along the northern edge of the Canadian Shield, where the remains of two individuals were recovered and radiocarbon dated to 6,630 +/- 90 and 7,080 +/- 90 C^{14} BP (Hamilton 2004). Artifacts potentially related to the late Paleoindian period have been recovered from the Allen site, located in the Sioux Lake District Ontario, and dated to 8,050 +/- 80 cal yr BP, 8,160 +/- 80 (Pilon and Dalla Bona 2004). The dates were received from charcoal fragments recovered from a layer associated with lanceolate point fragments. Many later Archaic sites were likely located along the shore of Lake Superior during the Houghton Phase, but were submerged as the water rose to present levels (Kingsmill 2011). With such a paucity of sites attributed to the Shield Archaic phase and the limited information available at the sites that have been documented, there is a great deal that is not understood about this stage in the human history of Northwestern Ontario.

3.3 SUMMARY

The archaeological record of Northwestern Ontario is poorly understood, particularly in terms of its pre-ceramic cultures. There are a number of challenges that traditional archaeological research faces when trying to understand cultural development and dispersion. The sheer size of the region combines with a poor understanding of site distribution (a problem reflecting the size of the region and compounded by sampling bias towards the more populated areas) to ensure that only a limited number of sites are located. Even when a site is found, the taphonomic conditions in the region (discussed below) result in the limited preservation of organic materials.

The first people known to inhabit the region belonged to the Plano culture of the Late Paleoindian period. Current evidence suggests that multiple complexes migrated into the region sometime after the final deglaciation. This culture, referred to locally as the Lakehead Complex and part of the Inter Lakes Composite, appears to be comprised of those different cultures which at some point may have begun a process of cultural melding that resulted in the unique archaeological record. While recent excavations have increased our understanding of the Lakehead Complex material culture, the distribution of their population is still poorly understood.

The Lakehead Complex was followed by the Shield Archaic. The timing of the transition from the Lakehead Complex to the Shield Archaic is still poorly understood. Some evidence suggests the transition was an adaptation to climate change, resulting in a tool kit distinct from that of the Shield Archaic culture. This tool kit included use of copper in the manufacture of tools and ornaments, the transition to notched projectile points, and the proliferation of wood working tools. These facts aside, very little is known about the Shield Archaic people. Much like the Lakehead Complex, these problems stem from limited site inventory and poor organic preservation. The patterns of site distribution appear to be even more poorly understood than those of the Plano, and no large occupation sites have ever been found. Attempts are being made to address and explain this lack of data and could prove very useful in locating Archaic sites or, at the least, understanding why we cannot locate them. With this lack of traditional evidence hampering the interpretations of archaeologists it is becoming ever important to find alternative forms of evidence that may be derived from materials already recovered.

Chapter 4 THEORETICAL AND METHODOLOGICAL PERSPECTIVE

There are two key objectives for this chapter. The first is the introduction of two theoretical perspectives that act as the foundation for this investigation. The second purpose is to introduce methodological considerations that are essential in the application of archaeological organic residue analysis. The methodological considerations focus on introducing aspects of organic chemistry and integrating these aspects of methodology into the theoretical perspectives.

4.1 THEORETICAL INTRODUCTION

This thesis utilized two theoretical approaches for the collection and interpretation of archaeological data. Research questions were approached from the *Artifact as Site Concept* perspective. This approach states that in the absence of excavations, or when an archaeological site lacks special and contextual control, a collection of artifacts recovered from the region of interest may act as an alternate focus of investigation (Loy 1993). Using an individual artifact type as a focus, organic residue analysis is then applied, utilizing the *Archaeological Biomarker Concept* to identify the presence and source of any organic residues (Evershed 2008).

4.2 ARTIFACT AS SITE

The *Artifact as Site Concept* was proposed by Loy (1993) as an alternative form of archaeological investigation to be applied when artifacts have been recovered, but excavations are not possible. This approach operates on the understanding that in the absence of conventional site analysis, recovered artifacts may provide sufficient data to draw an inference about the related culture. It must be emphasised that this approach, as it is applied to this thesis, is not intended to replace the site analysis. This thesis involves the analysis of an artifact type that has

been recovered from both non-contextual surface collections and excavations of multiple occupation sites with poor spatial and contextual control. This has resulted in ambiguity over dating, tool function and cultural affiliation. Until a trihedral adze is recovered from traditional excavations of a securely stratified site which can be attributed to a specific culture, it is not likely that any more data on the artifact type will be acquired.

While Loy's (1993) approach was designed to be used in place of excavations, it will be adapted for the purpose of this thesis to both fulfill its original purpose and act as a supplementary tool. To this end it will provide further insight into sites which have been successfully excavated but which suffer from limiting factors such as poor taphonomy and a lack of contextual delineation. In the case of regions such as Northwestern Ontario, this theoretical adaptation could prove extremely useful in assisting the interpretation of sites which commonly suffer from the above mentioned conditions.

Loy (1993) states that any information obtained from the analysis of an individual artifact type may be applied to the *Artifact as Site Concept*. Due to the nature of the research goals, this thesis will utilize an organic residue analysis methodology employed through the theoretical perspective of the *Archaeological Biomarker Concept*.

4.3 ORGANIC RESIDUE ANALYSIS AND THE *ARCHAEOLOGICAL BIOMARKER CONCEPT*

The *Archaeological Biomarker Concept* operates on the underlying principle that all biological materials are comprised of a mixture of organic chemical components. While many components may be common in many substances, individual molecular components of the mixtures may be unique to specific floral or faunal species responsible for the biological

material. Additionally, the overall makeup (i.e. various molecular components and their ratios within the mixture) may also be specific (Evershed 2008).

A number of factors affect the interpretive resolution and taxonomic level of identification possible for organic residues. This reflects the nature of the residue or the level of chemical degradation it has been subjected to since archaeological deposition (Evershed 1993). An interpretation of any identified compounds must also consider the potential career of the artifact. The deposition of residues can occur at any stage in the life of the artifact, beginning with the manufacturing process. The mode in which an artifact is employed can impact the nature and volume of any deposited residues. Multiuse artifact will have been exposed to multiple sources of residue, potentially confusing the results. If an artifact is curated in nature (i.e. used for an extended period of time) the potential for residue deposition can increase. If it was created for an expedient purpose (i.e. single or few uses) there will be fewer sources for residues and less potential instances for residue deposition. Even after an artifact has been discarded the nature of any associated residues can continue to change as they face chemical alteration by taphonomic processes during deposition. Post-excavation conditions such as excess handling or improper storage may lead to the deposition of contaminants while any attempt to clean the artifact may remove authentic residues. All of these factors must be taken into consideration when analyzing and interpreting residue data. A failure to do so could easily lead to a misinterpretation of data.

Once the chemical composition of a residue is determined, and its authenticity is verified, it is then compared to the composition of candidate organisms that might have been used by humans in the past (Evershed 1993). This generally involves the use of reference materials, either pre-existing in the literature or created for the purpose of the study. Such reference

collections are formed based on current knowledge of the environment in which the artifact was employed. Even a basic understanding of the ecology of the region in question allows researchers to focus their search for relevant bio-markers and avoid a larger trial and error process (Evershed 2008).

Methodologies required for obtaining molecular level identification were developed in the field of analytical chemistry during the 1950s and 60s, ultimately culminating with the technological innovation that linked gas chromatography (GC) and mass spectroscopy (MS), otherwise referred to as GC/MS (Evershed 2008). The combination of these two methods allowed for the separation (chromatography) and identification (spectroscopy) of multiple chemical constituents from a single sample, making it possible for the various chemical components of a residue to be individually qualified and quantified (Evershed 2008).

The separation of specific chemical components is a necessary requirement when applying the *Archaeological Biomarker Concept.* Due to their nature, any organic residue will be comprised of a mixture of organic chemicals. This issue is often compounded by human action, resulting in the mixing of components from multiple organisms (Evershed 2008). For this reason, the use of GC/MS is almost always a necessity. Past studies have shown that the application of GC/MS can allow for the separation of biological compounds mixed through both human and natural actions (Charters *et al.* 1995).

Although biological residues have been shown to survive long periods of time in archaeological contexts, they are not immune to chemical degradation. Oxidation, hydrolysis, and other natural processes can cause residue degradation past the point of direct identification. However identification of these degraded residues is possible as some biomolecules will degrade in a predictable manner, creating identifiable bi-products that act as indicators. For such an

identification to be made an understanding of the specific mechanisms of chemical alteration is required. Given that partial preservation is never assured, the recovery and identification of organic residues cannot be guaranteed (Evershed 2008). This thesis involves the study of an artifact class which has never been evaluated for its retention of biological residues. Therefore, the presence of residues cannot be assumed as the specific interactions of taphonomy and residues in this context is well not understood.

The *Archaeological Biomarker Concept* is applied to this thesis in an attempt to ascertain the nature of residues adhering to the surface of the trihedral and related adze types in Northwestern Ontario. The analysis will focus on determining which tree species the tool type may have been used to process. As such, lipids will be the most relevant biomolecule as terpenoids, a lipid sub-type, are the most useful in identifying tree species (Mills and White 1977). A more in depth discussion on the chemical nature of lipids and terpenoids, including usefulness as bio-markers and taphonomic concerns, will be conducted in the methods chapter. This study has also employed presumptive biochemical analysis in conjunction with the *Archaeological Biomarker Concept* in order to improve the effectiveness of the study, and assess the application of biochemistry as a methodology in the context of Northwestern Ontario.

4.4 BIOCHEMICAL ANALYSIS

Biochemical analysis relies on the principle that all biological substances will react in a predictable manner when exposed to specific chemical reagents. The nature of a residue can be determined by observing its reaction to various reagents. The data obtained from such biochemical analysis is presumptive in nature, i.e. a reaction indicates the presence of a specific organic compound (Briuer 1976). While a variety of reactions may occur (release of thermal

energy, change of state, etc), a change of colour is used as the primary indicators for the majority of presumptive tests as such a change may be more easily and reliably interpreted with the use of absorbance spectroscopy.

The primary application of biochemical testing in archaeology thus far has been to evaluate the methods of identifying blood residues from both a presumptive and analytical perspective (Loy 1983, 1987; Loy and Wood 1989; Hyland 1990; Kooyman et al 1992; Remington and Loy 1994; Heaton et al 2009; Matheson and Veall 2014; Lombard 2014). This form of biochemical testing has so far been the only organic residue analysis study to originate in Boreal Forest Ontario (Newman 1992; Newman and Julig 1989).

Briuer (1976) published one of the earliest studies to utilize presumptive biochemical methodologies. In his study, Briuer (1976) sought to identify the presence of plant and animal residues on various artifacts by determining the presence of organic residues specific to those taxonomic kingdoms. This included tests for plant lignin, starch and plant cell walls to determine the presence of plant residues and a test for blood residue and proteins to determine the presence of animals. To achieve this, Briuer (1976) employed methodologies developed in the field of biochemistry that could be easily adapted towards archaeological analysis.

While the data obtained from such tests are presumptive and do not provide the same resolution as analytical methods, it does allow for a later focusing of efforts. The nature of residues and the taxonomic kingdom of the associated organism (i.e. plant or animal) can be ascertained, providing a focus from which further research can be based (Briuer 1976). Such presumptive tests are low cost when compared to analytical chemical methods. They are also versatile in that once a test has been established it is possible to gain reliable results without the use of analytical laboratory equipment (Briuer 1976). Therefore, these methods may prove

extremely useful in Northwestern Ontario. This thesis will in part provide an evaluation of these methods in the Boreal Forest context. As stated above, a biochemical type study has already been conducted in Northwestern Ontario, however there are several issues related to the study and it should not be viewed as a fair evaluation of the methodology.

Newman and Julig (1989) attempted to determine the species of origin from blood residues adhering to the surface of artifacts recovered from the Cummins site (DcJi-1) utilizing crossover immunoelectrophoresis (CIEP). From this, Newman and Julig (1989) proposed the presence of blood residues related to bovid (possibly *Bison antiquus* an extinct species of bison), rodent (possibly muskrat, porcupine or beaver), cervid (possibly moose, deer, elk or caribou) and feline (possibly lynx). Newman and Julig (1989) did not propose that the blood residues were proof of the presence of the above-mentioned species, but included the possibility of these interpretations as an explanatory device to aid non-biologists. However, problems still arise with their interpretations. While an evaluation of the presence of hemoglobin was conducted on soil samples from the Cummins site in an attempt to exclude that as a source of contamination, the same tests were not conducted on the identified residues to determine their nature. Newman and Julig (1989) instead assumed the residues were blood related based on their physical appearance as a black/brown shiny plaque (Newman and Julig 1989: 121). Pursuing a uniformity in applied methodologies would have ruled out potential contamination or misidentification of residues. The asymmetric nature of this analysis leaves unanswered questions, such as whether the soil samples would have caused an unexpected cross reaction with the experiment, or, if the identified residues were indeed blood. Fiedel (1993) points out that Newman and Julig (1989) also failed to run control blind experiments on tools which appeared to be free of residues, leaving questions

regarding control samples. Unfortunately no re-evaluation of biochemical methodologies has since been conducted in Northwestern Ontario.

The nature of archaeological investigations in the region has largely been focused around cultural resource management (CRM) projects which do not typically utilize residue analysis. It is hoped that this study, and others like it, will offer a cost effective method of basic residue analysis with the potential for future expansion.

4.5 SUMMARY

This thesis applies the *Artifact as Site Concept* to the evaluation of data recovered through biological and analytical chemical analysis using the *Archaeological Biomarker Concept*. The nature of recovery for the trihedral adze, and associated chipped adze morphologies, in Northwestern Ontario has resulted in limited temporal or cultural association. The *Artifact as Site Concept* (Loy 1993) as applied in this thesis, will attempt to place the tool type within the archaeological record in the absence of an interpretable site context. To accomplish this, the *Archaeological Biomarker Concept* (Evershed 2008) is applied in order to characterize the nature of residues adhering to the surface of the adzes. An evaluation of the residues using biochemical and analytical chemical techniques provides an opportunity to place this tool type within a specific period of the culture history of the region. Furthermore, residue results can be used to propose a possible function, adding a greater understanding of tool form in relation to function. This thesis will act as an evaluation of these methods in the context of Northwestern Ontario.

Chapter 5 MATERIALS AND METHODS

5.1 SAMPLE ARTIFACTS

A total of 41 adzes were examined from 12 sites located in Northwestern Ontario. The artifacts came from five separate sample sets; three from local archaeologists, one from Lakehead University, and one from the Ministry of Tourism, Culture and Sport's (MTCS) Northwestern Ontario storage facility in Thunder Bay. Each collection varied in method of recovery, degree of cleaning and manner of storage. The full range of morphological types discussed by Mcleod (1978) are included in this analysis in order to determine if there was a notable difference in identifiable residues. An attempt was made to gather artifacts from multiple collections in order to compare the state of residues identified on tools subjected to differing curatorial conditions. A more diverse representation of cleaning and storage practices will allow for an assessment of the effects post-excavation processes have on residues. All artifacts examined in this study are referred to by the Borden number of their originating sites. Where multiple artifacts are attributed to a single site the artifact is represented by the Borden number followed by a number in brackets assigned during cataloguing. For examples: the third artifact catalogued from site DeJj-8 is referred to as artifact DeJj-8(3).

Geographically, the majority of artifacts (33 of 41) were recovered from the Dog Lake region. It has been previously noted that the highest concentration of adzes in Northwestern Ontario is found at Dog Lake. The reasons for this concentration of known adzes is not well understood apart from the fact that a body of water like Dog Lake may have represented an ideal location for the creation of watercraft. Alternatively, it could be a result of sampling biases as discussed above. The high concentration of adzes found through surface collections is also likely

the result of shoreline erosion due to hydroelectric developments as well as a local tradition of artifact collection.

5.1.1 Sample Set 1

Sample set 1 consists of 17 adzes belonging to two local avocational archaeologists. All artifacts originate from four sites, DeJj-1 (n=2), DeJj-2 (n=2), DeJj-8 (n=11) and DfJj-21 (n=1) located at Dog Lake (see figure 5.5). All artifacts were recovered as surface collections and have been stored in cardboard boxes in each of their private collections since discovery. All adzes have been subjected to a moderate amount of cleaning with water which has removed any adhering matrix.

5.1.2 Sample Set 2

Sample Set 2 consists of 5 adzes stored in the private collections of a local avocational archaeologist. Three originated from surface collection at Dog Lake (DeJj-2(n=1), see figure 5.5, remaining two sites unknown), and two from surface collections at the Cummins Site (DcJi-1) (See figure 1.2). Prior to storage, all adzes were thoroughly cleaned with a brush and water.

5.1.3 Sample Set 3

Sample Set 3 consists of 14 adzes from the artifact collections at Lakehead University. All but two adzes originate from the Dog Lake region, from sites DeJj-8(n= 5), DeJj-4 (n=6) and DeJj-21 (n=2) (Figure 5.5). Circumstances of recovery are not known, although it is believed to have been part of a survey or surface collection. Of the remaining two adzes, one was recovered during excavations at the Kozak Site (DbJm-3) (Figure 1.2) while another was recovered from excavations at the Mackenzie 1 Site (DbJf-9) (Figure 1.2). The degree of cleaning varied throughout the collection, but is generally minimal.

5.1.4 Sample Set 4

Sample Set 4 consists of two adzes from two sites within the Lac Seul region, EaKa-49 and EaKa-9 (Figure 1.2). The adzes were part of a private collection belonging to a local avocational archaeologist. All artifacts were stored in cardboard boxes and were subjected to a moderate amount of cleaning with water.

5.1.5 Sample Set 5

Sample Set 5 consists of 3 adzes on loan from the collection of the MTCS. They originate from three sites, DeJj-8 (Dog Lake, see figure 5.5), DbJs-8 and DhJf-5 (both locations unknown). Their mode of recovery and curatorial history is unknown. All appeared to be thoroughly cleaned.

Figure 5.1 Location of sites on Dog Lake from which some adzes analyzed in this study were recovered

5.2 LABORATORY PROTOCOL

Every attempt was made to eliminate the possibility of artifact contamination during this analysis within the laboratory environment. Non-powdered gloves were worn during the handling of artifacts and laboratory materials. Disposable pipette tips and centrifuge tubes were autoclaved prior to use in order to assure their sterility while all non-disposable materials were thoroughly cleaned and autoclaved before use. All collections were stored in separate containers and individual artifacts were bagged separately. This was done in order to eliminate cross-contamination between collections and artifacts.

5.3 MICROSCOPY

Microscopy was employed almost exclusively as a documentation tool. Basic characteristics of residue colour and physical formation were recorded along with their location on the tool's surface. All documentation was done with the intent of matching compounds identified through organic residue analysis with potential residues recorded during the microscopy phase. This process has proven useful in artifact analysis conducted by Lombard (2004, 2005a, 2006). In these studies the documentation of the specific locations of residues proved extremely useful in the interpretation of tool use.

All artifacts were first examined using a Nikon SMZ800 incident light microscope. Magnification ranged from 20x to 64x. This initial examination was conducted to determine the presence or absence of potential residues. Identified residues were recorded based on their location on the tool surface, as well as a basic description of colour and morphology. Artifacts that exhibited no visible residues were excluded from further microscopic examination.

A subsequent examination employing higher magnifications was completed using an Olympus BX51 microscope. This microscope allowed for a broader range of visibility using transmitted and incident light microscopy. Magnification ranged from 100x-500x. Increasingly detailed images and descriptions of any visible residues were taken with the intention of creating classifications based on morphology and colour.

Several physically removed residue samples were mounted to microscope slides. Each sample was held in place by a cover slip that was fixed to the slide using generic clear nail polish. Care was taken to ensure the residue samples themselves did not come into contact with the nail polish. This form of mounting facilitates the introduction of histological stains.

The physical nature of the artifacts led to several difficulties in capturing single detailed images. The triangular shape of the artifacts made it nearly impossible to create a flat surface so that the whole field of view could be in focus at the same time. This meant that only small slivers of the field of view could be focused upon at a time. To resolve this, multiple micrographs were taken of the same surface of the artifact with a shift of the focus in the "Z" (vertical) axis in an attempt to capture the entire image in a series of individually focused slices. These images were then compiled into a single composite image using Image Pro Plus software. This allowed for the creation of detailed micrographs of specific areas of interest. While automated Z-stacking microscopy systems capable of combining both steps do exist, they were not available for this study.

All identified residues were then classified into sub-categories based on morphology and colour. These classifications will be discussed in detail further in Chapter 6.

5.4 RESIDUE REMOVAL

Due to the nature of this study, *in-situ* residue analysis was not possible. Removals were completed using both chemical solvents and physical removals in order to suspend the residues within a liquid medium required for biochemical and GC/MS analysis. All tools were subjected to removal using a solvent bath during which individual portions of the tools were sampled separately. A limited number of tools required the use of physical removal techniques due to the location and nature of the residues.

5.4.1 Solvent Removal

The dorsal ridges, distal, proximal and lateral edges of the tools were separately sonicated in a bath of distilled water for fifteen minutes. This was done in preparation for biochemical tests to detect starch and carbohydrates that required suspension in water. The hydrophobic nature of other residues such as lipids prevented accidental removal. The same areas of the artifacts were then placed in a solvent tri-mixture of water, ethanol and acetonitrile (1:1:1 v/v/v) and sonicated for fifteen minutes. The solvents were then removed from the sonication tray and stored in micro-centrifuge tubes.

The tri-mixture was chosen to maximize the effectiveness of the removal. Organic solvents, such as acetonitrile and ethanol, have been shown to be effective at removing hydrophobic metabolites, such as lipids, when mixed with water (Lin *et al.* 2007). The addition of water to a solvent mixture also increases the total polarity of the mixture, ensuring organic compounds damaged by oxidation are soluble. Ethanol was specifically chosen as it is effective at dissolving resin acids, the key biological compound in this study. Acetonitrile was used because of it is miscible with water and for its capacity to dissolve fatty acids and amino acids. Katerina *et al.* (2004) demonstrated that acetonitrile is the least volatile commonly used solvent,

has low toxicity and is an effective solvent while also being compatible with a diverse range of analytical techniques. Other commonly employed solvents such as chloroform, methanol and dichloromethane were avoided in this study. Lin *et al.* (2007) demonstrated that chloroform and methanol are less effective than acetonitrile, while Katerina *et al.* (2004) highlighted the volatile and toxic nature of chlorinated solvents like dichloromethane. Acetone, chloroform and dichloromethane are not miscible in water thus preventing these solvents from being used as tri-mixture for the removal of residues. While this practice has not yet become wide spread in the field of organic residue analysis, it has become an increasingly common methodology amongst biologists studying biomolecules in living organisms. The biomolecules within those studies are the same as those being studied in organic residue analysis (Coen *et al.* 2003; Kim *et al.* 2004; Stentiford *et al.* 2005; Lin *et al.* 2007).

5.4.2 Physical Removal

Physical removals were conducted on four tools. The triangular cross section of the trihedral adze makes the use of solvent baths on the surfaces between the lateral edge and dorsal ridge impractical. In each instance a visible portion of potential residue was identified on a surface that could not be placed in a solvent bath due to physical limitations.

Removals were purposely limited to one per tool with locations recorded separately for future reference. Removals were conducted using sterilized scalpels and medical spatulas. Samples were then transferred into glass GC vials to which 500mL of the tri-mixture solution was added. The GC vials were sealed and samples were allowed to sit over night before the solvent was transferred to a separate GC vial for further preparation.

5.5 HISTOLOGICAL STAINING

Histological staining involves the use of dyes which, by their chemical nature, will interact with different biological compounds in a unique manner, allowing the compound to be identified. In the case of this research it was necessary to differentiate between faunal and floral residues in order to determine tool use.

A fiber removed from artifact DcJi-1 (1) of Sample Set 2 was mounted to a microscope slide for examination. The nature of the fiber could not be determined through physical morphology alone. As a result it was decided to use histological staining to determine the origin of the fiber. Toluidine Blue was chosen based on its properties as a metachromatic dye, meaning it will differentially stain specific tissue types. Any amino acid based materials will be stained blue indicating the presence of proteins while polysaccharide based materials will stain pink or red.

The fiber sample was held in place by a cover slip and 10μL of Toluidine Blue solution was introduced. The sample was allowed to sit for two minutes before being rinsed with distilled water. The fiber was then examined and photographed under high-powered transmitted light microscopy using an Olympus BX51 microscope with a DP72 digital camera. The fiber stained blue, indicating it is protenatious in composition.

5.6 BIOCHEMICAL TESTS

A series of four biochemical tests were conducted on extracted samples. Each biochemical test established the presence or absence of a specific group of organic compounds (starch, carbohydrates, protein and fatty acids). Each test was modified to perform as a micro-chemical test measured through spectrophotometry. The product of each test was examined at specific wavelengths using a Bio-Tech Epoch Micro Plate Spectrophotometer. The

spectrophotometer was programmed to measure the absorbance at the wavelength specified in the test procedure.

The primary reason for the application of biochemical testing within this study was to directly assess their usefulness in archaeological residue investigations. Additionally, the use of multiple analytical approaches has proven beneficial in the past (Monnier *et al.* 2013; Helwig *et al.* 2014; Veall and Matheson 2014). Results observed from the biochemical testing phase were later compared to results from the GC/MS analysis. If the tests were accurate, positive results would be incident in the compounds identified through GC/MS. This allowed for both an evaluation of the methodology and a cross-analysis or verification of results.

5.6.1 Iodine Potassium Iodide (IKI) Test for Starches

The IKI test for starch is based on the principle that iodine produces various colour complexes when it reacts with polysaccharides. The nature of this colour difference is based on the chemical structure and specific type of carbohydrate being tested. The complex carbohydrates and coiled structure of starch produces a blue colour change when exposed to iodine solutions (Briuer 1976).

A 5µL volume of aqueous residue sample is placed in a 0.5mL micro-centrifuge tube. The sample is heated at 60°C for 15 minutes. A 5µL volume of a 0.12 M Iodine Potassium Iodide (IKI) solution and 5µL of a 0.01M iodine solution are added to the aqueous residue sample. The resulting product is analysed at 595nm and the absorbance measured. A reaction producing a blue colour change indicates the presence of starches.

5.6.2 Phenol Sulfuric Acid Test for Carbohydrates

The Phenol-Sulfuric Acid Test, developed by DuBois *et al.* (1956) is considered one of the most reliable methods for evaluating the presence of carbohydrates. Sulfuric acid causes the

carbohydrates to be broken down into reducing sugars which then interact with the phenol to produce a yellow-brown colour change (Albalasmeh *et al.* 2013).

To perform this test, 5µL of aqueous residue sample is placed in a 0.5mL micro-centrifuge tube and heated to 90°C for 10 minutes. After heating, 5µL of 4% phenol solution and 25µL of concentrated sulphuric acid are added to the sample. The test is allowed to sit for 10 minutes before being analysed at 490nm. A brown colour change indicates the presence of carbohydrates.

5.6.3 Bradford Protein Assay

The Bradford Protein Assay, developed by Bradford (1976) operates on the understanding that the dye Coomassie Brilliant Blue G-250 will bind with protein molecules. The interaction of the protein and the dye will cause the absorbance of the dye to shift from 465 to 595nm. The Bradford Reagent used in the experiment is a standard solution of the dye used specifically for this purpose.

To conduct the Bradford Protein Assay, 5µL of tri-mixture solvent residue sample and 1µL of Bradford Reagent are combined in a 0.5 mL micro-centrifuge tube. Samples were then vortex mixed and left to sit for 20 minutes. All samples were then analyzed at 595nm. A blue colour change indicates the presence of proteins.

5.6.4 Copper, Triethanolamine/diphenylcarbazide Fatty Acid Test

This method was originally developed by Falholt *et al.* (1973) to determine the presence of free fatty acids in blood plasma. The original experiment called for the use of phosphate blockers for the purpose of eliminating false positives resulting from interactions with phospholipids, a component of red blood cells. Since the goal of this research is not to isolate a specific form of lipid, the phosphate blockers were omitted in this modified method. This test

operates on the principal that the copper triethanolamine will bond with and isolate the fatty acids which will then be susceptible to colourimetic interaction with the diphenylcarbazide.

A 5µL of tri-mixture solvent residue sample is combined with 20µL of copper triethanolamine solution in a 0.5mL micro-centrifuge tube and vortex mixed. Following this a 5µL volume of diphenylcarbazide solution is added and the sample is left to sit for 15 minutes before being analysed at 550nm. A purple colour change indicated the presence of fatty acids.

5.7 ANALYTICAL CHEMISTRY

The analytical chemical component of this research relied exclusively on GC/MS to analyse the chemical makeup of samples removed from various surfaces of the trihedral adzes. This research focuses primarily on the identification of terpenoid compounds, a form of plant aromatic compound that includes resin acids.

5.7.1 Identification and Classification of Lipids

In general, the term lipid refers to the various forms of fats, waxes and resins produced by living organisms (Pollard 2007; Evershed 2008). They are often the focus of organic residue analysis as they are the most common medium sized biomolecules produced by living organisms. Additionally, they are commonly recovered from archaeological material and may also vary in chemical structure between organisms (Pollard 2007; Evershed 2008).

Lipids are composed primarily of carbon, an element that is unique in its ability to bond with itself and other elements to form a variety of chemical skeletons (Evershed 1993; Stoker 2012). These carbon skeletons can be linear, branched, or cyclic (either mono or polycyclic) in form (Evershed 2008; Stoker 2012). The details of these skeletons are made more complex by the addition of various functional groups and saturation by hydrogen molecules. This variation

increases the potential of the biomolecule to be specific to a taxonomic classification of the organism that produced them (Pollard 2007; Evershed 2008). The presence of saturated hydrocarbon compounds conveys a hydrophobic property on lipids, resulting in increased chances of survivability in damp environments and resistance to transportation via water leaching (Pollard 2007; Evershed 2008). Plant polymers alone have the potential to outlast lipids in most depositional environments, but are of limited use in organic residue analysis (Mills and White 1977).

Lipids are found in all living organisms and perform a variety of functions. Fatty acids, a sub category of lipids, are a component in both triglycerides and phospholipids which are major constituents of animal fats and animal cell membranes respectively (Mead *et al.* 1986). Polycyclic triterpenoids and diterpenoids are major components of plant resins, while other long chain compounds are found as major components of natural waxes (Kolattukudy 1970).

Lipids found in plant resins are of particular relevance for this thesis as they may allow for the identification of tree species utilized with adzes. Tree resins are comprised of mixtures of lipids classified as either mono, sesqui, di or triterpenoid compounds. Mono and sesquiterpenoids are highly volatile, existing in a liquid state at room temperature. They act as solvents, suspending the diterpenoid and triterpenoid compounds in solution. When the resin is removed from a tree, the mono and sesquiterpenoids evaporate. This process leaves the diterpenoid or triterpenoids in a solid state (Mills and White 1977).

Any tree belonging to the order *Pinales* (coniferous) has resin containing only diterpenoid compounds (Mills and White 1977). Within the classification of diterpenoid, only three primary compound types are stable enough to be of use in archaeological investigations: abietanes, pimaranes and labdanes. Abietane and pimarane compounds are comprised of three

primary benzene rings and are differentiated by the double bonds between the carbon atoms. The third compound, labdanes are comprised of only two benzene rings, meaning they typically have a lower molecular weight and are less chemically stable. The ratios of these compounds within the overall makeup of a resin may allow for a further determination of genus level identification (Mills and White 1977). Trees of the *Pinus* genus will have higher ratios of pimarane compounds when compared to other conifers (Mills and White 1977).

5.7.2 Taphonomy of Lipids

Lipids are hydrophobic in nature, meaning they do not bond with water molecules. As a result, they are resistant to degradation and leaching by water (Evershed 2008; Pollard 2007). Additionally, their hydrophobic nature means that lipids will remain immobile within the soil matrix. The majority of soils contain high levels of lipids as by-products of the decomposition of higher order plants as well as components of various microscopic organisms. Contamination by these alternate sources is avoided by the hydrophobic nature of the lipids. A chemical solvent would be required to suspend them in solution and allow them to move through the soil matrix, and onto the surface of an artifact. The highly volatile nature of most organic solvents, combined with the fact that most are synthetic in origin, make this scenario extremely unlikely. As a result the chemical nature of lipids ensures that they will remain immobile unless intentionally removed, thereby limiting contamination from the depositional environment (Heron *et al.* 1991).

Lipids do, however, remain susceptible to taphonomic degradation through oxidization (Eerkins *et al.* 2002). The rate of degradation may vary depending on the context in which they are deposited, although generally it is possible (but not guaranteed) for compounds to survive time spans relevant to archaeological investigations (Mills and White 1977).

When diterpenoid compounds are oxidized they are transformed from their original states (Mills and White 1977). Abietane compounds will degrade through a specific process known as dehydrogenation into dehydroabietic acid (Sadhra *et al.* 1998). This compound exists naturally in diterpenoid resins but the ratio within the overall mixture will increase with time. Pimarane compounds will last approximately the same amount of time as the abietane compounds with the exception of dehydroabietic acid. When pimarane compounds degrade they begin a process of polymerization, transforming from lipids into different forms of plant polymers that are not as easily differentiated (Mills and White 1977). Labdane compounds will begin oxidization within years or even months, depending on conditions, and will also undergo a process of polymerization (Sadhra et al 1998). Because labdanes are extremely susceptible to oxidization, the analysis of the ratios of pimarane to abietane compounds is used in determining plant genus (Mills and White 1977; Helwig *et al.* 2008).

5.7.3 Sample Preparation and Analysis

For samples removed through the use of a solvent bath, 500µL of the distilled water removal and 500µL of the tri-mixture solution removed from identical locations on the tool were combined in a glass GC/MS vial. Meanwhile, the tri-mixture solvent from the physically removed samples were transferred into a second glass GC/MS vial to remove any remaining solids which may damage the GC/MS injection and sampling mechanisms. All samples were freeze dried to ensure purity and limit contaminants which could interfere with GC/MS analysis.

Samples were then derivatized using 0.1 ml of BSTFA (bis(trimethylsilyl)trifluoroacetamide) with 1% TMS (trimethylchlorosilane) (Sigma-Aldrich) and 0.9 ml of acetonitrile (Sigma-Aldrich). Derivatization was undertaken to reduce the polarity of functional groups containing oxygen or nitrogen and assist in the separation of molecules

within the column (Halket *et al.* 2004). Vials were then purged with nitrogen and sealed with Teflon-coated septa before being incubated on a Baxter Scientific Multi-Block at 120° C for 30 minutes. All samples were then immediately analysed using GC/MS.

The GC/MS analysis was performed with a Varian model 450 gas chromatograph coupled to a Varian model 300-MS quadruple mass spectrometer using a FactorFour™ capillary column. An autosampler introduced samples in splitless mode with an injection port temperature of 270°C, using helium as the carrier gas. Initial column temperature was 50°C, which was held for 2 minutes before being increased to 155°C at a rate of 8°C a minute. Temperature was again increased to 275°C at a rate of 40°C a minute and was held there for 9 minutes. The ion source was set at 200°C under electron ionisation conditions, producing ionisation energy of 70 eV. A scan range of 40 to 500 m/z was used and the GC/MS interface temperature was set at 266°C.

5.7.4 Data Analysis and Interpretation

An analysis of the data obtained from GC/MS was undertaken with Varian Microsoft Workstation version 6 software which utilized the NIST98 Mass Spectral Database. All chemical components were first analysed through comparison with the database. All compounds identified by the software with a 75% or greater probability of positive identification were recorded separately. Any compounds of potential archaeological relevance that fell below this 75% threshold were manually examined to ensure a positive identification. Chemicals that were identified as likely deriving from a contaminant were noted and excluded from archaeological interpretations. This included a range of synthetic compounds and organic compounds that may be common in modern substances, as well as fatty acids potentially deposited from human handling. Propanoic and palmitic acid are both common chemical components of human sweat

and skin oils (Bojar and Holland 2002), while fatty acids such as lauric acid, myristic acid and octadecanoic acid are extremely common in many modern consumer products (Anneken 2006).

Chemicals not excluded as possible contamination were examined in an attempt to relate them to potential sources. This was done through a comparison with reference samples and published data. Data was first analysed using the NIST98 Mass Spectral Database. Any compounds of interest were subjected to further scrutiny through an examination of their ion spectra. While the NIST98 database is extremely useful it should not be solely relied upon as it operates by means of a best match approach. The Varian Microsoft Workstation program compares the spectra of the unknown chemical compound to a list of spectra detailed in the NIST98 database. It will then provide a list of all possible matches in the database and indicate the probability of a successful match with the compound. A further comparison by the researcher is required to ensure that the program has not misidentified a compound. Close attention must be paid to the percentage of the probability of the match. A chemical match may be identified but the probability of the match being correct can be extremely low. A visual comparison between the spectra of the identified compound and the potential match in the library can easily confirm or disprove the computer's result. The use of comparative samples likewise relies on the researcher's visual confirmation by comparing the spectra of the comparative sample to that of the research sample.

Chapter 6 RESULTS

6.1 MICROSCOPY

6.1.1 Sample Set 1

Microscopic examination identified a moderate volume of residues adhering to the surface of the artifacts including a sufficient volume on artifact DeJj-8 (1) to allow for physical removal and analysis. All residues identified in Sample Set 1 were separated into subcategories based on physical appearance, with each sub-category being recorded as either probable contamination or of potential archaeological relevance. This distinction was made when the presence of a residue sub type could be readily explained as contamination.

Probable Contamination

Five residue types were identified as probable contamination in Sample Set 1. Diatoms were observed on three artifacts (DeJj-8(0), DeJj-8(4), and DeJj-8 (5), see figure 6.2). These diatoms (microscopic aquatic organisms) are likely associated with the recovery of artifacts from sites on the shores of Dog Lake.

A beige to brown amorphous residue was identified on five artifacts. The texture of this residue varied slightly, from bubbly to more homogeneous in appearance with colours varying from beige to brown. On artifact DfJj-21 the residue appeared in pod-like formations, while on artifacts DeJj-8 (5) diatoms were identified resting on and in the matrix of the residue, indicating a possible aquatic origin (see figure 6.2).

A homogeneous bright red amorphous residue was identified on the surface of three artifacts (DeJj-9(8), DeJj-8(9), DeJj-8(10), see figure 6.2). The residue consisted of minute

homogeneous bright red smears, indicative of a synthetic origin. The residue was only observed in Sample Set 1, suggesting it is a source of contamination specific to this collection.

Orange to yellow amorphous flakes were identified on the dorsal surface of artifact DeJj-1(2) (see figure 6.2). They appear homogeneous in color and do not appear to be embedded on the surface. The appearance and placement of these flakes on the tool surface indicates they are likely the result of contamination.

A brown fibrous residue with root like tendrils (possibly representing fungal hyphae) was identified on the ventral surface of artifact DeJj-8(6) (see figure 6.2). Larger concentrations of a similar residue were identified on artifact DdJm-3 in Sample Set 3.

Potential Archaeological Relevance

An additional four residue types were identified as having potential archaeological relevance. A brown, semi translucent amorphous residue with a glossy sheen was identified on three artifacts (DeJj-8(0), DeJj-8(1) and DeJj-1(3), see figures 6.1). Globular masses of the residue were identified on artifacts DeJj-8(0) and DeJj-8(1), with the volume on artifact DeJj-8(1) being large enough to allow for a physical removal for further analysis. The residue was confined to the proximal end of the ventral face on artifacts DeJj-8(0) and DeJj-8(1) and was located on both the ventral and dorsal surfaces of the working edge on artifact DeJj-1(3).

A black amorphous residue was identified in small concentrations on four artifacts (DeJj-8(0), DeJj-8(4), DeJj-8(7) and DeJj-8(10), see figures 6.1). The residue appears exclusively on the dorsal surface of the artifacts with the exception of a small concentration around the working edge.

An amorphous brown residue with a particulate texture was identified on four artifacts (DeJj-8(2), DeJj-8(6), DeJj-8(8) and DeJj-1(1), see figures 6.1). The residue does not appear to be associated with a specific location on the tools. When removed and mounted on a microscope slide the individual particles of the residue become apparent (see image 6.1).

A yellow/red amorphous residue was identified on five artifacts (DeJj-8(3), DeJj-8(9), DeJj-1(1), DeJj-2(1), DfJj-21, see figures 6.1) and appears to be found exclusively on the dorsal surface of the tools. The texture of the residue appears both particulate with no luster and solid with a slight luster. Similar residues were observed in Sample Set 3, and were examined on a microscope slide under high power magnification, the residue appeared to be particulate in composition.

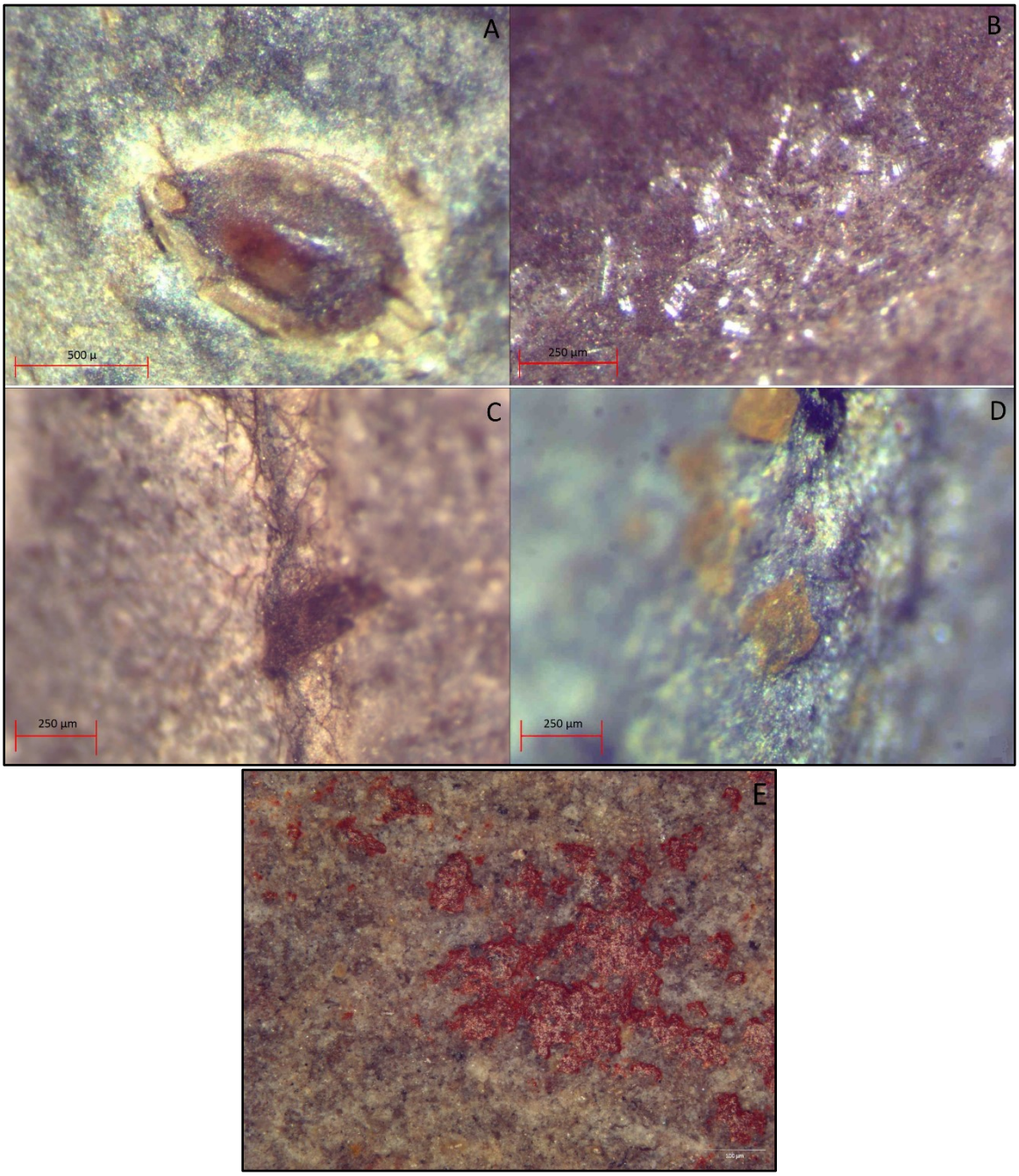

Figure 6.1 Contamination
A: Beige to brown amorphous, B: Diatoms, C: Brown Fibrous, D: Yellow to Orange Amorphous Flakes, E: Bright Red Amorphous Residue

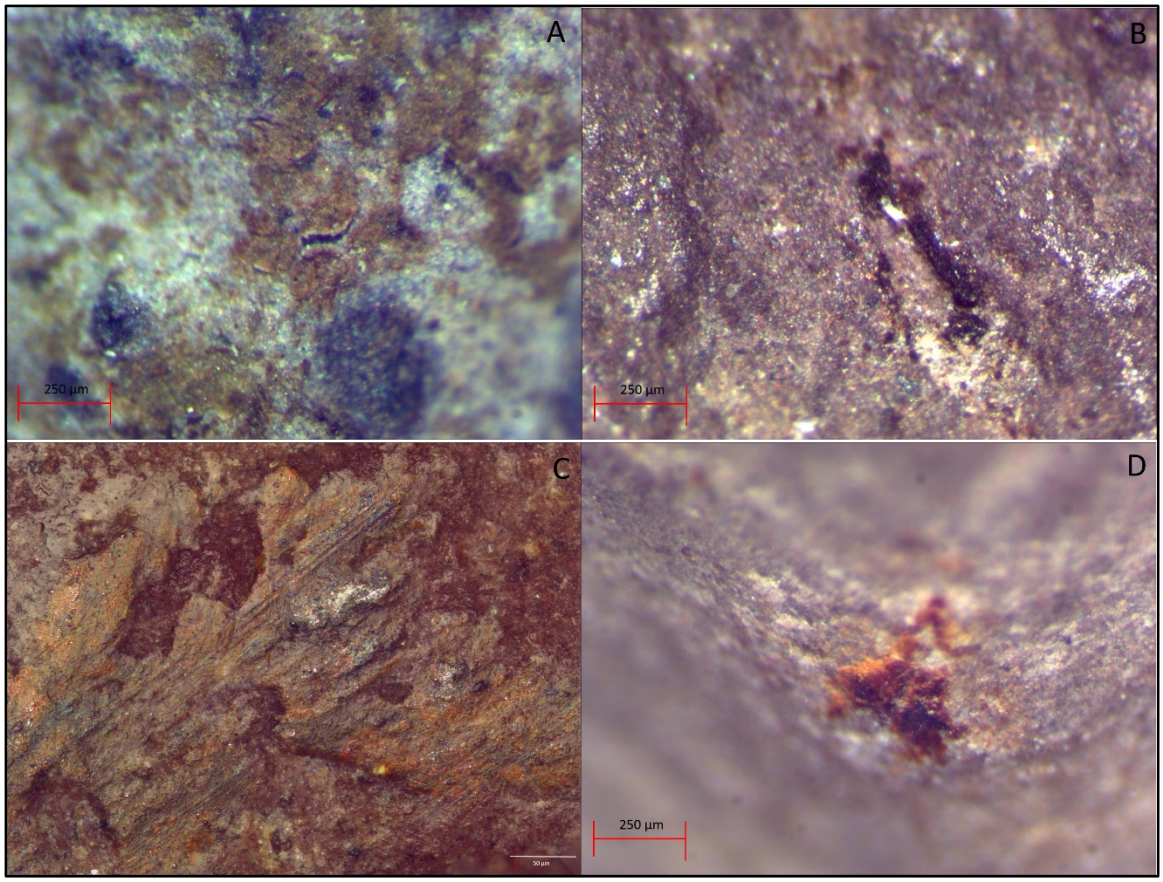

Figure 6.2 Residues with Potential Archaeological Relevance
(A: Brown particulate amorphous) (B: Black amorphous) (C: Brown, glossy amorphous) (D: Yellow to red amorphous)

Table 6.1 Microscopy Results from Sample Set 1

Artifact	Residue Description	Location
DeJj-8 (0)	Diatoms	Distal end of dorsal ridge
	Brown, glossy, amorphous	Proximal portion of right ventral surface and proximal end of ventral surface.
	Brown, glossy, translucent, amorphous globular mass	Proximal portion of ventral surface
	Black, amorphous	Ventral surface, near working edge
	Light beige to brown, amorphous	Distal end of dorsal ridge
DeJj-8 (1)	Brown, glossy, translucent, amorphous globular mass	Proximal end of ventral surface. (Note: tool is broken at proximal end)
	Beige, amorphous	Medial portion of ventral surface and ventral surface near working edge

DeJj-8 (2)	Brown, course amorphous	Dorsal surface, left edge of working end
DeJj-8 (3)	Red, amorphous	Dorsal surface, distal end (note, working edge appears to have broken off)
DeJj-8 (4)	Diatoms	Dorsal and ventral surface of working edge
	Black, amorphous	Medial dorsal ridge, ventral surface, near working edge
DeJj-8 (5)	Beige amorphous	Ventral surface of proximal end
DeJj-8 (6)	Brown, course amorphous	Left side of dorsal ridge, near working edge
	Brown fibrous mass with root like tendrils	Medial portion of ventral surface.
DeJj-8 (7)	Black, amorphous	Dorsal ridge at distal end (tool is broken at distal end)
DeJj-8 (8)	Brown, course amorphous	Dorsal surface, near proximal edge. Ventral surface, proximal end
	Bright red homogeneous, amorphous	Dorsal surface, near right lateral edge and working edge
	Red amorphous	Dorsal surface, near working edge
DeJj-8 (9)	Red, amorphous	Dorsal surface, distal portion near right lateral edge and left lateral edge
	Beige, amorphous	Dorsal surface, near working edge
	Bright red, homogeneous, amorphous	Ventral surface near working edge.
DeJj-8 (10)	Black, amorphous	Dorsal ridge, near proximal end (note: tool broken at proximal end)
	Bright red, homogeneous, amorphous	Ventral surface, near working edge
DeJj-1(1)	Brown, course, amorphous	Ventral surface at working edge
	Red, amorphous	Dorsal ridge, towards working edge
DeJj-1(2)	Orange to yellow amorphous flakes	Dorsal surface, working edge
DeJj-1(3)	Brown, glossy, amorphous	Ventral and dorsal surface of working edge
DeJj-2(2)	Beige, amorphous	Medial and proximal portion of ventral surface
DeJj-2(1)	Red, amorphous	Ventral surface, near working edge
DfJj-21	Red, amorphous	Dorsal ridge, medial portion
	Beige to brown, amorphous	Ventral surface, medial portion, several examples

6.1.2 Sample Set 2

Fewer residues were found throughout Sample Set 2 when compared to Sample Set 1, however, the amount was sufficient to permit further investigation. The majority of identified residues were located within recessed portions on the tools surface, most likely due to the tools being previously cleaned during curation.

Probable Contamination

Clusters of white fibers were found on two artifact (D 45 , see figure 6.5). The bright white colour and physical appearance of the fibers indicates they are of a synthetic origin.

Potential Archaeological Relevance

A yellow/red amorphous residue similar to that identified in Sample Set 1 was found on four artifacts (DeJi-1(1), DeJi-1(2), DeJj-2(3) and DEJJ-18, see figure 6.3). The residue did not appear to be specific to any particular tool surface.

Small concentrations of a black amorphous residue similar to that found in Sample Set 1 was identified on the dorsal face of the working edge of artifact DeJi-1(1) (see figure 6.3).

A fiber surrounded by a mass of black and red amorphous residue resembling both residues discussed above was found on artifact DeJi-1(1), on the dorsal side near the left lateral edge and slightly back from the working edge (see figure 6.4). The fiber is between 25-40μm in diameter and appears clear and translucent, consisting of a series of smaller intertwined fibers many of which are visibly fraying from the central fiber concentration.

A brown coarse amorphous residue, similar to that identified in Sample Set 1 was identified on the dorsal ridge and on the distal break of artifact DEJJ-4(6) (see figure 6.3). The residue here appears to be cohesive but also exhibits some breaking in a mud crack pattern.

A reddish brown amorphous residue was noted on the medial ventral surface of artifact DEJJ-4(6) (see figure 6.3). This residue was nearly homogenous in colour, the texture appeared cohesive with a light gloss on some areas.

Table 6.2 Microscopy Results from Sample Set 2

Artifact	Residue Description	Location
DcJi-1(1)	Red amorphous	Dorsal surface, near working edge,
	Black and red amorphous mass with fiber	Left lateral surface in crevice
	Black amorphous	Working edge
	White, amorphous with fibers (contamination)	Ventral surface
DcJi-1 (2)	Brown to black amorphous	Dorsal ridge
DeJj-2(3)	Trace of red amorphous	Working edge, dorsal ridge near working edge
DEJJ-18	Trace pf red amorphous	Ventral surface of working edge, ventral surface, medial portion and proximal end
DEJJ-4(6)	Brown to black amorphous residue with cracking course texture	Dorsal ridge, towards working edge and medial portion, distal break, left side
	Diatoms?	Possibly intermixed with above concentration
	White fibrous cluster (contamination)	Distal break, right side
	Reddish brown amorphous	Medial ventral surface and ventral near distal break

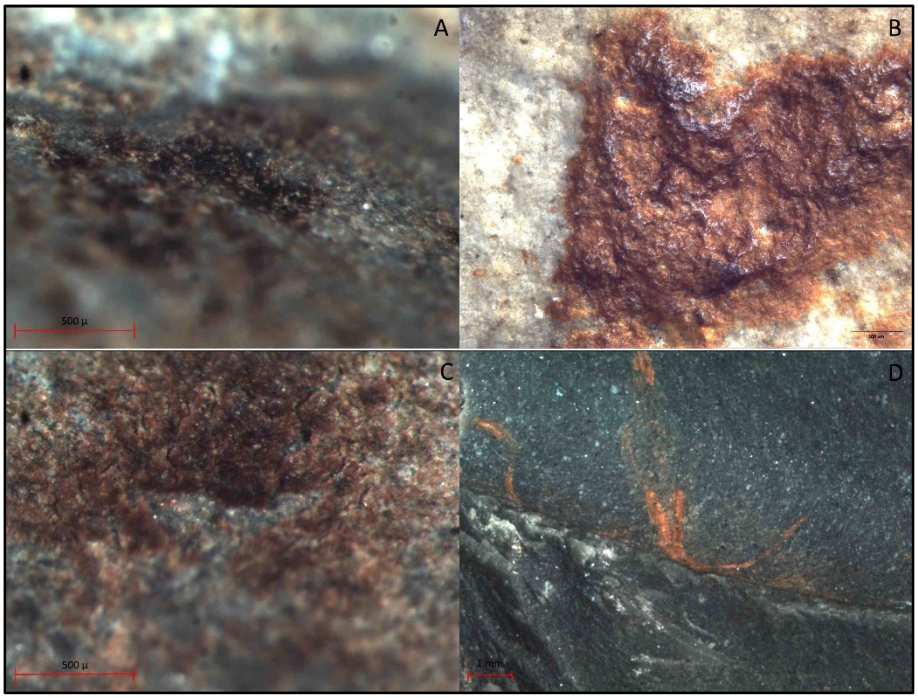

Figure 6.3 Residues with Potential Archaeological Relevance
A: Black amorphous, B: Reddish Brown amorphous, C: Brown Particulate Amorphous, D: Red Amorphous

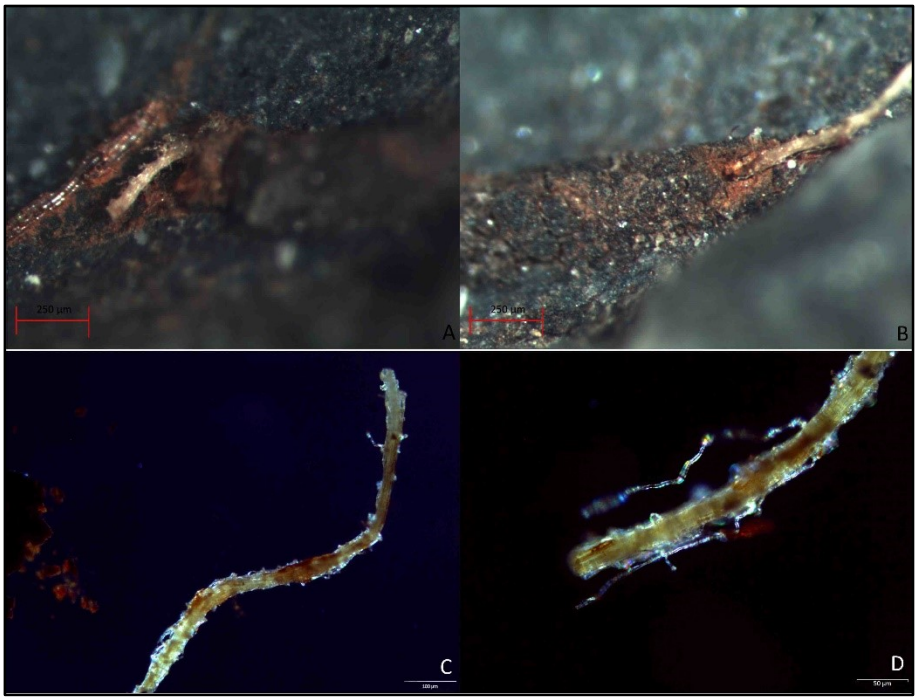

Figure 6.4 Fibrous Residue
A and B: Images of fiber in situ. C and D: Fiber viewed under cross polarized light

Figure 6.5 White fibrous contamination

6.1.3 Sample Set 3

Sample Set 3 contained the highest volume of potential residue seen in the study. Most residues similar to those identified in other samples. Artifacts DeJj-8 (13) and DeJj-8 (14) had sufficient residue to allow for physical removal.

Probable Contamination

Pollen was found on the ventral surface of artifact DeJj-21(2) (see figure 6.7). Based on the size and morphology of the individual grains the pollen appears to originate from either *P. strobus* or *Abies balsamea*. Determining when the pollen was deposited on the tool surface is not possible, however its position on the open surface of the tool would suggest it is most likely contamination. The pollen was discarded from further study based on this conclusion.

Diatoms were identified on the surface of three artifacts (DeJj-8(15), DeJj-4(4), DeJj-21(2) see figure 6.7). The presence of the microfossils is likely the result of these artifacts being recovered in close proximity to an aquatic environment.

Several concentrations of beige to brown amorphous residues were identified on artifacts DeJj-4(4) DeJj-4(2) and DdJm-3. On artifacts DeJj-4(4) and DeJj-4(2) the residues appeared in pod like formations (see figure 6.7). The residues are not limited to any specific tool surface and appear to be related to similar residues identified in Sample Sets 1 and 2.

A brown fibrous residue with root like tendrils was found adhering to the surface of artifact DdJm-3. The residue appears very similar to the suspected contamination noted on artifact DeJj-8(6) in Sample Set 1 but in higher quantity.

Potential Archaeological Relevance

A beige to brown amorphous residue with a particulate texture was identified on four artifacts (DeJj-8 (12), DeJj-4(2), DeJj-8(14), DeJj-4(1), see figure 6.6). The residue appears only to be limited to the dorsal surface, both on the dorsal ridge and near the working edge. The texture and colour of the residue is similar to those identified in Sample Set 1.

Orange to yellow amorphous flakes were identified on the dorsal surface of artifact DeJj-8(12) (see figure 6.6). The residue appears identical to the orange to yellow flakes identified on artifact DeJj-1(2) from Sample Set 1.

A yellow/red amorphous residue was identified on two artifacts (DeJj-8(13), DeJj-8(14), see figure 6.6). The texture of the residue varied, appearing both particulate and solid in composition. A sample removed from the dorsal ridge of artifact DeJj-8(13) was examined under high-power magnification, revealing that despite the solid appearance of some concentrations,

the residue appears to be made of minute particles and inorganic crystals. The residue is similar to the red amorphous residues identified in Sample Sets 1 and 2 but in much greater quantity.

A black amorphous residue was found on nine artifacts (DeJj-8(15), DeJi-4, DeJj-4(1), DeJj-4(3), DeJj-4(4), DeJj-4(5), DeJj-21(1), DeJj-21(2), DdJf-9, see figure 6.6). The residue was confined to the dorsal surface with two exceptions (DeJj-8(15) and DeJj-4(5)) where it was observed on the ventral surface of the working edge. The residue appears identical to the black amorphous residues identified in Sample Sets 1 and 2. A red staining was present beneath the residue on the ventral working edge of artifact DeJj-4(5) (see figure 6.6).

A brown glossy amorphous residue similar to that found in Sample Set 1 was identified on three artifacts (DeJj-8(15), DeJj-4(2) and DeJj-21(2) see figure 6.6). The residue did not appear to be limited to any specific tool surface.

Table 6.3 Microscopy Results from Sample Set 2

Artifact	Residue Description	Location
DeJj-8 (12)	Light beige to brown, amorphous	Left lateral surface to lateral edge
	Orange to yellow amorphous flakes	Medial portion of ventral surface
DeJj-8 (13)	Yellow to red amorphous	Covers much of the tool, major concentrations on dorsal and ventral
DeJj-8 (14)	Yellow to red amorphous	Covers much of the tool, distinct concentrations on dorsal and ventral
	Beige-brown, course amorphous	Dorsal ridge and working edge
DeJj-8 (15)	Glossy, transparent, amorphous	Medial portion of ventral
	White to beige amorphous	Working edge
	Diatoms	Working edge, intermixed with white to beige amorphous
	Black amorphous	Ventral surface of working edge
	Light brown, glossy, amorphous	Distal portion of dorsal ridge, distal portion of left lateral surface

DeJi-4	Black amorphous	Large portions of dorsal surface, higher concentration on distal portion
DeJj-4 (1)	Light brown to black, course amorphous	Near working edge
	Black amorphous	Dorsal surface, near working edge and dorsal ridge, distal end
DeJj-4 (2)	Beige-brown, amorphous 'pod-like'	Multiple locations on dorsal surface
	Yellowish brown, glossy amorphous	Left side of medial portion of dorsal ridge
DeJj-4 (3)	Black amorphous	Dorsal ridge
DeJj-4 (4)	Black amorphous	Dorsal surface and working edge
	Yellowish beige, pod like, bubble like texture	Crevices in ventral surface
	Diatoms	Ventral surface, various locations
DeJj-4 (5)	Black amorphous	Ventral surface of working edge and dorsal surface of proximal end as well as concentrations on dorsal surface
	Red amorphous staining	Located beneath black amorphous residue on working edge
	Brown amorphous	Dorsal ridge and proximal end of ventral surface
DeJj-21 (1)	Black amorphous	Various locations on dorsal surface and around working edge
	Dark brown to black amorphous concentration	Several small concentrations on dorsal surface
DeJj-21 (2)	Black amorphous	Spread across dorsal ridge and lateral surfaces only
	Diatoms	Ventral surface, near distal end, note working edge is not present
	Pollen	Crevices on ventral surface
	Brown, translucent	Ventral surface, in proximity to pollen
DdJf-9	Black amorphous	Directly distal of the dorsal ridge
DdJm-3	Reddish brown fibrous amorphous	Bands on the dorsal ridge and lateral surfaces
	Light yellow, beige amorphous	Left lateral surface

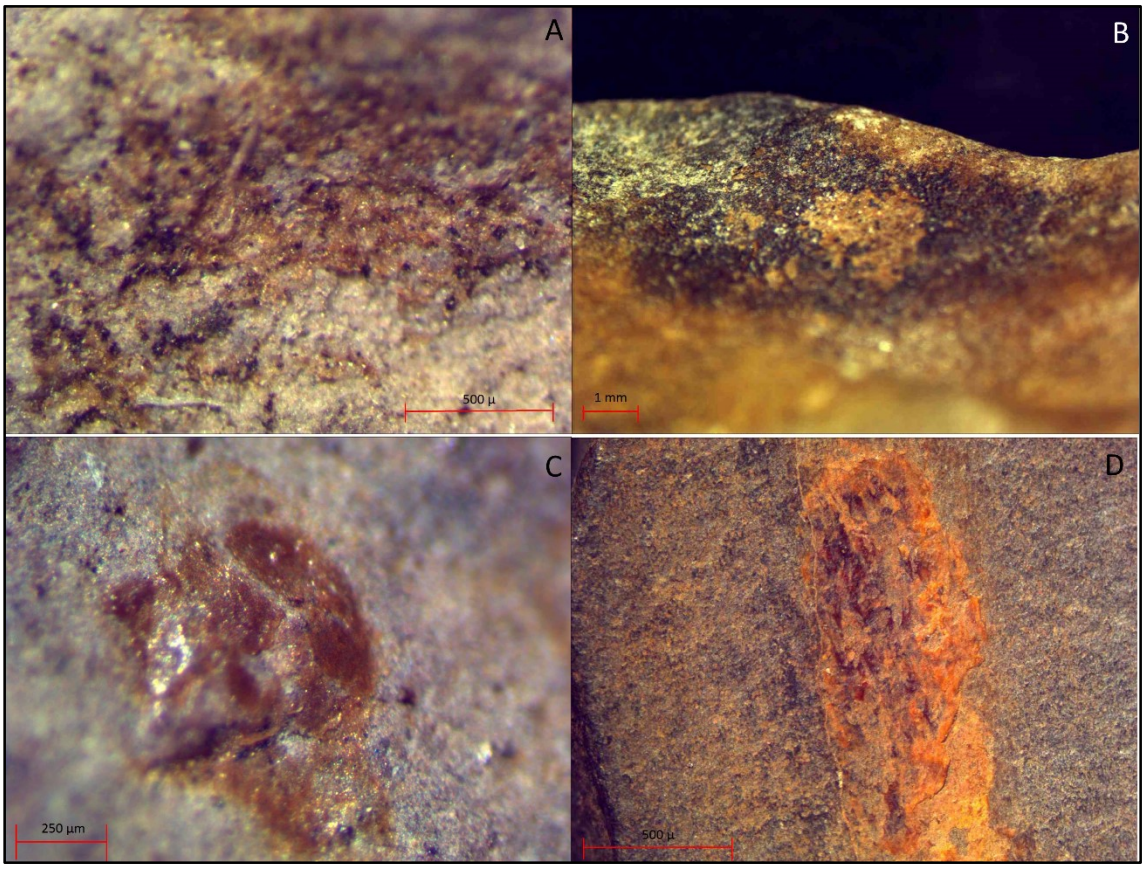

Figure 6.6 Residues with Potential Archaeological Relevance

A: Black amorphous, B: Reddish Brown amorphous, C: Brown Particulate Amorphous, D: Red Amorphous

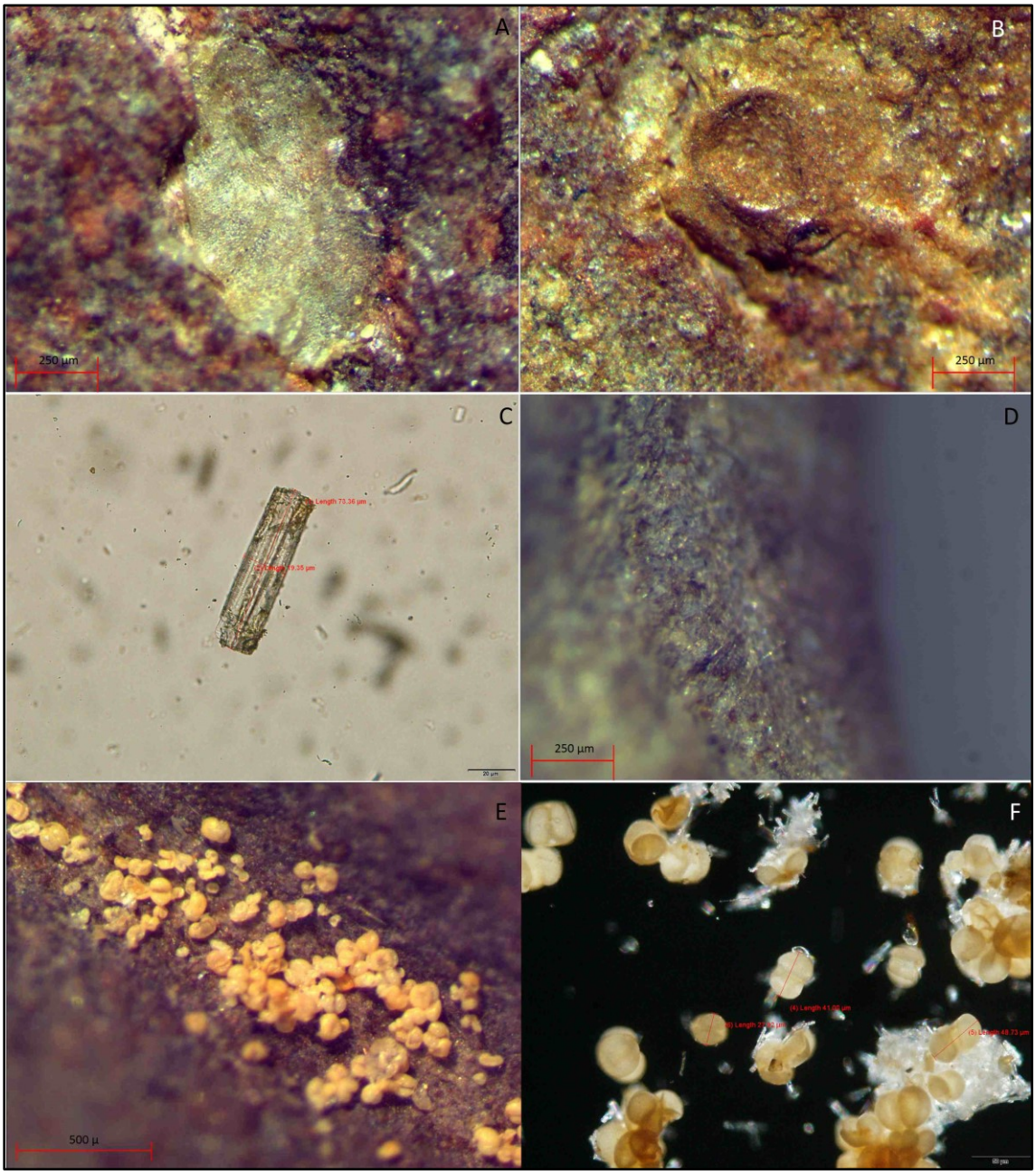

Figure 6.7 Contamination
A, B: Beige to brown amorphous, C, D: Possible Diatoms, E, F: Pollen

6.1.4 Sample Set 4

While the amount of residues identified in Sample Set 4 was low, there was enough was to warrant further analysis. All residues recorded are similar to those identified in other Sample Sets.

Probable Contamination

A beige amorphous residue with a bubble-like texture was identified on artifact EaKa-49 (see figure 6.9). This residue is similar in colour, texture and morphology to others identified in Sample Sets 1 and 3. Several diatoms were identified on the surface of the residue while being absent from the remainder of the artifact. This suggests a possible aquatic origin.

Potential Archaeological Relevance

A red amorphous residue, similar to that identified in Sample Sets 1, 2 and 3 was identified on both artifacts belonging to this set (see figure 6.8). The residue was found in minute quantities on both the dorsal and ventral surfaces.

Table 6.4 Microscopy Results from Sample Set 4

Artifact	Residue Description	Location
EaKa-49	Red amorphous residue	Medial portion of dorsal surface
	White to beige, amorphous, bubble like texture	Right lateral edge, dorsal side, near proximal end
EaKa-6	Red amorphous	Ventral surface, medial portion near left lateral edge, also near working edge

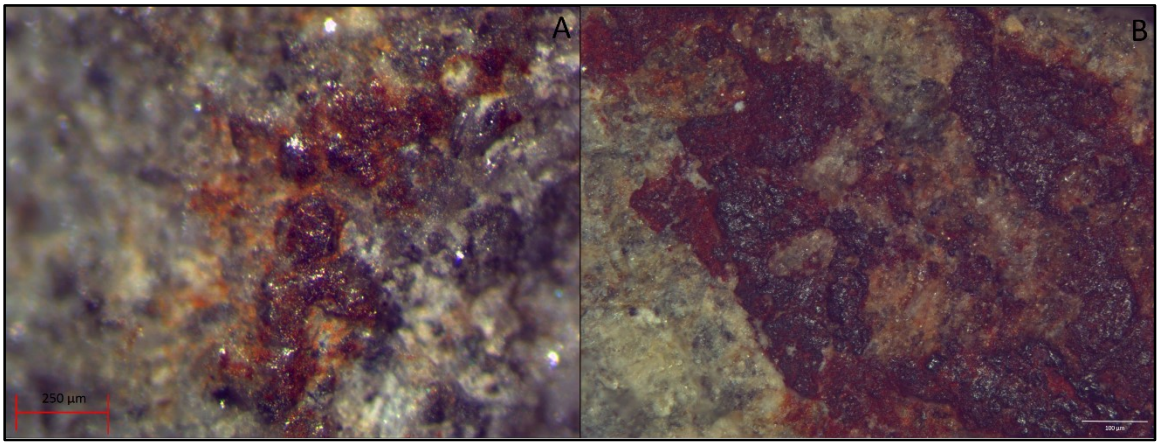

Figure 6.8 Residues of Potential Archaeologically Relevant
A: Red Amorphous EaKa-49, B: Red Amorphous EaKa-6

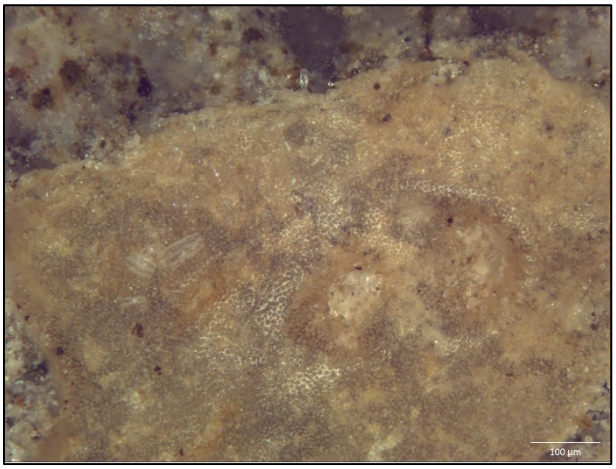

Figure 6.9 Beige Amorphous Contamination

6.1.5 Sample Set 5

A limited amount of residues were identified in Sample Set 5. Many identified residues were visibly covered by contamination.

Probable Contamination

A very light blue amorphous residue was identified on artifacts DeHh-8(16) and DhJf-5-129. The colour of the residue combined with its appearance covering other residues indicates it is most likely a contaminant (see figure 6.11).

Potential Archaeological Relevance

A small concentration of black amorphous residue was identified on the distal portion of the left lateral face of artifact DhJf-5 (see figure 6.10). It appears identical to the black amorphous residue identified in Sample Sets 1,2 and 3.

A brown to black amorphous residue was identified on the proximal end of the ventral surface and right lateral face of artifact DeJj-8 (16). The residue both resembles the black

amorphous residue mentioned above as well as the brown, course amorphous residue identified in Sample Sets 1, 2 and 3 (see figure 6.10).

A small concentration of light brown amorphous residue was identified on the right lateral edge of artifact DdJs-8 (see figure 6.10). The residue was not noted on any other artifacts from this Sample Set.

Table 6.5 Microscopy Results from Sample Set 5

Artifact	Residue Description	Location
DbJs-8	Light brown amorphous	Right lateral edge, dorsal view
DeJj-8 (16)	Brown to black course amorphous residue	Proximal end of ventral surface and right lateral face
	Light blue amorphous (contamination)	Right lateral face, near above residue
DhJf-5	Black amorphous	Left lateral face, distal portion
	Light blue amorphous (contamination)	Appears to cover part of above mentioned residue, also found on right lateral face

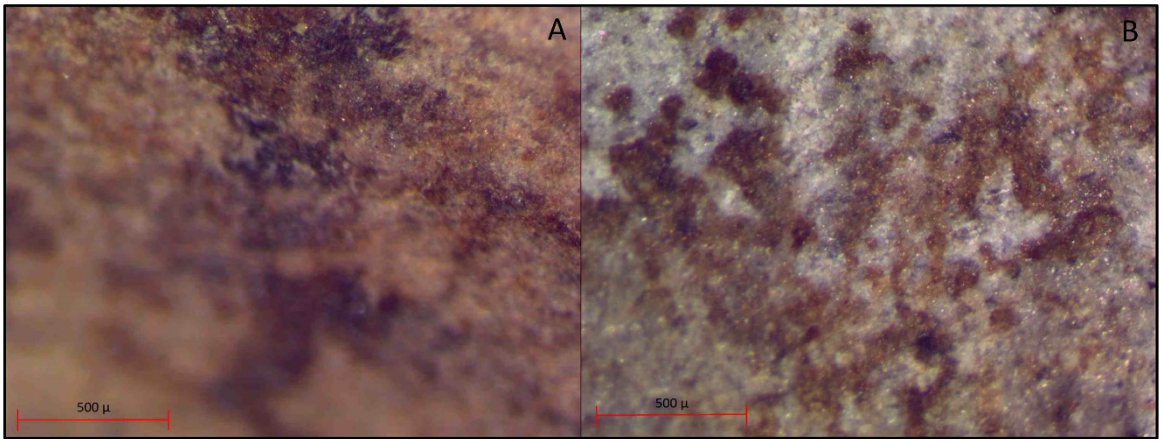

Figure 6.10 Potential Archaeological Relevance
A: Black Amorphous, B: Brown to Black Amorphous

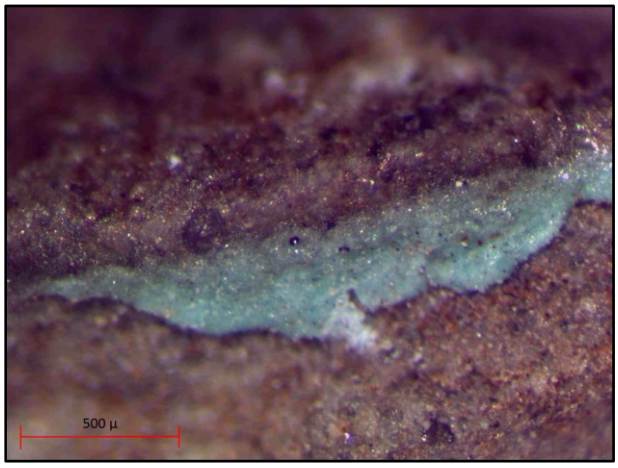

Figure 6.11Light Blue Amorphous Contamination

6.1.6. Microscopy Summary

Total residue levels varied between collections, however all collections showed a sufficient quantity of residue to warrant further study. Residue volumes in Sample Sets 1 and 3 allowed for the physical removal of some concentrations for further study.

Several microscopic residues were identified in multiple sample sets. Diatoms were observed on artifacts from Sample Sets 1, 2, 3 and 4. The presence of these microorganisms is likely the result of the various collections previous proximity to an aquatic environment. Beige to brown amorphous residues with pod like structures were identified on artifacts from Sample Sets 1, 3 and 4. The origin of these residues is not known, however their physical appearance and common proximity to diatoms suggests they are the result of an aquatic organism.

Three residues of potential archaeological significance were identified throughout the collection. A brown course amorphous residue was identified in Sample Sets 1, 2 and 5, with the residue not related to a specific tool surface. A black amorphous residue was identified on Sample Sets 1, 2, 3 and 5 and appeared almost exclusively on the dorsal surface and ventral face

of the working edge. A red to yellow amorphous residue was seen on artifacts from Sample Sets 1, 2, 3 and 4, the residue does not appear to be specific to any tool surface.

6.2 STAINING

The fiber removed from artifact DcJi-1(2) of Sample Set 2 became light blue in colour when stained with Toluidine Blue (see figure 6.12). This colour change indicates that the fiber is is composed primarily of protein. Touladine Blue is a metachromatic dye, meaning it will react differently to specific substances. Amino acids found in proteins cause a blue colour change while polysaccharides, the building material of most major plant supporting structures, will stain red-pink (Young *et al.* 2006).

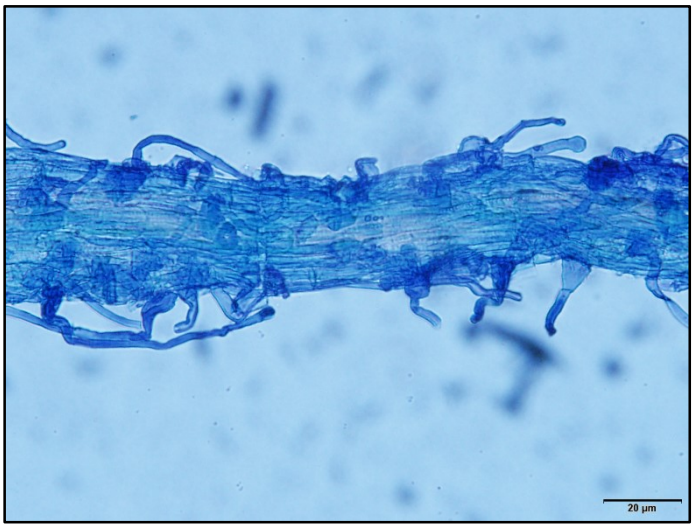

Figure 6.12 Fibrous residue from artifact DcJi-1(1). Result of staining with Toluidine Blue

6.3 BIOCHEMICAL TEST RESULTS

6.3.1 Sample Set 1

A total of 76 samples were taken from various locations on 17 artifacts and subjected to biochemical testing. The results from each test are presented separately.

Phenol Sulphuric Acid Test for Carbohydrates

Carbohydrates treated with sulfuric acid and exposed to phenol will produce a brown colour change. The degree of colour change, which can be quantified using absorbance spectrophotometry, will indicate the relative concentration of carbohydrates within the sample. No positive test results were recorded with this experiment. Colour change was not noted in any test. All readings from the absorbance spectrometer confirmed this result with an absorbance equal to or below that of the control sample.

IKI Test for Starches

IKI interacts with starch to produce a blue to black colour change. The degree of colour change can be quantified using absorbance spectrophotometry, indicating the relative presence of starch within the sample. One strong positive result was recorded from a sample taken from the dorsal ridge of artifact DeJj-8(0). A total of 16 samples from 13 artifacts returned weak positive results, each with a recorded absorbance only slightly above that of the control sample.

Copper, Triethanolamine/diphenylcarbazide Test for Fatty Acids

The Copper, Triethanolamine/diphenylcarbazide test was used to identify the presence of fatty acids within the sample set. A copper triethanolamine solution is used to isolate the fatty acids which then interact with diphenylcarbazide to produce a purple colour change. The degree of colour change is indicative of the concentration of fatty acids within the sample. This colour change can be quantified using absorbance spectrophotometry. Ten artifacts returned strong positive results, demonstrating the presence of fatty acids. An additional 39 samples from 16

artifacts returned weak positive results, indicating the likely presence of a reduced volume of fatty acids.

Bradford Protein Assay

When added to aqueous residue samples Coomassie Brilliant Blue G-250 dye will bind to protein molecules producing a blue colour change indicating the relative concentration of protein with the sample. This colour change is quantified using absorbance spectrophotometry. A total of 12 samples from seven artifacts returned strong positive results indicating the presence of protein. An additional 38 samples from 14 artifacts returned weak positive results, likely the result of the presence of a trace quantity of protein.

6.3.2 Sample Set 2

A total of 18 samples were taken from five artifacts in Sample Set 2. Artifact DcJi-1(2) had only one extract sample taken from a residue concentrated on the dorsal ridge. This sample was not tested for starch or carbohydrates. All other samples were subjected to the full range of tests.

Phenol Sulfuric Acid Test for Carbohydrates

No positive results were recorded for this test. All results were either equal to or below the recorded absorbance of the control sample.

IKI Test for Starches

Five weak positive test results were recorded between four artifacts. Each result was only slightly above the recorded absorbance of the control test, indicating possible false positives.

Copper, Triethabolamine/diphenylcarbazide Test for Fatty Acids

Six samples from two artifacts returned strong positive results for the presence of fatty acids on tool surfaces. Artifact DeJj-2(3) returned strong positive results from all four samples taken from its surface. Eleven samples from four artifacts returned weak positive results.

Bradford Protein Assay

Two samples from the working edge of artifact DeJj-2(3) returned strong positive results for the presence of protein; well above the recorded control. An additional five samples from three artifacts returned weak positive results.

6.3.3 Sample Set 3

A total of 55 samples were taken from the surface of 14 artifacts. All samples were subjected to the full range of tests.

Phenol Sulfuric Acid Test for Carbohydrates

Two strong positives results were recorded for two samples, each originating from the dorsal ridge of artifacts DeJj-8(14) and DdJf-9. Six weak positive samples were also recorded from four artifacts.

IKI Test for Starches

Only one strong positive result was recorded, originating from the dorsal ridge of artifact DdJf-9. An additional 14 weak positive results were recorded from seven artifacts.

Copper, Triethanolamine/diphenylcarbozide Fatty Acid Test

All 55 samples from the 14 artifacts in Sample Set 3 returned weak positive results. While the results were weakly positive all measurements of absorbance appear high enough above the control sample to indicate the presence of trace amounts of fatty acids throughout the sample set.

Bradford Protein Assay

A total of 16 strong positive results were recorded from nine artifacts. A further 28 samples from all 14 artifacts retuned weak positive results. These result indicate trace amounts of proteinaceous residue may be present throughout the sample set.

6.3.4 Sample Set 4

Eight samples were taken from the two artifacts belonging to Sample Set 4. All samples were subjected to the full range of biochemical tests.

Phenol Sulfuric Acid Test for Carbohydrates

All test results were below or equal to the control sample. This indicates no carbohydrates were present in the Sample Set.

IKI Test For Starch

Two samples, one from each artifact in the collection, returned weak positive results with recorded absorptions barely above the control sample. While this may indicate the presence of trace amount of starch the limited absorbance is possibly a false positive.

Copper, Triethanolamine/diphenylcarbazide Fatty Acid Test

Six samples, three from each artifact, returned weak positive results. The recorded absorption was enough to suggest the results are authentic.

Bradford Protein Assay

One sample from the right lateral edge of artifact EaKa-49 returned a strong positive result indicating the presence of protein. Two weak positive results were returned from samples taken from the dorsal ridge and proximal end on artifact EaKa-6.

6.3.5 Sample Set 5

Eight samples were taken from the two artifacts belonging to Sample Set 4. All samples were subjected to the full range of biochemical tests.

Phenol Sulfuric Acid Test for Carbohydrates

No positive results were recorded in Sample Set 5. All results were below or equal to the control tests indicating there were no carbohydrates present.

IKI test for Starch

All four samples from DbJs-8 returned weak positive results. The absorbance was narrowly above that of the control sample possibly indicating a false positive.

Copper, Triethanolamine/diohenylcarbazide Test for Fatty Acids

Eight samples from all three artifacts returned weak positive results. The recorded absorbances were high enough to indicate that trace amounts of fatty acids were present.

Branford Protein Assay

Two samples from the dorsal ridge and right lateral edge of artifact DbJs-8 returned strong positive results indicating the presence of proteinaceous residue. A further five samples retuned weak positive results indicating that trace amounts of protein were present.

6.3.6 Biochemical Test Summary

The biochemical tests for starch and carbohydrates returned primarily negative results. The IKI test for starch returned 156 negative results from 164 tests with all eight positive results coming from Sample Set 3. The Phenol Sulfuric Acid test for carbohydrates returned 126 negative results from 164 tests. Only two of the 43 positive results were strongly positive with all but one of the 41 weak positive results being barely above the recorded absorption of the control test.

Table 6.6 Results for IKI Test for Starch

Sample Set	Strong Positive	Weak Positive	Negative
1	1	16	59
2	0	5	13
3	1	14	36
4	0	2	6
5	0	4	4

Table 6.7 Results for Phenol Sulfuric Acid Test for Carbohydrates

Sample Set	Strong Positive	Weak Positive	Negative
1	0	0	76
2	0	0	18
3	2	6	47
4	0	0	8
5	0	0	8

A higher proportion of the Bradford Protein Assay returned positive results. Strong positive results were returned from 34 samples with an additional 81 showing weak positive results from a total of 165 samples.

Table 6.8 Results for Bradford Protein Assay

Sample Set	Strong Positive	Weak Positive	Negative
1	12	38	26
2	2	5	11
3	16	28	11
4	1	2	5
5	2	5	1

The Copper, triethanolamine/diphenylcarbozide test for fatty acids returned the greatest frequency of positive results of any biochemical test. A total of 29 samples returned strong positive results while 119 tests returned weak positive results. This totals 148 positives or 89.6% of the total samples. This data is reflected in the GC/MS results which show an abundance of fatty acid compounds identified throughout all collections.

Table 6.9 Results for Copper, Triethanolamine/Diphenylcarbozide Test for Fatty Acids

Sample Set	Strong Positive	Weak Positive	Negative
1	10	39	27
2	6	11	1
3	0	55	0
4	0	6	2
5	0	8	0

6.4 GC/MS RESULTS

6.4.1 Sample Set 1

A total of 15 chemical compounds were identified on artifacts from Sample Set 1. Only one compound was of archaeological significance with the remaining 14 compounds being

excluded through cautious interpretation and being present through natural, environmental and anthropogenic process but interpreted as most likely the result of contamination.

Dehydroabietic acid, a diterpenoid compound found in the resin of conifers, was identified in the physical removal taken from sample DeJj-8(1). The amount of the compound was low compared to modern contaminants identified in the same sample (see figure 6.13). If the presence of dehydroabietic acid was the result of contamination by conifer resins then other resin acid compounds such as pimaric acid or abietic acid would also have been present in the sample as these compounds would not have yet degraded. Dehydroabietic acid is the most robust resin acid found in conifer exudate, thus any archaeological resin sample exposed to oxidization would lose the more volatile compounds, retaining only the dehydroabietic acid (Mills and White 1977).

Degraded examples of glycine, an amino acid indicating the presence of proteins was identified on two artifacts (Creighton 1993). The common nature of this compound means it must be excluded from further interpretations. Contamination in the form of common organic acids were present in all samples. Palmitic acid, one of the most common naturally occurring fatty acids, was found on all artifacts (Gunstone *et al.* 2007). Four other common fatty acids used in various food products and cosmetics were identified throughout the collection. Seven of the identified compounds are used in the manufacturing of plastics, likely the result of plastic materials which the artifacts and samples were exposed to during various stages of curation and research. At least one of these compound types was identified on each artifact. For a full list of GC/MS results see section 1.8 of this chapter. For a comprehensive listing of all GC/MS results see Appendix C.

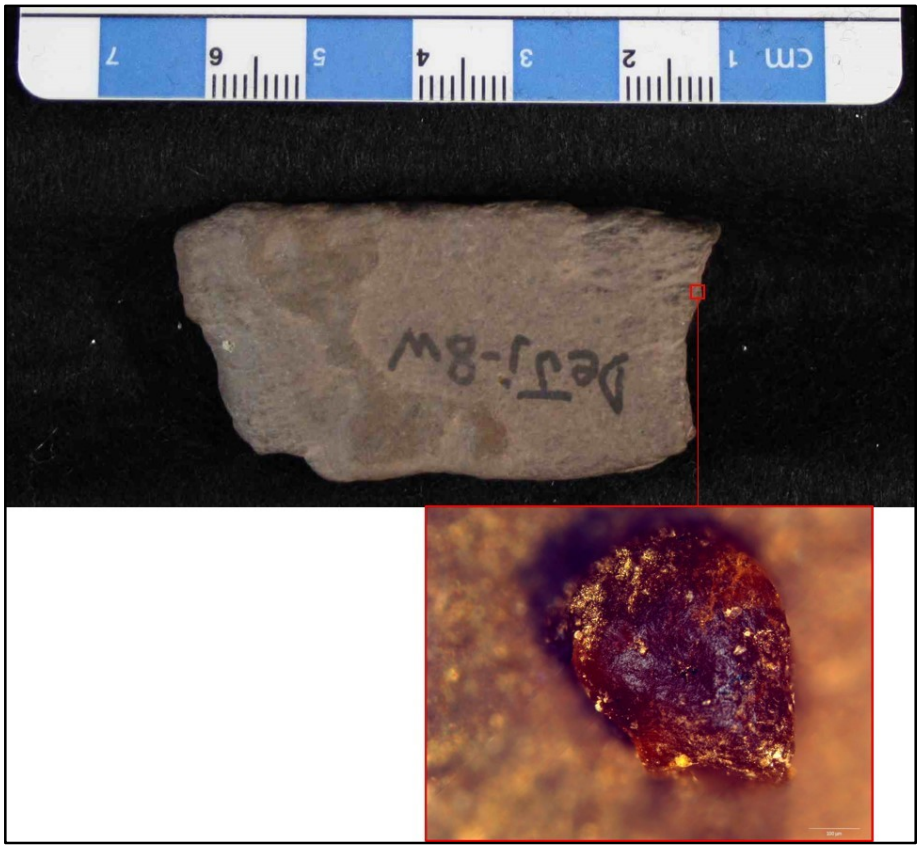

Figure 6.13 Location of dehydroabietic acid on artifact DeJj-8(1)

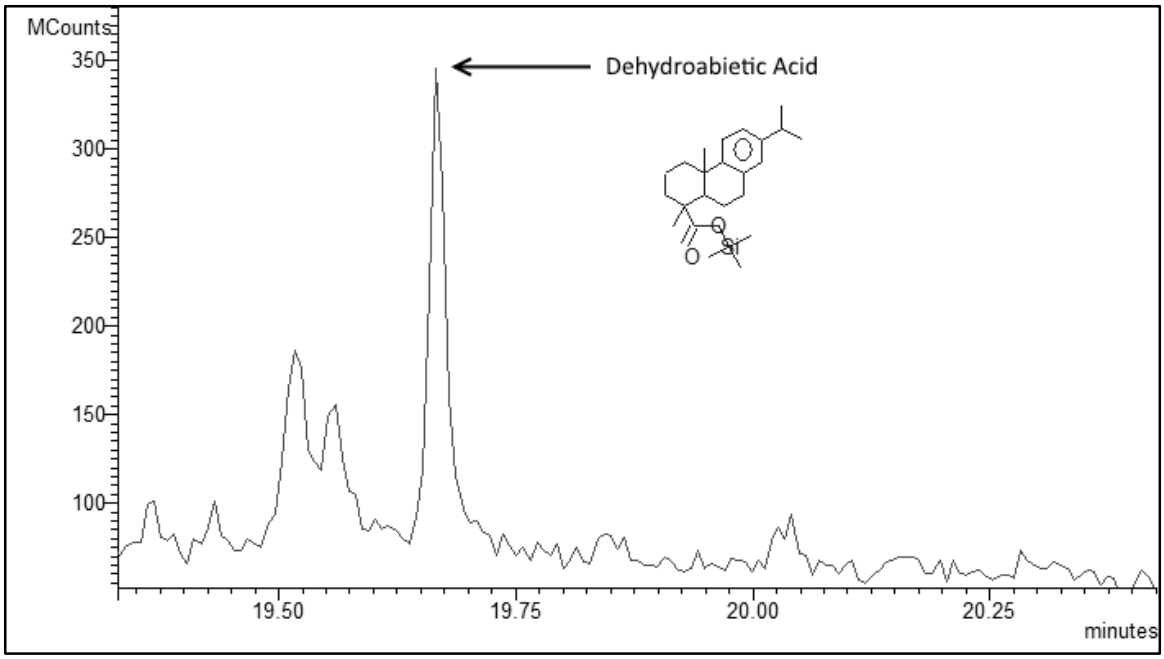

Figure 6.14 GC/MS peak indicating the presence of dehydroabietic acid

6.4.2 Sample Set 2

Five examples of contamination were identified in this sample. No compounds of archaeological relevance were identified. Glycine, an amino acid, was identified on the working edge of DcJi-1(1) (Creighton 1993). While this indicates the presence of proteins which may relate to the presence of the protenatious fiber the compound has been classified as possible contamination due to its common occurrence in proteins. Azelaic acid, a component in plastic manufacturing and a breakdown product of other naturally occurring fatty acids (Cornils and Lappe 2006; Eerksins *et al.* 2002) as well as a naturally occurring product fatty acid degradation (Eerkins *et al.* 2002), and palmitic acid, the most common fatty acid found in nature, were identified throughout the collection (Gunstone *et al.* 2007). Tetrasiloxane, a component of skin care products, was identified on one artifact as was Benzoic acid, a chemical component of many plastics (Lang and Stanhope 2001). A full list of identified substances can be found in section 1.8 of this chapter. For a comprehensive description of all GC/MS results see Appendix C.

6.4.3 Sample Set 3

A total of 29 chemical compounds were confidently identified in Sample Set 3. Dehydroabietic acid was identified in the physical removal samples taken from the dorsal ridges of artifacts DeJj-8(13) and DeJj-8(14) (see figure 6.17, 6.18) and in solvent removals from left lateral edge of artifact DeJj-4(4) (see figure 6.15) and the working edge of artifact DeJj-4(5) (see figure 6.16) (Mills and White 1977). The amount and nature of the dehydroabietic acid was similar to that found in Sample Set 1.

Naphthalene, benzonitrile and benzene were identified in a solvent removal sample from the working edge of artifact DeJj-21(1) (see figure 6.20). These compounds are consistently found together in burnt organic materials (Kaal *et al.* 2009).

The remaining 25 chemical compounds were the result of contamination. Glycine, an amino acid, was identified on two artifacts and excluded due to its common occurrence in proteins (Creighton 1993). Organic acid compounds found in plastics were by far the most common contaminant with 11 such examples being identified in this collection. The remaining compounds are most likely from food and cosmetic sources. For a full list of identified compounds see section 1.8 of this chapter. For a comprehensive description of all GC/MS results see Appendix C.

Figure 6.15 Location of dehydroabietic acid identified on artifact DeJj-4(4)

Figure 6.16 Location of dehydroabietic acid identified on artifact DeJj-4(5)

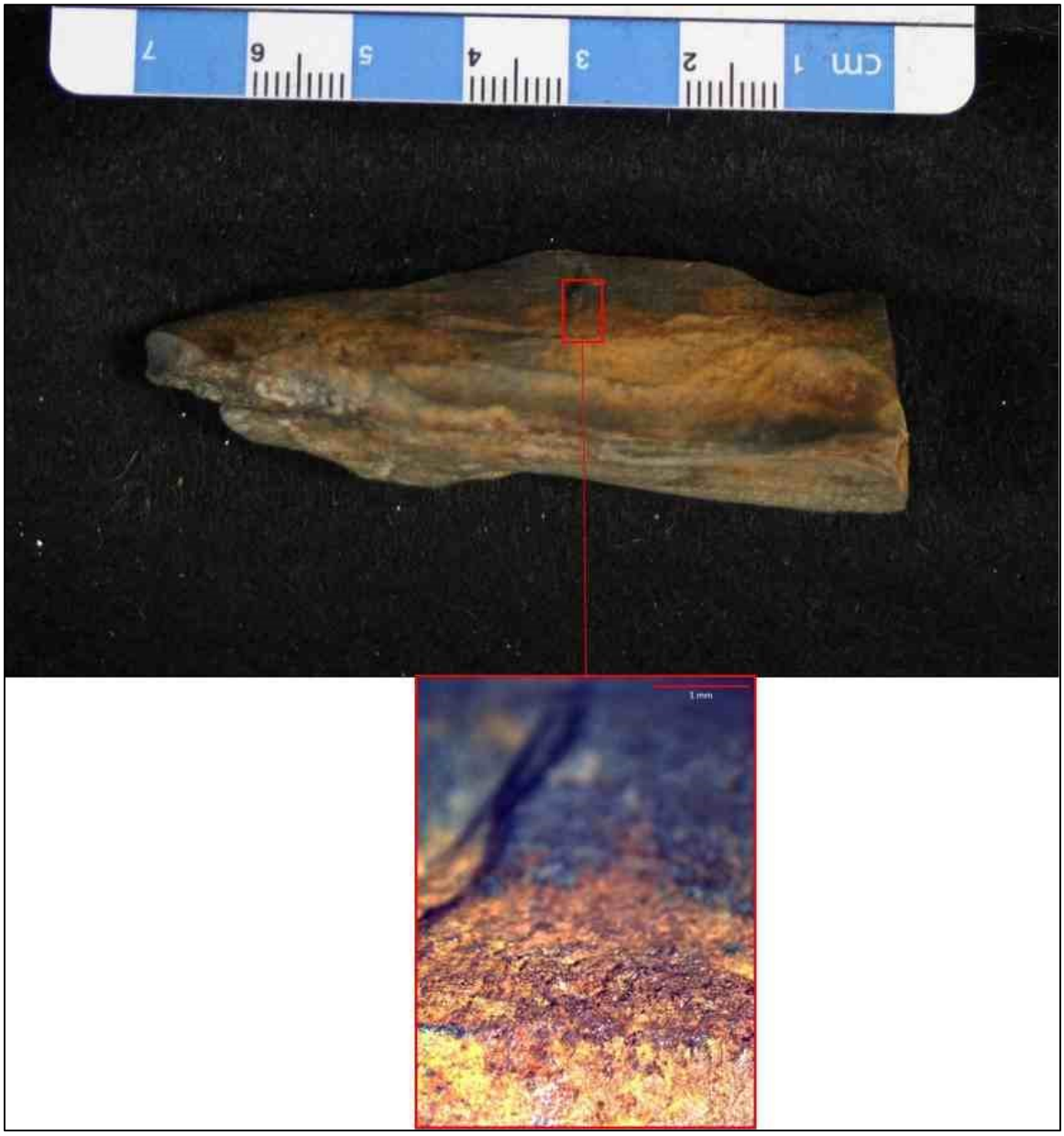

Figure 6.17 Location of dehydroabietic acid identified on artifact DeJj-8(13)

Figure 6.18 Location of dehydroabietic acid identified on artifact DeJj-8(14)

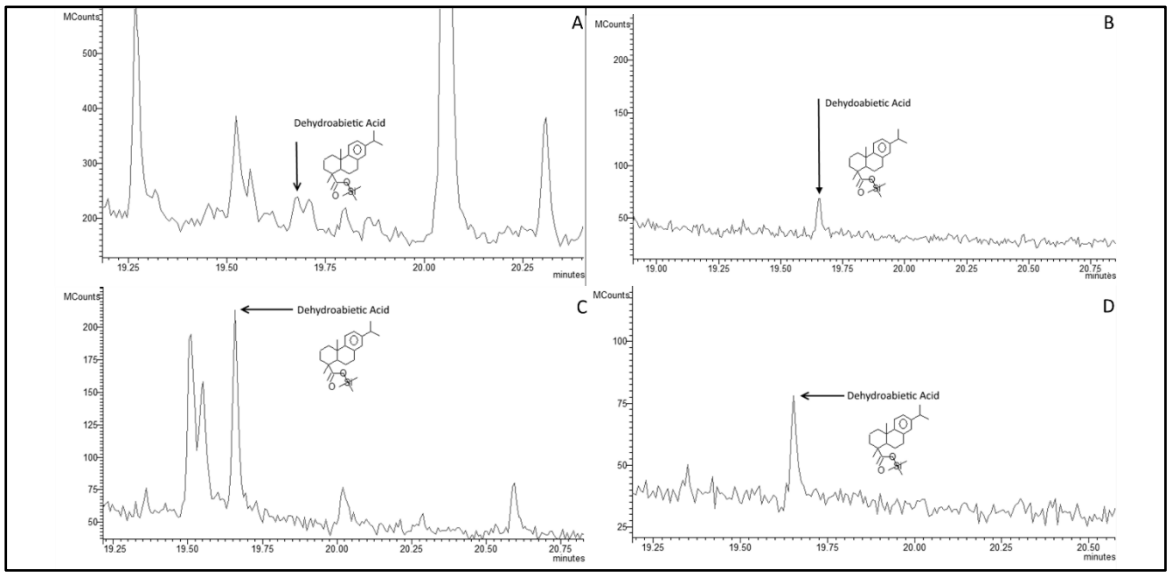

Figure 6.19 GC/MS peaks indicating the presence of dehydroabietic acid
(A: DeJj-4(4), B: DeJj-4(5), C: DeJj-8(13), D: DeJj-8(14))

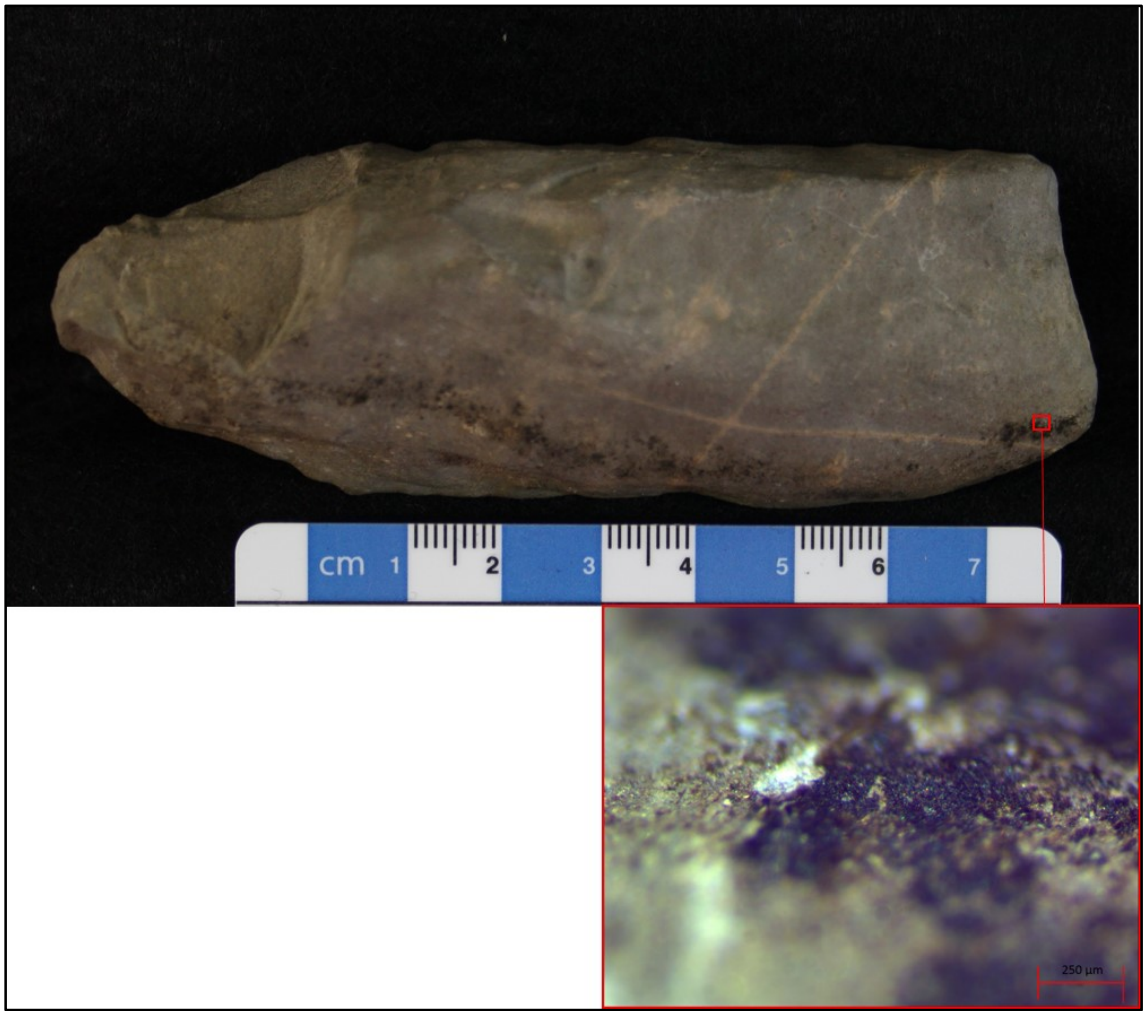

Figure 6.20 Location of naphthalene, benonitrile and benzene on artifact DeJj-21(1)

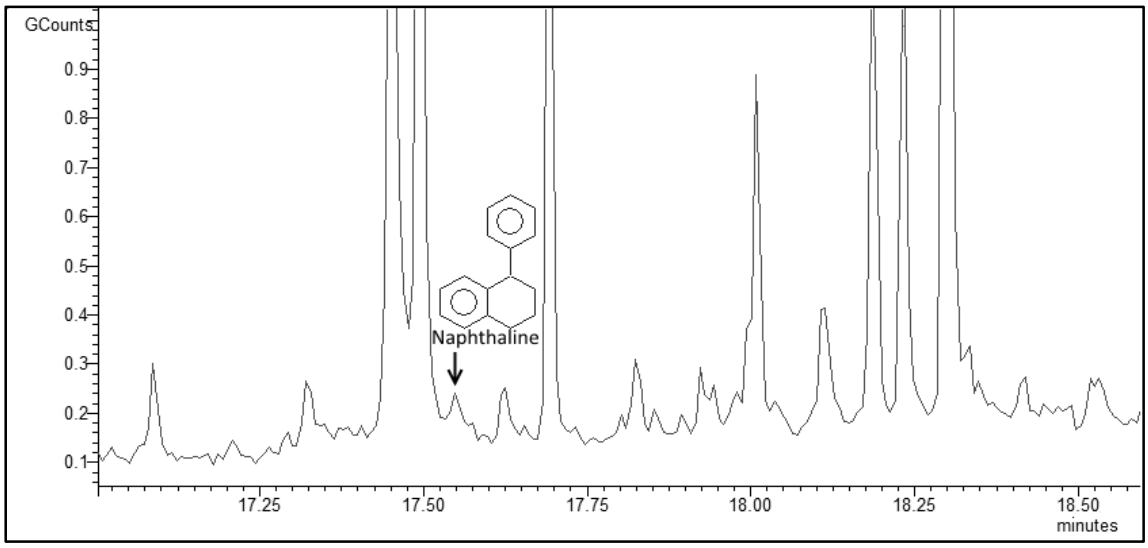

Figure 6.21 GC/MS peaks indicating the presence of naphthaline on artifact DeJj-21(1)

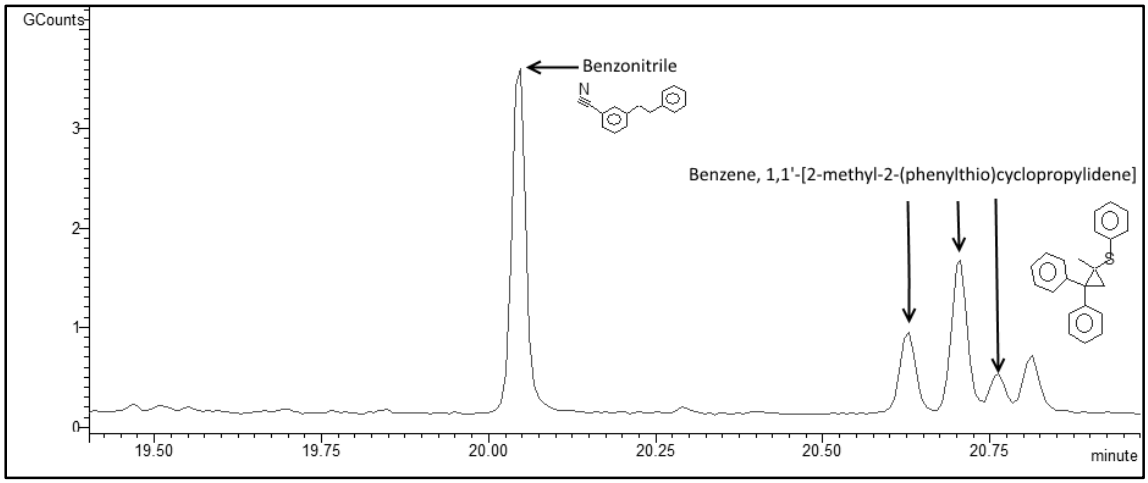

Figure 6.22 GC/MS peaks indicating the presence of benzonitrile and benzene, 1,1'-[methyl-2-(phenylthio)cyclopropylidene] on artifact DeJj-21(1)

6.4.4 Sample Set 4

A total of 23 chemical compounds were identified in Sample Set 4. All compounds were most likely the result of contamination. The most common source of contamination consisted of nine compounds related to plastics. Azelaic acid, found in both plastics and natural sources (Crnils and Lappe 2006; Eerksins *et al.* 2002) was the most prevalent of these, being identified in every sample. This contamination most likely occurred during the extraction and storage of the samples. Other sources of contamination appear to have come from modern food sources, cosmetics, detergents and disinfectants. Glycine was also identified in limited quantity indicating the presence of protein (Creighton 1993). A full listing of identified compounds and their sources can be found in section 1.8. For a comprehensive list of GC/MS results see Appendix C.

6.4.5 Sample Set 5

Only four compounds were identified in this sample set. None were archaeologically relevant. Glycine was identified on one artifact, indicating the presence of proteins (Creighton 1993). Azelaic acid, a naturally occurring organic acid also used in the production of plastics was

identified in all but one sample (Cornils and Lappe 2006; Eerksins *et al.* 2002). Palmitic acid, the most common fatty acid found in nature (Gunstone *et al.* 2007), and benzoic acid, found in plastics, were also identified (Lang and Stanhope 2001). See the summary section of this chapter for a full list of identified compounds and their potential sources. For a comprehensive breakdown of GC/MS results see Appendix C.

6.4.6 GC/MS Summary

A total of 37 chemical compounds were identified over all five sample sets. Only four of these compounds are considered archaeologically relevant. The remainder are interpreted as contamination and were excluded through a cautious interpretive approach. The most common source of contamination came from artifact and sample contact with plastics. A total of eight chemical compounds primarily used in the production of plastics were identified throughout the collection with an additional two compounds found in both plastics and plant sources (table 6.10). The remaining contaminating compounds are commonly found in modern food sources, cosmetics and cleaning materials (table 6.10).

Dehydroabietic acid was the only compound of archaeological relevance identified. This diterpenoid compound found in conifer resin was identified in samples from five artifacts, one from Sample Set 1 and four from Sample Set 3 (Mills and White 1977). Three of these samples were the result physical removals while two were taken from solvent soaks of the working edge and left lateral edge of two artifacts.

Table 6.10 Summary of GC/MS Results

Compound	Recorded	Most Likely Source	Citation
Dehydroabietic Acid	5	Resin of trees of the *Pinales* division	Mills and Whilte 1977
Naphthalene	1	Burnt organics	Kaal *et al.* 2009
Benzonitrile	1	Burnt organics	Kaal *et al.* 2009
Benzene	3	Burnt organics	Kaal *et al.* 2009
Benzoic Acid	26	Plants and plastics	Qually *et al.* 2012; Lang and Stanhope 2001
Glycine	8	Unknown protein source	Creighton 1993
Myristic Acid (Tetradecanoic)	26	Plant Oils, including modern food sources	Musa 2009
Palmitic Acid (Hexadecanoic)	48	Common fatty acid (plants, animals etc.)	Gunstone et al 2007; Malainey 2004; Regert *et al.* 2001; Croxton *et al.* 2010
Stearic Acid (Octadecanoic)	27	Animal fats	Magg 1984; Helwig *et al.* 2014; Malainey 1999
Hydrocinnamic Acid	1	Found in burn organic material	Smith *et al.* 2002
Phosphoric Acid	3	Non-organic mineral acid	Gonzalez-Parra *et al.* 2012; Iyamuremye & Dick 2008
Adipic Acid (Hexanedioic)	7	Plastics	Musser 2005
Azelaic Acid	64	Common fatty acid, natural and synthetic sources (includes plastics)	Cornils and Lappe 2006
Linoleic Acid (Octadecadienoic)	12	Plant oils, including modern food sources	Lambert *et al.* 2007
Phthalic Acid	12	Plastics	Lorz *et al.* 2007
Triethylamine	2	Plastics	Sprgi 2001
Triphenyl phosphate	3	Plastics	Svara and Hofmann 2006
Trisiloxane	3	Skin products (sunscreen etc.), derivatization	Montemayor *et al.* 2013
Pentasiloxane	5	Skin products (sunscreen etc.), derivatization,	Montemayor *et al.* 2013
Tetrasiloxane	10	Skin products (sunscreen etc.), derivatization	Montemayor *et al.* 2013
Urea	3	Fertilizer, metabolic process of animals	Meessen 2005
Octanedioic acid	12	Plastics	Cornils and Lappe 2014
Caprylic Acid (Octanoic)	3	Plant oils, includes modern food sources.	Beare-Rogers and Diefenbacher 2001
Nonanoic Acid	7	Plastics	Clampitt 1978
n-Pentadecanoic Acid	3	Animal fats (primarily in dairy)	Smedman at al. 1999

Sebacic Acid (Decanedioic)	1	Plastics	Motwane *et al.* 2005
Margarcic Acid (Heptadecanoic)	2	Animal fats (primarily in dairy)	Hansen *et al.* 1957
Archidic Acid (Eicosanoic)	1	Plant oils, including modern food sources	Wayne 1960
Behenic Acid (Docosanoic)	2	Plant oils, including modern food sources	Linko *et al.* 1994
Beta-sitosterol-acetate	1	Plant sterol, found in multiple plant species	Akhisa and Kokke 1991
Capric Acid (Decanoic)	10	Plant oils, including modern food sources	Beare-Rogers *et al.* 2001; Anneken *et al.* 2006
Borane	1	Simple synthetic compound, unknown source	Geenwood 1997
Acetamide	1	Plastics	Le Berre *et al.* 2014
Phenylacetic Acid (Benzeneacetic)	1	Plant hormones found in plant fruits	Larios *et al.* 2004
Cinnamic Acid	1	Fatty acid, common in tree species	Garbe 2000
Acetylcitric Acid	1	Plants, part of citric acid cycle	Penniston *et al.* 2008
Lauric Acid (Dodecanoic)	5	Plant oils, found in food and soap	Musa 2009

Chapter 7 INTERPRETATIONS

7.1 SAMPLE SETS

7.1.1 Sample Set 1

Sample Set 1 contains 17 adzes from four sites (DeJj-1 (n=2), DeJj-2 (n=2), DeJj-8 (n=11) and DfJj-21 (n=1)), all located at Dog Lake. All artifacts were recovered as surface collections and were subjected to a moderate amount of cleaning with water. Most adhering soil has been removed from the surface of the artifacts with the exception of some microscopic traces. This collection was not the most thoroughly cleaned out of those studied in this research nor was it the least disturbed, it instead represents the median of conditions found throughout the study.

The effect of the cleaning and handling are reflected in the analysis of these tools. Residues were identified through microscopic examination and were consistent with types identified in other sample sets. However, the volume of these residues was limited in most cases. The GC/MS analysis identified 14 compounds, primarily fatty acids, adhering to the surface of the tools. One example of authentic residue, specifically dehydroabietic acid, was identified by GC/MS in a sample of residue physically removed from tool DeJj-8(1). A small concentration of this residue apparently survived cleaning and was available for analysis.

An additional tool type was also identified in this collection. Two tools, initially thought of as broken trihedral adzes, are most likely picks or wedges. Tools similar to these were noted by Buchner (1984) as a component of the Caribou Lake Complex. The tools are similar in form to a trihedral adze with a pronounced dorsal ridge and a flat ventral surface. However, the portion of the tool identified as the distal end of a trihedral adze ends abruptly rather than tapering to a defined working edge. This was initially thought to represent a fracture resulting in

the loss of the working edge, as several examples of discarded adze distal portions have been identified in the set (DeJj-8(1), DeJj-8(10) and DeJj-8(2)). However, upon closer examination the break appeared rounded with polish evident on the dorsal ridge leading up to and extending over the edge. Finally, the opposite end of the tool was examined and a fracture consistent with light impacts was noted. This has led to a reclassification of the tool as a pick or wedge and has subsequently reversed the labeling of the tool ends with the narrow end being the distal or working end. It is possible this tool once functioned as an adze and was re-used as a pick after the loss of the working edge.

7.1.2 Sample Set 2

Sample Set 2 consists of 5 adzes, three originating from surface collections at Dog Lake (sites unknown), and two from surface collections at the Cummins Site (DcJi-2). All adzes were thoroughly cleaned with a brush and water, removing all evidence of the adhering soil matrix. Sample Set 2 appears to be the most thoroughly cleaned collection represented in this study. Limited residue was found under microscopic examination with one notable exception. A diagnostic fiber indicative of animal processing was recovered from artifact DcJi-1 (1), protected in a small crevice near the working edge of the tool. The biochemical analysis of the tools identified fatty acids adhering to the surface off the tools, however only eight compounds, as opposed to the 14 identified in Sample Set 1, were identified through GC/MS analysis with four of those compounds being identified in only one sample.

7.1.3 Sample Set 3

Sample Set 3 consists of 14 adzes from the artifact collections at Lakehead University. All but two adzes originate from sites in the Dog Lake region (DeJj-8(n=5), DeJj-4(n=6) and DeJj-21 (n=2)). The circumstances under which these artifacts were recovered as well as their

curatorial history are both unknown, however they exhibited signs of limited cleaning. Both remaining adzes were recovered during excavations, one from the Kozak Site (DbJm-3) and the other from the Mackenzie 1 Site (DbJf-9). The adze originating from the Mackenzie 1 Site exhibited very minimal cleaning with a thin layer of soil matrix still adhering while the adze from the Kozak Site showed a moderate amount of cleaning with no visible soil matrix.

Sample Set 3 showed the most minimal amount of cleaning of all the collections analyzed. This was reflected in the microscopic examination as residue concentrations were generally larger and more common than in other sample sets. Bio-chemical analysis indicated that fatty acids were present on every tool surface tested which was reflected in the GC/MS results with a total of 26 individual compounds, mostly fatty acids, identified. Two samples obtained through solvent sampling contained dehydroabietic acid, a resin acid found in conifer trees. Two physical removals were conducted on two artifacts from this sample. Both samples also contained dehydroabietic acid.

The effects of minimal cleaning were clearly characterized in the results on this sample set. The artifacts in this sample set contained the most microscopic residues present, the most consistent biochemical results were returned and the highest number of compounds were identified in GC/MS including four of the five results for dehydroabietic acid.

7.1.4 Sample Set 4

Sample Set 4 consists of two adzes, both originating from sites in the Lac Seul region (Eaka-49 and Eaka-9). Both adzes were recovered as surface finds and were subjected to a moderate amount of cleaning with water, removing all traces of soil from the surface. A minimal amount of residue was identified on the surfaces of both tools. Biochemical analysis revealed some fatty acids and proteinaceous residues were present on the surface of the tools, with

GC/MS analysis identifying 23 compounds. These results are consistent with Sample Set 1 which showed similar levels of cleaning.

7.1.5 Sample Set 5

Sample Set 5 consisted of three adzes belonging to the MTCS collections in Thunder Bay. Three sites (DeJj-8, DhJf-5 and DbJs-8) are represented in this collection. The history of recovery and subsequent curation of these artifacts are unknown. The artifacts appeared well cleaned with very minimal visible residues. Biochemical results indicated some fatty acids and proteins were present and only three compounds, all fatty acids, were identified with GC/MS. The sparse results are likely due to the apparent cleaning of the artifacts.

7.2 CONTAMINATION

Sources of modern contamination were present in every sample set. The most common sources of contamination likely resulted from both environmental contamination and the use of plastics in the solvent extraction phase. Possible plastic related compounds comprised 10 of the 37 chemical compounds identified by GC/MS. The remaining contaminants included fatty acids commonly used in both environmental contamination and modern food products (found in various plant oils), cosmetics (sunscreen, hand creams etc.) or are general fatty acids with no single identifiable source.

Environmental contamination potentially contributed to many of the non-synthetic contaminants. Glycine, an amino acid commonly found in proteins was present in all sample sets. The presence of this compound can result from any environmental or anthropogenic contaminant containing proteins. Soils contain many of the fatty acids identified through GC/MS in this research. Common fatty acids such as palmitic acid, pentadecanoic acid, stearic acid and

myristic acid have been identified as common components in soil samples (Tinoco *et al.* 2006). Lipids are generally thought to remain immobile in a soil matrix however there is still the danger of contamination by any remaining soil matrix (Heron *et al.* 1991). While it is common practice to recover soil samples during excavation and examine these soils to identify possible contaminants this was not possible for the artifacts in this study due to the nature of the sample sets, being primarily surface collections from amateur archaeologists and professional surveys. The presence of potential environmental contaminants was taken into account during the interpretation of data and only those compounds which could be ruled out as environmental contamination were included.

All contaminants with the exception of the plastic compounds may also have resulted from artifact handling which is not surprising given the extensive curatorial history of all collections in this study. The plastic compounds likely resulted from the use of plastic trays during the solvent extraction phase. The trays were chosen for their shape which allowed specific tool surfaces to be immersed in the solvent tri-mixture. The likelihood of plastic contamination was recognized prior to the solvent removal stage but was deemed acceptable as it would allow us to target specific tool surfaces and limit the areas where residues were removed.

While it is acknowledged that certain chemical compounds used in the manufacture of plastics may also be found in various plant species it was determined that none of those would be relied upon for the interpretation in this research. In addition to their use in plastics such compounds are usually far too general to allow for a specific identification of source. The goal of this research was to test the current interpretation of the artifact type as a wood working tool and potentially determine the species of tree being processed. While some terpenoid compounds are found in plastics these tend to be monoterpenoid compounds that would not be relevant to this

study. Diterpoenoid compounds found in conifer trees are not used in the manufacturing of plastics. Additionally, the dehydroabietic acid positive sample from artifact DeJj-4(5) was obtained without the use of plastics during the extraction phase. The combination of these factors makes the appearance of dehydroabietic acid through contamination highly unlikely. However any studies which aim to identify basic tools use (i.e. floral vs faunal exploitation) should attempt to eliminate the use of plastics wherever possible.

Additional microscopic evidence of environmental and handling related contamination were identified. Handling related contaminants included synthetic fibers and two unidentified amorphous contaminants. The amorphous contaminants included a pale blue amorphous mass identified on artifact DeJj-8(16) in Sample Set 5 and a bright red amorphous smear on artifacts DeJj-8(8), DeJj-8(9) and DeJj-8(10). The white fibers were identified in concentrations on artifacts DEJJ-4(6) and DeJj-1(1). Each of these contaminants were not unexpected as any artifact which has been handled prior to microscopic examination has a high likelihood of picking up a fiber used in textiles, papers etc. These contaminants are easily identified and excluded.

Environmental contaminants included pollen, diatoms and three unidentifiable organic contaminant, one possibly related to an aquatic organism with the other two being contaminants of unknown origin. The pollen sample was identified as being either *P. stobus* or *A. balsamea* (Balsam Fir) although a more precise identification was not made at due to the likely occurrence as contamination (McAndrews *et al.* 1984). While pollen can prove useful if its authenticity as a residue can be assured, the examples identified in this research were found resting on an open surface of the artifact and did not appear degraded, demonstrating they were almost certainly contamination. The diatoms and the unidentified biological contaminant are both likely a result

of these tools being recovered from a lake shore. While this did not add any new data to our research, such microorganism should be taken into account when examining artifacts of unknown origin as they are only found in specific locations (in this case only in aquatic environments) may indicate the origin of the artifact. The three unidentified organic contaminants consisted of beige to brown pod like masses, brown fibrous masses with smaller root like tendrils and amorphous yellow/orange flakes. The beige to brown pod like residue is possibly the result of an unknown aquatic organism as the residues were often found in connection with diatoms. The brown fibrous masses are possibly the remains of plant or fungal growth with the small tendrils representing fungal hyphae. The origin of the yellow/orange flakes could not be determined

7.3 MICROSCOPY

7.3.1 Amorphous

An amorphous residue is any residue without a clearly defined shape or form. This can include substances that once existed in a liquid or semi-liquid state which have since adhered to the surface of an artifact. Three amorphous residues were identified in multiple collections. A brown particulate amorphous residue was identified in Sample Sets 1, 2 and 5, a black amorphous residue was identified in Sample Sets 1, 2, 3 and 5, and a red/yellow amorphous residue was identified in Sample Sets 1, 2, 3, and 4.

The brown particulate amorphous residue is not identifiable. When viewed under transmitted light microscopy the residue appears to be a particulate residue embedded in an amorphous matrix. No distinct GC/MS results were recorded for samples with this residue, the reason for this is unknown.

The black amorphous residue is interpreted via GC/MS analysis of a sample obtained from artifact DeJj-21(1) as representing burnt organic material. A concentration of black amorphous residue identified on the working edge of artifact DeJj-4(5) is interpreted as charred wood residue due to its co-occurrence with a conifer tree biomarker and a red amorphous residue. This residue is found specifically on the working edges and dorsal surfaces of artifacts throughout four of the five sample sets. It is possible that these examples, being visually indistinguishable from the compounds identified through GC/MS, also represent charred wood residue.

The red amorphous residue was present in all sample sets with the exception of Sample Set 5. GC/MS analysis of samples obtained from three artifacts (DeJj-4(5), DeJj-8(13) and DewJj-8(14)) indicated the presence of dehydroabietic acid, a resin acid found in conifer trees. This indicates the residue is degraded conifer resin. The degradation of resin acids primarily occurs through oxidization. Due to the slow sediment deposition and shore line erosion at many of the sites of origin, the artifacts were possibly openly exposed for large periods of their depositional history with all but two of the tools in this study being recovered as surface finds. Certain concentrations of residue appear to contain a portion of soil matrix, although this is not found in every example. On the dorsal ridge of artifacts DeJj-8 (13) and (14) the soil grains can be observed in conjunction with a glossy luster on other portions of the concentration. It is likely that some soil matrix mixed with the conifer resin, creating this appearance. This residue was not limited to any specific tool surface, however examples found on the proximal end of the ventral surface appear smeared and contain no soil matrix. It is likely that this residue was deposited during tool use and became flattened between the ventral and hafting surfaces. The possibility of these residue concentrations representing a hafting adhesive was considered however the

distribution on the ventral surface is not indicative of this with the residue found near both the proximal and distal ends including the working edge.

A brown, glossy amorphous residue was identified in sample sets 1 and 3. Analysis by GC/MS of a physically removed sample taken from artifact DeJj-8(1) identified dehydroabietic acid as a chemical component, indicating the presence of conifer resin. The residue is only identified in small quantities and does not appear to be limited to any specific tool surface. On artifact DeJj-4(5) thin layers of the residue was found adhering to the proximal end of the ventral surface of the artifact. Unfortunately, due to the decreased volume of the residue none could be physically removed for testing to confirm this.

7.3.3 Fibrous Residue

A fiber was identified on the dorsal surface of artifact DcJi-1(1), approximately 1.5cm from the working edge. The artifact, part of Sample Set 2, was thoroughly cleaned, however the fiber was contained within a small crevice which appears to have protected it from removal. The fiber was surrounded by a small concentration of amorphous black and red residue and the remains of removed residue concentrations can be seen directly adjacent to the fiber. Due to these combined factors the fiber is believe to be authentic. When examined under high magnification transmitted light microscopy the fiber was made up of a series of smaller, colourless, translucent interwoven fibers (see figure 6.4). The fiber exhibited notable fraying, implying that this fiber is damaged or degraded, and interpreted as authentic.

The fiber was stained with Toluidine Blue to indicate its basic chemical composition and source. Toluidine Blue is a metachromatic dye, meaning it will differentiate between various compounds. Polysaccharides, the basic building material in most plant tissues, will be stained red-pink while amino acids, the building material of proteins, will be stained blue. Various other

compounds will be stained other colours along this spectrum. The fiber was stained a light blue colour, indicating it is proteinaceous. The form of the fiber is consistent with soft tissue. The location and composition of the fiber is consistent with residue resulting from animal butchering. The residue which was found coating the fiber is similar to the red and black amorphous residues identified throughout the collection which was shown to indicate both conifer resin and burnt plant material. The tool was likely used to butcher an animal and shortly afterwards was possibly used to work charred conifer wood.

7.3.4 Basic Use Wear

Abundant polish was noted on the dorsal ridge of six artifacts. Polish of this nature is generally the result of continued friction with a soft surface (Rots 2008). It is possible that surface polish could occur as a result of artifact transport in hide containers or as a result of tool manufacture. However, this polish is identified specifically on the dorsal ridge of the tools and while dorsal ridge grinding is observed on all complete specimens the polish is only found on artifacts with working edges which show signs of dulling and battering consistent with tool use (Rots 2008). No polish was identified on artifacts with working edges that appeared unused. The extensive nature of certain examples of polish, combined with its distribution on used tools is consistent with continuous friction of a binding material. This supports the current interpretations that the artifacts were hafted with the flat ventral face likely seated on a wooden platform and then bound with sinew.

7.4 BIOCHEMISTRY

7.4.1 IKI Test for Starch and Phenol Sulphuric Acid Test for Carbohydrates

All but three of 164 samples returned negative results. The lack of starches is not surprising given the harsh taphonomy of the region and many of these artifacts were recovered in close proximity to an aquatic environment. One of the remaining three and the only artifact to return a strong positive result (DdJf-9) was the only artifact not cleaned. The residue on this artifact was coated in a fine layer of soil matrix. Although no starch was observed during microscopic examination it is possible that the positive result for both carbohydrates and starches from this residue came from a source within the soil matrix. This helps to highlight the use of soil samples when possible as an important aspect of residue authentication. The examination of associated soil samples would have allowed for the identification of environmental contaminants, making it possibly to more confidently evaluate the results. These results highlight that minimal cleaning of an artifact is ideal. However it also demonstrates that it is still important to remove the various layers of soil adhering to the surface of an artifact with care and consideration, as a step in the residue analysis, as the out layers of soil will contain greater environmental contaminants while the lower layers of soil may contain residue or be trapped in the residue. The removed soil matrix should still be analyzed in tandem with soil samples to avoid any loss of authentic residues.

7.4.2 Bradford Protein Assay

A total of 34 samples returned strong positive results for protein with an additional 81 samples showing weak positive results. This could indicate the presence of some trace proteins on the surface of several artifacts. However the GC/MS method employed here was not designed to analyze proteins. Eight examples of one amino acid (glycine), a basic component of many

proteins, was identified in the collections, explaining at least some of these positives. For this method to be reliable further validation is required. Such a validation study should include effects of contamination and a further understanding of limitations. As a result this test is not included in further interpretations.

7.4.3 Copper, Triethanolamine/diphenylcarbozide Test for Fatty Acids

Results for the copper, triethanolamine/diphenylcarbozide test for fatty acids were the most consistent. A total of 29 tests returned strong positive results while 119 returned weak positive accounting for 89.6% of the total samples. This is consistent with the GC/MS results and demonstrates the test is effective at detecting the presence of fatty acids. Further validation including sources of contamination and test limitations is required if it is going to be applied to archaeological material. When greater understanding of the method is achieved and the risk of contamination can be limited in artifact recoveries this test may prove useful for identifying the presence of fatty acids.

7.5 GC/MS

7.5.1 Contaminants

The most common source of contaminant identified through GC/MS analysis potentially originated from a use of plastics. The identified compounds are: adipic acid, benzoic acid, phthalic acid, triethylamine, triphenyl phosphate, octanedioic acid, nonanoic acid, sebacic acid, azelaic acid, and acetamide (see table 6.10 for references). These compounds were easily recognized and excluded from further analysis. It is noted that some compounds used in the production of plastics are also found in natural sources. Benzoic acid is found in a large variety of plant species while azelaic acid is a breakdown product of animal fatty acids (Eerkins *et al.*

2010). The occurrence of these compounds within a sample would not have altered any archaeological interpretation as they are far too general to allow for a specific interpretation. While it is recognized that eliminating the use of plastics would be ideal for any archaeological residue study it must also be recognized that doing so is not always a practical choice. In addition the contribution of plastic contaminants on artifacts that have unknown, long or varied curation will be unknown and must be considered.

Fatty acids and other compounds found in modern food sources were common throughout the GC/MS analysis. These compounds are: myristic acid, linoleic acid, caprylic acid, archidic acid, behenic acid, capric acid, phenylacetic acid, acetylcitric acid and lauric acid (see table 6.10 for references). The majority of these compounds are fatty acids found in plant oils (palm kernel oil, coconut oil, canola oil etc. see table 6.10 for references) that are found in a variety of modern foods. Phenylacetic acid and acetylcitric acid are both found in various fruits. Since these could be the result of handling and especially because the curatorial history of these artifacts is not confidently known it has been assumed that these compounds are the result of handling contamination.

Trisiloxane, pentasiloxane and tetrasiloxane, three compounds commonly found in skin lotions, were identified in 18 samples. These compounds may be the result of human handling, being found in products such as sun screen and various skin care products (see table 6.10 for references). Siloxane compounds may also result from oxygen contamination during sample preparation for GC/MS.

Several compounds of unknown origin were also identified through GC/MS. Phosphoric acid and borane are inorganic compounds used in a range of synthetic and industrial applications

as well as possibly being present in the soil matrix. Urea, a chemical that is vital to the metabolic processes of most animals and also used in fertilizers, was also identified.

Fatty acids that have been used for interpretation in other archaeological residue studies were identified in GC/MS analysis but were regarded with caution in this analysis. These compounds, primarily palmitic and stearic acids, have proven useful in the past due to the fact that when recovered from secure contexts (i.e. artifacts with known curatorial histories or from samples known to be free of major contaminants) they can be used to determine the origin of a residue. Palmitic acid is used in some studies by comparing its ratios to that of other compounds within a total sample (Malainey 2004). In this way it can be used to determine the source of the residue, however, if the authenticity of the palmitic acid is unknown, there is a mixture or any threat of contamination exists then it must be treated cautiously as it is one of the most common fatty acids found in nature and it can present due to handling (Croxton *et al.* 2010). Stearic acid is found primarily in animal fats, although it may also occur in low concentrations in some plant oils. The presence of stearic acid can be used to infer the presence of animal fats (Craig *et al.* 2003; Helwig *et al.* 2014). Much like palmitic acid, stearic acid is very common in nature and given the unknown curatorial history of these tools, could have been deposited as a contaminant by human handling (Maag 1984).

7.5.2 Archaeological

Dehydroabietic acid, a resin acid found in conifer trees was identified on five artifacts, DeJj-8(1), DeJj-8(13), DeJj-8(14), DeJj-4(4) and DeJj-4(5). The residue is considered authentic due to the chemical characteristics of dehydroabietic acid with regards to conifer resin composition. Conifer resin is comprised primarily of three types of diterpenoid compounds: labdanes, pimaranes and abietanes. Labdane compounds are the most volatile and typically decay

through oxidization in a matter of days. Pimarane compounds are less volatile but unless the residue is preserved in an anaerobic environment these compounds will typically become degraded within several years. Abietane compounds are the most stable of the diterpenoids. Of the abietanes, dehydroabietic acid is the most stable. The previous pimarane and abietane compounds will form dehydroabietic acid as they degrade through an oxidative process called dehydrogenation. Dehydroabietic acid is the dominant compound usually found in archaeological samples because of this process. However if dehydroabietic acid was identified through GC/MS in high frequency in a collection of artifacts, its authenticity may be suspicious. In this study it was found only on a small number of artifacts (n=5) and has been interpreted as authentic. The presence of dehydroabietic acid on a small number of artifacts attests to their age and thus is old enough to be of archaeological relevance.

The dehydroabietic acid was identified on multiple tool surfaces, being found on the ventral surface, of DeJj-8(1), the dorsal surface of DeJj-8(13) and DeJj-8(14), the left lateral edge of DeJj-4(4) and the working edge of DeJj-4(5). It appears the artifacts were coated in the residue during use, with traces of it ending up on every tool surface, including the ventral face. The microscopic appearance of the residue on the ventral surface of DeJj-8(14) supports this interpretation.

GC/MS analysis of a black amorphous residue from artifact DeJj-21(1) contained napthaleine, a polycyclic aromatic hydrocarbon; benzonitrile, a polyaromatic compound; and benzene, a simple aromatic hydrocarbon. When identified in tandem these compounds are indicative of burnt organic material. This finding is consistent with the interpretation that the black amorphous residue represents thin layers of burnt wood or resin and that these tools were used to work charred wood. The occurrence of forest fires combined with the fact that these

artifacts were found as part of a surface collection means the possibility of contamination cannot be discounted. However, this residue appears almost exclusively on the dorsal surface and working edge of artifacts, regardless of collection and is only found as thin layers adhering to the surface of the artifact. Additionally, the concentration of this residue along the working edge of artifact DeJj-4(5) occurred in conjunction with a conifer biomarker. These distributions are most consistent with residues deposited via tool use and are considered authentic.

Chapter 8 DISCUSSION

8.1 ADZES AS A WOODWORKING TOOL

The presence of dehydroabietic acid has been interpreted in these tools as being used for processing wood from a tree in the order *Pinales* (conifer). The exact species of tree cannot be identified as the resin has degraded to the point that only dehydroabietic acid, the most resilient of the resin acids found in conifer trees, remains. While it is possible to identify to the genera or even species level, a much less degraded sample is required (Mills and White 1977, Helwig *et al.* 2014). Based on our current understanding of the region's ecological history this would make a tree in genus *Picea* (Spruce) or *Pinus* (Pine) the most likely candidate (Bjorck 1984). The hypothesis that these tools were introduced due to the arrival of *P. strobus* (White Pine) during the Hypsithermal cannot at this point in time be confirmed or refuted. Because of this it is not possible to assign an approximate date to the trihedral and related adze typologies as the order *Pinales* has been present in the region since the post glacial emergence of the Boreal Forest biome (Bjorck 1984).

This information does however support the commonly held interpretation of the trihedral adze and related tool types as wood working tools. Additionally, a thin layer of black amorphous material was identified on the working edge of tool DeJj-4(5), covering a layer of red staining and some red amorphous residue. A sample taken from this working edge was also shown to contain dehydroabietic acid. The isolated concentration of this residue on the working edge of a tool in conjunction with conifer biomarkers supports the interpretation that this black residue most likely represents charred wood or resin.

The process of burning wood prior to working it has been recorded in North America primarily as a step in the production of dugout canoes. Historical accounts from the East Coast

dating to the 15th century describe the process of felling a tree with the assistance of fire and then using fire in combination with stone and shell tools to hollow out the center of the trunk (Champlain 1604; Williams 1643; Wood 1634). Tools referred to as stone-hatchets and musket flint like scrapers were described by Samuel de Champlain which possibly indicates the use of stone axes and scrapers to work charred wood (Champlain 1604). The geographic distance and temporal disconnect between the historical accounts and the area currently under study means these accounts cannot be used to directly infer the use of the trihedral adze. However it does present one potential mode of employment

Some of the clearest archaeological evidence for the production of dugout canoes comes from Massachusetts. In 1965 a complete dugout canoe was recovered from the recently dried bed of Great Pond, a reservoir lake in Weymouth Massachusetts. Radio carbon dating placed the boat at 445 ± 100 Cal BP (Kevit 1968). The excavated Eaton Site, near Skud River, Massachusetts has also been interpreted as a dugout canoe workstation (Petzold 1961). The Eaton Site contained a large ash lens with large pieces of charcoal and several diagnostic woodworking tools, including ground stone axes and gouges. The wood working tools, combined with the recovery of a diagnostic point from a nearby habitation site placed the site within the Late Archaic period. Additional evidence for the production of dugout canoe via wood burning comes from Northeast Arkansas where a use-wear study has shown that adzes belonging to the Dalton tool tradition of the Early Archaic were used for heavy woodworking involving charred wood (Gaertner 1994). Several adzes in this collection, including artifact DeJj-4(4) which tested positive for dehydroabietic acid, resemble the Dalton adze in form.

It is largely assumed that the ancient peoples of the Thunder Bay region used the area's waterways as a means of transportation. While the overwhelming density of archaeological sites

along such water ways is likely a result of sampling bias it does still illustrate the importance of these areas to prehistoric peoples. Dense forests and rocky terrain would have made travel over any great distance difficult. Water ways, as well as providing subsistence resources, offer open lines of travel throughout Northwestern Ontario and beyond. Unfortunately the conditions of poor preservation in the area has meant that virtually all evidence of prehistoric water craft has been permanently lost and as a result we are forced to speculate and imply based on indirect evidence.

It is clear that many prehistoric peoples in North America employed dugout canoes and the recorded methods of construction appear consistent throughout time. The presence of charred conifer resin does not itself definitively prove the creation of dugout canoes. However, given that these artifacts were recovered from a lake shore and that the process of creating dugout canoes through the controlled burning is a recognized method as far back as the Late and perhaps even Early Archaic it is not a leap to speculate that these tools were used in the production of such water craft.

8.2 ADDITIONAL TOOL APPLICATIONS

The fiber recovered from artifact DcJi-1(1) has been identified as a component of animal soft tissue. The degraded nature of the fiber makes an exact histological evaluation nearly impossible, however the fiber's interaction with the dye Toluidine Blue indicates it is possibly a strand of elastin, the fiber which allows soft tissue to stretch. Because elastin fibers are comprised primarily of amorphous proteins they tend to interact with most dyes to produce a pale colour change, such as the light blue staining observed with this fiber (Young *et al.* 2006).

It appears the fiber was protected from taphonomic degradation by a surrounding layer of residue. Image 8.1 shows the fiber prior to removal from the tool. The fiber is coated in a cracking, black and red amorphous residue. The artifact was cleaned after recovery which appears to have removed the majority of the surrounding residue, the fiber was likely completely coated prior to cleaning. Outlines of former residue concentrations can be noted around the fiber (see figure 8.1). The presence of this fiber with its close proximity to the working edge of the tool indicates that the adze was likely used in the butchering of an animal. While adzes are typically thought of as wood working tools this does not mean that they were strictly employed in such a fashion.

The trihedral and related adze types are thought of as wood working tools, and this research demonstrates this was most likely their primarily role. However it appears they also served at least one secondary function. While it is all too easy to assign an artifact's use based solely on appearance it must always be taken into account that form does not necessarily equal function and all possible modes of employment must be considered.

Figure 8.1 Fiber prior to removal

8.3 EVIDENCE OF HAFTING METHODS

The trihedral adze is commonly interpreted as being hafted to a wooden platform at the end of a handle, using a hide/sinew binding to hold the artifact in place. Polish was identified on the dorsal ridges of six artifacts and was absent from the remainder of the dorsal surface. This is consistent with the interpretations that a binding of some kind was used to haft at least some of the tools examined in this collection. Residues identified as degraded conifer resin were noted on the ventral surface of several tools. However the distribution of those residues across the entire ventral surface is consistent with deposition from use. The smeared appearance of residue concentrations on the proximal portion of the ventral face suggests that these tools were hafted with the ventral face fastened to a flat surface. The residues here were likely deposited during tool use with some of the resin being forced between the haft and the ventral surface.

On several artifacts the polish extends the entire length of the dorsal ridge. This appears to indicate these adzes were bound up to the point where the dorsal ridge terminates and the slope towards the working edge begins. This is consistent with several discarded adze working edges which appear to have broken at the point where their dorsal ridge terminates. This interpretation would seem logical given the nature of the likely tool uses, being employed in heavy wood working. Leaving a larger than necessary portion of the tool free of haft or binding would increase the stress on the tool and cause pre-mature breakage.

8.4 ARTIFACT MORPHOLOGY AND RESIDUES

A range of artifact morphologies were examined in this research with both the classic trihedral adze and other similar forms defined by McLeod (1978) being included. There was no discernible difference in residues between the artifact morphologies. Of the five artifacts with

results indicating the presence of conifer resin three were classic trihedral adzes, one is defined as a kind of 'quadrahedral' adze with the dorsal ridge being removed by a single long flake and the third falls somewhere between with a rounded, dorsal surface rather than a well-defined dorsal ridge. Based on microscopic and GC/MS analysis it appears both artifact sub-types were also involved in the working of charred wood. At this point it is still not possible to comment on the reasons for this variation in form.

8.5 SITE FUNCTION/ACTIVITIES

None of the sites from the Dog Lake region represented in this study has yet been excavated. However, our interpretation of the five artifacts with residues containing dehydroabietic acid allows us to infer at least one activity at the various sites.

The five artifacts originate from two sites located on Dog Lake. Site DeJj-8, known as the Portage Isle site, is located on a small island close to the southern shore of Dog Lake (see figure 5.1). A total of 17 tools examined in this study, including adzes and the pick/wedge like tools originated from this site. Given that this site has not been excavated, this collection likely represents only a small proportion of the total number of artifacts at the site. The abundance of adzes and the variety of forms implies this site was likely inhabited multiple times. Three artifacts from this site (DeJj-8(1), DeJj-8(13) and DeJj-8(14)) were used to process conifer trees. The location of the site, combined with the functional interpretation that these tools were likely employed in the production of dugout canoes, would imply that the construction of such watercraft is one activity undertaken by ancient peoples at this site.

Site DeJj-4, known as the Wakatis Site, is also located on the shores of Dog Lake. Five artifacts, all adzes, originated from this site. Two of these tools (DeJj-4(4) and DeJj-4(5)) were

found to be used as wood working tools, with artifact DeJj-4(5) likely used to process charred wood. The Wakatis site may also represent a dugout canoe work station.

Site DcJi-1, the Cummins Site, has been partially excavated, however it is uncertain if this artifact is representative of that excavation. The adzes recovered from the Cummins site were found as part of a surface collection at a different location from the excavation and possibly represent a re-occupation. While the overall function of the site as it relates to the adzes cannot be commented on due to a lack of evidence, the interpretation of the fiber removed from artifact DcJi-1(1) would indicate that the butchering of an animal was undertaken here.

8.6 EFFECTS OF CURATION ON RESIDUE ANALYSIS

There appeared to be a connection between the degree to which the artifacts were cleaned and the amount of residues that were recovered. Sample Set 3 was the least cleaned and returned four of the five GC/MS results indicating the presence of conifer resin as well as the one result indicating the presence of burnt organic material. Microscopic evidence of burnt organic material indicative of working charred wood was also recovered mostly from this collection. However, it must be noted that even though an artifact may have been cleaned there is still the possibility that authentic residues can be recovered. Artifact DcJi-1(1), part of Sample Set 2, was thoroughly cleaned with a brush and running water, however this artifact provided good physical evidence for the butchering of an animal. This demonstrates that even cleaned artifacts have the potential to provide interpretable residue data and should not be outright excluded from any study.

The unknown or incomplete curatorial history of many of these artifacts was overcome by applying the appropriate amount of caution to any interpretations. Artifacts with unknown histories have the potential to contain unknown contaminants. However, misinterpretation of

data can be easily avoided so long as the researcher is diligent in exploring all potential sources for residue deposition.

8.7 EVALUATION OF THE METHODOLOGICAL APPROACH

Evidence from microscopic and GC/MS analysis proved the most useful for archaeological interpretations. The identification of conifer resin throughout GC/MS and the specific locations and appearance of those resins allowed for interpretations of tool use and manufacture. Basic use wear analysis through microscopic examination suggests an aspect of tool manufacture, notably the dorsal polish indicative of binding with hide/sinew. The identification and classification of the animal tissue fiber removed from the working edge of artifact DcJi-1(1) was done through a combination of microscopy and staining.

If only a single form of analysis had been used the study would have been limited to a single line of evidence and the full range of interpretations would not have been possible. If this research had relied solely on microscopic examination it would have been impossible to determine the nature of the majority of the residues. Alternatively if only GC/MS analysis had been used specific details relating to tool manufacture and all evidence of animal butchering would not have been available.

Biochemical analysis proved less useful in the final interpretation of data. The copper, triethanolamine/diphenylcarbazide test for fatty acids effectively identified the presence of fatty acids, however this was not useful for the purpose of our study due to the presence of contamination. In other contexts where contamination has been limited this test could prove beneficial. Additional evaluation is required to determine the full functional capabilities of presumptive biochemical testing. While the tests may act as useful indicators of certain

compounds the specificity of many tests is not yet validated to the appropriate sensitivity required in archaeological research. The test for fatty-acids has proven effective and in the future may be successfully employed alongside other validated biochemical tests for the purpose of screening samples for residue which may not have been visible under microscopic examination. The use of GC/MS analysis, while useful, can prove expensive if it is necessary to examine every sample. Further developments in the use of biochemical testing can help to avoid some unnecessary costs.

In many academic research contexts it would be considered far more prudent to run every sample possible, however if these kinds of practices are ever going to find traction in private archaeological consulting firms then overall cost must be taken into account. The full cost of GC/MS for this research was approximately $600, priced at an internal research rate of $5 a sample. Not all samples taken were run through GC/MS, primarily due to cost and time. For an external researcher not directly affiliated with a university this price would be closer to $50-$100 a sample. The entirety of the reagents needed for the biochemical tests employed in this study totaled $633.70 as priced by Sigma Aldrich. This amount represents the minimum volume of reagents that can be purchased. Even at the minimum volume the reagents priced here would be enough to fund multiple studies of this scope. There is potential in the employment of biochemical analysis and the use of such methods could assist in avoiding a loss of knowledge through artifacts being stored without full research. Unfortunately this specific methodology still requires more research and tailoring to the specific conditions encountered in archaeological research to ensure the tests are demonstrably effective.

To further reduce the risk of contamination it is recommended that residue analysis be considered during excavation and survey. Any unnecessary handling should be avoided. Even

limited handling can pass contaminants such as fatty acids naturally exuded by the skin as well as those found in foods, skin care products and any other source the individual may have come in contact with. The artifacts should remain un-cleaned prior to laboratory examination and accompanying soil samples should be taken when possible. This precaution would help eliminate the potential loss of residues through cleaning with the accompanying soil samples assisting researches in eliminating contamination by the soil matrix. The use of plastics should be avoided wherever possible, however plastic bags may be used for the purposes of expedient storage as plastic based contaminants are not likely to be passed to the artifacts through physical contact alone.

8.8 EVALUATION OF THE THEORETICAL APPROACH

The use of the Artifact as Site concept in combination with the Archaeological Biomarker Concept has proven effective at confirming assumptions of tool use and manufacture by providing evidence that the adzes were used in the processing of conifer trees and hafted using a binding. The analysis was also able to suggest these tools served at least one secondary role as butchering tools. The research has also provided insight into methods of tool manufacture, supporting the interpretation that these tools were hafted using a hide or sinew binding.

Because of this information it is now possible to infer site activities and function where no excavations have yet been conducted. Activities at sites DeJj-8 (the Portage Isle Site) and DeJj-4 (the Wakatis Site) included wood working, with site DeJj-4 showing evidence of charred wood working. While this is not direct evidence for the manufacture of dugout canoes it is currently the most likely interpretation. We are also able to conclude that animal butchering occurred at DcJi-1 (the Cummins Site).

All of these interpretations, with the exception of DcJi-1, are made despite the fact that not a single excavation has been carried out. In Northwestern Ontario all but a few excavations are academic in nature with the vast majority undertaken as part of CRM operations. The collections resulting from many of these excavations join a growing list of artifacts currently being stored with limited or no analysis. Additional surface collections are undertaken by amateur archaeologists who prudently mark the location of these sites and note the artifact styles recovered but who are unable to fully investigate due to obvious budget restrictions. While the study of old collections or of artifacts recovered as surface finds is not always seen as ideal this research has demonstrated that useful insight into tool uses and site function can still be gained.

Chapter 9 CONCLUSIONS

This thesis has reinforced the hypothesis that the trihedral and related adze typologies were employed as wood working tools. The evidence suggests that several were used in the processing of conifer trees, with at least some trees appearing to be prepared with controlled burning. This mode of employment is most consistent with current interpretations for dugout canoe manufacturing, although no direct link between these tools and the production of water craft yet exists. One artifact was also demonstrated as being employed in a secondary role as a butchering tool and evidence of hafting methods employing bindings were noted on several examples.

Unfortunately it is still not possible to comment on the age of these artifacts. At least some tools examined in this study have the potential to be related to the Caribou Lake Complex in age, based on their similar morphology, however this hypothesis is not supported by any direct evidence.

Many factors, both natural and manmade, have impacted the progress of archaeological investigations in the Boreal Forest. The challenging terrain and harsh taphonomy impedes archaeological investigations while past issues of sampling bias compound these issues to create a partial stagnation in research. Progress is being made with many of these discrepancies being acknowledged and new methods being developed to address them. The introduction of multi-analytical residue analysis into future artifact investigations in the Boreal Forest has the potential to help archaeological research in the region continue this transition. This is especially true with regards to pre-ceramic cultures where only stone artifacts have been recovered. While organic remains on a macroscopic scale will decay quickly the microscopic preservation of diagnostic residues on the surface of stone artifacts has been demonstrated. The methods have been shown

through this case study to be effective at testing, and in this case reinforcing, previously held hypothesis of artifact manufacture and use. Combined with the approach of viewing artifacts as indicative of site activity it is also possible to comment on the nature of sites which have not been formally excavated. This approach has the potential to be applied to a range of artifacts and scenarios, being effective at analyzing artifacts which have been held in various collections for extended periods of time. Even when working with unknown variables in regards to potential contamination it is still possible to gain valuable insight. Artifacts which have been recently recovered and have a known curatorial history have the potential to provide increasingly detailed accounts of past tool use and site activities.

A further refining and application of these methods within the boreal setting will be an important next step in ensuring this approach achieves its full potential, specific to the region, as well as more widespread and accepted use. Certain aspects of this research, particularly the employment of biochemical analysis, require further research before they can be confidently relied upon. Other aspects, such as microscopic residue analysis and GC/MS analysis can still be further refined to take into account environmental aspects such as soil chemistry and enhance our understanding of the processes of preservation and decay of archaeologically relevant material on the microscopic scale. With this region specific focus archaeologists in the boreal forest will have an indispensable tool to continue deciphering the lives of the region's earliest inhabitants.

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APPENDIX A ARTIFACT PHOTOGRAPHY

Appendix A.1 Sample Set 1

Figure 0.1 DeJj-1(1) Dorsal and Lateral View

Figure 0.2 DeJj-8(2) Dorsal and Lateral View

Figure 0.3 DeJj-2(1) Dorsal and Lateral View

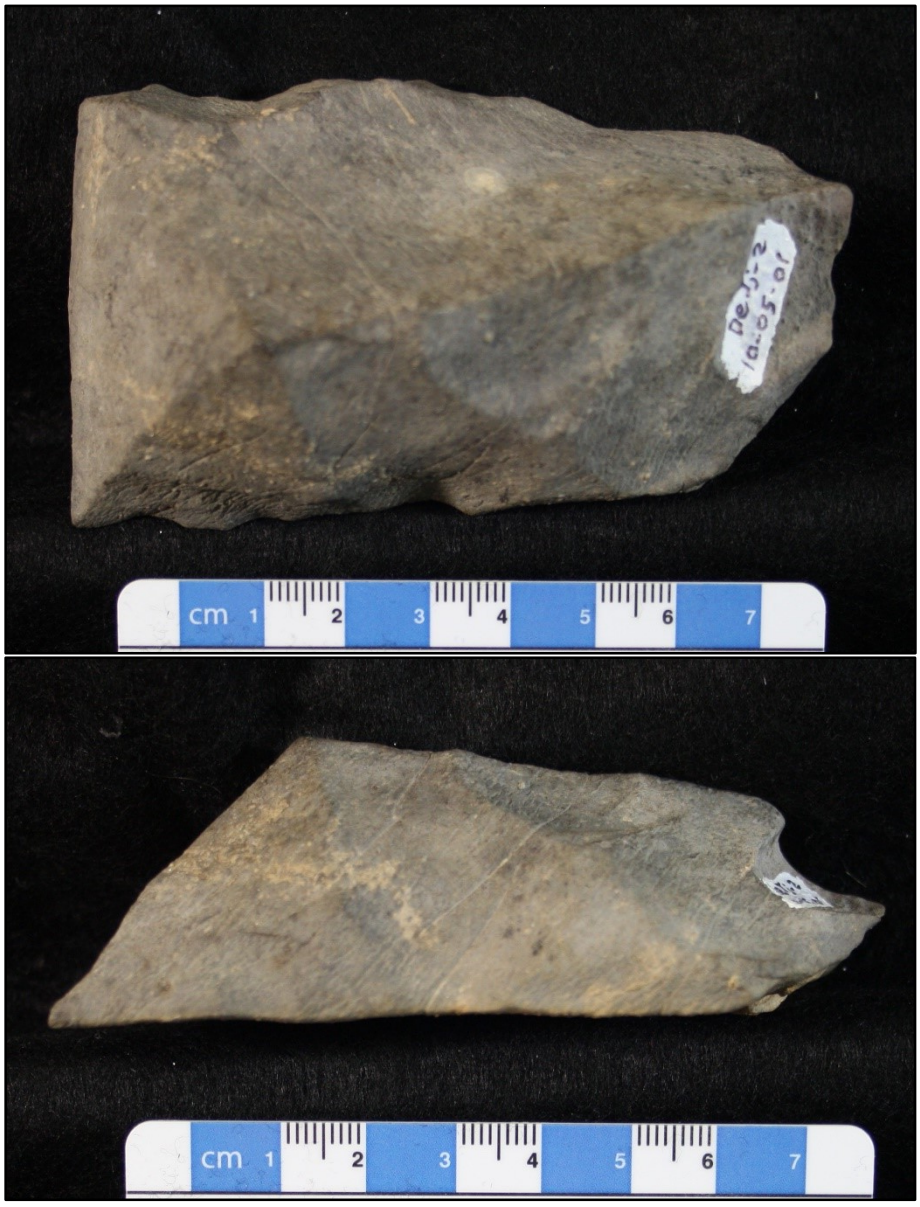


Figure 0.4 DeJj-2(2) Dorsal and Lateral View

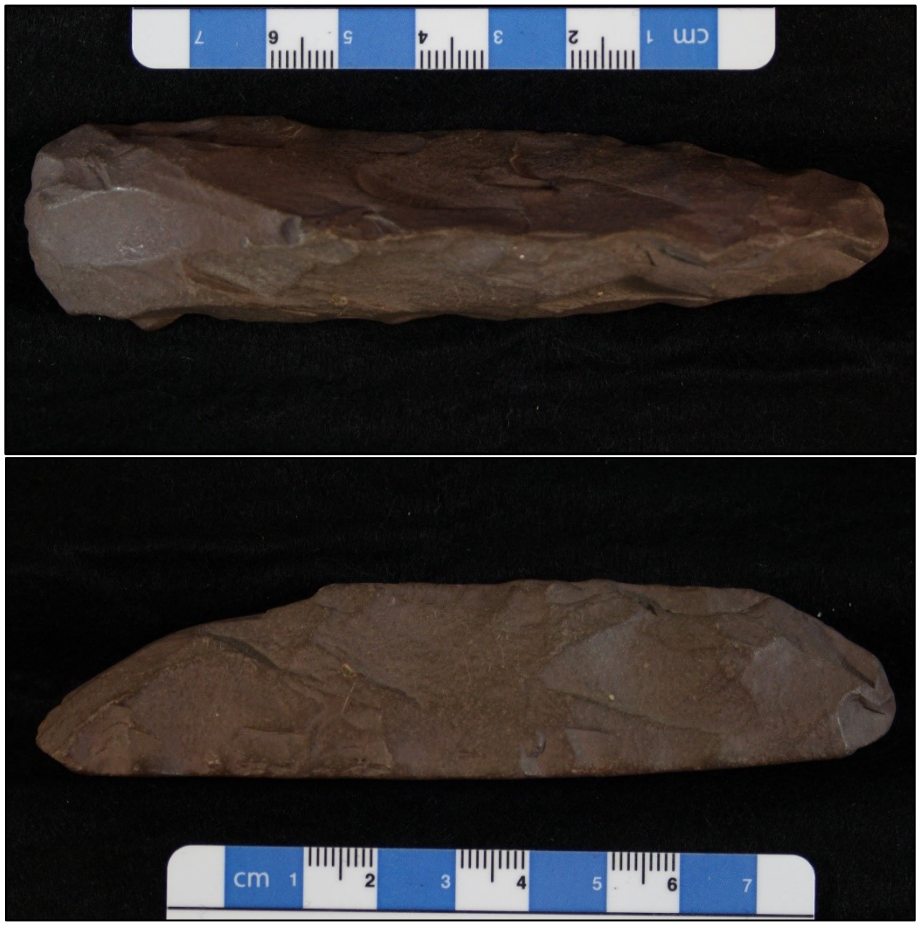


Figure 0.5 Dorsal and Lateral View

Figure 0.6 DeJj-8(1) Dorsal and Lateral View

Figure 0.7 DeJj-8(2) Dorsal and Lateral View

Figure 0.8 DeJj-8(3) Dorsal and Lateral View

Figure 0.9 DeJj-8(4) Dorsal and Lateral View

Figure 0.10 DeJj-8 (5) Dorsal and Lateral View

Figure 0.11 DeJj-8(6) Dorsal and Lateral View

Figure 0.12 DeJj-8(7) Dorsal and Lateral View

Figure 0.13 DeJj-8(8) Dorsal and Lateral View

Figure 0.14 DeJj-8(9) Dorsal and Lateral View

Figure 0.15 DeJj-8(10) Dorsal and Lateral View

Figure 0.16 DfJj-21Dorsal and Lateral View

Appendix A.2 Sample Set 2

Figure 0.17 DcJi-1(1) Dorsal and Lateral View

Figure 0.18 DcJi-1(2) Lateral and Dorsal View

Figure 0.19 DeJj-2(3) Dorsal and Lateral View

Figure 0.20 DeJj-18 Dorsal and Lateral View

Figure 0.21 DeJj-4(6) Dorsal and Lateral View

Appendix A.3 Sample Set 3

Figure 0.22 DeJj-4(1) Dorsal and Lateral View

Figure 0.23 DeJj-4(2) Dorsal and Lateral View

Figure 0.24 DeJj-4(3) Dorsal and Lateral View

Figure 0.25 DeJj-4(4) Dorsal and Lateral View

Figure 0.26 DeJj-4(5) Dorsal and Lateral View

Figure 0.27 DeJj-8(11) Dorsal and Lateral View

Figure 0.28 DeJj-8(12) Dorsal and Lateral View

Figure 0.29 DeJj-8(13) Dorsal and Lateral View

Figure 0.30 DeJj-8(14) Dorsal and Lateral View

Figure 0.31DeJj-8(15) Ventral and Lateral View

Figure 0.32 DeJj-8(14) Dorsal and Lateral View

Figure 0.33 DeJj-21(1) Dorsal and Lateral View

Figure 0.34 DeJj-21(2) Dorsal and Lateral View

Figure 0.35 DdJm-3 Dorsal and Lateral View

Figure 0.36 DdJf-9 Dorsal and Lateral View

Appendix A.4 Sample Set 4

Figure 0.37 EaKa-6 Dorsal and Lateral View

Figure 0.38 EaKa-49 Dorsal and Lateral View

Appendix A.5 Sample Set 5

Figure 0.39 DbJf-8 Dorsal and Lateral View

Figure 0.40 DeJj-8(16) Dorsal and Lateral View

Figure 0.41 DhJf-5 Dorsal and Lateral View

APPENDIX B BIOCHEMICAL TEST RESULTS

Appendix B.1 Sample Set 1

Table 0.1 Biochemical Results Sample Set 1

Artifact	Location on Tool	Protein	Fatty Acid	Starch	Carbohydrate
Control		**111**	**133**	**101**	**112**
DeJj-8 (0)	Proximal half of dorsal ridge	119	135	98	100
	Distal half of dorsal ridge	123	133	116	98
	Proximal end	209	258	101	99
	Working edge	121	134	100	99
DeJj-8 (1)	Dorsal ridge	106	180	101	102
	Working edge	197	163	97	99
	Left lateral edge	256	134	97	97
	Right lateral edge	201	132	98	103
DeJj-8 (2)	Dorsal ridge	207	144	99	103
	Left lateral edge	120	148	100	101
	Right lateral edge	117	128	98	100
	Proximal end	207	130	107	99
	Working edge	98	129	103	106
DeJj-8 (3)	Dorsal ridge	112	280	98	111
	Left lateral edge	112	172	103	109
	Right lateral edge	98	151	100	99
	Proximal edge	116	155	101	101
	Working edge	117	187	99	103
DeJj-8 (4)	Dorsal ridge	102	150	99	104
	Left lateral edge	111	231	102	108
	Right lateral edge	126	135	100	96
	Proximal edge	116	143	100	104
	Working edge	119	136	104	98
DeJj-8 (5)	Dorsal ridge and proximal edge	108	217	98	107
	Dorsal ridge and working edge	97	234	100	103
	Left lateral edge	96	235	99	101
	Right Lateral edge	126	159	99	111
	Ventral surface	105	294	101	99
DeJj-8 (6)	Dorsal ridge	111	142	103	100
	Left lateral edge	112	132	100	98
	Right lateral edge	109	134	98	111
	Proximal edge	133	139	101	108
	Working edge	105	141	94	104
DeJj-8 (7)	Dorsal ridge	204	131	100	106
	Left lateral edge	242	131	99	107
	Right lateral edge	230	171	99	112
	Proximal	252	142	99	97
	Working edge	252	142	101	103
DeJj-8 (8)	Dorsal ridge	121	152	101	111

	Left lateral edge	147	137	98	109
	Right lateral edge	118	132	102	99
	Proximal end	117	136	100	102
	Working edge	122	137	97	100
DeJj-8 (9)	Dorsal ridge and proximal	112	135	107	104
	Left lateral edge	116	153	99	96
	Right lateral edge	149	147	97	99
	Working edge	139	151	101	95
DeJj-8 (10)	Dorsal ridge	112	168	102	101
	Left lateral edge	123	197	99	111
	Right lateral edge	115	164	100	97
	Working edge	140	151	99	106
DeJj-1 10-00-03	Dorsal ridge	95	136	101	100
	Left lateral edge	100	149	104	96
	Right lateral edge	120	152	95	108
	Proximal edge	124	132	93	110
	Ventral	128	141	100	99
	Working edge	100	126	99	99
DeJj-1 10-04-15	Left lateral edge	119	181	98	101
	Right lateral edge	109	166	103	111
	Proximal end	123	157	101	101
	Working edge	108	155	100	101
DeJj-1 10-05-30	Dorsal ridge	114	130	96	110
	Proximal end	133	145	102	97
	Working edge	101	199	98	106
DeJj-2 10-05-01	Dorsal ridge	107	132	97	97
	Left lateral edge	102	144	92	99
	Proximal end	122	150	105	98
	Working edge	134	146	95	98
DeJj-2 95-5-25	Dorsal ridge	98	130	104	101
	Proximal end	105	135	98	103
	Working edge	100	134	102	103
DfJj-21 (0)	Dorsal ridge	104	165	99	100
	Left lateral edge	102	134	103	98
	Proximal end	115	274	101	99
	Right lateral edge	119	176	94	100
	Working edge	112	210	100	101

Appendix B.2 Sample Set 2

Table 0.2 Biochemical Results Sample Set 2

Artifact	Location on Tool	Protein	Fatty Acid	Starch	Carbohydrate
Control		**111**	**133**	**101**	**112**
DcJi-1 (1)	Left half of proximal end	96	145	102	101
	Right half of proximal end	99	142	99	100

	Right side of working edge	98	143	98	111
	Left side of working edge	108	145	99	97
DcJi-1 (2)	Dorsal ridge	110	159	N/A	N/A
D10	Dorsal ridge	116	237	102	104
	Left lateral edge and proximal	104	254	97	97
	Right lateral edge and proximal	126	251	98	103
	Working edge left	241	241	99	96
	Working edge right	207	207	103	100
DEJJ-18	Dorsal ridge	113	132	99	101
	Left half of proximal end	111	155	97	97
	Right half of proximal end	123	139	103	104
	Working edge	102	191	98	110
DEJJ-4(6)	Dorsal ridge, medial portion	97	147	99	99
	Dorsal ridge and proximal end	140	151	96	112
	Dorsal ridge, distal end	109	143	102	107
	Ventral	101	134	100	108

Appendix B.3 Sample Set 3

Table 0.3 Biochemical Results Sample Set 3

Artifact	Location on Tool	Protein	Fatty Acid	Starch	Carbohydrate
Control		**111**	**133**	**101**	**112**
DeJj-8 (11)	Dorsal ridge	118	143	99	95
	Left ventral edge	133	134	101	98
	Proximal end	122	148	102	95
	Working edge	136	139	99	103
DeJj-8 (12)	Dorsal	128	141	100	99
	Right ventral edge	112	143	98	98
	Proximal end	104	144	98	98
	Working edge	117	137	98	98
DeJj-8 (13)	Dorsal ridge	110	155	98	117
	Working edge	272	138	95	110
	Proximal edge	122	139	101	104
DeJj-8 (14)	Dorsal ridge	114	148	95	147
	Left lateral edge and ventral	225	140	95	102
	Proximal end	189	139	95	101
	Working edge	112	152	94	111
DeJj-8 (15)	Dorsal ridge	94	134	95	109
	Left edge and ventral	114	140	100	104
	Proximal end	102	136	102	101
	Working edge	218	142	98	101
DeJj-14	Dorsal ridge	114	134	108	110
	Left lateral edge	116	149	102	101
	Right lateral edge	108	151	99	103
	Proximal end	127	151	103	96

	Working edge	112	150	108	96
DeJj-4 (1)	Dorsal ridge	139	137	108	99
	Left lateral edge	109	134	99	97
	Proximal end	118	135	99	100
	Working edge	102	144	96	98
DeJj-4 (2)	Dorsal ridge, proximal portion	158	137	96	99
	Dorsal ridge, distal portion	145	139	96	101
	Proximal end	107	136	94	97
	Working edge	130	142	96	91
DeJj-4 (3)	Dorsal ridge	138	145	108	109
	Left lateral edge and ventral	126	139	100	110
	Right lateral edge and ventral	168	158	103	108
	Working edge	189	158	108	112
DeJj-4 (4)	Left lateral edge and ventral	200	142	95	99
	Right lateral edge and ventral	113	155	100	107
	Proximal end	113	141	95	102
	Working edge	119	146	99	109
DfJj-21 (2)	Dorsal ridge	113	148	101	101
	Proximal end	218	135	95	105
	Working edge	199	153	95	99
DfJj-21 (3)	Dorsal ridge	131	136	103	125
	Left lateral edge and ventral	107	136	97	101
	Proximal end	107	136	97	101
	Working edge	131	144	102	126
DdJf-9	Dorsal, proximal portion	116	146	105	116
	Dorsal, distal portion	214	139	132	142
	Left lateral edge and ventral	164	144	110	113
	Working edge	240	135	95	111
DdJm-3	Dorsal ridge	143	141	96	115
	Right lateral edge and ventral	111	136	100	108
	Proximal end	128	140	97	101
	Working edge	141	142	96	109

Appendix B.4 Sample Set 4

Table 0.4 Biochemical Results Sample Set 4

Artifact	Location on Tool	Protein	Fatty Acid	Starch	Carbohydrate
Control		**111**	**133**	**101**	**112**
EaKa-49	Dorsal	111	151	101	105
	Right lateral edge and ventral	151	145	103	109
	Proximal end	102	131	97	101
	Working edge	107	158	99	105
EaKa-6	Dorsal	118	139	98	108
	Left lateral edge and ventral	98	141	100	99

	Proximal end	122	152	102	110
	Working edge	101	130	99	103

Appendix B.5 Sample Set 5

Table 0.5 Biochemical Results Sample Set 5

Artifact	Location on Tool	Protein	Fatty Acid	Starch	Carbohydrate
DeJj-8 (16)	Working edge	100	143	95	97
	Dorsal	112	134	94	102
	Right lateral edge and Ventral	125	143	96	97
	Proximal end	114	133	96	98
DhJf-5	Working edge	111	132	97	94
	Dorsal	109	140	98	96
	Left lateral edge and ventral	106	134	98	99
	Proximal end	120	149	98	106
DbJs-8	Working edge	102	138	102	104
	Dorsal	149	133	102	101
	Right lateral edge and ventral	206	149	102	102
	Proximal end	118	132	102	103

APPENDIX C GC/MS RESULTS

Appendix C.1 Sample Set 1

Table 0.6 GC/MS Results Sample Set 1

Sample Set 1	Compound	Retention Time	Percent Correct ID	MW
DeJj-1(1) Working Edge	no good			
DeJj-1(1) Proximal	Trifluoromethyl-bis-(trimethylsilyl)methyl ketone	6.035	93.78	338
	Trifluoromethyl-bis-(trimethylsilyl)methyl ketone	6.049	91.48	338
	Trifluoromethyl-bis-(trimethylsilyl)methyl ketone	6.077	90.72	338
	Bis(trimethylsiloxy)ethane	6.955	73.92	206
	Butanoic acid	6.998	34.57	247
	3-Propylnorleucine	7.069	15.19	173
	1-(2-Ethyl-[1,3]dithian-2-yl)-3-methyl-butan-1-ol	7.706	10.7	234
	Methyltris(trimethylsiloxy)silane	7.819	38.99	310
	Tetrasiloxane, decamethyl	7.854	74.39	310
	Silane	8.293	51.36	32
	Dimethyl-2-thioxo-1,2-dihydro-3-pyridinecarbonitrile tbdms	8.47	28.8	236
	Benzoic acid trimethylsilyl	11.997	68.85	194
	Benzoic acid trimethylsilyl ester	11.997	68.85	194
	Silanol, trimethyl, phosphate	12.365	85.16	314
	Narceine	14.645	12.67	445
	Hexanedioic acid, bis(trimethylsl) ester	15.912	20.59	290
	Phenol, 2,5-bis(1,1-dimethylethyl)-	16.011	28.71	206
	Amine, N,N,N-tris((triemthlsilyloxy)ethyl)	16.712	55.68	365
	Benzoic acid, 4-[(trimethylsilyl)oxy]-, tirmethylsily ester	16.762	48.04	282
	.beta.-D-Glucopyranosiduronic acid	17.512	33.86	648
	.beta.-D-Glucopyranosiduronic acid	17.647	33.01	648
	Tetradecanoic acid, trimethylsily ester	17.71	62.5	300
	2,4-Imidazolidinedione, 5-[3,4-bis[(trimethylsilyl)oxy]phenyl]-3-methyl-5-methyl-5-phenyl-1-(trimethylsilyl)-	18.029	59.69	516
	Phythalic acid, butyl tridec-2-yn-1-yl ester	18.128	12.35	166
	Hexadecanoic Acid	18.312	93.24	328

	Pregan-20-one, 2-hydroxy-5,6-epoxy-15-methyl	18.503	13.28	346
	Silane, trimethyl	18.645	27.76	32
	.beta.-D-Glucopyranosiduronic acid	18.822	20.48	648
	Octadecadienoic acid, trimethylsil ester	18.85	80.09	352
	Octadecadienoic acid, trimethylsil ester	18.935	95.17	352
	Eicosatriyonic acid, tert-butyldiethylsilyl ester	18.992	9.04	306
	Desoxo-9-x-acetoxy-3,8,12-tri-O-acetylingol	19.063	50.7	534
	Benzenedicarboxylic acid, 2-butoxyethyl butyl ester	19.275	64.49	322
	Octadecanoic acid, decyl ester	19.523	28.88	356
	Tetradecane, 2,6,10-trimethyl	19.566	5.07	240
	2-Butenoic acid	20.11	34.77	200
	Phthalic acid, 6-ethyl-3-octyl heptyl ester	20.309	7.01	166
	Cholestan-3-one, cyclic 1,2-ethanediyl aetal	20.394	26.65	430
	5H-Cyclopropa[3,4]benz[1,2-e]azulen-5-one,	20.436	29.82	608
	5H-Cyclopropa[3,4]benz[1,2-e]azulen-5-one,	20.712	34.69	608
	Serverogenin acetate	21.315	27.43	544
	Cholestan-3-one, cyclic 1,2-ethanediyl aetal	22.115	41.07	430
	Cholestan-3-one, cyclic 1,2-ethanediyl aetal	22.2	6.54	430
DeJj-1(2) Working Edge	Trifluoromethyl-bis-(trimethylsilyl)methyl ketone	5.992	91.92	338
	Trifluoromethyl-bis-(trimethylsilyl)methyl ketone	6.035	91.09	338
	Trifluoromethyl-bis-(trimethylsilyl)methyl ketone	6.077	92.55	338
	Bis(trimethylsiloxy)ethane	6.941	71.14	206
	Butanoic acid, 2-[(trimethylsyl)amino]-, trimethylsilyl ester	6.997	17.98	247
	Ethanedioic acid, bis(trimethylsilyl) ester	7.968	10.84	234
	Acetonitrile	8.194	37.96	41
	Silane	8.286	70.15	32
	Propanoic acid	8.364	32.11	234
	4,6-Dimethyl-2-thioxo-1,2-dihydro-3-pyridinecarbonitrile	8.456	21	236
	Acetonitrile	9.836	67.28	41
	Benzoic acid trimethylsilyl ester	11.925	56.54	194
	Benzoic acid trimethylsilyl	11.989	53.71	194
	Silanol, trimethyl, phosphate	12.357	80.97	314
	Butanedoic acid, bis(trimethylsilyl) ester	13.093	19.83	118
	Phenol, 2,5-bis(1,1-dimethylethyl)-	15.996	61.82	206

	Hexanedioic acid, bis(trimethylsl) ester	15.897	63.88	290
	Phenol, 2,5-bis(1,1-dimethylethyl)-	15.996	61.82	206
	3-methyl-12-pyridin-2-yl-8,9,10,12-tetrahydro-7H-benzo[b][4,7]phenanthrolin-11-one	16.166	46.22	341
	Benzoic acid trimethylsilyl ester	16.754	77.51	194
	D-Xylofuranose, 1,2,3,5-tetrakis-O-(trimethylsilyl)	17.469	30.54	438
	.alpha.-D-Glucopyranosiduronic acid	17.497	16.31	648
	Tetradecanoic acid	17.695	85.52	300
	Trimethylsilyl 3,5-dimethoxy-4-(trimethylsilyloxy)benzoate	17.858	46.8	342
	Prosta-5, 13-dien-1-oic acid	18.014	10.9	642
	Dibutyl phthalate	18.113	26.05	278
	Hexadecanoic Acid	18.304	96.85	328
	Silane	18.63	59.56	32
	.alpha.-D-Glucopyranoside, methyl 2,3,4-tris-O-(trimethylsilyl)-6-dodecanoyl	18.771	16.17	648
	Octadecadienoic acid, trimethylsil ester	18.835	82.02	352
	Octadecadienoic acid, trimethylsil ester	18.92	90.95	352
	Benzenedicarboxylic acid, 2-butoxyethyl butyl ester	19.26	76.77	322
	Octadecanoic acid, 2-methylpropyl ester	19.508	36.05	356
	Hentriacontane	19.55	4.72	436
	D-Turanose, heptakis(trimethylsilyl)-	20.23	18.18	846
	1,2-Benzenedicarboxylic acid, diisooctyl ester	20.293	10.84	266
	Severogenin acetate	22.17	30.95	544
	Oleic acid, 3-(octadecyloxy)propyl ester	22.191	10.24	592
	9,12,15- Octadecatrienoic acid, 2,3-bis [(trimethylsilyl)oxy]propyl ester	22.311	47.76	496
	5H-Cyclopropa[3,4]benz[1,2-e]azulen-5-one2,4a,9,9a-tetrakis(acetyloxy)-3,[(acetyloxy)methyl]-1,	23.267	36.22	608
DeJj-1(2) Dorsal	Trifluoromethyl-bis-(trimethylsilyl)methyl ketone	5.929	92.96	338
	Trifluoromethyl-bis-(trimethylsilyl)methyl ketone	6.091	89.47	338
	2-Dimethyl(trimethylsilyl)silyloxytridecane	6.729	11.8	344
	Bis(trimethylsiloxy)ethane	6.906	50.06	206
	Bis(trimethylsiloxy)ethane	6.962	71.75	206
	2-Methyl-1 ,4-bis(trimethylsiloxy)butane	7.012	18.94	248
	Silane,	7.345	39.22	32
	Ethanedioic acid, bis(trimethylsilyl) ester	7.706	40.03	234
	Silane	8.293	74.33	32

	Acetonitrile	9.03	55.78	41
	Benzeneacetic acid alpha.-phenyl-.alpha.-[(trimethylsilyl)oxy]-, 3-quinuclidinyl ester	11.083	7.16	409
	Acetonitrile	11.848	69.95	41
	Benzoic acid trimethylsilyl ester	11.996	83.65	194
	Benzoic acid trimethylsilyl	12.004	77.25	194
	Silanol, trimethyl, phosphate	12.365	80.52	314
	Acetonitrile	12.492	73.93	41
	Monoamidoethylmalonic acid	13.115	23.35	347
	Acetonitrile	15,388	67.34	41
	Phenol, 2,5-bis	16.004	38.25	206
	3-methyl-12-pyridin-2-yl-8,9,10,12-tetrahydro-7H-benzo[b][4,7]phenanthrolin-11-one	16.181	41.29	341
	Benzoic acid trimethylsilyl ester	16.761	60.35	194
	D-Xylofuranose, 1,2,3,5-tetrakis-O-(trimethylsilyl)	17.469	19.66	438
	.alpha.-D-Glucopyranosiduronic acid	17.498	34.45	648
	.alpha.-D-Glucopyranosiduronic acid	17.639	35.5	648
	Hexadecanoic Acid	18.305	96.61	328
	Tetradecanoic acid, trimethylsily ester	17.703	65.47	300
	Glycine, N-formyl-N-(trimethyltilyl)-, trimethylsilyl ester	18.015	14.71	247
	Phtalic acid	18.121	8.39	166
	Hexadecanoic Acid, trimethylsilyl ester	18.305	96.61	328
	Hexadecanoic Acid, trimethylsilyl ester	18.772	53.75	328
	.alpha.-D-Glucopyranosiduronic acid	18.815	46.69	648
	9, 12-Octadecadienoic acid, trimethylsilyl ester	18.843	80.9	352
	Octadecadienoic acid, trimethylsil ester	18.928	96.4	352
	Octadecane, 2-methyl-	19.154	3.57	366
	1,2 Benzenedicarboxylic acid	19.261	66.17	322
	Androst-4-ene-3,20-dione, 11, 16, 22-triacetoxy	19.516	44.31	488
	Triphenyl phosphate	19.792	53.15	326
	Eicosane, 2-methyl-	20.025	8.13	296
	1,2-Benzenedicarboxylic acid, diisooctyl ester	20.294	19.07	266
	Octadecane,3-ethyl-5-(2-ethylbutyl)-	20.606	6.41	366
	Cholestan-3-one, cyclic 1,2-ethanediyl aetal	21.307	19.3	430
	Severogenin acetate	22.185	26.55	544
	1'-Carboethoxy-1'-cyano-1	22.546	52.7	451
	Octadecatrienoic acid	23.049	57.07	496
	5H-Cyclopropa[3,4]benz[1,2-e]azulen-5-one..	24.309	64.52	608

DeJj-8(0) Working Edge	Alanine, 2-Methyl-N-(trimethylsilyl)-, trimethylsilyl ester	6.976	38.72	247
	2-Ethyl-1-Pentamethyldisilyloxyhexane	7.047	11.01	260
	Butanedioc acid, bis(trimethylsilyl) ester	7.684	24.05	276
	Tetrasiloxane, decamethyl	7.84	59.47	310
	Propanoic acid, 2-[(trimethylsilyl)oxy]-, trimethylsilyl ester	8.35	49.75	234
	Mercaptoacetic acid, bis(trimethylsilyl)-	8.442	8.68	236
	5-Hydroxy-5-methyl-2-phenyl-3-isoxazolidinone ditms pk2	10.884	50.97	337
	Benzoic acid trimethylsilyl ester	11.982	81.48	194
	1-Dimethyl(trimethylsilylmethyl)silyloxycyclopentane	13.101	110.49	230
	2-Propenamide, N-3(3,4-dichlorophenyl)-2-methyl	14.792	62.77	229
	2,4-Imidazolidinedione, 5-[3,4-bis[(trimethylsilyl)oxy]phenyl]-3-methyl-5-phenyl-1-(trimethylsilyl)-	15.791	54.77	516
	Hexanedioic acid, bis(trimthylsilyl) ester	15.897	62.5	290
	Hydantoin, 5-hydroxy-tris-O-(trimethylsilyl)-	15.94	46.255	332
	2,4,6-Tri-t-butylbenzenethiol	16.159	31.21	278
	Amine, N,N,N-tris((trimethylsilyloxy)ethyl)-	16.69	76.22	365
	Benzoic acidd, 3-[(trimethylsilyl)oxy]-, trimethyl ester	16.747	45.22	282
	Dodecanoic acid, trimethylsilyl ester	16.874	42.81	272
	Octanedioic acid, bis(trimethylsilyl)ester	17.086	35.64	318
	D-Fructose, 1,3,4,5,6-pentakis-O-(trimeethylsilyl)-	17.462	27.99	540
	2-Keto-d-gluconic acid, pentakis(O-trimethylsilyl)-	17.49	116.46	554
	2,4-Imidazolidinedione, 5-[3,4-bis[(trimethylsilyl)oxy]phenyl]-3-methyl-5-phenyl-1-(trimethylsilyl)-	17.575	35.85	516
	Glucofuranosidde, methyl 2,3,5,6-tetrakis-O-(trimethylsilyl)-,.alpha.-D-	17.632	16.8	482
	Tetradecanoic acid, trimethylsilyl ester	17.696	78.72	300
	Trimethylsilyl 3,5-dimethoxy-4-(trimethylsilyloxy)benzoate	17.851	22.77	342
	Glycine, N-formyl-N-(trimethyltilyl)-, trimethylsilyl ester,	18.007	18.65	519

	Phthalic acid, butyl ester, ester with butyl glycolate	18.113	7.52	334
	Hexadecanoic acid, trimethylsilyl ester	18.297	95.76	328
	Prost-13-en-1-oic acid, 9-(methoxyimino)-11, 15-bis[(trimethylsilyl)oxy]-, trimethylsilyl ester, (8. xi ,12.xi.)-	18.418	31.9	599
	Hexadecanoic acid, butyl ester	18.765	69.85	312
	9,12,15-Octadecatrienoic acid, 2,3-bis[(trimethylsilyl)oxy]propyl ester	18.807	42.34	496
	9,12-Octadecadienoic acid (Z,Z)-, trimethylsilyl ester	18.836	76.88	352
	Octadecanoic acid, trimethylsilyl ester	18.921	96.23	356
	Octadecane, 3-ethyl-5-(2-ethylbutyl)-	19.147	12.71	366
	Phthalic acid, butyl ester, ester with butyl glycolate	19.26	50.91	336
	Octadecanoic acid, trimethylsilyl ester	19.501	51.63	340
	Eicosane, 2-methyl-	19.551	5.34	296
	Tetradecane, 2,6,10-trimethyl-	20.025	5.83	240
	1,2-Benzenedicarboxylic acid, diisooctyl ester	20.287	40.12	390
	Thiocarbamic acid, N,N-dimethyl, S-1,3-diphenyl-2-butenyl ester	20.705	53.11	311
	5H-Cyclopropa[3,4]benz[1,2-e]azulen-5-one, 2,4a,9,9a-tetrakis(acetyloxy)-3,[(acetyloxy)methyl]-1,	20.91	48.6	608
	Serverogenin acetate	21.307	11.15	544
	9,12,15-Octadecatrienoic acid, 2,3-bis[(trimethylsilyl)oxy]propyl ester	23.282	53.09	496
DeJj-8(0) Dorsal Ridge, Distal Portion	Bis(4-pyridyl)amine	6.481	33.29	171
	2-Methyl-1 ,4-bis(trimethylsiloxy)butane	6.998	16.31	248
	N-Trimethylsilylcyclohexylamine	7.076	27.68	171
	Amine, N,N,N-tris((trimethylsilyloxy)ethyl)-	7.692	13.33	365
	Tetrasiloxane, decamethyl	7.84	61.69	310
	Propanoic acid, 2-[(trimethylsilyl)oxy]-, trimethylsilyl ester	8.364	53.87	234
	2-Dimethyl(triemthylsilyl)silyloxytridecane	8.704	9.81	330
	1-Pentamethyldisiloxytridecane	11.125	9.47	344
	Benzoic acid trimethylsilyl ester	11.982	82.44	194
	Butanedioc acid, bis(trimethylsilyl) ester	13.101	55.11	262
	Propanedinitrile, cyclopentylidene-	13.908	39.38	132
	2,6-Dimethoxyphenol, trimethylsilyl ether	14.61	30.2	226

	2-Propenamide, N-3(3,4-dichlorophenyl)-2-methyl	15.424	15.45	229
	Hexanedioic acid, bis(trimthylsilyl) ester	15.905	32.32	290
	Phenol, 2,5-bis(1,1-dimethylethyl)-	16.004	43.77	206
	Amine, N,N,N-tris((trimethylsilyloxy)ethyl)-	16.705	95.15	365
	Benzoic acid, 4-[(trimethylsilyl)oxy]-, trimethylsilyl ester	16.755	75.92	282
	5,8,11-Eicosatriynoic acid, tert-butyldimethylsilyl ester	16.883	21.16	414
	.alpha.-D-Glucopyranoside, methyl 2-(acetylamino)-2-deoxy-3-O(trimethylsilyl)-	17.095	25.08	648
	Benzaldehyde, 3,5-dimethoxy-4-[(trimethylsilyl)oxy]-	17.166	55.67	254
	Benzoic acid, 3-methoxy-4-[(triemthylsilyl)oxy]-, triemthylsilyl ester	17.392	75.05	312
	Azelaic acid, bis(trimethylsilyl) ester	17.499	53.13	332
	.alpha.-D-Glucopyranoside, methyl 2-(acetylamino)-2-deoxy-3-O(trimethylsilyl)-	17.64	21.58	648
	Tetradecanoic acid, trimethylsilyl ester	17.695	83.96	300
	Trimethylsilyl 3,5-dimethoxy-4-(trimethylsilyloxy)benzoate	17.86	69.62	342
	9-Desoxo-9-x-acetoxy-3-desoxy-7.8.12-tri-O-acetylingol-3-one	17.98	51.86	536
	Prosta-5, 13-dien-1-oic acid,	18.016	11.21	642
	9,12,15-Octadecatrienoic acid, 2,3-bis[(trimethylsilyl)oxy]propyl ester	18.192	25.78	496
	Hexadecanoic acid, trimethylsilyl ester	18.306	95.51	328
	11.beta.,19-Cyclopregn-5-ene-3,20-dione, 11-hydroxy-, cyclic bis(ethylene acetal)	18.426	30.41	416
	Hexadecanoic acid, butyl ester	18.773	69.3	312
	9,12-Octadecadienoic acid (Z,Z)-, trimethylsilyl ester	18.844	79.44	352
	Octadecanoic acid, trimethylsilyl ester	18.929	96.56	356
	Hexacosane	19.155	5.1	366
	1,2-Benzenedicarboxylic acid, 2-butoxyethyl butyl ester	19.262	81.17	322
	Bezyl butyl phthalate	19.517	64.41	312
	Triphenyl phosphate	19.793	96.2	326
	Hentriacontane	20.026	7.69	436
	Phosphoric acid, (1-methyethyl)phenyl diphenyl ester	20.437	86.79	368
	3-hydroxybenzenepropanoic acid, octadecyl ester	20.749	95.99	530

	Octadecane, 3-ethyl-5-(2-ethylbutyl)-	22.186	4.97	366
	1'-Carboethoxy-1'-cyano-1	22.356	22.52	451
	Cholestan-3-one, cyclic 1,2-ethandiyl aetal	23.291	66.39	430
	.psi. ,.psi.-Carotene, 3,4-didehydro-1, 1',2,2'-tetrohydro-1'-hydroxy-1-methoxy-	24.367	21.88	582
	9-Desoxo-9-x-acetoxy-3-desoxy-7.8.12-tri-O-acetylingol-3-one	25.118	51.51	534
	5H-Cyclopropa[3,4]benz[1,2-e]azulen-5-one, 2,4a,9,9a-tetrakis(acetyloxy)-3,[(acetyloxy)methyl]-1,	26.392	20.18	608
DeJj-8(0) Proximal	2-Methyl-1 ,4-bis(trimethylsiloxy)butane	7.005	13.98	248
	2-Ethyl-1-Pentamethyldisilyloxyhexane	7.083	9.29	260
	Butanedioc acid, bis(trimethylsilyl) ester	7.706	23.01	276
	Benzoic acid trimethylsilyl ester	11.989	80.35	194
	Butanedioc acid, bis(trimethylsilyl) ester	13.101	43.05	262
	2,6-Dimethoxyphenol, trimethylsilyl ether	14.149	52.42	226
	Benzene, 1-(trimethylsilyloxy)-2-(trimethylsilyloxymethyl)-	15.077	49.21	268
	Phenol, 2,4-bis(1,1-dimethylethyl)-	15.707	42.17	206
	Hexanedioic acid, bis(trimthylsilyl) ester	15.898	81.64	290
	Trimethy(2,6 ditert.-butylphenoxy)silane	16.167	74.06	278
	Prosta-5, 13-dien-1-oic acid,	16.45	21.96	642
	Glycine, N-formyl-N-(trimethyltilyl)-, trimethylsilyl ester,	17.003	33.81	695
	Isoquinoline, 1,2,3,4-tetrahydro-5-6-7-8-tetramethoxy-2-methyl-	17.059	28.46	267
	Benzaldehyde, 3,5-dimethoxy-4-[(trimethylsilyl)oxy]-	17.166	79.44	254
	9,10-Anthracenedione, 1-(methylamino)-4-[(4-methylphenyl)amino]-	17.244	16.96	268
	3,5-Dimethoxymandelic acid, di-TMS	17.293	9.58	356
	Cholestan-3-one, cyclic 1,2-ethandiyl aetal	17.378	12.03	430
	Octadecane, 1,1'-[(1-methyl-1, 2-ethanediyl)bis(oxy)]bis-	17.407	8	580
	Azelaic acid, bis(trimethylsilyl) ester	17.498	71.46	332
	Trifluoromethyl-bis-(trimethylsilyl)methyl ketone-(trimethylsilyl)methyl ketone	17.52	3.15	338
	Tetradecanoic acid, trimethylsilyl ester	17.697	84.26	300
	Trimethylsilyl 3,5-dimethoxy-4-(trimethylsilyloxy)benzoate	17.86	91.98	342
	Pentadecanoic acid, 14-metyl-, methyl ester	17.973	34.48	270

	Cinnamic acid, m-(trimethylsiloxy)-, trimethylsilyl ester	18.016	17.86	308
	1,2-Benzenedicarboxylic acid, butyl decyl ester	18.115	9.72	362
	Glaucine	18.214	40.56	355
	Hexadecanoic acid, trimethylsilyl ester	18.306	98.17	328
	9,12-Octadecadienoic acid (Z,Z)-, trimethylsilyl ester	18.816	95.25	352
	Octadecanoic acid, trimethylsilyl ester	18.922	94.7	356
	1,2-Benzenedicarboxylic acid, 2-butoxyethyl butyl ester	19.262	76.86	322
	Benzyl butyl phthalate	19.51	72.27	312
	Triphenyl phosphate	19.793	91.83	326
	1,2-Benzenedicarboxylic acid, mono(2-ethylhexyl) ester	20.296	55.9	278
	Phosphoric acid, (1-methyethyl)phenyl diphenyl ester	20.43	97.74	368
	Docosanoic acid, trimethylsilyl ester	20.805	43.75	412
	1'-Carboethoxy-1'-cyano-1	22.37	15.35	451
	Benzoic acid, 9-[2-(adamantan-2-yliden-methoxymethyl)-phenyl]-6-oxo-6H-xanthen-3-yl ester	23.284	26.99	568
	4H-Cyclopropa[5',6']benz[1'2':7,8]azuleno[5,6-b]oxiren-4-one, 8,8a-bis(acetoxy)-2a-[(acetyloxy)methyl]1,1a,1b,1c,2a,3,3a,6a,6b,7,8,8a	23.787	15.6	520
	4a-Phorbol 12,13-didecanoate	24.594	15.63	672
	17-(1,5-Dimethylhexyl)-10,13-dimethyl-3	26.704	36.95	488
DeJj-8(1) Physical Removal	Propanoic acid, 2-[(trimethylsilyl)oxy]-, trimethylsilyl ester	8.378	54.14	234
	Acetic acid	8.718	20.89	220
	Pentasiloxane	10.382	73.11	384
	Hexadecanoic acid	18.314	97.08	328
	Hexadecanoic acid	18.781	60.64	312
	9,12-Octadecadienoic acid	18.852	52.04	352
	Dehydroabietic acid, trymethylsilyl ester	19.666	96.16	372
DeJj-8(2) Working Edge	Glycine, N-formyl-N-(trimethyltilyl)-, trimethylsilyl ester	6.99	19.17	247
	Ethanedioic acid	7.698	25.62	234
	Nicotinaldehyde	8.052	28.13	396
	Propanoic acid	8.364	46.43	234
	Oxanilic acid	8.605	38.65	309

	Dithioerythritol	10.615	33.52	442
	Benzoic acid	11.996	82.98	194
	Hexanedioic acid	15.911	52.36	290
	Dodecanoic acid	16.889	63.28	272
	Octanedioic acid	17.101	75.9	318
	Azelaic acid	17.511	86.25	332
	Glucopyranosiduronic acid	17.646	13.87	648
	Tetradecanoic acid	17.703	93.45	300
	Pregna-1,4-diene-3,20-dien	17.837	17.69	786
	Pentadecanoic acid	17.936	72.36	314
	Palmitelaidic acid	18.248	52.8	326
	Hexadecanoic acid	18.311	95.78	328
	Heptadecanoic acid	18.425	60.1	342
	Oleic acid	18.857	32.38	354
	Octadecanoic acid	18.934	95.6	356
	Benzenedicarboxylic acid	19.267	59.59	322
	Octadecatrienoic acid	19.883	39.64	496
DeJj-8 (2) Left Lateral Edge	Benzoic acid	11.989	85.2	194
	Hexanedioic acid	15.897	57.09	290
	Phenol	16.004	41.02	206
	Dodecanoic acid	16.881	72.95	272
	Glucopyranosiduronic acid	17.498	23.73	648
	Tetradecanoic acid	17.696	90.78	300
	Pentadecanoic acid	17.929	52.09	314
	Phthalic acid	18.114	8.22	334
	Palmitelaidic acid	18.241	59.72	326
	Hexadecanoic acid	18.305	97.67	328
	Heptadecanoic acid	18.418	48.83	342
	Octadecatrienoic acid	18.539	30.34	496
	Ocleic acid	18.843	39.42	354
	Octadecanoic acid	18.921	83.65	356
	Benzenedicarboxylic acid	19.261	72.19	322
	Thiocarbamic acid	20.62	34.34	311
DeJj-8 (2) Dorsal	Propanoic acid	8.378	46.3	234
	Benzoic acid	11.982	81.33	194
	Propanedioic acid	13.108	50.72	262
	Hexanedioic acid	15.897	71.57	290
	Octanedioic acid	17.094	48.2	318
	Azelaic acid	17.497	63.55	332

	Prosta-5,13-dien-1-oic acid	17.639	49.31	642
	Tetradecanoic acid	17.696	89.87	300
	Octadecatrienoic acid	18.014	40.37	496
	Benzenedicarboxylic acid	18.113	9.49	304
	Hexadecanoic acid	18.304	97.7	328
	Octadecadienoic acid	18.835	84.57	352
	Octadecanoic acid	18.92	91.9	356
	Phthalic acid	19.26	81.92	336
	Benzenedicarboxylic acid	20.294	32.77	278
	Phosphoric acid	20.436	46.6	368
	Oleic acid	22.185	13.64	592
DeJj-8(7) Dorsal	Ethanedioic acid	7.67	10.72	234
	Benzoic acid	11.981	73.38	194
	Octanedioic acid	17.093	31.13	318
	Azelaic acid	17.503	96.37	332
	Hexadecanoic acid	18.303	89.3	328
	Octadecadienoic acid	18.834	46.85	352
	Acetonitrile	8.555	58.12	41
	Acetonitrile	9.617	79.35	41
	Borane, trimethyl	10.31	79.25	56
	Acetonitrile	10.941	73.91	41
	Benzoic acid trimethylsilyl ester	11.974	47.05	194
	Silanol, trimethyl-, phosphate	12.342	90.24	314
	Azelaic Acid	17.497	89.13	332
	Hexadecanoic Acid	18.304	88.47	328
	Hexadecanoic Acid	18.311	23.48	328
	Octadecadienoic acid, trimethylsil ester	18.849	20.64	352

Appendix C.2 Sample Set 2

Table 0.7 GC/MS Results Sample Set 2

Sample Set 2	Compound	Retention Time	Percent Correct ID	MW
DcJi-1(1) Working Edge				
	E-2-Hydroxymethylcyclopentanol, d(trimethylsilyl) ether	6	21.33	260
	1-Pentamethyldisiloxytridecane	7.019	15.73	330
	1-(2-Ethyl-[1,3]dithian-2-yl)-3-methyl-butan-1-ol	7.656	30.85	234
	Propanoic acid, 2-[(trimethylsilyl)oxy]-, trimethylsilyl ester	8.329	64.5	234

	Borane, diisopropylpropyl-	8.669	23.11	140
	Benzoic acid trimethylsilyl ester	11.884	56.04	194
	Octanoic acid, trimethylsilyl ester	12.224	70.8	216
	Octanedioic acid, bis(trimethylsilyl)ester	17.079	80.2	318
	Azelaic acid, bis(trimethylsilyl) ester	17.483	97.18	332
	Benzene, 1-(trimethylsilyloxy)-2-(trimethylsilyloxymethyl)-	17.674	356	
	Sebacic acid, bis(trimethylsilyl) ester	17.823	44.96	346
	Cinnamic acid, p-(trimethylsiloxy)-, trimethylsilyl ester	17.993	18.03	308
	Hexadecanoic acid, trimethylsilyl ester	18.284	93.24	328
	1,3-Dioxane, 5-(hexadecyloxy)-2-pentadecyl',trans-	18.588	24.12	538
	9,12-Octadecadienoic acid (Z,Z)-, trimethylsilyl ester	18.822	91.67	352
	Octadecanoic acid, trimethylsilyl ester	18.907	89.13	356
	Eicosanoic acid, trimethylsilyl ester	19.679	384	384
	Heneicosanoic acid, trimethylsilyl ester	20.175	10.43	398
	Docosanoic acid, trimethylsilyl ester	20.784	83.24	412
	Prost-13-en-1-oic acid, 9-(methoxyimino)-11, 15-bis[(trimethylsilyl)oxy]-, trimethylsilyl ester, (8. xi ,12.xi.)-	21.527	42.46	599
	5H-Cyclopropa[3,4]benz[1,2-e]azulen-5-one, 2,4a,9,9a-tetrakis(acetyloxy)-3,[(acetyloxy)methyl]-1,	22.923	52.95	608
	Fluocinolone Acetone	25.411	53.63	452
	Cholestan-3-one, cyclic 1,2-ethandiyl aetal	25.517	34.16	430
	9-Desoxo-9-x-acetoxy-3-desoxy-7.8.12-tri-O-acetylingol-3-one	25.275	59.15	534
	Glycine, N-formyl-N-(trimethyltilyl)-, trimethylsilyl ester,	26.048	18.94	695
	.beta.-Sitosterol acetate	26.686	61.28	456
DcJi-1(2) Dorsal				
	4-Hexenoic acid, 4-methyl-6-(fluorodimethylsilyl)-6-trimethylsilyl-	5.638	11.82	276
	Trifluoromethyl-bis-(trimethylsilyl)methyl ketone-(trimethylsilyl)methyl ketone	5.985	92.26	256
	Ethanedioic acid, bis(triemthylsilyl) ester	7.677	36.57	234
	Tetrasiloxane, decamethyl	7.819	55.97	310
	Propanoic acid, 2-[(trimethylsilyl)oxy]-, trimethylsilyl ester	8.357	58.15	234
	Pentasiloxane, dodecamethyl-	10.347	57.67	384

	Dihydrobenzofurane-2-one, 3-[2-methiophenylene-	10.92	37.92	268
	Trisiloxane, octamethyl-	11.083	44.72	384
	Benzoic acid, trimethylsilyl ester	11.006	70.88	194
	Acetic acid, cyano-	15.898	61.46	85
	Azelaic acid, bis(trimethylsilyl) ester	17.512	96.92	332
	Hexadecanoic acid, trimethylsilyl ester	18.312	60.18	328
	2,4,6,8,10-Tetradecapentaenoic acid, 9a-(acetyloxy).	18.857	20.75	606
	Cholesta-8,24-dien-3-ol,4-methyl-. (3.beta.,4.alpha.)-	26.725	27.89	398
	3,19;14,15-Diepoxypregnan-20-one,3,11,18-triacetoxy	26.824	15.35	504
DeJj-18 Working Edge	Trifluoromethyl-bis-(trimethylsilyl)methyl ketone	5.964	92.86	338
	Bis(trimethylsiloxy)ethane	6.877	62.65	206
	Silane	8.272	58.16	32
	Acetonitrile	9.561	49.45	41
	Benzoic acid trimethylsilyl ester	11.982	67.35	194
	Silanol, trimethyl-, phosphate	12.343	80.89	314
	Azelaic Acid	17.497	97.95	332
	Hexadecanoic Acid	18.305	82.34	328
	Octadecadienoic acid, trimethylsil ester	18.836	52.74	352
DeJj-18 Right Lateral	Trifluoromethyl-bis-(trimethylsilyl)methyl ketone	5.964	90.04	338
	Trifluoromethyl-bis-(trimethylsilyl)methyl ketone	6.247	97.49	338
	Bis(trimethylsiloxy)ethane	6.87	59.29	206
	1-(2-Ethyl-[1,3]dithian-2-yl)-3-methyl-butan-1-ol	7.663	12.38	234
	Silane	8.265	64.63	32
	Borane, trimethyl	10.913	21.38	56
	Benzoic acid trimethylsilyl ester	11.989	60.53	194
	Silanol, trimethyl-, phosphate	12.336	86.83	314
	Acetonitrile	16.711	79.07	41
	Azelaic Acid	17.497	90.39	332
	Hexadecanoic Acid	18.304	89.19	328
DEJJ-18 Dorsal	Trifluoromethyl-bis-(trimethylsilyl)methyl ketone	5.971	90.6	338
	Bis(trimethylsiloxy)ethane	6.877	41.39	206
	Disiloxane, hexamethyl	7.677	17.35	162
	tetrasiloxane decamethyl	8.187	78.53	310
	tetrasiloxane decamethyl	8.201	80.85	310

	Propanoic acid	8.35	55.02	234
	Dimethyl-2-thioxo-1,2-dihydro-3-pyridinecarbonitrile	10.913	24.73	236
	Benzoic acid trimethylsilyl ester	11.996	77.15	194
	Silanol, trimethyl-, phosphate	12.35	56.19	314
	Acetonitrile	12.909	77.01	41
	Azelaic Acid	17.509	93.25	332
	Androstan-17, 19-diol, 3,3-ethylenedioxy-4,4-dimethyl	18.855	21.22	378
DeJj-18 Proximal	Trifluoromethyl-bis-(trimethylsilyl)methyl ketone	5.95	90.21	338
	Bis(trimethylsiloxy)ethane	6.856	51.29	206
	Silanamine, 1,1,1-trimethyl-N-(trimethylsilyl)-N-[2-[(triemthylsilyl)oxy]ethyl]-	7.649	8.62	277
	tetrasiloxane decamethyl	8.159	80.92	310
	Silane	8.258	55.42	32
	Acetonitrile	8.64	75.63	41
	1,2,4-triazino[5,6-E]-triazine-3,6-dione, hexahydro	9.277	11.89	172
	Acetonitrile	9.971	66.57	41
	Silane	10.587	28.3	32
	Acetonitrile	10.679	58.95	41
	Benzenedicarboxylic acid, diphenyl ester	10.989	15.49	322
	Borane trimethyl	11.04	29.73	56
	Acetonitrile	11.408	53.07	41
	Benzene	11.061	17.06	316
	Acetonitrile	11.082	48.87	41
	Acetonitrile	11.429	83.05	41
	Borane, trimethyl	11.627	67.16	56
	Acetonitrile	11.677	73.17	41
	benzoic acid trimethylsilyl ester	11.967	50.98	194
	benzoic acid trimethylsily ester	11.988	47.41	194
	silanol, trimethyl, phosphate	12.329	89.06	314
	Acetic acid, cyano	13.299	17.32	85
	Borane, trimethyl	13.363	41.41	56
	Octadecadienoic acid, bis(trimethylsil) ester	17.073	30.1	352
	Azelaic Acid	17.484	97.54	332
	Hexadecanoic Acid	18.291	90.02	328
	1-Monolinoleoglycerol trimethylsilyl ether	18.829	11.33	498
	N-2,4-Dnp-L-arginine	22.929	35.08	230
	Ethyl iso-allocholate	26.72	14.11	436

Appendix C.3 Sample Set 3

Table 0.8 GC/MS Results Sample Set 3

Sample Set 3	Compound	Retention Time	Percent Correct ID	MW
DeJj-8(14) Working Edge	Tetrasiloxane, decamethyl-	7.79	75.21	310
	Benzoic acid	11.96	64.35	194
	Azelaic acid	17.49	94.62	332
	Hexadecanoic acid	18.29	63.94	328
	9,12-Octadecadienoic acid	18.821	28.62	352
DeJj-8(14) Dorsal	Tetrasiloxane	7.819	33.71	310
	Benzoic acid	11.989	65.41	194
	Octanoic acid	12.258	11.93	258
	Azelaic acid	17.497	80.35	332
	Hexadecanoic acid	18.311	64.67	356
	Androstane	26.71	36.57	378
DeJj-8(14) Proximal	Benzoic acid	11.974	77.66	194
	Azelaic acid	17.497	92.29	332
	Hexadecanoic acid	18.304	57.61	328
	Octadecadienoic acid	18.835	36.98	352
	Octadecatrienoic acid	19.522	30.09	496
DeJj-8(14) Left Lateral and Ventral	Butanoic acid	7.019	19.28	247
	Ethanedioic acid	7.705	28.24	234
	Tetrasiloxane	7.847	55.1	310
	Nicotinaldehyde	8.059	27	396
	Tetrasiloxane	8.22	66.46	310
	Propanoic acid	8.378	45.06	234
	Titanium	8.675	25.05	492
	Pentasiloxane	11.075	72.8	384
	Urea	11.897	93.8	204
	Benzoic acid	11.989	80.28	194
	Octanoic acid	12.243	75.23	216
	Butanedioic acid	13.093	21.9	262
	Nonanoic acid	13.907	87.38	230
	Decanoic acid	15.422	44.06	244

	Hexanedioic acid	15.89	37.81	290
	Dodecanoic acid	16.881	64.53	272
	Prosta-5, 13-dien-1-oic acid	17.093	28.19	642
	Azelaic acid	17.497	51.04	332
	Tetradecanoic acid	17.695	95.15	300
	Phthalic acid	17.808	42.78	362
	n-Pentadecanoic acid	18.013	79.93	314
	Dibutyl phthalate	18.113	20.17	278
	Palmitelaidic acid	18.233	46.19	326
	Hexadecanoic acid	18.304	96.46	328
	Octadecenoic acid	18.842	91.35	356
	Phenanthrenecarboxylic acid	19.543	56.3	314
	Benzonitrile	20.046	38.31	207
	Thiocarbamic acid	21.49	17.85	311
DeJj-8(14) Physical Removal	Octadecane	10.368	20.33	366
	dehydroabietic acid, trimethylsilyl ester	19.653	50.86	372
DeJj-8(15) Working Edge	Ethanedioic acid	7.656	17.77	234
	Propanoic acid	8.322	43.9	234
	Benzoic acid	11.968	30.87	194
	Octanoic acid	12.238	35.83	216
	Azelaic acid	17.492	93.18	332
	Hexadecanoic acid	18.3	35.23	328
DeJj-8(15) Left Lateral and Ventral	Ethanedioic acid	7.642	29.31	234
	Azelaic acid	17.485	90.06	332
	Hexadecanoic acid	18.286	49.24	328
DeJj-8(15) Dorsal	Benzoic acid	11.982	65.88	194
	Azelaic acid	17.506	95.41	332
	Hexadecanoic acid	18.313	48.15	328
DeJj-8(11) Working Edge	Azelaic acid	17.493	94	332
	Hexadecanoic acid, trimethylsilyl ester	18.293	52.08	328
DeJj-8(11) Left Lateral and Ventral	Alanine	6.962	24.52	247
	Acetamide	7.238	86.5	141

	Ethanedioic acid, bis(trimethylsilyl) ester	7.677	26.7	234
	Nicotinaldehyde thiosemicarbazone tritms	8.01	57.79	396
	Propanoic acid	8.329	57.15	234
	Pentasiloxane, dodecamethyl-	10.319	82.53	384
	Dithioerythritol, O,O',S,S'-tetrakis(trimethylsilyl)-	10.58	39.48	442
	Hexasiloxane, tetradecamethyl-	13.894	37	458
	Decanoic acid, trimethylsilyl ester	15.409	65.63	244
	Benzaldehyde, 2,4-bis(trimethylsiloxy)-	15.905	14.68	282
	1H-Pyrrolo[2,3-b]quinoline-4-carboxylic acid	16.542	48.62	342
	Benzoic acid	16.734	64.44	282
	Dodecanoic acid	16.861	55.15	272
	Octanedioic acid, bis(trimethylsilyl) ester	17.073	73.29	318
	Azelaic acid, bis(trimethylsilyl) ester	17.484	97.04	332
	Tetradecanoic acid, trimethylsilyl ester	17.682	85.13	300
	n-Pentadecanoic acid, trimethylsilyl ester	17.994	78.25	314
	Dibutyl phthalate	18.1	26.37	278
	Palmitelaidic acid, trimethylsilyl ester	18.221	51.59	326
	Hexadecanoic acid, trimethylsilyl ester	18.284	94.47	328
	9,12-Octadecadienoic acid (Z,Z)-, trimethylsilyl ester	18.823	87.3	352
	Octadecanoic acid, trimethylsilyl ester	18.908	96.34	356
	Phthalic acid	19.247	55.35	336
	9-Desoxo-9-x-acetoxy-3,8,12-tri-O-acetylingol	19.658	34.84	536
	Benzonitrile, m-phenethyl-	20.026	38.09	207
	Benzene	20.614	22.82	316
	(2,3-Diohenylcyclopropyl)methyl phenyl sulfoxide, trans-	20.692	37.46	332
	Cholesta-8,24-dien-3-ol, 4-methyl-, (3.beta.,4.alpha)-	26.721	33.48	398
DeJj-8(11) Dorsal	Alanine	6.997	33.9	247
	Ethanedioic acid, bis(triemethylsilyl) ester	7.698	29.03	234
	Nicotinaldehyde thiosemicarbazone tritms	8.053	67.11	396
	Tetrasiloxane, decamethyl-	8.194	57.16	310
	Propanoic acid	8.371	51.36	234
	Oxanilic acid, O,O'-bis(trimethylsilyl)	8.605	55.3	309
	N'-(1H-lindol-3-ylmethylene)benzohydrazide ditms	10.205	60.37	407
	Pentasiloxane, dodecamethyl-	10.332	71.67	384
	Dithioerythritol, O,O',S,S'-tetrakis(trimethylsilyl)-	10.602	43.42	442
	Trisiloxane, octamethyl-	10.913	27.89	236
	(1H)Benzimidazole	11.232	58.11	424
	Urea, N,N'-bis(trimethylsilyl)-	11.911	75.95	204

	Benzoic acid trimethylsilyl ester	11.989	52.35	194
	Octanoic acid, trimethylsilyl ester	12.237	46.45	216
	Octane	12.789	20.1	466
	2-Trimethylsiloxyheptanoic acid	13.879	38.34	290
	Hexanedioic acid, bis(trimethylsilyl) ester	15.898	44.28	290
	Dodecanoic acid, trimethylsilyl ester	16.868	43.29	272
	Octanedioic acid, bis(triemthylsilyl) ester	17.087	87.43	318
	Azelaic acid	17.491	97.9	332
	Tetradecanoic acid	17.689	91.16	300
	Sebacic acid, bis(trimethylsilyl) ester	17.824	39.42	346
	Cinnamic acid, p-(trimethylsiloxy)-, trimethylsilyl ester	18.008	58.31	308
	Dibutyl phthalate	18.107	15.95	278
	Hexadecanoic acid, trimethylsilyl ester	18.298	98.55	328
	9,12,15-Octadecatrienoic acid,	18.595	24.56	496
	9,12-Octadecadienoic acid (Z,Z)-, trimethylsilyl ester	18.829	94.3	352
	Octadecanoic acid, trimethylsilyl ester	18.914	89.33	356
	Phthalic acid	19.254	54.01	336
DeJj-8(11) Proximal	Propanoic acid	8.329	41.64	234
	Octanedioic acid, bis(trimethylsilyl) ester	17.088	46.45	318
	Azelaic acid	17.499	95.8	332
	Hexadecanoic acid	18.299	35.52	370
	2,4,6,8,10-Tetradecapentaenoic acid	26.714	29.31	606
DeJj-8(12) Working Edge	Benzoic acid trimethylsilyl	11.982	31.3	194
	Azelaic acid	17.492	90.07	332
	Hexadecanoic acid	18.292	34.74	328
DeJj-8(12) Right Lateral and Ventral	Borane	8.329	62.31	56
	Octanedioic acid, bis(trimethylsilyl) ester	17.082	27.18	318
	Acetic acid	17.202	57.52	85
	Azelaic acid	17.485	97.78	332
	Hexadecanoic acid	18.293	67.9	328
	Octadecanoic acid	18.838	24.04	446
DeJj-8(12) Dorsal				
	Ethanedioic acid	7.642	46.48	234
	Propanoic acid	8.322	53.44	234

	Benzoic acid trimethylsilyl ester	11.976	43.18	194
	Azelaic acid	17.492	85.89	332
	Hexadecanoic acid	18.299	31.46	356
DeJj-8(13) Right Lateral and Ventral	Propanoic acid	8.329	66.61	234
	Trisiloxane	11.062	51.75	384
	Benzoic acid trimethylsilyl ester	11.976	69.82	194
	Azelaic acid	17.499	97.81	332
	Hexadecanoic acid	18.307	39.15	328
	Prost-13-en-1-oic acid	18.837	21.92	600
DeJj-8(13) Dorsal				
	Propanoic acid	8.329	25.8	234
	Hexadecanoic acid	18.293	30.33	328
DeJj-8(13) Proximal				
	Disiloxane, hexamethyl-	7.642	46.51	162
	Tetrasiloxane, decamethyl-	7.777	77.44	310
	Propanoic acid	8.315	55.63	234
	Azelaic acid	17.485	92.21	332
	Hexadecanoic acid	18.292	69.67	328
DeJj-8(13) Physical Removal				
	1-(2-Ethyl-[1,3]dithian-2-yl)-3-methyl-butan-1-ol	7.699	31.48	234
	Propanoic acid	8.378	47.29	234
	.alpha.-D-Glucopyranosiduronic acid	17.697	45.49	648
	Prost-13-en-1-oic acid	18.023	38.92	600
	Octadecane	18.193	29.5	366
	Hexadecanoic acid	18.306	94.28	328
	Hexadecanoic acid	18.773	80.26	312
	9,12-Octadecadienoic acid	18.844	46.46	352
	Octadecanoic acid	18.922	87.23	356
	Serverogenin acetate	19.149	40.18	544
	Dehydroabietic acid, trimethylsilyl ester	19.659	81.55	372
DdJm-3 Working Edge	Trifluoromethyl-bis-(trimethylsilyl)methyl ketone	5.964	92.41	338
	silanamine, 1,1,1-trimethyl-N-(trimethylsilyl)-N-[2-[(triemthylsilyl)oxy]ethyl]-	6.438	91.62	277
	1-(2-Ethyl-[1,3]dithian-2-yl)-3-methyl-butan-1-ol	6.863	27.02	234

	Bis(trimethylsiloxy)ethane	6.884	75.02	206
	Borane, trimethyl	7.493	77.55	56
	Borane, trimethyl	7.585	79.84	56
	Ethanedioic acid, bis(trimethylsily) ester	7.663	31.36	234
	Silane,	8.272	53.53	32
	Propanoic acid	8.343	55.38	234
	Propanoic acid	8.414	36.94	234
	Acetonitrile	10.325	64.31	41
	Butanoic acid	10.283	34.44	247
	Borane, trimethyl	10.559	76.25	56
	Benzoic acid trimethylsilyl ester	11.975	51.06	194
	Silanol, (1,1-dimethylethyl)dimethyl-, benzonate	11.989	42.14	236
	Octanoic acid, trimethylsilyl ester	12.244	48.97	216
	Silanol, trimethyl, phosphate	12.336	81.02	314
	Acetic acid, cyano	14.637	34.86	85
	Borane, trimethyl	14.97	73.23	56
	Azelaic Acid	17.497	87.8	332
	Hexadecanoic Acid, trimethylsilyl ester	18.304	81.51	328
	1-Monolinoleoglycerol trimethylsilyl ether	18.842	23.12	498
	Cholestan-3-one, cyclic 1,2-ethanediyl aetal	22.913	53.65	430
	Cholestan-3-one, cyclic 1,2-ethanediyl aetal	26.319	53.69	430
DdJm-3 Right Lateral and Ventral	Trifluoromethyl-bis-(trimethylsilyl)methyl ketone-(trimethylsilyl)methyl ketone	5.95	93.46	338
	Trifluoromethyl-bis-(trimethylsilyl)methyl ketone	6.162	96.38	338
	Bis(trimethylsiloxy)ethane	6.863	52.86	206
	Ethanedioic acid, bis(trimethylsilyl) ester	7.649	32.7	234
	Tetrasiloxane, decamethyl	7.804	83.15	310
	Tetrasiloxane, decamethyl	8.159	60.26	310
	Tetrasiloxane, decamethyl	8.173	76.77	310
	Propanoic acid	8.328	59.14	234
	Pentasiloxane, dodecamethyl	10.318	66.42	384
	Dithioerythritol, O,O',S,S'-tetrakis(trimethylsilyl)-	10.899	28.17	442
	Pentasiloxane, dodecamethyl	11.054	69.72	384
	Benzoic acid trimethylsilyl ester	11.975	47.01	194
	n-Octanoic acid, allyldimethylsilyl ester	12.23	42.19	216
	Silanol, trimethyl, phosphate	12.329	82.38	314
	Acetic acid, cyano	13.058	23.93	85
	Acetonitrile	16.542	30.59	41
	2',6'-Dihydroxyacetophenone, bis(trimethylsilyl) ether	17.349	26.17	296

	Azelaic Acid	17.491	92.64	332
	Hexadecanoic Acid	18.298	92.98	328
	9,12-Octadecadienoic acid (Z,Z)-, trimethylsilyl ester	18.836	20.16	352
	N-2,4-Dnp-L-arginine	22.649	22.6	230
	Cholestan-3-one, cyclic 1,2-ethanediyl aetal	38.14	430	
DdJm-3 Dorsal	Trifluoromethyl-bis-(trimethylsilyl)methyl ketone	5.978	93.08	338
	Trifluoromethyl-bis-(trimethylsilyl)methyl ketone	6.028	94.88	338
	Trifluoromethyl-bis-(trimethylsilyl)methyl ketone	6.091	97.17	338
	Bis(trimethylsiloxy)ethane	6.891	63.38	206
	Ethanedioic acid, bis(trimethylsilyl) ester	7.684	37.5	234
	Tetrasiloxane, decamethyl	7.833	54.38	310
	Tetrasiloxane, decamethyl	8.187	57.31	310
	Tetrasiloxane, decamethyl	8.201	79.81	310
	Propanoic acid	8.357	58.64	234
	Acetonitrile	9.56	74.16	41
	Borane, trimethyl	9.957	65.57	56
	Dithioerythritol, O,O',S,S'-tetrakis(trimethylsilyl)-	10.608	15.72	442
	Quinoline, N-benzoyl-1 ,2,3,4-tetrahydro	10.679	14.92	129
	Silane	10.926	18.61	32
	Benzoic acid trimethylsilyl ester	11.988	59.27	194
	Silanol, trimethyl, phosphate	12.349	92.75	314
	Acetonitrile	13.107	69.56	41
	Azelaic Acid	17.51	86.87	332
	Hexadecanoic Acid, trimethylsilyl ester	18.317	71.26	328
	9,12,15-Octadecatrienoic acid	18.855	56.74	496
	Cholestan-3-one, cyclic 1,2-ethanediyl aetal	20.328	48.45	430
	Androst-4-ene-3,20-dione, 11, 16, 22-triacetoxy	22.509	42.33	488
DeJj-21(1) Working Edge	N-(trimethylsilyl)acetamide	5.773	96.7	131
	Trifluoromethyl-bis-(trimethylsilyl)methyl ketone	5.964	95.84	338
	Trifluoromethyl-bis-(trimethylsilyl)methyl ketone	6.077	91.5	338
	Disilathiane, hexamethyl	6.382	80.95	178
	1,2-bis(trimethylsiloxy)ethane	6.948	79.61	206
	Acetamide	7.005	40.17	84
	Silane	7.337	47.15	32
	Butanoic acid, methyl-, bis(trimethylsiyl) ester	7.684	8.62	247
	1-(2-Ethyl-[1,3]dithian-2-yl)-3-methyl-butan-1-ol	7.698	14.56	234
	Tetrasiloxane, decamethyl	7.833	80.88	310

	4-Methyl-2-(2-nitro-5-piperidin-1-yl-phenyl)-2H-phthalazin-1-one	8.024	70.81	364
	Silane,	8.286	77.11	32
	Propanoic acid	8.35	44.6	234
	Pentanoic acid	8.654	29.95	234
	3H-Pyrazol-3-one	8.76	60.56	468
	Acetonitrile	9.596	67.16	41
	5-Hydroxy-5-methyl-2-phenyl-3-isoxazolidinone ditms pk2	10.899	18.24	337
	Benzoic acid trimethylsilyl ester	11.919	69.22	194
	Benzoic acid trimethylsilyl ester	11.989	84.11	194
	n-Pentadecanoic acid, trmethylsilyl ester	12.265	17.11	314
	Silanol, trimethyl-, phosphate	12.357	87.39	314
	2(3H)-Furanone, 3-bromodihydro-	12.896	36.56	164
	3-Dimethyl(trimethylsilyl)silyloxytetradecane	13.044	10.59	240
	Butanedoic acid, bis(trimethylsilyl) ester	13.087	14.38	118
	Butanedoic acid, bis(trimethylsilyl) ester	13.101	33.77	118
	2,4-Imidazolidinedione, 5-[3,4-bis[(trimethylsilyl)oxy]phenyl]-3-methyl-5-methyl-5-phenyl-1-(trimethylsilyl)-	13.887	12.36	516
	Pregan-20-one, 2-hydroxy-5,6-epoxy-15-methyl	14.708	34.41	346
	Hexanedioic acid, bis(trimethylsl) ester	15.898	72.66	290
	3-methyl-12-pyridin-2-yl-8,9,10,12-tetrahydro-7H-benzo[b][4,7]phenanthrolin-11-one	16.167	24.23	341
	Silane	16.556	15.88	32
	Heptanedioic acid, bis(trimethylsilyl) ester	16.599	24.25	304
	Benzoic acid, 4-[(trimethylsilyl)oxy]-, tirmethylsily ester	16.747	55	282
	Phenylhexanoic acid, triemthylsilyl ester	16.875	32.54	264
	Nonanoic acid, 9-(o-propylphenyl)-, methyl ester	16.91	17.51	230
	4H-1-Benzopyran-4-one	16.988	44.31	314
	Octanedioic acid, bis(trimethylsilyl) ester	17.087	88.76	318
	2,4-Imidazolidinedione, 5-[3,4-bis[(trimethylsilyl)oxy]phenyl]-3-methyl-5-methyl-5-phenyl-1-(trimethylsilyl)-	17.208	37.35	516
	2,4-Imidazolidinedione, 5-[3,4-bis[(trimethylsilyl)oxy]phenyl]-3-methyl-5-methyl-5-phenyl-1-(trimethylsilyl)-	17.321	17.94	516
	Benzene, 1,1'-(1,2-cyclobutanediyl) bis-	17.455	47.71	268
	Azelaic Acid, bis(trimethylsilyl) ester	17.498	95.63	332
	Naphthalene, 1,2,3,4-tetrahydro-2-phenyl	17.548	75.52	128
	9,12,15-Octadecatrienoic acid	17.626	54.56	496
	Tetradecanoic acid, trimethylsily ester	17.689	95.63	300

	Phthalic acid, cyclohexyl isohexyl ester	17.803	14.18	166
	n-Pentadecanoic acid, trmethylsilyl ester	17.824	68.67	314
	4,5,6,7-Tetrahydroxy	17.852	19.74	342
	n-Pentadecanoic acid, trmethylsilyl ester	17.923	71.72	314
	.alpha. -D-Glucopyranoside	17.944	27.84	648
	n-Pentadecanoic acid, trmethylsilyl ester	18.008	90.98	314
	Silane	18.036	22.7	32
	Phthalic acid, butyl nonyl ester	18.114	16.16	166
	Cyclohexanecarboxylic acid	18.185	31.15	268
	Palmitelaidic acid, trimethylsilyl ester	18.234	50.19	326
	Hexadecanoic Acid, trimethylsilyl ester	18.298	96.47	328
	Prosta-5, 13-dien-1-oic acid	18.334	12.47	642
	1,3-Dioxane	18.419	22.45	538
	cis-10-Heptadecanoic acid, trimethyl ester	18.532	38.45	342
	1,3-Dioxane,	18.603	24.03	538
	Silane	18.631	56.47	32
	Hexadecanoic acid	18.766	66.25	328
	9,12-Octadecadienoic acid (Z,Z)-, trimethylsilyl ester	18.837	68.25	352
	Octadecanoic acid, trimethylsilyl ester	18.922	96.33	356
	9,12,15-Octadecanoic acid	18.999	34.31	356
	9,12,15-Octadecanoic acid	19.155	19.55	356
	1,2-Benzenedicarboxylic acid, 2-butoxyethyl butyl ester	19.254	64.06	266
	(2,3-Diphenylcyclopropyl)methyl phenyl sulfoxide, trans-	19.467	42.2	332
	Androst-4-ene-3,20-dione, 11, 16, 22-triacetoxy	19.509	46.12	488
	Cholestan-3-one, cyclic 1,2-ethanediyl aetal	19.552	46.87	430
	Glycine, N-formyl-N-(trimethyltilyl)-, trimethylsilyl ester.	19.694	30.63	247
	2,4-Imidazolidinedione, 5-[3,4-bis[(trimethylsilyl)oxy]phenyl]-3-methyl-5-methyl-5-phenyl-1-(trimethylsilyl)-	19.764	21.76	516
	Morphinan	19.849	16.91	227
	Benzonitrile, m-phenethyl-	20.047	47.81	227
	Phtalic acid, octyl 2-pentyl ester	20.295	8.51	166
	Benzene, 1,1'-[2-methyl-2-(phenylthio)cyclopropylidene] bis-	20.628	43.95	316
	Benzene, 1,1'-[2-methyl-2-(phenylthio)cyclopropylidene] bis-	20.707	38.15	316
	Benzene, 1,1'-[2-methyl-2-(phenylthio)cyclopropylidene] bis-	20.763	38.2	316

	(2,3-Diphenylcyclopropyl)methyl phenyl sulfoxide, trans-	20.813	41.24	332
	Naphthalene	21.195	45.09	128
	Octadecanoic acid	21.301	13.24	356
	9,12,15-Octadecatrienoic acid	21.323	45.75	496
	(2,3-Diphenylcyclopropyl)methyl phenyl sulfoxide, trans-	21.492	31.32	332
	1'-Carboethoxy-1'-cyano-1	22.222	42.37	451
	Glycine, N-formyl-N-(trimethyltilyl)-, trimethylsilyl ester	22.491	32.82	247
	Prosta-5, 13-dien-1-oic acid	22.519	43.13	642
	7,8-Epoxylanostan-11-ol, 3-acetoxy	22.583	14.99	502
	2,4 Imidazolidinedione	22.732	35.8	128
	17-(1,5-Dimethylhexyl)-10	23.022	27.59	488
	Cholestan-3-one, cyclic 1,2-ethanediyl aetal	24.064	61.79	430
	.beta.-Silosterol aceetate	26.743	13.15	456
DeJj-21(1) Dorsal Ridge	Acetonitrile	5.68	70.92	41
	N-(trimethylsilyl)acetamide	5.794	97.04	131
	Trifluormethyl-bis-(trimethylsilyl)methyl ketone	5.964	93	338
	1 ,2-Bis(trimethylsiloxy)ethane	6.969	67.13	206
	Butanoic acid, 2-[(trimethylsyl)amino]-, trimethylsilyl ester	7.04	37.07	247
	Silane	7.415	55.12	32
	Tetrasiloxane, decamethyl	7.868	42.53	310
	Silane,	8.307	67.93	32
	Propanoic acid,	8.364	61.59	234
	Propanoic acid,	8.392	43.23	234
	Hexanoic acid, trimethylsilyl ester	8.704	91.13	116
	Borane, trimethyl	8.824	66.61	56
	Propanoic acid, methyl-, bis(trimethylsilyl) ester	11.146	32.97	262
	Mendelic acid, ethyl ester, trimethylsilyl	11.84	22.98	152
	Benzoic acid trimethylsilyl ester	11.939	78.53	194
	Benzoic acid trimethylsilyl ester	11.996	82.39	194
	Silanol, trimethyl-, phosphate	12.385	91.47	314
	Butanedoic acid, bis(trimethylsilyl) ester	13.115	36.67	118
	2-Trimethylsilyloxyheptanoic acid, trimethylsilyl ester	13.908	15.63	290
	Benzaldehdyde, 4-[(trimethylsilyl)oxy]-	14.262	87.05	194
	Prosta-5, 13-dien-1-oic acid,	14.644	30.3	642
	Silane, trimethyl	15.02	26.85	32
	Benzene	15.09	86.98	316

	Decanoic acid, trimethylsilyl ester	15.43	75.26	244
	Hexanedioic acid, bis(trimethylsl) ester	15.905	96.34	290
	Benzoic acid, 2-[(trimethylsilyl)oxy]-, trimethylsilyl ester	15.933	41.49	282
	Benzaldehyde, 3-methoxy-4-[(trimethylsilyl)oxy]-	16.209	53.3	224
	2-Propenoic acid, 3-phenyl-, trimethylsilyl ester	16.294	68.05	72
	5,8, 11-Eicosatriynoic acid, tert-butyldimethylsilyl ester	16.414	20.18	414
	Heptanedioic acid, bis(trimethylsilyl) ester	16.598	82.67	304
	Benzoic acid, 4-[(trimethylsilyl)oxy]-, tirmethylsily ester	16.7554	46.9	282
	Dodecanoic acid, trimethylsilyl ester	16.882	86.08	272
	4H-1-Benzopyran-4-one	17.002	31.78	314
	Octanedioic acid, bis(trimethylsilyl) ester	17.094	93.19	318
	Tridecanoic acid, dimethyl(isopropyl)silyl ester	17.328	45.16	286
	Azelaic Acid, bis(trimethylsilyl) ester	17.469	96.52	332
	Azelaic Acid, bis(trimethylsilyl) ester	17.505	96.18	332
	9, 12, 15-Octadecatrienoic acid	17.632	63.39	278
	Tetradecanoic acid, dimethyl(isopropyl)silyl ester	17.668	42.45	300
	Tetradecanoic acid, dimethyl(isopropyl)silyl ester	17.696	96.73	300
	Sebacic acidd, bis(trimethylsilyl) ester	17.83	77.36	202
	Cinnamic acid, m-(trimethylsiloxy)-, trimethylsilyl ester	17.965	32.68	308
	Cinnamic acid, p-(trimethylsiloxy)-, trimethylsilyl ester	18.015	74.37	308
	Dibutyl phthalate	18.114	14.64	278
	Palmitelaidic acid, trimethylsilyl ester	18.234	56.02	326
	Hexadecanoic acid, trimethylsilyl ester	18.291	97.31	328
	Heptanedioic acid, trimethylsilyl	18.595	75.94	304
	9,12-Octadecadienoic acid (Z,Z)-, trimethylsilyl ester	18.822	96.07	352
	Octadecanoic acid, trimethylsilyl ester	18.921	93.35	356
	Silane	19.303	81.07	32
	Benzyl butyl phthalate	19.516	74.19	312
	13-Eicosenoic acid, triemthylsilyl ester	19.686	95.08	310
	Triphenyl phosphate	19.792	97.1	326
	Hexadecanedioic acid, bis(trimethylsilyl) ester	19.848	89.91	286
	Heneicosanoic acid, trimethylsilyl ester	20.196	69.18	398
	1,2-Benzenedicarboxylic acid	20.295	47.94	266
	Docosanoic acid, trimethylsilyl ester	20.805	97.74	412
	9-Octadecenoic acid,	21.633	73.54	356

	4H-Cyclopropa[5',6']benz[1'2':7,8]azuleno[5,6-b]oxiren-4-one, 8,8a-bis(acetoxy)-2a-[(acetyloxy)methyl]1,1a,1b,1c,2a,3,3a,6a,6b,7,8,8	21.832	40.15	520
	Tetracosanoic acid, trimethylsilyl ester	22.498	71.11	368
	D-Turanose, heptakis(trimethylsilyl)-	24.559	30.42	846
	Hexacosanoic acid, trimethylsilyl ester	25.175	22.06	396
	Rhodopin	26.082	13.71	554
DeJj-21(1) Proximal	Acetonitrile	5.822	61.16	41
	Trifluoromethyl-bis-(trimethylsilyl)methyl ketone-(trimethylsilyl)methyl ketone	5.943	92	338
	1,2-Bis(trimethylsiloxy)ethane	6.849	69.25	206
	Propanedioic acid, methyl-, bis(trimethylsilyl) ester	7.649	8.37	262
	Tetrasiloxane, decamethyl	7.798	44.15	310
	Silane,	8.237	29.54	32
	Propanoic acid, 2-[(trimethylsilyl)oxy]-, trimethylsilyl ester	8.322	8.77	234
	Acetamide, 2-cyano-	10.135	58.77	84
	Pentasiloxane, dodecamethyl-	11.041	30.02	384
	Acetic acid, cyano-	11.601	71.33	85
	Benzoic acid trimethylsilyl ester	11.961	52.93	194
	Silanol, trimethyl-, phosphate	12.316	84.53	314
	2-Oxa-3-azabicyclo[4.4.0]dec-3-ene, 5-methyl-1-trimethylsilyloxy-, N-oxide	13.966	55.09	257
	Azelaic acid, bis(trimethylsilyl) ester	17.492	96.64	332
	Hexadecanoic acid, trimethylsilyl ester	18.3	40.47	328
	Cholestan-3-one, cyclic 1,2-ethandiyl aetal	20.169	51.58	430
	Prosta-5, 13-dien-1-oic acid,	20.807	26.17	642
DeJj-21(2) Working Edge	No good			
DeJj-21(2) Left Lateral and Ventral	Acetonitrile	5.674	63.58	41
	Trifluprmethyl-bis-(trimethylsilyl)methyl ketone	5.957	91.52	338
	Pyrazinecarboxylic acid,	6.424	29.94	124
	1H-Pyrido[3,4-b]indole, 2,3,4,9-tetrahydro-1-(1-methylethyl)-	6.445	34.32	214
	1,2-bis(trimethylsiloxy)ethane	6.863	65.91	206
	2-Dimethyl(trimethylsilyl)silyloxytridecane	7.061	13.58	344
	Silane,	7.323	62.42	32
	Borane, trimethyl	7.472	58.69	56
	Amine, N,N,N-tris((triemthlsilyloxy)ethyl)	7.649	12.46	365

	Tetrasiloxane, decamethyl	7.891	61.52	310
	Methyltris(trimethylsiloxy)silane	8.173	40.15	310
	Silane,	8.258	48.27	32
	Propanoic acid,	8.329	52.76	234
	Benzoic acid trimethyl ester	11.968	64.12	194
	Silanol, trimethyl-, phosphate	12.329	80.2	314
	Azelaic Acid, bis(trimethylsilyl) ester	17.49	97.7	332
	Hexadecanoic acid, trimethylsilyl ester	18.29	85.44	328
	9,12-Octadecadienoic acid (Z,Z)-, trimethylsilyl ester	18.828	26.27	352
	9,12-Octadecadienoic acid, 2 ,3-bis[(trimethylsilyl)oxy]propyl ester	19.147	47.59	352
	9-Desoxo-9-x-acetoxy-3-desoxy-7.8.12-tri-O-acetylingol	22.044	59.77	534
	2,4-Imidazolidinedione, 5-[3,4-bis[(trimethylsilyl)oxy]phenyl]-3-methyl-5-methyl-5-phenyl-1-(trimethylsilyl)-	25.785	59.93	516
DeJj-21(2) Dorsal	Monoamidoethylmalonic acid, O,O,O'-tris(trimethylsilyl)-	5.681	21.51	347
	Trifluoromethyl-bis-(trimethylsilyl)methyl ketone(trimethylsilyl)methyl ketone	5.978	91.37	338
	1H-Pyrido[3,4-b]indole, 2,3,4,9-tetrahydro-1-(1-methylethyl)-	6.452	15.37	214
	Acetonitrile	6.622	77.05	41
	Borane, trimethyl	6.814	27.44	56
	1,2-bis(trimethylsiloxy)ethane	6.891	63	206
	3-Dimethyl(trimethylsilyl)silyloxytetradecane	7.061	20.57	240
	Silane,	8.279	46.23	32
	Propanoic acid,	8.35	47.78	234
	Acetic acid, cyano	8.888	56.9	60
	Benzene, [1-(2-propenyloxy)-3-butenyl]-	9.985	51.7	202
	Allyl chloride	10.233	35.32	76
	2(3H)-Furanone, 3-bromodihydro-	10.721	48.61	164
	Acetamide, 2-cyano-	11.38	47.11	84
	Benzoic acid, trimethylsilyl ester	12.003	75.47	194
	Silanol, trimethyl-, phosphate	12.35	80.25	314
	Methyl isocyanide	13.263	31.3	41
	Acetic acid, cyano	14.24	72.72	60
	Benzoic acid, 3-[(trimethylsilyl)oxy]-, trimethyl ester	16.761	29.55	312
	3H-Pyrazol-3-one	17.101	37.4	468
	Azelaic Acid, bis(trimethylsilyl) ester	17.511	94.59	332
	Hexadecanoic acid, trimethylsilyl ester	18.311	69.1	328

	9, 12-Octadecadienoic acid, trimethylsilyl ester	18.849	11.01	352
	9, 12, 15-Octadecatrienoic acid	19.012	36.21	278
	2,4,6,8,10-Tetradecapentaenoic acid	23.085	33.18	606
	1-Monolinoleoglycerol trimethylsilyl ether	25.168	32.17	498
	2,4,6,8,10-Tetradecapentaenoic acid.	26.032	33.93	606
DeJj-21(2) Proximal	N-(Trimethylsilyl)acetamide	5.638	39.01	131
	Trifluoromethyl-bis-(trimethylsilyl)methyl ketone-(trimethylsilyl)methyl ketone	5.971	94.13	338
	1,2-Bis(trimethylsiloxy)ethane	6.877	68.2	206
	Ethanedioic acid, bis(triemthylsilyl) ester	6.912	9.43	234
	Acetonitrile	7.069	76.47	41
	Borine, ethyldiisopropyl-	7,217	26.77	126
	Silane,	7.352	17.94	32
	Borane, trimethyl-	7.458	72.48	56
	Propanoic acid, methyl-, bis(trimethylsilyl) ester	7.67	6.93	262
	Hexestrol di-TMS	7.812	16	414
	Methyltris(trimethylsiloxy)silanr	8.159	32.36	310
	Trimethyl(4-tert.-butylphenoxy)silane	8.18	20.13	
	Silane,	8.251	70.18	32
	Propanoic acid, 2-[(trimethylsilyl)oxy]-, trimethylsilyl ester	8.343	48.37	234
	Oxalic acid, dially ester	8.562	28.19	170
	Acetic acid, cyano-	10.679	50.29	60
	Benzoic acid trimethylsilyl ester	11.982	83.24	194
	n-Octanoic acid, dimethyl(chloromethyl) silyl ester	12.237	18.17	216
	Silanol, trimethyl-, phosphate	12.343	86.58	314
	Hexanedioic acid, bis(trimthylsilyl) ester	15.89	57.33	290
	Octanedioic acid, bis(trimethylsilyl)ester	17.086	86.43	318
	Azelaic acid, bis(trimethylsilyl) ester	17.497	95.64	332
	Sebacic acid, bis(trimethylsilyl) ester	17.83	33.84	202
	Cinnamic acid, p-(trimethylsiloxy)-, trimethylsilyl ester	18.007	35.14	308
	Hexadecanoic acid, trimethylsilyl ester	18.297	93.76	328
	9-Desoxo-9-x-acetoxy-7.8.12-tri-O-acetylingol-3-one	18.694	26.9	534
	9,12-Octadecadienoic acid (Z,Z)-, trimethylsilyl ester	18.835	75.22	352
	Octadecanoic acid, trimethylsilyl ester	18.92	86.49	356
	3',8,8'-Trimethoxy-3-piperidyl-2,2'-binaphthalene-1,1',4,4'-tetrone	20.294	21.6	487
	2,4,6,8,10-Tetradecapentaenoic acid, 9a-(acetyloxy)	21.264	22.08	606

	.beta.-Sitosterol trimethylsilyl ether	22.581	30.77	486
DeJj-4(1) Working Edge	Trifluoroacetamide, N-Trimethylsilyloxymethyl-	6,233	94.88	215
	2,4-Di-tert-butylphenyl benzoate	6.559	29.26	310
	Ethanedicarboxamide, N-allyl-N'-(2,5-dimethylphenyl)-	6.742	47.51	232
	Benzenemethanol, 3-hydroxy-.alpha.-[(methylamino)methyl]-, (R)-	6.785	12.53	167
	D-(-)-Lactic acid, trimethyl ether, trimethylsilyl ester	8.335	15.62	234
	Bicyclo[3.1.0]hexane-6,6-dicarbonitrile	9.716	42.04	132
	Acetonitrile	10.473	62.06	41
	Octanoic acid, trimethylsilyl ester	12.258	23.98	216
	Silanol, trimethyl-, phosphate	12.343	89.76	314
	Butanoic acid, bis(trimethylsilyl) ester	13.101	27.69	262
	Dodecanoic acid, trimethylsilyl	16.881	50.33	272
	Azelaic acid, bis(trimethylsilyl) ester	17.497	95.56	332
	9,12,15-Octadecatrienoic acid, 2,3-bis[(trimethylsilyl)oxy]propyl ester	17.83	43.27	496
	n-Pentadecanoic acid, trimethylsilyl ester	18.007	71.31	314
	Dibutyl phthalate	18.114	10.63	278
	Palmitelaidic acid, trimethylsilyl ester	18.234	24.02	326
	Hexadecanoic acid, trimethylsilyl ester	18.305	94.93	328
	2-Hexanamine, 4-methyl-	18.573	47.83	115
	1 ,3-Dioxane, 4-(hexadecyloxy)-2-pentadecyl-	18.63	42.07	538
	Octadecanoic acid, trimethylsilyl ester	18.921	76.24	356
	Phthalic acid, butyl ester, ester with butyl glycolate	19.26	83.48	336
	5H-Cyclopropa[3,4]benz[1,2-e]azulen-5-one, 2,4a,9,9a-tetrakis(acetyloxy)-3,[(acetyloxy)methyl]-1,	19.707	38.64	608
	Benzene, (5-iodopentyl)-	20.039	6.82	274
	9-Desoxo-9-x-acetoxy-3-desoxy-7.8.12-tri-O-acetylingol-3-one	20.287	52.32	534
	Benzene, 1, 1'-[2-methyl-2-(phenylthio)cyclopropylidene]bis-	20.62	19.61	316
	(2,3-Diphenylcyclopropyl)methyl phenyl sulfoxide, ttrans-	20.698	58.12	332
	Carnegine	20.755	14.5	221
	Thieno[2,3-c]furan-3-carbonitrile, 2-amino-4,6-dihydro-4,4,6,6-tetramthyl-	22.894	29.01	222
	Calconcarboxylic acid	23.263	50.09	438

DeJj-4(1) Left Lateral and Ventral	Trifluoroacetamide, N-Trimethylsilyloxymethyl-	6.12	98.17	215
	Tetrasiloxane, decamethyl	7.783	45.76	310
	Propanoic acid, 2-[(trimethylsilyl)oxy]-, trimethylsilyl ester	8.293	43.01	234
	Acetic acid, [(trimethylsilyl)oxy]-, trimethylsilyl ester	8.654	28.97	220
	1-Pentamethyldisulyloxy-10-undecene	8.803	13.79	300
	3-Trifluoroacetoxydodecane	9.476	12.32	282
	2-Furancarboxylic acid, trimethylsilyl ester	9.858	47.3	184
	N'-(1H-Indol-3-ylmethylene)benzohydrazide ditms	10.183	63.53	407
	Pentasiloxane, dodecamethyl-	10.311	68.98	384
	Trimethylsilyl ether of glycerol	12,315	30.44	308
	2-Dimethyl(triemthylsilyl)silyloxytridecane	13.086	12.04	330
	Nonanoic acid, trimethylsilyl ester	13.901	48.09	230
	Amidephrine	14.885	40.61	244
	Decanoic acid, trimethylsilyl ester	15.423	38.88	244
	Phenylhexanoic acid, trimethylsilyl ester	16.874	26.92	264
	.psi. ,.psi.-Carotene, 3,4-didehydro-1, 1',2,2'-tetrohydro-1'-hydroxy-1-methoxy-	17.094	41.76	584
	2-(2-Benzyldecahydroisoquinolin-3-yl)ethanol	17.214	44.67	273
	6-Dicyanomethylene-4-isopropyl-2,4,7-cycloheptatrien-1 ,2-ylene diacetate	17.391	69.88	312
	2-(2-Benzyldecahydroisoquinolin-3-yl)ethanol	17.497	67.66	273
	1,2-Benzenedicarboxylic acid, ethyl trimethylsilyl ester	17.632	36.46	266
	Tetradecanoic acid, trimethylsilyl ester	17.695	95.82	300
	Phthalic acid, isobutyl octyl ester	17.802	12.86	334
	n-Pentadecanoic acid, trimethylsilyl ester	17.823	60.31	314
	n-Pentadecanoic acid, trimethylsilyl ester	18.014	85.29	314
	Dibutyl phthalate	18.113	29.13	278
	Palmitelaidic acid, trimethylsilyl ester	18.233	60.83	326
	Hexadecanoic acid, trimethylsilyl ester	18.304	96.59	328
	Pregnane-3,11,20,21-tetrol, cyclic 20,21-(butyl boronate), (3.apla ,5.beta., 11. beta. ,20R)-	18.425	18.1	418
	1-Tripropylsilyloxyundecane	18.538	30.67	328
	1-Cyclohexyldimethylsilyloxypentadecane	18.63	51.26	410
	Silane, dimethyloctyloxyundecyloxy-	18.698	17.08	358
	trans-9-Octadecenoic acidd, trimethylsilyl ester	18.843	18.57	354
	Octadecanoic acid, trimethylsilyl ester	18.921	93.28	356
	Phthalic acid, butyl ester, ester with butyl glycolate	19.26	59.68	336

	9,12,15-Octadecatrienoic acid, 2,3-bis[(trimethylsilyl)oxy]propyl ester	19.919	49.31	496
	9-Desoxo-9-x-acetoxy-3-desoxy-7.8.12-tri-O-acetylingol-3-one	19.983	34.83	534
	2,4-Imidazolidinedione, 5-[3,4-bis[(trimethylsilyl)oxy]phenyl]-3-methyl-5-phenyl-1-(trimethylsilyl)-	20.457	56.27	516
	Benzene, 1, 1'-[2-methyl-2-(phenylthio)cyclopropylidene]bis-	20.698	42.72	316
	5H-Cyclopropa[3,4]benz[1,2-e]azulen-5-one, 2,4a,9,9a-tetrakis(acetyloxy)-3,[(acetyloxy)methyl]-1,	21.187	52.99	608
DeJj-4(1) Dorsal	Acetonitrile	9.398	43.06	41
	Benzoic	12.003	46.09	194
	Acetamide, 2-cyano-	15.444	68.15	84
	Phenylhexanoic acid, trimethylsilyl ester	16.874	33.1	264
	Azelaic acid, bis(trimethylsilyl) ester	17.497	41.82	332
	Tetradecanoic acid, trimethylsilyl ester	17.698	83.59	300
	Methyl (4-iodophenyl)pentadecanoate	18.015	20.03	458
	Phthalic acid, hex-2-yn-4-yl isobutyl ester	18.1114	14.08	302
	Hexadecanoic acid, trimethylsilyl ester	18.305	95.9	328
	.alpha.-N-Normethadol	18.354	18.17	297
	2,4,6,8,10-Tetradecapentaenoic acid, 9a-(acetyloxy).	18.602	24.26	606
	1,3-Dioxane, 4-(hexadecyloxy)-2-pentadecyl-	18.631	55.68	538
	2-Butenoic acid, 2-methyl-, 1,1a,1b,4,4a,5,7a,7b,8,9	18.836	12.59	490
	Octadecanoic acid, trimethylsilyl ester	18.921	66.99	356
	5H-Cyclopropa[3,4]benz[1,2-e]azulen-5-one, 2,4a,9,9a-tetrakis(acetyloxy)-3,[(acetyloxy)methyl]-1,	19.154	36.57	608
	1,2-Benzenedicarboxylic acid, ethyl trimethylsilyl ester	19.268	65.71	266
	Benzyl butyl phthalate	19.516	39.64	312
	Benzonitrile, m-phenethyl-	20.04	17.17	207
	9,12,15-Octadecatrienoic acid, 2,3-bis[(trimethylsilyl)oxy]propyl ester	20.153	43.59	496
	1,2-Benzenedicarboxylic acid, ethyl trimethylsilyl ester	20.302	43.03	266
	Thieno[2,3-b]quinolin-3-amine, 5,6,7,8-tetrahydro-2-octylsulfonyl-	20.571	10.94	380

	Benzene, 1, 1'-[2-methyl-2-(phenylthio)cyclopropylidene]bis-	20.627	26.28	316
	(2,3-Diphenylcyclopropyl)methyl phenyl sulfoxide, ttrans-	20.698	37.57	332
	Benzene, 1, 1'-[2-methyl-2-(phenylthio)cyclopropylidene]bis-	20.755	27.49	316
	(2,3-Diphenylcyclopropyl)methyl phenyl sulfoxide, ttrans-	20.811	44.33	332
	Androst-4,9(11),16-trien-3-one, 16-[2-(methylcarbonyloxy)-1-oxoethyl]-	22.015	32.2	368
	9-Desoxo-9-x-acetoxy-3-desoxy-7.8.12-tri-O-acetylingol-3-one	22.539	40.85	534
	Propane-1,1,2,2-tetracarbonitrile, 3-(4-acetyl-2,5-dimethyl-3-fuuranoyl)-	22.761	31.98	308
	Cyclosiloxane, hexamethyl-	22.907	50	222
	Milbemycin B, 6,28-anhydro-15-chloro-25-isopropyl-13-dehydros-5-O-demthyl-4-methyl-	24.175	39.55	590
	2,4-Imidazolidinedione, 5-[3,4-bis[(trimethylsilyl)oxy]phenyl]-3-methyl-5-phenyl-1-(trimethylsilyl)-	24.663	57.8	516
	Cholestan-3-one, cyclic 1,2-ethandiyl aetal	26.271	58.85	430
	Thieno[2,3-c]furan-3-carbonitrile, 2-amino-4,6-dihydro-4,4,6,6-tetramthyl-	26.639	32.33	222
DeJj-4(1) Proximal	Dimethyl-(6-methyl-2-thioxo-[1,2,3]oxathiaphosphinan	5.647	37.14	211
	1-Methyl-2-phenoxyethylaminee	5.73	56.77	151
	4-Chloro-2,5-dimethoxyamphetamine	5.801	31.95	229
	Oxalic acid, dially ester	5.879	55.08	170
	Borane, trimethyl-	5.921	13.77	56
	Benzenemethanol, 3-hydroxy-.alpha.-[(methylamino)methyl]-, (R)-	5.935	25.45	167
	Trifluoroacetamide, N-Trimethylsilyloxymethyl-	6.155	72.54	215
	2-Hydroxy-2-methyl-succinic acid, bis-(2-oxo-2-phenyl-ethyl ester	6.481	9.35	384
	3-Pyridinecarboxaldehyde, O-acetyloxime	6.615	15.32	164
	Acetic acid, cyano-	6.721	71.48	85
	Silane, trimethyl[1-methyl-2-oxo-2-(trimethylsilyl)ethoxy]-	8.307	26.13	218
	Benzeneethanamine, 2,5-difluoro-.beta.,3,4-trihydrroxy-N-methyl-	9.39	12.29	219
	Acetamide, 2-cyano-	9.511	31.76	84
	2-Furancarboxylic acid, trimethylsilyl ester	9.872	19.94	184

	Butanoic acid, 3-[(trimethylsilyl)oxy]-, trimethylsilyl ester	10.275	64.32	248
	3,5-Dimethoxy-N-(2-methyl-1 ,3-dioxo-5-isoindolinyl) benzamide	10.721	38.67	340
	Benzoic acid trimethylsilyl ester	11.988	59.91	194
	Octanoic acid, trimethylsilyl ester	12.243	48.33	216
	3H-Benzimidazol-7-ol, 3-methyl-2,6-diphenyl-	12.349	29.13	300
	Nonanoic acid, trimethylsilyl ester	13.907	85.61	230
	(Z)-2-Hyddroxyimino-3-oxobutyric acid, 1,1-dimethylethyl ester	14.247	31.61	187
	Decanoic acid, trimethylsilyl ester	15.429	76.77	244
	Phenylhexanoic acid, trimethylsilyl ester	16.881	31.14	264
	Octanedioic acid, bis(trimethylsilyl)ester	17.093	30.84	318
	Azelaic acid, bis(trimethylsilyl) ester	17.504	75.49	332
	Tetradecanoic acid, trimethylsilyl ester	17.702	86.39	300
	1 ,2-Benzenedicarboxylic acid	17.823	28.47	334
	n-Pentadecanoic acid, trimethylsilyl ester	18.014	41.05	314
	Phthalic acid, butyl tridec-2-yn-1-yl ester	18.12	8.25	400
	9,12,15-Octadecatirenoic acid, 2,3-bis[(trimethylsilyl)oxy]propyl ester	18.198	42.4	496
	Palmitelaidic acid, trimethylsilyl ester	18.24	37.48	326
	Hexadecanoic acid, trimethylsilyl ester	18.304	87.23	328
	Pentadecanoic acidd, triethylsilyl ester	18.637	21.64	356
	Octadecanoic acid, trimethylsilyl ester	18.927	79.18	356
	Phthalic acid, butyl ester, ester with butyl glycolate	19.267	77.3	336
	2,4-Imidazolidinedione, 5-[3,4-bis[(trimethylsilyl)oxy]phenyl]-3-methyl-5-phenyl-1-(trimethylsilyl)-	19.649	58.46	516
	Benzonitrile, m-phenethyl-	20.046	34.37	207
	Benzene, 1, 1'-[2-methyl-2-(phenylthio)cyclopropylidene]bis-	20.627	44.81	316
	(2,3-Diphenylcyclopropyl)methyl phenyl sulfoxide, ttrans-	20.704	40.03	332
	5H-Cyclopropa[3,4]benz[1,2-e]azulen-5-one, 2,4a,9,9a-tetrakis(acetyloxy)-3,[(acetyloxy)methyl]-1,	21.045	44.63	608
	9-Desoxo-9-x-acetoxy-3-desoxy-7.8.12-tri-O-acetylingol-3-one	21.689	56.2	534
	1,2-Benzisothiazol-3-amine tbdms	24.488	43.01	264
DeJj-4(2) Working Edge	Oxalic acid, dially ester	5.723	49.84	170
	Acetonitrile	5.865	70.36	41

	Trifluoromethyl-bis-(trimethylsilyl)methyl ketone-(trimethylsilyl)methyl ketone	5.971	93.65	338
	Borane, trimethyl-	6.771	28.52	56
	1,2-Bis(trimethylsiloxy)ethane	6.884	63.06	206
	Silane,	7.323	30.76	32
	Ethanedioic acid, bis(triemthylsilyl) ester	7.67	28.88	234
	Tetrasiloxane, decamethyl	7.812	68.12	310
	Methyltris(trimethylsiloxy)silanr	8.159	51.85	310
	Silane,	8.272	51.25	32
	Oxalic acid, dially ester	9.341	67.45	170
	Benzoic acid trimethylsilyl ester	11.989	36.07	194
	Octanoic acid, trimethylsilyl ester	12.251	44.89	216
	Silanol, trimethyl-, phosphate	12.35	88.01	314
	4-Hexenoic acid, 4-methyl-6-(fluorodimethylsilyl)-6-trimethylsilyl-	17.01	27.23	276
	Azelaic acid, bis(trimethylsilyl) ester	17.504	95.93	332
	Hexadecanoic acid, trimethylsilyl ester	18.311	84.03	328
	2,4-Imidazolidinedione, 5-[3,4-bis[(trimethylsilyl)oxy]phenyl]-3-methyl-5-methyl-5-phenyl-1-(trimethylsilyl)-	18.729	52.38	516
	9, 12-Octadecadienoic acid, trimethyl ester	18.842	27.41	352
	9-Desoxo-9-x-acetoxy-7.8.12-tri-O-acetylingol-3-one	25.62	37.36	534
DeJj-4(2) Dorsal	Trifluoromethyl-bis-(trimethylsilyl)methyl ketone-(trimethylsilyl)methyl ketone	5.978	93.56	338
	2,4-Imidazolidinedione, 5-[3,4-bis[(trimethylsilyl)oxy]phenyl]-3-methyl-5-methyl-5-phenyl-1-(trimethylsilyl)-	6.233	70.11	516
	1,2-Bis(trimethylsiloxy)ethane	6.877	72.38	206
	Silane,	7.33	45.29	32
	Ethanedioic acid, bis(triemthylsilyl) ester	7.663	44.04	234
	Butanoic acid, 4-[bis(trimeethylsilyl)amino]-, trimeethylsilyl ester	7.72	8.01	247
	Tetrasiloxane, decamethyl	8.187	82.77	310
	Silane,	8.272	60.86	32
	Propanoic acid, 2-[(trimethylsilyl)oxy]-, trimethylsilyl ester	8.343	36.67	234
	Acetonitrile	8.414	70.88	41
	Dihydrobenzofuran-2-one, 3-[2-methiophenyl]methylene	10.892	51.71	268
	Benzoic acid trimethylsilyl ester	11.89	54.51	194
	Octanoic acid, trimethylsilyl ester	12.237	14.69	216
	Silanol, trimethyl-, phosphate	12.329	87.24	314

	1-Dimethyl(trimethylsilylmethyl)silyloxycyclopentane	13.093	11.25	
	Hexanedioic acid, bis(trimthylsilyl) ester	15.883	86.97	290
	Heptanedioic acid, bis(trimethylsilyl) ester	16.584	58.01	304
	Benzoic acid , 4-[(trimethylsilyl)oxy]-, trimethylsilyl	16.74	50.48	
	Octanedioic acid, bis(trimethylsilyl)ester	17.079	88.49	318
	2,4-Imidazolidinedione, 5-[3,4-bis[(trimethylsilyl)oxy]phenyl]-3-methyl-5-methyl-5-phenyl-1-(trimethylsilyl)-	17.341	19.5	516
	Azelaic acid, bis(trimethylsilyl) ester	17.483	97.42	332
	Tetradecanoic acid, trimethylsilyl ester	17.681	29.66	300
	Sebacic acid, bis(trimethylsilyl) ester	17.816	82.85	202
	Prosta-5, 13-dien-1-oic acid,	17.95	18.08	642
	Cinnamic acid, p-(trimethylsiloxy)-, trimethylsilyl ester	17.993	47.15	308
	Phthalic acid, decyl hex-2-yn-4-yl ester	18.099	6.45	166
	9,12,15-Octadecatrienoic acid,	18.205	49.42	496
	Prosta-5, 13-dien-1-oic acid,	18.233	10.92	642
	Hexadecanoic acid, trimethylsilyl ester	18.283	96.41	328
	Heptadecanoic acid, trimethylsilyl ester	18.587	85.88	342
	9,12-Octadecadienoic acid (Z,Z)-, trimethylsilyl ester	18.821	96.07	352
	Octadecanoic acid, trimethylsilyl ester	18.906	92.62	356
	9,12-Octadecadienoic acid (Z,Z)-, trimethylsilyl ester	19.14	88.36	352
	Silane,	19.296	49.63	32
	.psi. ,.psi.-Carotene, 3,4-didehydro-1, 1',2,2'-tetrahydro-1'-tetrahydro-1'-hydroxy-1-methoxy-	19.387	34.64	584
	9,12,15-Octadecatrienoic acid,	19.43	14.9	496
	cis-13-Eicosenoic acid, trimethylsilyl ester	19.586	25.01	310
	Eicosanoic acid, trimethylsilyl ester	19.68	92.49	384
	Benzothiophene-3-carbonitrile	19.777	30.79	159
	Hexadecanoic acid, trimethylsilyl ester	19.827	40.9	328
	Heneicosanoic acid, trimethylsilyl ester	20.181	66.32	398
	3’,8,8’-Trimethoxy-3-piperidyl-2,2'binaphthanlene-1, 1',4,4'-tetrone	20.287	10.57	487
	1,3-Dipalmitin trimethylsilyl ether	20.393	45.22	640
	Butyladehyde, 4-benzyloxy-4-[2,2,-dimethyl-4-dioxolanyl]-	20.598	60.15	278
	Docosanoic acid, trimethylsilyl ester	20.797	95.74	412
	Nalmefene, trimethylsilyl ether	21.547	16.55	411

	5H-Cyclopropa[3,4]benz[1,2-e]azulen-5-one2,4a,9,9a-tetrakis(acetyloxy)-3,[(acetyloxy)methyl]-1,	21.774	52.89	608
	Tetracosanoic acid, trimethylsilyl ester	22.482	38.62	368
	.beta.-Sitosterol trimethylsilyl ether	22.744	77.87	486
	Stigmasta-3,5-dien-7-one	25.549	77.31	410
	Trilinolein	26.073	11.82	879
	.beta.-Sitosterol acestate	26.739	56.43	456
DeJj-4(3) Working Edge	Trifluoroacetamide, N-Trimethylsilyloxymethyl-	6.332	97.69	215
	Glycine, N-formyl-N-(trimethyltilyl)-, trimethylsilyl ester, N-formyl-N-(trimethyltilyl)-, trimethylsilyl ester	7.012	19.89	247
	3-Dimethyl(3-cyanopropyl)silyloxytetradecane	7.352	64.53	339
	Ethanedioic acid, bis(triemthylsilyl) ester	7.699	42.65	234
	Nicotinaldehyde thiosemicarbazone tritms	8.06	37.36	396
	Tetrasiloxane, decamethyl	8.187	57.15	310
	Propanoic acid, 2-[(trimethylsilyl)oxy]-, trimethylsilyl ester	8.378	57.47	234
	N'-(1H-Indol-3-ylmethylene)benzohydrazide ditms	10.212	60.47	407
	Pentasiloxane, dodecamethyl-	10.34	75.21	384
	Silane, (3,3-diphenyl-1,2-propadienylidene)bis[trimethyl-	10.609	34.77	336
	Trisiloxane, octamethyl-	10.927	56.54	236
	(1H)Benzimidazole, 5-(2-thienyl)carbonyl-2-[2(2-thienyl)thienyl)thien-5-yl)-1-hydroxy-3-oxide	11.239	44.33	424
	3,6,9-Trioxa-2,10-disilaundecane, 2,2,10,10-tetramethyl	11.841	69.76	250
	Benzoic acid trimethylsilyl ester	11.997	79.74	194
	Octanoic acid, trimethylsilyl ester	12.237	11.78	216
	Silanol, trimethyl-, phosphate	12.358	80.94	314
	Decanoic acid, trimethylsilyl ester	15.431	85.89	244
	Pros-13-en-1-oic, acid, 9-(methoxyimino)-11, 15-bis[(trimethylsilyl)oxy]-, trimethylsilyl ester, (8. xi. ,12.xi.)-	15.679	31.76	599
	Hexanedioic acid, bis(trimthylsilyl) ester	15.898	67.21	290
	Silane, [1,2,3-benzenetriyltris(oxy)]tris[trimethyl-	16.564	24.39	342
	Phenylhexanoic acid, trimethylsilyl ester	16.883	28.23	264
	Octanedioic acid, bis(trimethylsilyl)ester	17.095	88.29	318
	Isoquinoline, decahydro-3-(2-chloroethyl)-2-phenylmethyl	17.223	41.37	291
	Azelaic acid, bis(trimethylsilyl) ester	17.513	77.43	332

	1,2-Benzenedicarboxylic acid, ethyl trimethylsilyl ester	17.64	54.06	266
	Tetradecanoic acid, trimethylsilyl ester	17.69	92.53	300
	Phthalic acid, heptyl tridec-2-yn-1-yl ester	17.81	8.36	442
	Cinnamic acid, p-(trimethylsiloxy)-, trimethylsilyl ester	18.016	64.26	308
	Dibutyl phthalate	18.115	25.6	278
	Adenosine, N-(2,3-dihydroxy-3-methylbutyl)-	18.193	26.45	369
	Hexadecanoic acid, trimethylsilyl ester	18.306	96.39	328
	1-Cyclohexyldimethylsilyloxypentadecane	18.54	13.25	368
	9,12-Octadecadienoic acid (Z,Z)-, trimethylsilyl ester	18.837	92.88	352
	Octadecanoic acid, trimethylsilyl ester	18.922	80.45	356
	Prosta-5, 13-dien-1-oic acid,	19.156	26.22	642
	Phthalic acid, butyl ester, ester with butyl glycolate	19.262	57.41	336
	Androstane-17, 19-diol, 3,3-ethylenedioxy-4,4-dimethyl-	19.914	32.59	378
	5H-Cyclopropa[3,4]benz[1,2-e]azulen-5-one, 2,4a,9,9a-tetrakis(acetyloxy)-3,[(acetyloxy)methyl]-1,	19.949	67.25	608
	2,3,6,8,10-Tetradecapentaenoic acid, 9a-(acetyloxy)-1a, 1b,4,4a,5,7,a,7b,8,9,9a-decahydro-4a,7b-dihydroxy	20.02	40.02	606
	Rhodopin	20.62	17.75	554
	9-Desoxo-9-x-acetoxy-7.8.12-tri-O-acetylingol-3-one	20.204	52.82	534
	Cholestan-3-one, cyclic 1,2-ethandiyl aetal	20.58	43.42	430
	2,2-Bis-[4-[[4-chloro-6-(3-ethynylphenoxy)-1,3,5-triazin-2-yl]oxy]phenyl]propane	20.806	28.2	686
	2,4-Imidazolidinedione, 5-[3,4-bis[(trimethylsilyl)oxy]phenyl]-3-methyl-5-phenyl-1-(trimethylsilyl)-	20.941	60.97	516
	3,8,12-Tri-O-acetoxy-7-desoxyingol-7-one	21.543	46.48	490
	4H-Cyclopropa[5',6']benz[1'2':7,8]azuleno[5,6-b]oxiren-4-one, 8,8a-bis(acetoxy)-2a-[(acetyloxy)methyl]1,1a,1b,1c,2a,3,3a,6a,6b,7,8,8	21.649	38.95	520
	9,12,15-Octadecatrienoic acid, 2,3-bis[(trimethylsilyl)oxy]propyl ester	22.499	37.71	496
	Prost-13-en-1-oic acid, 9-(methoxyimino)-11, 15-bis[(trimethylsilyl)oxy]-, trimethylsilyl ester, (8. xi ,12.xi.)-	22.541	39.88	599
	1-Monolinoleoylglycerol trimethylsilyl ether	23.094	20.11	498

	2-Butenoic acid, 2-methyl-, 1,1a,1b,4,4a,5,7a,7b,8,9	23.611	14.21	528
DeJj-4(3) Left Lateral and Ventral	Trifluoroacetamide, N-Trimethylsilyloxymethyl-	6.325	96.54	215
	Butanoic acid, 2-[b(trimethylsilyl)amino]-, trimeethylsilyl ester	6.996	18.72	247
	3-Propylnorleucine	7.068	9.94	173
	Ethanedioic acid, bis(triemthylsilyl) ester	7.701	39.81	234
	Tetrasiloxane, decamethyl	7.85	63.85	310
	Nicotinaldehyde thiosemicarbazone tritms	8.041	37.12	396
	Silane, (1-cyclohexen-1yloxy)trimethyl-	8.296	62.1	170
	Propanoic acid, 2-[(trimethylsilyl)oxy]-, trimethylsilyl ester	8.36	51.2	234
	Trisiloxane, octamethyl-	8.466	80.64	236
	Nicotinaldehyde thiosemicarbazone tritms	8.643	34.25	396
	Stearic acid, 2-(1-octadecenyloxy)ethyl ester,	9.393	33.08	578
	3-(6-Methyl-3-pyridyl)-5-phenyl-1-(p-sulfamoylphenyl)-2-pyrazoline	10.229	29.52	392
	Pentasiloxane, dodecamethyl-	10.335	72.14	384
	2-Hexenoic acid, trimethylsilyl ester	10.526	14.44	186
	Silane, (3,3-diphenyl-1,2-propadienylidene)bis[trimethyl-	10.611	41.15	336
	Trisiloxane, octamethyl-	10.916	31.03	236
	Pentasiloxane, dodecamethyl-	11.086	72.65	384
	(1H)Benzimidazole, 5-(2-thienyl)carbonyl-2-[2(2-thienyl)thienyl)thien-5-yl)-1-hydroxy-3-oxide	11.241	36.53	424
	Benzoic acid trimethylsilyl ester	11.999	59.78	194
	Octanoic acid, trimethylsilyl ester	12.261	85.1	216
	Silanol, trimethyl-, phosphate	12.367	80.19	314
	Octane, 1,8-bis[4-(trimethylsilylcarbonyl)phenyl]-	12.807	53.56	466
	Tetrasiloxane, decamethyl	13.43	56.13	310
	Nonanoic acid, trimethylsilyl ester	13.918	89.68	230
	Decanoic acid, trimethylsilyl ester	15.434	92.23	244
	Hexanedioic acid, bis(trimthylsilyl) ester	15.908	87.29	290
	Silane, [1,2,3-benzenetriyltris(oxy)]tris[trimethyl-	16.574	78.9	342
	Phenylhexanoic acid, trimethylsilyl ester	16.893	40.45	264
	Octanedioic acid, bis(trimethylsilyl)ester	17.105	93.96	318
	Azelaic acid, bis(trimethylsilyl) ester	17.508	96.39	332
	Tetradecanoic acid, trimethylsilyl ester	17.707	95.58	300
	n-Pentadecanoic acid, trimethylsilyl ester	18.026	85.05	314
	Dibutyl phthalate	18.125	11.13	278
	Clocortolone Pivalate	18.203	19.3	494

	cis-9-Hexadecenoic acid, trimethylsilyl ester	18.252	44.64	45
	Hexadecanoic acid, trimethylsilyl ester	18.316	97.96	328
	[1]Benzothiopyrano[4,3-b]benzo[e]indole	18.549	42.1	285
	Heptadecanoic acid, trimethylsilyl ester	18.62	70.11	342
	9,12-Octadecadienoic acid (Z,Z)-, trimethylsilyl ester	18.854	42.02	352
	Octadecanoic acid, trimethylsilyl ester	18.939	97.76	356
	1,2-Benzenedicarboxylic acid, ethyl trimethylsilyl ester	19.272	78.3	266
	Cholestan-3-one, cyclic 1,2-ethandiyl aetal	19.718	30.32	430
	Benzonitrile, m-phenethyl-	20.065	41.85	207
	Benzenem 1,1'-[2-methyl-2-(phenylthio)cyclopropylidene]bis-	20.639	30.87	316
	1-Propene, 3-(2-cyclopentenyl)-2-methyl-1,1-dipheenyl-	20.716	32.05	274
	(2,3-Diphenylcyclopropyl)methyl phenyl sulfoxide, ttrans-	20.773	50.47	332
	2,4,6,8,10-Tetradecapentaenoic acid, 9a-(acetyloxy)	21.702	27.27	606
	2,4-Imidazolidinedione, 5-[3,4-bis[(trimethylsilyl)oxy]phenyl]-3-methyl-5-phenyl-1-(trimethylsilyl)-	22.962	58.76	516
	5H-Cyclopropa[3,4]benz[1,2-e]azulen-5-one, 2,4a,9,9a-tetrakis(acetyloxy)-3,[(acetyloxy)methyl]-1,	23.656	25.24	548
	9,12,15-Octadecatrienoic acid, 2,3-bis[(trimethylsilyl)oxy]propyl ester	23.847	37.82	496
	9-Desoxo-9-x-acetoxy-3-desoxy-7.8.12-tri-O-acetylingol-3-one	24.903	25.64	534
	3,8,12-Tri-O-acetoxy-7-desoxyingol-7-one	25.172	16.51	490
	D-Glucopyranosiduronic acid,	26	48.36	676
	Prosta-5, 13-dien-1-oic acid,	26.298	23.93	642
	Docosahexaenoic acid, 1,2,3-propanetriyl ester	26.759	26.759	1023
	Docosanoic acid, 1,2,3-propanetriyl ester	26.802	15.01	412
DeJj-4(3) Right Lateral and Ventral	Ethanedioic acid, bis(triemthylsilyl) ester	7.706	48.78	234
	Tetrasiloxane, decamethyl	7.847	60.84	310
	Nicotinaldehyde thiosemicarbazone tritms	8.053	50.07	396
	Propanoic acid, 2-[(trimethylsilyl)oxy]-, trimethylsilyl ester	8.371	51.02	234

	Butanoic acid, 2-[b(trimethylsilyl)amino]-, trimeethylsilyl ester	9.639	45.75	248
	2-Furancarboxylic acid, trimethylsilyl ester	9.894	68.87	184
	1-Dimethyl(trimethylsilylmethyl)silyloxycyclopentane	10.014	10	230
	N'-(1H-Indol-3-ylmethylene)benzohydrazide ditms	10.212	54.88	407
	Pentasiloxane, dodecamethyl-	10.333	82.44	384
	Silane, (3,3-diphenyl-1,2-propadienylidene)bis[trimethyl-	10/609	36.91	336
	Trisiloxane, octamethyl-	10.913	52.77	236
	Pentasiloxane, dodecamethyl-	11.069	74.26	384
	N'-(1H-Indol-3-ylmethylene)benzohydrazide ditms	11.232	30.42	407
	3,6,9-Trioxa-2,10-disilaundecane, 2,2,10,10-tetramethyl	11.841	58.28	250
	Benzoic acid trimethylsilyl ester	11.989	56.52	194
	Octanoic acid, trimethylsilyl ester	12.237	36.39	216
	Silanol, trimethyl-, phosphate	12.358	85.68	314
	Tetrasiloxane, decamethyl	13.427	71.84	310
	Nonanoic acid, trimethylsilyl ester	13.908	43.38	230
	(.+/-.)-2-Phenylbutyric acid, trimethylsilyl ester	14.701	57.82	236
	Ricinoleic, trimethylsiloxy, trimethyl ester	15.31	20.46	442
	Decanoic acid, trimethylsilyl ester	15.423	92.94	244
	Pentasiloxane, dodecamethyl-	15.558	37.3	384
	Hexanedioic acid, bis(trimthylsilyl) ester	15.898	85.08	290
	Undecanoic acid, trimethylsilyl ester	16.288	22.23	258
	Amine, N,N,N-tris((trimethylsilyloxy)ethyl)-	16.698	93.57	365
	Phenylhexanoic acid, trimethylsilyl ester	16.875	28.53	264
	Octanedioic acid, bis(trimethylsilyl)ester	17.095	88.57	318
	2-(2-Benzyldecahydroisoquinolin-3-yl)ethanol	17.222	32.32	273
	Thizolo[4,5-f]quinoline, 2,7,9-trimethyl-	17.392	18.88	228
	1,2-Benzenedicarboxylic acid, ethyl trimethylsilyl ester	17.633	43.83	266
	Tetradecanoic acid, trimethylsilyl ester	17.697	97.6	300
	Cinnamic acid, p-(trimethylsiloxy)-, trimethylsilyl ester	18.015	71.76	308
	Dibutyl phthalate	18.115	18.76	278
	Cyclohexanecarboxylic acid, 4-(1,5-dimethyl-3-oxohexyl)-,	18.192	41.75	268
	Hexadecenoic acid, trimethylsilyl ester	18.306	98.14	328
	Acetic acid, 2-hydroxy-2	18.532	63.09	342
	9, 12-Octadecadienoic acid, trimethyl ester	18.837	89.42	352
	Octadecanoic acid, trimethylsilyl ester	18.922	94.63	356

	Prosta-5, 13-dien-1-oic acid,	19.666	23.6	642
	9-Desoxy-9-x-acetoxy-3,8, 12-tri-O-acetylingol	26.098	38.46	536
	.beta.-Sitosterol acestate	26.729	23.03	456
	Astaxanthin	26.743	8.25	596
DeJj-4(3) Dorsal	Propanoic acid, 2-[(trimethylsilyl)oxy]-, trimethylsilyl ester	8.35	57.08	234
	Benzoic acid, trimethylsilyl ester	11.982	77.59	194
	Silanol, trimethyl-, phosphate	12.364	81.57	314
	Borane, trimethyl-	15.621	57.55	56
	Hexanedioic acid, bis(trimthylsilyl) ester	15.89	89.09	290
	2,4-Imidazolidinedione, 5-[3,4-bis[(trimethylsilyl)oxy]phenyl]-3-methyl-5-phenyl-1-(trimethylsilyl)-	15.961	31.56	516
	Heptanedioic acid, bis(trimethylsilyl) ester	16.591	75.08	304
	Benzoic acid, 4-[(trimethylsilyl)oxy]-, trimethylsilyl ester	16.747	66.64	282
	Octanedioic acid, bis(trimethylsilyl)ester	17.087	91.58	318
	Azelaic acid, bis(trimethylsilyl) ester	17.49	96.85	332
	2-4-Imidazolidinedione, 5-[3,4-bis[(trimethylsilyl)oxy]	17.689	22.22	516
	Sebacic acid, bis(trimethylsilyl) ester	17.83	52.97	346
	Cinnamic acid, p-(trimethylsiloxy)-, trimethylsilyl ester	18.007	82.47	308
	Hexadecanoic acid, trimethylsilyl ester	18.298	96.78	328
	9,12-Octadecadienoic acid (Z,Z)-, trimethylsilyl ester	18.829	91.94	352
	Prosta-5, 13-dien-1-oic acid,	19.841	28.85	642
	17.beta.-Acetoxy-1', 1'-dicarboethoxy	20.804	16.87	488
	.beta.-Sitosterol acestate	22.562	82.13	486
	Stigmasta-3,5-dien-7-one	25.362	94.86	410
	926 [Ov]	26.73	14.11	456
DeJj-4(4) Working Edge	Alanine, 2-Methyl-N-(trimethylsilyl)-, trimethylsilyl ester	6.998	17.24	247
	Ethanedioic acid, bis(triemthylsilyl) ester	7.698	20.97	234
	Nicotinaldehyde thiosemicarbazone tritms	8.046	32.48	396
	Silane, (1-cyclohexen-1yloxy)trimethyl-	8.3	73.87	170
	Propanoic acid, 2-[(trimethylsilyl)oxy]-, trimethylsilyl ester	8.364	53.49	234
	Prostaglandin E2, O,O'-bis(trimethylsilyl)-, trimethylilyl ester	8.661	14.04	522

	2,4-Imidazolidinedione, 5-[3,4-bis[(trimethylsilyl)oxy]phenyl]-3-methyl-5-phenyl-1-(trimethylsilyl)-	11.076	40.61	516
	Benzoic acid trimethylsilyl ester	12.003	87.93	194
	Silanol, trimethyl-, phosphate	12.357	83.04	314
	1-(2-Ethyl-[1,3]dithian-2-yl)-3-methyl-butan-1-ol	13.115	13.69	234
	Hexanedioic acid, bis(trimthylsilyl) ester	15.909	29.82	290
	9,10-Anthracenedione, 1-(methylamino)-4-[(4-methylphenyl)amino]-	16.575	19.81	342
	Benzoic acid, 4-[(trimethylsilyl)oxy]-, trimethylsilyl ester	16.766	50.55	282
	Dodecanoic acid, trimethylsilyl	16.893	66.26	272
	Octanedioic acid, bis(trimethylsilyl)ester	17.106	80.14	318
	Prosta-5, 13-dien-1-oic acid,	17.339	14.7	642
	Azelaic acid, bis(trimethylsilyl) ester	17.509	97.97	332
	Tetradecanoic acid, trimethylsilyl ester	17.708	95.57	300
	Cinnamic acid, p-(trimethylsiloxy)-, trimethylsilyl ester	18.026	36.85	308
	Phthalic acid, butyl hexyl ester	18.125	22.28	306
	Palmitelaidic acid, trimethylsilyl ester	18.246	72.69	326
	Hexadecanoic acid, trimethylsilyl ester	18.316	97.75	328
	1 (2H)-Naphthalenone, 3,4-dihydro-4-phenyl-	18.366	58.2	222
	2-Cyclohexyldimethylsilyloxy-pentadecane	18.55	21.75	368
	1 ,3-Dioxane, 4-(hexadecyloxy)-2-pentadecyl-	18.614	41.02	538
	Hexadecanoic acid, 1,1-dimethylethyl ester	18.784	57.2	312
	9,12-Octadecadienoic acid (Z,Z)-, trimethylsilyl ester	18.855	76.12	352
	1 ,2-Benzenedicarboxylic acid	19.272	55.16	322
	Octadecane, 3-ethyl-5-(2-ethylbutyl)-	19.563	14.94	366
	Benzonitrile, m-phenethyl-	20.058	38.4	207
	4-Apo-.beta.,.psi.-carotenoic acid, methyl ester	20.306	51.86	512
	Benzene, 1, 1'-[2-methyl-2-(phenylthio)cyclopropylidene]bis-	20.639	38.26	316
	(2,3-Diphenylcyclopropyl)methyl phenyl sulfoxide, ttrans-	20.83	27.81	332
	1-Penten-3-ol, 4,4-dimethyl-1 ,3-diphenyl-	21.22	9.11	266
	5H-Cyclopropa[3,4]benz[1,2-e]azulen-5-one, 2,4a,9,9a-tetrakis(acetyloxy)-3,[(acetyloxy)methyl]-1,	25.484	23.56	608
	9-Desoxo-9-x-acetoxy-3-desoxy-7.8.12-tri-O-acetylingol-3-one	25.88	43.76	534
	Rhodopin	26.107	28.03	554

	.psi. ,.psi.-Carotene, 3,4-didehydro-1, 1',2,2'-tetrohydro-1'-hydroxy-1-methoxy-	26.759	31.89	600
DeJj-4(4) Left Lateral and Ventral	1 ,3-Dimethyl-5-pentamethyldisilyloxycyclohexane	7.713	16.28	258
	Silane, (1-cyclohexen-1yloxy)trimethyl-	8.3	55.74	170
	Propanoic acid, 2-[(trimethylsilyl)oxy]-, trimethylsilyl ester	8.358	47.49	234
	Urea, N,N'-bis(trimethylsilyl)-	11.933	68.54	204
	Benzoic acid trimethylsilyl ester	11.996	80.55	194
	Silanol, trimethyl-, phosphate	12.371	85.16	315
	Butanedioc acid, bis(trimethylsilyl) ester	13.115	67.31	262
	2-Trimethylsilyloxyheptanoic acid, trimethylsilyl estyer	13.901	45.79	290
	2-Dimethyl(triemthylsilyl)silyloxytridecane	14.644	13.51	330
	Benzene, 1-(trimethylsilyloxy)-2-(trimethylsilyloxymethyl)-	15.09	73.21	268
	Decanoic acid, trimethylsilyl ester	15.43	80.85	244
	Bicyclo[10.4.0]hexadecane, 16-amino-1-hydroxy-13, 13-ethylenedioxy-	15.515	9.2	311
	Hexadecanoic acid, bis(trimethylsilyl) ester	15.905	93.4	290
	Benzoic acid, 2-[(trimethylsilyl)oxy]-, trimeethylsilyl ester	15.933	20.96	282
	L-Proline, 5-oxo-1-(trimethylsilyl)-, trimethylsilyl ester	16.053	16.053	273
	7H-Thiazolo[3,2-a]pyridine-6-carboxylic acid, 2,3-dihydro-8-cyano-7-(2-furyl)-5-methyl-, allyl ester	16.294	14.08	328
	Benzoic acid, 4-[(trimethylsilyl)oxy]-, trimethylsilyl ester	16.762	68.86	282
	Dodecanoic acid, trimethylsilyl ester	16.889	74.14	272
	Octanedioic acid, bis(trimethylsilyl)ester	17.102	91.4	318
	2-(2-Benzyldecahydroisoquinolin-3-yl)ethanol	17.222	21	273
	n-Tridecanoic acid, trimeethylsilyl ester	17.3335	59.59	286
	Azelaic acid, bis(trimethylsilyl) ester	17.505	93.58	332
	9-Tetradecenoic acid, trimethylsilyl ester	17.633	84.88	298
	Tetradecenoic acid, trimethylsilyl ester	17.703	96.42	300
	n-Pentadecanoic acid, trimethylsilyl ester	18.022	95.2	314
	Dibutyl phthalate	18.121	14.47	278
	Cyclohexanecarboxylic acid, 4-(1,5-dimethyl-3-oxohexyl)-,	18.199	24.95	268
	cis-9-Hexadecenoic acid, trimethylsilyl ester	18.242	56.27	326
	Hexadecanoic acid, trimethylsilyl ester	18.313	98.56	328
	Heptadecanoic acid, trimethylsilyl ester	18.426	88.82	342

	cis-10-Hexadecenoic acid, trimethylsilyl ester	18.546	56.31	340
	Hexadecanoic acid, butyl ester	18.78	70.08	312
	Oleic acid, trimethylsilyl ester	18.951	43.17	354
	Octadecanoic acid, trimethylsilyl ester	18.929	85.76	356
	Cholestan-3-one, cyclic 1,2-ethandiyl aetal	19.163	56.63	430
	1 ,2-Benzenedicarboxylic acid, 2-butoxyethyl butyl ester	19.269	76.3	322
	Benzyl butyl phthalate	19.524	76.24	312
	Dehydroabietic acid, trymethylsilyl ester	19.672	83.33	372
	Eicosanoic acid, trimethylsilyl ester	19.708	54.56	384
	Triphenyl phosphate	19.8	72.71	326
	Hexadecandioic acid, bis(trimeethylsilyl) ester	19.857	33.95	430
	Benzonitrile, m-phenethyl-	20.055	37.11	207
	9-Desoxo-9-x-acetoxy-3,8,12-tri-O-acetylingol	22.215	59.45	536
	4',5,7-Trihydroxyflavanone, tris(trimethylsilyl) ether	23..043	61.22	488
	9-Desoxo-9-x-acetoxy-3-desoxy-7.8.12-tri-O-acetylingol-3-one	23.376	41.05	534
	926 [Ov]	26.748	11.98	456
	2,4,6,8,10-Tetradecapentaenoic acid, 9a-(acetyloxy).	36.57	36.57	606
DeJj-4(4) Proximal	2-Methyl-1 ,4-bis(trimethylsiloxy)butane	6.984	23.13	248
	Butanoic acid, methyl-, bis(trimethylsilyl) ester	7.691	24.43	276
	Propanoic acid, 2-[(trimethylsilyl)oxy]-, trimethylsilyl ester	8.371	57	234
	Acetic acid, [(trimethylsilyl)oxy]-, trimethylsilyl ester	8.718	9.39	220
	Benzoic acid trimethylsilyl ester	11.996	77.6	194
	Silanol, trimethyl-, phosphate	12.364	82.75	314
	Butanedioc acid, bis(trimethylsilyl) ester	13.115	57.39	262
	Hexanedioic acid, bis(trimthylsilyl) ester	15.904	84.38	290
	Heptanedioic acid, bis(trimethylsilyl) ester	16.605	16.67	304
	Benzoic acid, 4-[(trimethylsilyl)oxy]-, trimethylsilyl ester	16.761	52.28	282
	Dodecanoic acid, trimethylsilyl ester	16.88	59.61	272
	2,4-Imidazolidinedione, 5-[3,4-bis[(trimethylsilyl)oxy]phenyl]-3-methyl-5-phenyl-1-(trimethylsilyl)-	17.009	21.92	516
	Octanedioic acid, bis(trimethylsilyl)ester	17.101	89.77	318
	Benzoic acid, 3-methoxy-4-[(triemthylsilyl)oxy]-, triemthylsilyl ester	17.398	71.74	312

	Azelaic acid, bis(trimethylsilyl) ester	17.504	96.39	332
	.alpha.-D-Glucopyranosiduronic acid, 3-(5-ethylhexahydro-2,4,6-trioxo-5-pyrimidinyl)-1,1-dimethylpropyl 2,3,4-tris-O-(trimethylsilyl)-, methyl ester	17.646	32.81	648
	Tetradecanoic acid, trimethylsilyl ester	17.703	96.87	300
	Prosta-5, 13-dien-1-oic acid,	17.837	30	642
	Cinnamic acid, p-(trimethylsiloxy)-, trimethylsilyl ester	18.021	52.89	308
	Dibutyl phthalate	18.12	7.31	278
	5,8,11,14-Eicosatetraynoic acid, tert-butyldimethylsilyl ester	18.198	8.45	410
	Palmitelaidic acid, trimethylsilyl ester	18.248	24.29	326
	Hexadecanoic acid, trimethylsilyl ester	18.311	98.01	328
	9,12-Octadecadienoic acid (Z,Z)-, trimethylsilyl ester	18.849	72.37	352
	Octadecanoic acid, trimethylsilyl ester	18.928	77.99	356
	Serverogenin acetate	19.161	9.25	544
	1,2-Benzenedicarboxylic acid, ethyl trimethylsilyl ester	19.267	58.42	266
	9,12,15-Octadecatrienoic acid, 2,3-bis[(trimethylsilyl)oxy]propyl ester	22.517	27.04	496
	9-Desoxo-9-x-acetoxy-3-desoxy-7.8.12-tri-O-acetylingol-3-one	23.048	28.54	534
	2,4-Imidazolidinedione, 5-[3,4-bis[(trimethylsilyl)oxy]phenyl]-3-methyl-5-phenyl-1-(trimethylsilyl)-	26.759	40.87	516
	Carotene, 1,1',2,2'-tetrahydro-1 ,1'-dimethoxy-	26.795	32.38	600
DeJj-4(5) Working Edge	Acetic acid	32.28	8.697	220
	Heptanoic acid	33.52	10.049	272
	Pentasiloxane	35.61	10.34	384
	Octanoic acid	46.99	12.259	216
	Nonanoic acid	68.81	13.923	230
	Decanoic acid, trimethylsilyl ester	90.25	15.431	244
	Hexadecanoic acid	76.88	18.291	328
	Dehydroabietic acid, trymethylsilyl ester	45.2	19.659	372
	Benzene, 1,1'-[2-methyl-2-(phenylthio)cyclopylidene]bis-	30.37	20.684	316
DeJj-4(5) Left Lateral and Ventral	Silanamine, N,N'-methanetetraylbis[1,1,1-trimethyl-	6.431	46.8	186
	Cyclotetrasiloxane, octamethyl-	7.295	39.63	296

	Ethanedioic acid, bis(triemthylsilyl) ester	7.656	28.45	234
	Tetrasiloxane, decamethyl	7.804	82.23	310
	Nicotinaldehyde thiosemicarbazone tritms	8.024	21.3	396
	Tetrasiloxane, decamethyl	8.18	80.36	310
	Propanoic acid, 2-[(trimethylsilyl)oxy]-, trimethylsilyl ester	8.335	53.66	234
	Trisiloxane, octamethyl-	8.456	40.94	236
	Pentasiloxane, dodecamethyl-	10.325	74.9	384
	Silane, (3,3-diphenyl-1,2-propadienylidene)bis[trimethyl-	10.594	57.96	336
	Trisiloxane, octamethyl-	10.905	19.22	236
	Pentasiloxane, dodecamethyl-	11.061	85.13	384
	Benzoic acid trimethylsilyl ester	11.981	71.47	194
	Octanoic acid, trimethylsilyl ester	12.236	41.89	216
	Silanol, trimethyl-, phosphate	12.335	86.65	314
	Azelaic acid, bis(trimethylsilyl) ester	17.497	94.37	332
	Hexadecanoic acid, trimethylsilyl ester	18.297	69.45	328
	9, 12-Octadecadienoic acid, trimethyl ester	18.828	29.1	352
	2,4,6,8,10-Tetradecapentaenoic acid, 9a-(acetyloxy).	21.986	31.71	606
	9-Desoxo-9-x-acetoxy-3,8,12-tri-O-acetylingol	26.729	25.98	536
DeJj-4(5) Dorsal	Propanoic acid, 2-[(trimethylsilyl)oxy]-, trimethylsilyl ester	8.343	49.66	234
	Borane, trimethyl-	9.348	21.83	56
	Oxalic acid, dially ester	9.369	54.72	170
	Benzoic acid trimethylsilyl ester	11.974	71.94	194
	Silanol, trimethyl-, phosphate	12.335	91.94	314
	Azelaic acid, bis(trimethylsilyl) ester	17.497	96.76	332
	Hexadecanoic acid, trimethylsilyl ester	18.304	75.51	328
	Cholestan-3-one, cyclic 1,2-ethandiyl aetal	18.829	23.05	430
	Pregan-20-one, 2-hydroxy-5,6-epoxy-15-methyl-	25.96	19	346
DeJj-4(5) Proximal Dorsal	Propanoic acid, 2-[(trimethylsilyl)oxy]-, trimethylsilyl ester	8.336	34.85	234
	Benzoic acid trimethylsilyl ester	11.982	55.26	194
	.alpha.-D-Glucopyranosiduronic acid, 3-(5-ethylhexahydro-2,4,6-trioxo-5-pyrimidinyl)-1,1-dimethylpropyl 2,3,4-tris-O-(trimethylsilyl)-, methyl ester	15.896	18.48	648
	Octanedioic acid, bis(trimethylsilyl)ester	17.093	50.75	318
	Azelaic acid, bis(trimethylsilyl) ester	17.497	95.79	332
	Sebacic acid, bis(trimethylsilyl) ester	17.829	49.75	346
	Hexadecanoic acid, trimethylsilyl ester	18.304	81.54	328

	9,12-Octadecadienoic acid (Z,Z)-, trimethylsilyl ester	18.853	46.93	352
	Prosta-5, 13-dien-1-oic acid,	18.92	13.01	642
	2,4,6,8,10-Tetradecapentaenoic acid, 9a-(acetyloxy).	21.185	36.67	606
	Cholestan-3-one, cyclic 1,2-ethandiyl aetal	21.32	54.48	430
	9,12,15-Octadecatrienoic acid, 2,3-bis[(trimethylsilyl)oxy]propyl ester	21.504	39.51	496
DeJj-4(5) Proximal End	1H-Pyrido[3,4-b]indole, 2,3,4,9-tetrahydro-1-(1-methylethyl)-	6.424	21.15	214
	Borane, trimethyl-	6.707	76.21	56
	cis-2-Hexen-1-ol, tert-butyldimethylsilyl ether	7.33	25.02	214
	Butanoic acid, 4-[bis(trimeethylsilyl)amino]-, trimeethylsilyl ester	7.656	9.71	319
	Tetrasiloxane, decamethyl	7.819	73.56	310
	Propanoic acid, 2-[(trimethylsilyl)oxy]-, trimethylsilyl ester	8.328	47.33	234
	2(3H)-Furanone, 3-bromodoihydro-	10.573	29.83	164
	Benzoic acid trimethylsilyl ester	11.967	76.48	194
	Silanol, trimethyl-, phosphate	12.328	82.62	314
	Octanedioic acid, bis(trimethylsilyl)ester	17.079	56.25	318
	Azelaic acid, bis(trimethylsilyl) ester	17.49	97.58	332
	Hexadecanoic acid, trimethylsilyl ester	18.29	89.55	328
	9,12-Octadecadienoic acid (Z,Z)-, trimethylsilyl ester	18.828	22.52	352
	Prost-13-en-1-oic acid, 9-(methoxyimino)-11, 15-bis[(trimethylsilyl)oxy]-, trimethylsilyl ester, (8. xi ,12.xi.)-	24.904	26.42	600
	2,4-Imidazolidinedione, 5-[3,4-bis[(trimethylsilyl)oxy]phenyl]-3-methyl-5-phenyl-1-(trimethylsilyl)-	25.959	29.04	516
DdJf-9 Left Lateral and Ventral	Propanoic acid, 2-[(trimethylsilyl)oxy]-, trimethylsilyl ester	8.329	55.2	234
	Azelaic acid, bis(trimethylsilyl) ester	17.492	90.53	332
	Hexadecanoic acid, trimethylsilyl ester	18.3	78.2	328
	2,4-Imidazolidinedione, 5-[3,4-bis[(trimethylsilyl)oxy]phenyl]-3-methyl-5-phenyl-1-(trimethylsilyl)-	19.695	35.55	516
	5H-Cyclopropa[3,4]benz[1,2-e]azulen-5-one, 2,4a,9,9a-tetrakis(acetyloxy)-3,[(acetyloxy)methyl]-1,	23.25	31.58	548

DdJf-9 Working	Propanoic acid, 2-[(trimethylsilyl)oxy]-, trimethylsilyl ester	8.335	50.5	234
	Benzoic acid trimethylsilyl ester	11.982	65.92	194
	Silanol, trimethyl-, phosphate	12.336	82.07	314
	Azelaic acid, bis(trimethylsilyl) ester	17.491	95.25	332
	Acetamide, 2-cyano-	17.852	50.71	84
	Hexadecanoic acid, trimethylsilyl ester	18.298	51.35	328
DdJf-9 Dorsal	Silanol, trimethyl-, phosphate	12.315	83.28	314
	Borane, trimethyl-	13.045	34.01	56
	Azelaic acid, bis(trimethylsilyl) ester	17.492	88.08	332
	Hexadecanoic acid, trimethylsilyl ester	18.299	51.31	328
DeJj-14 Dorsal	Trifluoromethyl-bis-(trimethylsilyl)methyl ketone-(trimethylsilyl)methyl ketone	5.971	92.09	338
	Bis(trimethylsiloxy)ethane	6.884	72.73	206
	Silane	8.272	59.3	32
	Silanol, trimethyl-, phosphate	11.998	56.08	314
	Silanol, trimethyl-, phosphate	12.006	71.55	314
	Azelaic Acid	14.493	91.18	332
DeJj-14 Ventral	Trifluoromethyl-bis-(trimethylsilyl)methyl ketone-(trimethylsilyl)methyl ketone	5.943	89.96	338
	Bis(trimethylsiloxy)ethane	6.863	64.29	206
	Silane	8.251	66.42	32
	Propanoic acid	8.328	45.2	234
	Propanoic acid	8.335	52.05	234
	Benzoic acid trimethylsilyl ester	11.975	75.73	194
	Silanol, trimethyl-, phosphate	12.322	89.85	314
	Azelaic Acid	17.484	28.13	332
	Hexadecanoic Acid	18.297	84.26	328
	Octadecadienoic acid	18.836	21.02	352
	3,8,12-Tri-O-acetoxy-7-desoxyingol-7-one	20.811	30.79	490
	Cholesta-8,24-dien-3-ol,4-methyl-(3.beta.,4.alpha.)-	26.741	28.37	398
DeJj-14 Working Edge	Acetonitrile	5.822	78.78	41
	Trifluoromethyl-bis-(trimethylsilyl)methyl ketone-(trimethylsilyl)methyl ketone	5.964	92.02	338
	Acetonitrile	6.813	62.66	41
	Bis(trimethylsiloxy)ethane	6.877	64.04	206
	Acetic acid	7.047	8.96	60
	Silane	8.265	67.69	32
	Propanoic acid	8.335	52.51	234

	Acetonitrile	8.555	58.12	41
	Acetonitrile	9.617	79.35	41
	Borane, trimethyl	10.31	79.25	56
	Acetonitrile	10.941	73.91	41
	Benzoic acid trimethylsilyl ester	11.974	47.05	194
	Silanol, trimethyl-, phosphate	12.342	90.24	314
	Azelaic Acid	17.497	89.13	332
	Hexadecanoic Acid	18.304	88.47	328
	Hexadecanoic Acid	18.311	23.48	328
	Octadecadienoic acid, trimethylsil ester	18.849	20.64	352

Appendix C.4 Sample Set 4

Table 0.9 GC/MS Results Sample Set 4

Sample Set 4	Compound	Retention Time	Percent Correct ID	MW
EaKa-49 Working Edge	N-(Trimethylsilyl)acetamide	5.73	94.62	131
	Trifluoromethyl-bis-(trimethylsilyl)methyl ketone-(trimethylsilyl)methyl ketone	6.049	91.29	256
	Trifluoroacetamide, N-Trimethylsilyloxymethyl-	6.304	98.1	215
	2,4(1H,3H)-Pyrimidinedione, 6-methyl-5-nitro-	6.509	10.19	171
	1,2-Bis(trimethylsiloxy)ethane	6.934	77.27	206
	Alanine, 2-Methyl-N-(trimethylsilyl)-, trimethylsilyl ester	6.976	34.3	247
	3-Propylnorleucine	7.047	18.35	173
	Acetamide, N-ethyl-2,2,2-trifluoro-	7.259	81.333	141
	Cyclotetrasiloxane, octamethyl-	7.316	34.18	296
	Ethanedioic acid, bis(triemthylsilyl) ester	7.684	43.02	234
	Tetrasiloxane, decamethyl	7.833	88.83	310
	Nicotinaldehyde thiosemicarbazone tritms	8.024	55.48	396
	Tetrasiloxane, decamethyl	8.187	68.99	310
	Silane, (2-cyclohexen-1-yloxy)trimethyl-	8.279	47.69	170
	Propanoic acid, 2-[(trimethylsilyl)oxy]-, trimethylsilyl ester	8.343	37.9	234
	Trisiloxane, octamethyl-	8.456	43.36	236
	Dimethyl-(6-methyl-2-thioxo-[1,2,3]oxathiaphosphinan	9.624	21.94	211
	N'-(1H-Indol-3-ylmethylene)benzohydrazide ditms	10.205	52.37	407
	Pentasiloxane, dodecamethyl-	10.34	73.51	384
	Ditherioerythirtol, O,O',S,S'-tetrakis(trimethylsilyl)	10.602	56.43	442

	Trisiloxane, octamethyl-	10.913	44.73	236
	Pentasiloxane, dodecamethyl-	11.069	79.83	384
	Silanol, (1,1-dimethylethyl)dimethyl-, benzoate	11.989	53.34	236
	Octanoic acid, trimethylsilyl ester	12.244	67.62	216
	Silanol, trimethyl-, phosphate	12.351	81.76	314
	Tetrasiloxane, decamethyl	13.427	54.78	310
	Nonanoic acid, trimethylsilyl ester	13.909	82.23	230
	3-Methyl-2-buten-1-ol, trimethylsilyl ether	14.383	34.42	158
	Decanoic acid, bis(tert-butyldimethylsilyl	14.645	75.19	430
	Decanoic acid, trimethylsilyl ester	15.431	65.23	244
	2,4-Imidazolidinedione, 5-[3,4-bis[(trimethylsilyl)oxy]phenyl]-3-methyl-5-phenyl-1-(trimethylsilyl)-	15.509	40.05	516
	2',6'-Dihydroxyacetophenone, bis(trimethylsilyl) ether	15.559	18.29	296
	Hexanedioic acid, bis(trimthylsilyl) ester	15.898	72.68	290
	9,10-Anthracenedione, 1-(methylamino)-4-[(4-methylphenyl)amino]-	16.557	29.59	342
	Benzoic acid, 4-[(trimethylsilyl)oxy]-, trimethylsilyl ester	16.7555	65.24	282
	Dodecanoic acid, trimethylsilyl ester	16.883	75.13	272
	Octanedioic acid, bis(trimethylsilyl)ester	17.095	72.08	318
	Azelaic acid, bis(trimethylsilyl) ester	17.499	97.78	332
	Tetradecanoic acid, trimethylsilyl ester	17.697	94.39	300
	Sebacic acid, bis(trimethylsilyl) ester	17.831	19.46	346
	Cinnamic acid, p-(trimethylsiloxy)-, trimethylsilyl ester	18.016	51.68	308
	1,2-Benzenedicarboxylic acid, butyl octyl ester	18.115	22.67	266
	Palmitelaidic acid, trimethylsilyl ester	18.242	45.94	326
	Hexadecanoic acid, trimethylsilyl ester	18.306	97.81	328
	Prosta-5, 13-dien-1-oic acid,	18.42	35.95	642
	9,12-Octadecadienoic acid (Z,Z)-, trimethylsilyl ester	18.845	64.48	352
	Octadecanoic acid, trimethylsilyl ester	19.922	86.53	356
	9-Desoxo-9-x-acetoxy-3,8,12-tri-O-acetylingol	19.156	15.64	536
	1 ,2-Benzenedicarboxylic acid, 2-butoxyethyl butyl ester	19.262	61.63	322
	2-Benzylselanyl-1H-benzoimidazole	20.048	18.14	288
	Thiocarbamic acid, N,N-dimethyl, S-1,3-diphenyl-2-butenyl ester	20.714	24.86	311
	4H-Cyclopropa[5',6']benz[1'2':7,8]azuleno[5,6-b]oxiren-4-one, 8,8a-bis(acetoxy)-2a-[(acetyloxy)methyl]1,1a,1b,1c,2a,3,3a,6a,6b,7,8,8a	25.686	64.04	420

	2-Butenoic acid, 2-methyl-, 1,1a,1b,4,4a,5,7a,7b,8,9	26.211	39.39	528
	.beta.-Sitosterol acestate	26.749	10.07	456
EaKa-49 Right Lateral and Ventral	Nicotinaldehyde thiosemicarbazone tritms	8.052	33.7	396
	Silane, (1-cyclohexen-1yloxy)trimethyl-	8.341	71.88	170
	Propanoic acid, 2-[(trimethylsilyl)oxy]-, trimethylsilyl ester	8.371	62.71	234
	Hexanedioic acid, bis(trimthylsilyl) ester	8.683	53.18	188
	Pentasiloxane, dodecamethyl-	10.339	73.55	384
	Benzoic acid trimethylsilyl ester	11.996	80.51	194
	Octanoic acid, trimethylsilyl ester	12.251	69.41	216
	Silanol, trimethyl-, phosphate	12.379	87.89	314
	Propanoic acid, methyl-, bis(trimethylsilyl) ester	13.108	9.81	262
	Nonanoic acid, trimethylsilyl ester	13.915	91.26	230
	Decanoic acid, trimethylsilyl ester	15.43	78.75	244
	Hexanedioic acid, bis(trimthylsilyl) ester	15.905	61.38	290
	.alpha.-D-Glucopyranoside, methyl 2-(acetylamino)-2-deoxy-3-O(trimethylsilyl)-	16.606	17.57	331
	Dodecanoic acid, trimethylsilyl ester	16.882	80.78	272
	Dinaphtho(1,2-b:2',1'-d)thiophene	16.995	12.97	284
	Octanedioic acid, bis(trimethylsilyl)ester	17.095	84.28	318
	Azelaic acid, bis(trimethylsilyl) ester	17.505	97.05	332
	9,12,15-Octadecatrienoic acid, 2,3-bis[(trimethylsilyl)oxy]propyl ester	17.633	35.68	496
	Tetradecanoic acid, trimethylsilyl ester	17.696	93.45	300
	Sebacic acid, bis(trimethylsilyl) ester	17.838	23.4	346
	5,8,11-Eicosatriynoic acid, tert-butyldimethylsilyl ester	17.937	10	414
	Cinnamic acid, p-(trimethylsiloxy)-, trimethylsilyl ester	18.015	66.34	308
	1,2-Benzenedicarboxylic acid, butyl 2-methylpropyl ester	18.114	11.48	266
	Palmitelaidic acid, trimethylsilyl ester	18.241	46.46	326
	Hexadecanoic acid, trimethylsilyl ester	18.305	96.78	328
	Heptadecanoic acid, trimethylsilyl ester	18.61	59.7	342
	Hexadecanoic acid, butyl ester	18.773	57.72	312
	9,12-Octadecadienoic acid (Z,Z)-, trimethylsilyl ester	18.843	76.44	352
	Octadecanoic acid, trimethylsilyl ester	18.928	96.24	356
	Serverogenin acetate	19.155	42.19	544

	1,2-Benzenedicarboxylic acid, 2-butoxyethyl butyl ester	19.261	80.04	266
	Titanium(IV) butoxide	19.516	20.58	340
	1-Chloroeicosane	19.559	9.8	316
	9,12,15-Octadecatrienoic acid, 2,3-bis[(trimethylsilyl)oxy]propyl ester	19.707	27.79	496
	Prost-13-en-1-oic acid, 9-(methoxyimino)-11, 15-bis[(trimethylsilyl)oxy]-, trimethylsilyl ester, (8. xi ,12.xi.)-	22.511	37.81	599
	2,4,6,8,10-Tetradecapentaenoic acid, 9a-(acetyloxy).	22.568	13.66	606
	9-Desoxo-9-x-acetoxy-3,8,12-tri-O-acetylingol	24.955	36.25	536
	Prost-13-en-1-oic acid, 6-oxo-9,11,15-tris[(trimethylsil)oxy]-,methyl ester	25.473	48.83	600
	.beta.-Sitosterol acestate	26.754	12.77	456
EaKa-49 Dorsal	3-Propylnorleucine	7.082	25.66	173
	Ethanedioic acid, bis(triemthylsilyl) ester	7.705	44.67	234
	Tetrasiloxane, decamethyl	7.847	80.73	310
	Nicotinaldehyde thiosemicarbazone tritms	8.045	35.01	396
	Silane, (1-cyclohexen-1yloxy)trimethyl-	8.3	72.39	170
	Propanoic acid, 2-[(trimethylsilyl)oxy]-, trimethylsilyl ester	8.364	56.16	234
	4,6-Dimethyl-2-thioxo-1,2-dihydro-3-pyridinecarbonitrile tms	8.477	16.22	236
	Nicotinaldehyde thiosemicarbazone tritms	8.668	37.86	396
	Pentasiloxane, dodecamethyl-	10.318	75.05	384
	Ditherioerythirtol, O,O',S,S'-tetrakis(trimethylsilyl)	10.601	28.66	442
	Trisiloxane, octamethyl-	10.905	41.31	236
	Benzoic acid trimethylsilyl ester	11.982	82.58	194
	Octanoic acid, trimethylsilyl ester	12.251	60.29	216
	Silanol, trimethyl-, phosphate	12.364	82.01	314
	Silane, [1,2-phenylenebis(oxy)]bis[triemthyl-	13.108	61.08	254
	Trisiloxane, octamethyl-	13.419	69.63	310
	Tetrasiloxane, decamethyl	13.461	44.01	310
	Nonanoic acid, trimethylsilyl ester	13.908	92.58	230
	N-2,4-Dnp-L-arginine	113.978	30.58	340
	2-Butenoic acid, tert-butyldimethylsilyl ester	14.382	46.76	200
	Monoamidoethylmalonic acid, O,O,O'-tris(trimethylsilyl)-	14.637	19.54	347
	Benzene, 1-(trimethylsilyloxy)-2-(trimethylsilyloxymethyl)-	15.076	42.23	268

	2,4-Imidazolidinedione, 5-[3,4-bis[(trimethylsilyl)oxy]phenyl]-3-methyl-5-phenyl-1-(trimethylsilyl)-	15.21	37.25	516
	Decanoic acid, trimethylsilyl ester	15.423	94.76	244
	Benzeneacetic acid, .alpha.-phenyl-.alpha.-[(trimethylsilyl)oxy]-, 3-quinuclidinyl ester	15.508	22.5	409
	Hexanedioic acid, bis(trimthylsilyl) ester	15.897	94.47	290
	Benzaldehyde, 2,4-bis(triemthylsiloxy)-	15.926	18.67	282
	3-Methyl-2-buten-1-ol, trimethylsilyl ether	16.159	46.57	341
	Benzaldehyde, 3-methoxy-4-[(trimethylsilyl)oxy]-	16.202	38.16	224
	Undecanoic acid, trimethylsilyl ester	16.286	23.62	258
	Prosta-5, 13-dien-1-oic acid,	16.442	15.89	642
	Silane, [1,2,3-benzenetriyltris(oxy)]tris[trimethyl-	16.555	37.87	342
	Heptanedioic acid, bis(trimethylsilyl) ester	16.598	36.17	304
	Benzoic acid, 4-[(trimethylsilyl)oxy]-, trimethylsilyl ester	16.754	54.45	282
	Benzeneacetic acid, .alpha.-phenyl-.alpha.-[(trimethylsilyl)oxy]-, 3-quinuclidinyl ester	16.81	76.97	296
	Dodecanoic acid, trimethylsilyl ester	16.874	84.81	272
	4H-1-Benzopyran-4-one, 5-hydroxy-2-(3-hydroxy-4-methoxyphenyl)-7-methoxy-	16.995	22.09	314
	Octanedioic acid, bis(trimethylsilyl)ester	17.094	90.29	318
	.beta.-N-Acetylneuraminic acid, methyl ester-2-methyl-7,9-methyl-boronate-3,8-di(trimethylsilyl)-	17.207	16.01	505
	n-Tridecanoic acid, trimeethylsilyl ester	17.327	61.68	286
	1-Trimethylsilyloxytetradecane	17.377	22.99	286
	Azelaic acid, bis(trimethylsilyl) ester	17.497	96.98	332
	2-Butenoic acid, tert-butyldimethylsilyl ester	17.646	33.73	200
	Tetradecanoic acid, trimethylsilyl ester	17.698	96.73	300
	1,2-Benzenedicarboxylic acid	17.802	33.85	266
	Sebacic acid, bis(trimethylsilyl) ester	17.83	26.04	346
	Cinnamic acid, p-(trimethylsiloxy)-, trimethylsilyl ester	18.014	75.71	308
	1,2-Benzenedicarboxylic acid, butyl octyl ester	18.114	11.47	266
	Palmitelaidic acid, trimethylsilyl ester	18.234	48.6	326
	Hexadecanoic acid, trimethylsilyl ester	18.305	98.1	328
	Heptadecanoic acid, trimethylsilyl ester	18.418	17.96	342
	Trimethylsilyl 3-methoxy-4-(trimethylsilyloxy)cinnamate	18.467	18.467	338
	Oleic acid, trimethylsilyl ester	18.843	41.61	354
	Phthalic acid, butyl ester, ester with butyl glycolate	19.26	77.79	336
	Benzyl butyl phthalate	19.515	43.9	312

	D-Turanose, heptakis(trimethylsilyl)-	19.671	49.21	846
	Triphenyl phosphate	19.791	91.93	326
	Prosta-5, 13-dien-1-oic acid,	19.848	19.54	642
	Benzonitrile, m-phenethyl-	20.046	50.15	207
	(2,3-Diphenylcyclopropyl)methyl phenyl sulfoxide, ttrans-	20.62	38.12	332
	Benzene, 1,1'-[2-methy-2-(phenylthio)cyclopropylidene]bis-	20.705	34.08	316
	4H-Cyclopropa[5',6']benz[1'2':7,8]azuleno[5,6-b]oxiren-4-one, 8,8a-bis(acetoxy)-2a-[(acetyloxy)methyl]1,1a,1b,1c,2a,3,3a,6a,6b,7,8,8a	20.932	53.91	520
	Chromone, 2,3-dihydro-7-benzyloxy-2,2-dimethyl-,semicarbazone	21.031	40.33	339
	Napthalene--1,3,3-tricarbonitrile, 3,4,4a,5,6,7-hexadro-2-a	21.208	33.87	314
	2-Hydroxy-2-methyl-succinic acid, bis-(2-oxo-2-phenyl-ethyl ester	22.645	51.25	602
	4',5,7-Trihydroxyflavanone, tris(trimethylsilyl) ether	23.034	67.28	488
	D-Turanose, heptakis(trimethylsilyl)-	24.557	20.64	846
	9-Desoxo-9-x-acetoxy-3,8,12-tri-O-acetylingol	25.378	16.2	536
	Astaxanthin	26.731	10.56	596
	.beta.-Sitosterol trimethylsilyl ether	26.745	23.81	486
EaKa-49 Proximal	Glycine, N-formyl-N-(trimethyltilyl)-, trimethylsilyl ester, N-formyl-N-(trimethyltilyl)-, trimethylsilyl ester	7.005	24.47	247
	3-Propylnorleucine	7.09	14.94	173
	Borane, trimethyl-	7.146	38.36	56
	Silane, (cyclohexyloxy)trimethyl-	7.359	38.45	172
	Silanamine, 1,1,1-trimethyl-N-(trimethylsilyl)-N-[2-[(triemthylsilyl)oxy]ethyl]-	7.706	15.1	277
	4-Methyl-2-(2-nitro-5-piperidin-1-yl-phenyl)-2H-phthalazin-1-one	8.053	19.7	364
	Tetrasiloxane, decamethyl	8.194	65.24	310
	Silane(1-cyclohexene-1-yloxy)trimethyl-	8.301	51.68	170
	Propanoic acid, 2-[(trimethylsilyl)oxy]-, trimethylsilyl ester	8.371	29.24	234
	Pyrimidine-5-carboxylic acid, 1,4-dihydro-4-(2-furyl)-1,6-dimethyl-2-methylthio-. Ethyl ester	8.456	19.99	294
	Nicotinaldehyde thiosemicarbazone tritms	8.661	9.89	396
	Monoamidoethylmalonic acid, O,O,O'-tris(trimethylsilyl)-	10.522	11.95	347
	Trisiloxane, octamethyl-	11.062	45.14	384

	Benzoic acid trimethylsilyl ester	11.982	81.71	194
	Octanoic acid, trimethylsilyl ester	12.237	49.84	216
	Silanol, trimethyl-, phosphate	12.343	85.46	314
	Butanoic acid, 4-[bis(trimeethylsilyl)amino]-, trimeethylsilyl ester	13.094	12.58	262
	Nonanoic acid, trimethylsilyl ester	13.901	64.74	230
	2-Butenoic acid, tert-butyldimethylsilyl ester	14.375	55.7	200
	Decanoic acid, trimethylsilyl ester	15.416	37.36	244
	1,3-Benzoxazol-2-amine-ditms	16.152	38.22	278
	9,10-Anthracenedione, 1-(methylamino)-4-[(4-methylphenyl)amino]-	16.542	50.71	342
	Benzoic acd, 3-[(trimethylsilyl)oxy]-, trimethylsilyl ester	16.74	52.56	282
	Dodecanoic acid, trimethylsilyl ester	16.868	66.39	272
	Octanedioic acid, bis(trimethylsilyl)ester	17.08	57.91	318
	Azelaic acid, bis(trimethylsilyl) ester	17.484	95.28	332
	Tetradecanoic acid, trimethylsilyl ester	17.689	77.37	300
	Sebacic acid, bis(trimethylsilyl) ester	17.816	11.51	346
	Cinnamic acid, p-(trimethylsiloxy)-, trimethylsilyl ester	18.001	65.67	308
	Di-n-octylphthalate	18.1	6.21	390
	Palmitelaidic acid, trimethylsilyl ester	18.22	65.73	326
	Hexadecanoic acid, trimethylsilyl ester	18.291	97.95	328
	Silane, trimethyl(octadecyloxy)-	18.617	32.91	342
	9,12-Octadecadienoic acid (Z,Z)-, trimethylsilyl ester	18.822	89.01	352
	Octadecanoic acid, trimethylsilyl ester	18.907	93.71	356
	Ethyl iso-allocholate	19.141	21.3	436
	1,2-Benzenedicarboxylic acid, 2-butoxyethyl butyl ester	19.247	63.58	322
	9,12,15-Octadecatrienoic acid, 2,3-bis[(trimethylsilyl)oxy]propyl ester	19.488	18.97	496
	5H-Cyclopropa[3,4]benz[1,2-e]azulen-5-one, 2,4a,9,9a-tetrakis(acetyloxy)-3,[(acetyloxy)methyl]-1,	19.686	48.32	608
	Benzonitrile, m-phenethyl-	20.033	50.81	207
	Prost-13-en-1-oic, acid, 6-oxo-9,11,15-tris	20.231	28.33	600
	Benzene, 1,1'-[2-methy-2-(phenylthio)cyclopropylidene]bis-	20.614	36.31	316
	(2,3-Diphenylcyclopropyl)methyl phenyl sulfoxide, ttrans-	20.692	38.4	332
	.psi. ,.psi.-Carotene, 3,4-didehydro-1, 1',2,2'-tetrohydro-1'-hydroxy-1-methoxy-	21.188	17.31	584

	Prost-5,13-dien-1-oic acid, 9,11,15-tris[(trismethylsilyl)oxy]-	21.485	29.87	642
	9-Desoxo-9-x-acetoxy-3-desoxy-7.8.12-tri-O-acetylingol-3-one	24.539	32.64	534
	3,8,12-Tri-O-acetoxy-7-desoxyingol-7-one	25.403	30.29	490
	Prost-13-en-1-oic acid, 6-oxo-9,11,15-tris[(trimethylsil)oxy]-,methyl ester	26.722	10.15	600
	3,9.beta.;14,15-Diepoxypregn-16-en-20-one, 3,11.beta.,18-triacetoxy-	26.516	46.67	502
EaKa-6 Working Edge	1,1'-Biphenyl, 4,4'-dinitro	5.5	41.93	244
	Disilathiane, hexamethyl	6.36	37.05	178
	Butanoic acid, 4-[bis(trimeethylsilyl)amino]-, trimeethylsilyl ester	7.026	19.5	247
	Butanedioc acid, bis(trimethylsilyl) ester	7.72	16.59	276
	Trisiloxane, octamethyl-	7.84	79.33	310
	Silane, (1-cyclohexen-1yloxy)trimethyl-	8.315	55.055	170
	Propanoic acid, 2-[(trimethylsilyl)oxy]-, trimethylsilyl ester	8.385	45.22	234
	Acetic acid, [(trimethylsilyl)oxy]-, trimethylsilyl ester	8.733	53.76	220
	5-Hydroxy-5-methyl-2-phenyl-3-isoxazolidinone ditms pk2	10.871	34.09	337
	Benzoic acid trimethylsilyl ester	11.933	60.7	194
	Silanol, trimethyl-, phosphate	12.365	86.26	314
	Butanedioc acid, bis(trimethylsilyl) ester	13.108	32.3	262
	2-Trimethylsilyloxyheptanoic acid, trimethylsilyl estyer	13.901	64.33	290
	Benzene, 1-(trimethylsilyloxy)-2-(trimethylsilyloxymethyl)-	15.083	67.75	268
	Octanoic acid, 2-[(trimethylsilyl)oxy]-,trimethylsilyl ester	115.31	73.43	304
	Decanoic acid, trimethylsilyl ester	15.43	43.4	244
	Hexanedioic acid, bis(trimthylsilyl) ester	15.905	84.72	290
	3H-Pyrazol-3-one, 1,2-dihydro-1,2-diphenyl-5-[(trimethylsilyl)oxy]-4-[3-[(trimethylsilyl)oxy]butyl]-	16.061	47.19	468
	3,5-di-tert-Butyl-4-hydroxyphenylpropionic acid	16.167	41.2	278
	2,4-Imidazolidinedione, 5-[3,4-bis[(trimethylsilyl)oxy]phenyl]-3-methyl-5-phenyl-1-(trimethylsilyl)-	16.457	28.66	516
	Silane, [1,2,3-benzenetriyltris(oxy)]tris[trimethyl-	16.563	42.67	342

	Benzoic acid, 3-[(trimethylsilyl)oxy]-, trimethylsilyl ester	16.754	53.14	282
	Dodecanoic acid, trimethylsilyl ester	16.882	82.53	272
	Tetracyclo[11.4.0.0(1,10).0(5,9)]heptadec-12-	16.917	56.75	334
	4H-1-Benzopyran-4-one, 5-hydroxy-2-(3-hydroxy-4-methoxyphenyl)-7-methoxy-	16.995	20.44	314
	Octanedioic acid, bis(trimethylsilyl)ester	17.095	88.32	318
	Chidanthine, 1,2-dihydro-	17.222	27.67	289
	O-Acetylcitric acid triethyl ester	17.307	97.99	318
	Benzoic acid, 3-methoxy-4-[(triemthylsilyl)oxy]-, triemthylsilyl ester	17.392	88.04	312
	Azelaic acid, bis(trimethylsilyl) ester	17.505	96.95	332
	Tetradecanoic acid, trimethylsilyl ester	17.696	94.29	300
	Prosta-5, 13-dien-1-oic acid,	17.838	19.01	642
	4,5,6,7-Tetrahydroxy-1,8,9-tetrameethyl-8,9-	17.859	30.35	342
	Cinnamic acid, p-(trimethylsiloxy)-, trimethylsilyl ester	18.015	54.97	308
	Palmitelaidic acid, trimethylsilyl ester	18.242	32.34	326
	Hexadecanoic acid, trimethylsilyl ester	18.305	96.29	328
	Posta-5, 13-dien-1-oic acid, 9,11,15	18.405	20.83	642
	4H-Cyclopropa[5',6']benz[1'2':7,8]azuleno[5,6-b]oxiren-4-one, 8,8a-bis(acetoxy)-2a-[(acetyloxy)methyl]1,1a,1b,1c,2a,3,3a,6a,6b,7,8,8a	18.476	28.65	520
	1,3-Dioxane, 5-(hexadecyloxy)-2-pentadecyl',trans-	18.61	22.09	538
	1-Cyclohexyldimethylsilyloxypentadecane	18.631	50.89	410
	Hexadecanoic acid, butyl ester	18.773	71.01	312
	9,12-Octadecadienoic acid (Z,Z)-, trimethylsilyl ester	18.843	86.26	352
	Octadecanoic acid, trimethylsilyl ester	18.929	94.64	356
	Docosahexaenoic acid, 1,2,3-propanetriyl ester	19.014	28.24	1023
	Severogenin acetate	19.155	20.2	544
	1,2-Benzenedicarboxylic acid, 2-butoxyethyl butyl ester	19.268	55.17	322
	Androst-4-enee-3,20-dione, 11,16,22-triacetoxy-	19.516	57.45	488
	Octadecane, 3-ethyl-5-(2-ethylbutyl)-	19.559	12.01	366
	Prost-13-en-1-oic acid, 9,11,15-tris[(trimethylsilyl)oxy]-, trimethylsilyl ester	19.701	29.22	644
	Prost-5,13-dien-1-oic acid, 9,11,15-tris[(trismethylsilyl)oxy]-	19.856	27	642
	Phthalic acid, butyl ester, ester with butyl glycolate	20.302	23.33	418
	9-Desoxo-9-x-acetoxy-3,8,12-tri-O-acetylingol	20.437	50.55	536

	Cholestan-3-one, cyclic 1,2-ethandiyl aetal	25.602	35.96	430
	3,8,12-Tri-O-acetoxy-7-desoxyingol-7-one	25.722	20.55	490
	.psi. ,.psi.-Carotene, 3,4-didehydro-1, 1',2,2'-tetrohydro-1'-hydroxy-1-methoxy-	26.763	25.59	600
EaKa-6 Right Lateral and Ventral	Acetamide, N-methyl-N(trimethylsilyl)-	7.012	25.12	145
	3-Propylnorleucine	7.09	25.52	173
	1-(2-Ethyl-[1,3]dithian-2-yl)-3-methyl-butan-1-ol	7.706	12.52	234
	Silane, (1-cyclohexen-1yloxy)trimethyl-	8.293	77.27	170
	Propanoic acid, 2-[(trimethylsilyl)oxy]-, trimethylsilyl ester	8.378	53.21	234
	Nicotinaldehyde thiosemicarbazone tritms	8.683	49.39	396
	Monoamidoethylmalonic acid, O,O,O'-tris(trimethylsilyl)-	10.007	6.49	347
	Pentasiloxane, dodecamethyl-	10.34	46.25	384
	2-Methyl-1 ,4-bis(trimethylsiloxy)butane	10.559	25.58	186
	2,4-Imidazolidinedione, 5-[3,4-bis[(trimethylsilyl)oxy]phenyl]-3-methyl-5-phenyl-1-(trimethylsilyl)-	10.835	21.21	516
	Prostaglandin E2, O,O'-bis(trimethylsilyl)-, trimethylilyl ester	10.913	19.72	568
	Urea, N,N'-bis(trimethylsilyl)-	11.911	95.24	204
	Benzoic acid trimethylsilyl ester	11.989	67.01	194
	Octanoic acid, trimethylsilyl ester	12.237	70	216
	Silanol, trimethyl-, phosphate	12.35	90.29	314
	Butanedioc acid, bis(trimethylsilyl) ester	13.101	45.62	262
	3,9-Dioxa-2,10-dislaundecane, 2,2,10,10-tetramethyl-	13.278	21.8	248
	Borane, trimethyl-	13.413	28.14	56
	Nonanoic acid, trimethylsilyl ester	13.908	88.6	230
	Acetic acid, cyano-	14.142	69.55	85
	Prosta-5, 13-dien-1-oic acid,	14.645	20.98	642
	Benzene, 1-(trimethylsilyloxy)-2-(trimethylsilyloxymethyl)-	15.077	75.69	268
	Decanoic acid, trimethylsilyl ester	15.423	88.88	244
	2,4-Imidazolidinedione, 5-[3,4-bis[(trimethylsilyl)oxy]phenyl]-3-methyl-5-phenyl-1-(trimethylsilyl)-	15.551	34.64	516
	Hexanedioic acid, bis(trimthylsilyl) ester	15.898	82.4	290
	1,2,4-4H-Triazole-3-thiol, 5-[5-(1-hexynyl)-2-furyl]-4-methyl-	16.068	33.6	261

	3-Methyl-12-pyriin-2-yl-8,9,10,12-tetrahydro-7H-benzo[b][4,7]phenanthrolin-11-one	16.16	28.95	341
	Benzaldehyde, 3-methoxy-4-[(trimethylsilyl)oxy]-	16.209	51.76	224
	Silane, [1,2,3-benzenetriyltris(oxy)]tris[trimethyl-	16.556	45.39	342
	Benzoic acid, 4-[(trimethylsilyl)oxy]-, trimethylsilyl ester	16.755	51.38	282
	Dodecanoic acid, trimethylsilyl ester	16.875	94.74	272
	2,6-Bis(4-azidobenzylidene)-4-methylcyclohexanone	16.996	13.58	370
	Octanedioic acid, bis(trimethylsilyl)ester	17.088	71.86	318
	n-Tridecanoic acid, trimeethylsilyl ester	17.328	27.45	286
	Benzoic acid, 3-methoxy-4-[(triemthylsilyl)oxy]-, triemthylsilyl ester	17.385	90.71	312
	Benzene, 1,1'-(1,2-cyclobutanediyl)bis-, tans-	17.456	12.33	208
	Azelaic acid, bis(trimethylsilyl) ester	17.498	97.04	332
	9-Tetradecenoic acid, trimethylsilyl ester	17.626	49.53	298
	Tetradecanoic acid, trimethylsilyl ester	17.697	97.73	300
	n-Pentadecanoic acid, trimethylsilyl ester	17.824	80.35	315
	Oleic acid, trimethylsilyl ester	17.945	26.52	354
	n-Pentadecanoic acid, trimethylsilyl ester	18.008	92.89	314
	Phthalic acid, butyl ester, ester with butyl glycolate	18.115	20.3	306
	cis-9-Hexadecenoic acid, trimethylsilyl ester	18.235	52.16	326
	Hexadecanoic acid, trimethylsilyl ester	18.306	97.55	328
	Oleic acid, trimethylsilyl ester	18.844	45.26	352
	Octadecanoic acid, trimethylsilyl ester	18.922	94.58	356
	1,4-Ethano-1,2,3,4-tetrahydroanthracen-3-ol, 2-benzylidene-	21.492	30.24	312
	2,4,6,8,10-Tetradecapentaenoic acid, 9a-(acetyloxy).	21.614	41.43	606
	2,4-Imidazolidinedione, 5-[3,4-bis[(trimethylsilyl)oxy]phenyl]-3-methyl-5-phenyl-1-(trimethylsilyl)-	24.552	34.27	516
	4a,7a-Epoxy-5H-cyclopenta[a]cyclopropa[f]cycloundecene-2,4,7,10,11-pentol,	25.416	52.32	722
	Cholesta-8,24-dien-3-ol,4-methyl-. (3.beta.,4.alpha.)-	26.77	30.81	398
EaKa-6 Dorsal	Alanine, 2-Methyl-N-(trimethylsilyl)-, trimethylsilyl ester	6.998	20.64	247
	p-Chlorophenyl (2-(ethylthio)ethyl)carbamate	7.069	24.76	259
	D-thero-2,5-Hexodiulose, 1-deoxy-3,4,6-tris-O-(trimethylsilyl)-, bis(O-methyloxime)-	7.684	10.7	436

	Silane, (1-cyclohexen-1yloxy)trimethyl-	8.279	59.59	170
	Propanoic acid, 2-[(trimethylsilyl)oxy]-, trimethylsilyl ester	8.364	43	234
	Acetic acid, [(trimethylsilyl)oxy]-, trimethylsilyl ester	8.704	70.29	220
	3,8-Dioxa-2,9-disilicane, 2,2,9,9-tetramethyl-	10	23.73	234
	1-Cyclopentyl-1-trimethylsilyloxyethane	10.495	9.12	186
	Trisiloxane, octamethyl-	11.062	65.96	384
	Urea, N,N'-bis(trimethylsilyl)-	11.904	93.59	204
	Benzoic acid trimethylsilyl ester	11.982	81.91	194
	Octanoic acid, trimethylsilyl ester	12.237	67.72	216
	Silanol, trimethyl-, phosphate	12.35	87.65	314
	Butanedioc acid, bis(trimethylsilyl) ester	13.094	50.79	262
	2,4-Imidazolidinedione, 5-[3,4-bis[(trimethylsilyl)oxy]phenyl]-3-methyl-5-phenyl-1-(trimethylsilyl)-	13.285	49.52	516
	2-Trimethylsilyloxyheptanoic acid, trimethylsilyl estyer	13.887	56.38	290
	Parabanic acid, bis-O-(trimethylsilyl)-	14.588	32.65	258
	2-Hydroxyundecanoic acid, trimethylsilyl ether, trimethylsilyl ester	14.793	23.63	246
	Silane, trimethyl[[p-(trimethylsiloxy)benzyl)oxy]-	15.069	28.5	268
	Octanoic acid, 2-[(trimethylsilyl)oxy]-,trimethylsilyl ester	15.303	77.26	304
	Decanoic acid, trimethylsilyl ester	15.409	87.49	244
	2,4-Imidazolidinedione, 5-[3,4-bis[(trimethylsilyl)oxy]phenyl]-3-methyl-5-phenyl-1-(trimethylsilyl)-	15.494	48.55	516
	3-Trimethylsiloxyoctanoic acid, trimethylsilyl ester	15.543	64.49	304
	2-(4-Methoxy-2,6-dimethylphenyl)-3-2H-benzo[g]inadzole	15.72	44.4	316
	.alpha.-D-Glucopyranoside, methyl 2-(acetylamino)-2-deoxy-3-O(trimethylsilyl)-	15.855	14.67	393
	Hexanedioic acid, bis(trimthylsilyl) ester	15.89	85.85	290
	p-Trimethylsilyloxyphenyl-(trimethylsilyloxy)trimethylsilylacrylate	15.912	32.94	398
	L-Proline, 5-oxo-1-(trimethylsilyl)-, trimethylsilyl ester	16.032	62.92	273
	3,7,11,15,18-Pentaoxa-2,19-disilaeicosane,2,2,19,19-tetramethyl-	16.096	17.38	380
	Silane, tirmethyl(nonyloxy)-	16.153	23.05	216
	Benzaldehyde, 3-methoxy-4-[(trimethylsilyl)oxy]-	16.195	44.6	224
	10,12-Docosadeiynedioic acid ditms	16.28	6.11	506

	Hydantoin, 5-hydroxy-tris-O-(trimethylsilyl)-	16.521	21.42	332
	9,10-Anthracenedione, 1-(methylamino)-4-[(4-methylphenyl)amino]-	16.549	23.09	342
	Prosta-5, 13-dien-1-oic acid,	16.592	34	642
	Amine, N,N,N-tris((trimethylsilyloxy)ethyl)-	16.684	89.59	365
	Benzoic acid, 3-[(trimethylsilyl)oxy]-, trimethylsilyl ester	16.74	43.56	282
	Dodecanoic acid, trimethylsilyl ester	16.868	95.83	272
	4H-1-Benzopyran-4-one, 5-hydroxy-2-(3-hydroxy-4-methoxyphenyl)-7-methoxy-	16.988	30.11	314
	Octanedioic acid, bis(trimethylsilyl)ester	17.08	92.46	318
	Benzoic acid, 3-methoxy-4-[(triemthylsilyl)oxy]-, triemthylsilyl ester	17.377	88,96	312
	Azelaic acid, bis(trimethylsilyl) ester	17.491	96.66	332
	2,4-Imidazolidinedione, 5-[3,4-bis[(trimethylsilyl)oxy]phenyl]-3-methyl-5-phenyl-1-(trimethylsilyl)-	17.561	30.44	516
	9,12,15-Octadecatrienoic acid, 2,3-bis[(trimethylsilyl)oxy]propyl ester	17.625	34.71	496
	Tetradecanoic acid, trimethylsilyl ester	17.689	95.35	300
	n-Pentadecanoic acid, trimethylsilyl ester	17.816	61.69	314
	Dibutyl phthalate	118.1	12.31	278
	cis-9-Hexadecenoic acid, trimethylsilyl ester	18.227	57.05	326
	Hexadecanoic acidd, trimethylsilyl ester	18.291	96.53	328
	Heptadecanoic acid, trimethylsilyl ester	18.404	55.87	342
	9,12-Octadecadienoic acid (Z,Z)-, trimethylsilyl ester	18.822	83.48	352
	Octadecanoic acid, trimethylsilyl ester	18.914	95.69	356
	Phthalic acid, butyl ester, ester with butyl glycolate	19.261	75.62	336
	Tetradecane, 2,6,10-trimethyl-	19.544	6.66	240
	D-Turanose, heptakis(trimethylsilyl)-	19.658	14.11	846
	Eicosanoic acid, trimethylsilyl ester	19.686	40.59	384
	1,3-Dipalmitin trimethylsilyl ether	20.394	32.88	640
	Benzene, 1,1'-[2-methy-2-(phenylthio)cyclopropylidene]bis-	20.621	41.83	316
	(2,3-Diphenylcyclopropyl)methyl phenyl sulfoxide, ttrans-	20.698	43.27	332
	1-Monolinoleoglycerol trimethylsilyl ether	20.798	16.77	498
	Cholestan-3-one, cyclic 1,2-ethandiyl aetal	21.492	49.93	430
	.psi. ,.psi.-Carotene, 3,4-didehydro-1, 1',2,2'-tetrohydro-1'-hydroxy-1-methoxy-	21.563	30.62	600
	7,8-Epoxylanostan-11-ol, 3-acetoxy-	22.172	35.98	502

	4a,7a-Epoxy-5H-cyclopenta[a]cyclopropa[f]cycloundecene-2,4,7,10,11-pentol,	25.433	23.311	722
	.beta.-Sitosterol trimethylsilyl ether	26.738	13.89	486
EaKa-6 Proximal	Alanine, 2-Methyl-N-(trimethylsilyl)-, trimethylsilyl ester	7.005	30.94	247
	Cyclopent-3-ene-1,1,2-tricarbinitrile	8.046	66.25	318
	Titanium, bis (.	8.06	22.81	492
	Propanoic acid, 2-[(trimethylsilyl)oxy]-, trimethylsilyl ester	8.378	66.58	234
	Prostaglandin E2, O,O'-bis(trimethylsilyl)-, trimethylilyl ester	8.69	48.57	568
	N'-(1H-Indol-3-ylmethylene)benzohydrazide ditms	10.219	43.86	407
	Pentasiloxane, dodecamethyl-	10.34	56.34	384
	Benzoic acid trimethylsilyl ester	12.004	64.23	194
	Octanoic acid, trimethylsilyl ester	12.259	46.92	216
	Silanol, trimethyl-, phosphate	12.365	86.2	314
	Prosta-5, 13-dien-1-oic acid,	13.909	12.99	642
	Nonanoic acid, trimethylsilyl ester	13.923	46.77	230
	3H-Pyrazol-3-one, 1,2-dihydro-1,2-diphenyl-5-[(trimethylsilyl)oxy]-4-[3-[(trimethylsilyl)oxy]butyl]-	13.944	40.07	468
	2-Butenoic acid, tert-butyldimethylsilyl ester	14.39	41.36	200
	Hexanedioic acid, bis(trimthylsilyl) ester	15.913	29.35	290
	2,4-Imidazolidinedione, 5-[3,4-bis[(trimethylsilyl)oxy]phenyl]-3-methyl-5-phenyl-1-(trimethylsilyl)-	16.472	35.49	516
	.beta.-D-Glucopyranosiduronic acid, .	16.543	25.9	648
	Amine, N,N,N-tris((trimethylsilyloxy)ethyl)-	16.713	90.94	365
	9,12,15-Octadecatrienoic acid, 2,3-bis[(trimethylsilyl)oxy]propyl ester	17.017	33.01	496
	Octanedioic acid, bis(trimethylsilyl)ester	17.109	36.99	318
	Azelaic acid, bis(trimethylsilyl) ester	17.513	97.2	332
	5,8,11-Eicosatriynoic acid, tert-butyldimethylsilyl ester	17.711	20.59	414
	Obacunone	17.846	22.72	454
	Cinnamic acid, m-(trimethylsiloxy)-, trimethylsilyl ester	18.03	55.98	308
	Phthalic acid, butyl ester, ester with butyl glycolate	18.219	11.39	414
	Hexadecanoic acid, trimethylsilyl ester	18.32	96.34	328
	Titanium(IV) butoxide	18.78	28.32	340

	9,12-Octadecadienoic acid (Z,Z)-, trimethylsilyl ester	18.851	91.89	352
	Octadecanoic acid, trimethylsilyl ester	18.936	88.59	356
	Severogenin acetate	19.17	14.15	544
	Phthalic acid, butyl ester, ester with butyl glycolate	19.276	59.57	336
	1-Chloroeicosane	19.566	10.13	316
	Glycine, N-formyl-N-(trimethyltilyl)-, trimethylsilyl ester,	22.52	15.17	695
	2,4-Imidazolidinedione, 5-[3,4-bis[(trimethylsilyl)oxy]phenyl]-3-methyl-5-phenyl-1-(trimethylsilyl)-	22.633	68.07	416
	Ethyl iso-allocholate	26.765	12.98	436

Appendix C.5 Sample Set 5

Table 0.10 GC/MS Results Sample Set 5

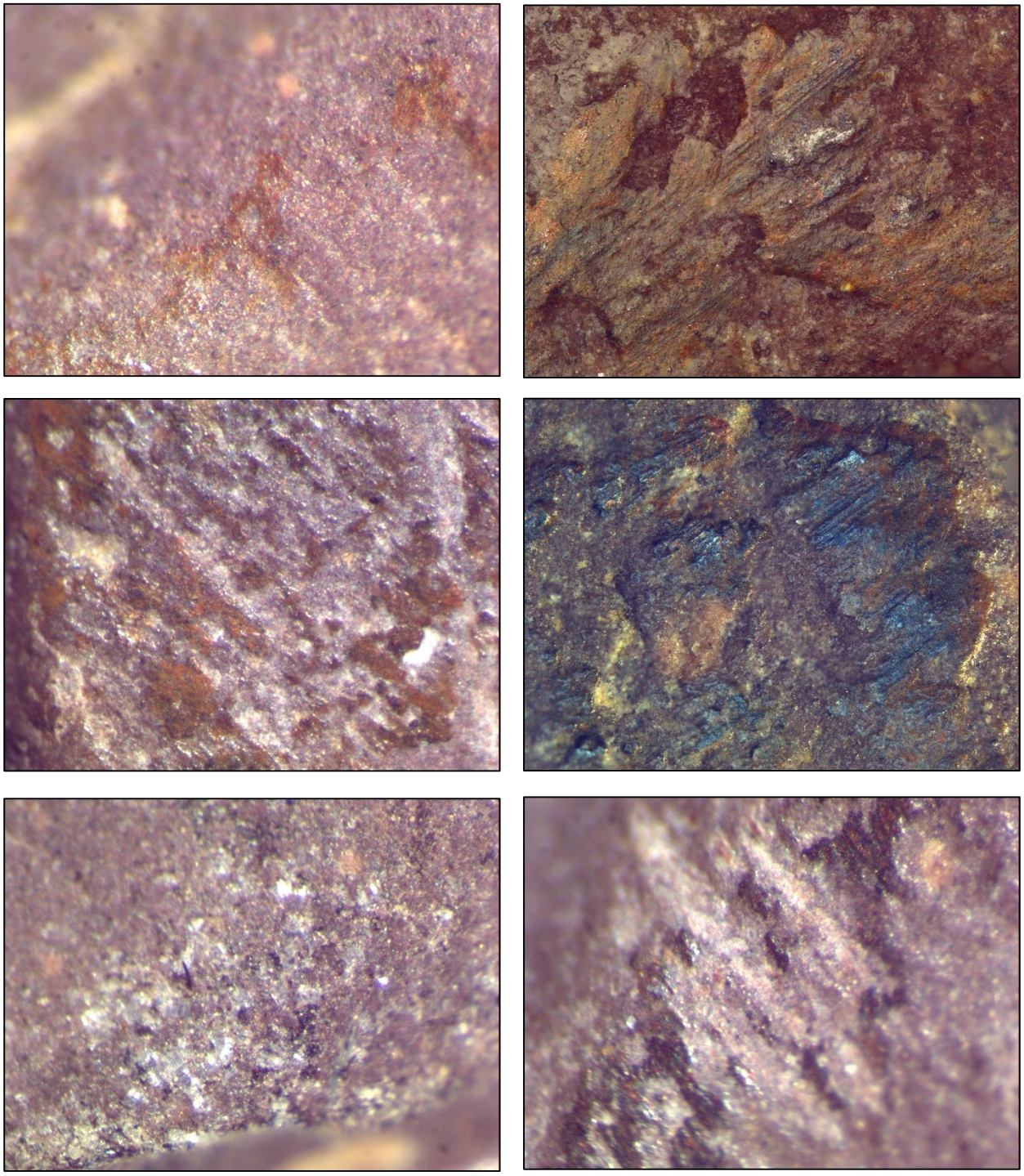
Sample Set 5	Compound	Retention Time	Percent Correct ID	MW
DbJs-8 Working edge	Borane, trimethyl-	7.331	67	56
	Silane, (1-cyclohexen-1yloxy)trimethyl-	8.251	70.78	170
	Benzoic acid trimethylsilyl ester	11.976	54.3	194
	Silanol, trimethyl-, phosphate	12.316	84.94	314
	Octanedioic acid, bis(trimethylsilyl)ester	17.074	68.57	318
	Azelaic acid, bis(trimethylsilyl) ester	17.485	97.44	332
	Hexadecanoic acid, trimethylsilyl ester	18.285	54.5	328
	2-Butenoic acid, 2-methyl-, 1,1a,1b,4,4a,5,7a,7b,8,9	25.298	32.55	528
	9-Desoxo-9-x-acetoxy-3-desoxy-7.8.12-tri-O-acetylingol-3-one	26.977	63.73	534
DbJs-8 Right Lateral	Trifluoromethyl-bis-(trimethylsilyl)methyl ketone	5.985	93.34	338
	Bis(trimethylsiloxy)ethane	6.884	57.44	206
	1-(2-Ethyl-[1,3]dithian-2-yl)-3-methyl-butan-1-ol	7.656	25.82	234
	Silane	8.272	70.54	32
	Borane, trimethyl	8.576	50.53	56
	Acetonitrile	9.072	77.72	41
	Borane, trimethyl	9.794	62.04	56
	Oxalic acid dially ester	10.063	52.15	170
	Benzoic acid trimethylsilyl	11.996	83.91	194

	Silanol, trimethyl, phosphate	12.371	88.08	314
	Phenol, 2,5-bis(1,1-dimethylethyl)-	16.004	70.76	206
	Benzoic acid trimethylsilyl	16.761	53.74	194
	Octadecadienoic acid, trimethylsil ester	17.505	15.15	352
	Octadecadienoic acid, trimethylsil ester	18.843	66.98	352
	Trimethylsilyl 3,5-dimethoxy-4-(trimethylsilyloxy)benzoate	17.866	37.59	342
	Prosta-5, 13-dien-1-oic acid, .	18.312	35.11	642
	Octadecadienoic acid, trimethylsil ester	18.843	66.96	352
	Glycine, N-formyl-N-(trimethyltilyl)-, trimethylsilyl ester	18.928	33.21	247
	9-Desoxo-9-x-acetoxy-3-desoxy-7.8.12-tri-O-acetylingol-3-one	22.553	45.36	534
	Milbemycin B, 6,28-anhydro-15-chloro-25-isopropyl-13-dehydros-5-O-demthyl-4-methyl-	24.862	38.96	590
DeJj-8(16) Working Edge	Benzoic acid	11.982	55.1	194
	Octanoic acid	12.258	18.88	216
	Azelaic acid	17.504	88.07	332
	Hexadecanoic acid	18.305	75.17	328
DeJj-8(16) Right Lateral and Ventral	Benzoic acid	11.975	81.41	194
	Azelaic acid	17.497	93.35	332
	Hexadecanoic acid	18.305	75.82	328
	Octadecatrienoic acid	26.832	43.66	496
DeJj-8(16) Dorsal	Ethanedioic acid	7.656	25.44	234
	Propanoic acid	8.335	35.19	234
	Nicotinaldehyde	8.64	23.03	396
	Benzoic acid	11.967	54.53	194
	Octanoic acid	12.229	35.18	216
	Azelaic acid	17.497	94.05	332
	Hexadecanoic acid	18.304	78.88	328
DeJj-8(16) Proximal	Propanoic acid	8.343	50.54	234
	Azelaic acid	17.497	89.14	332
	Hexadecanoic acid	18.297	45.1	328

APPENDIX D MICROSCOPY

Appendix D.1 Sample Set 1

Figure 0.42 DeJj-8(0) Microscopy



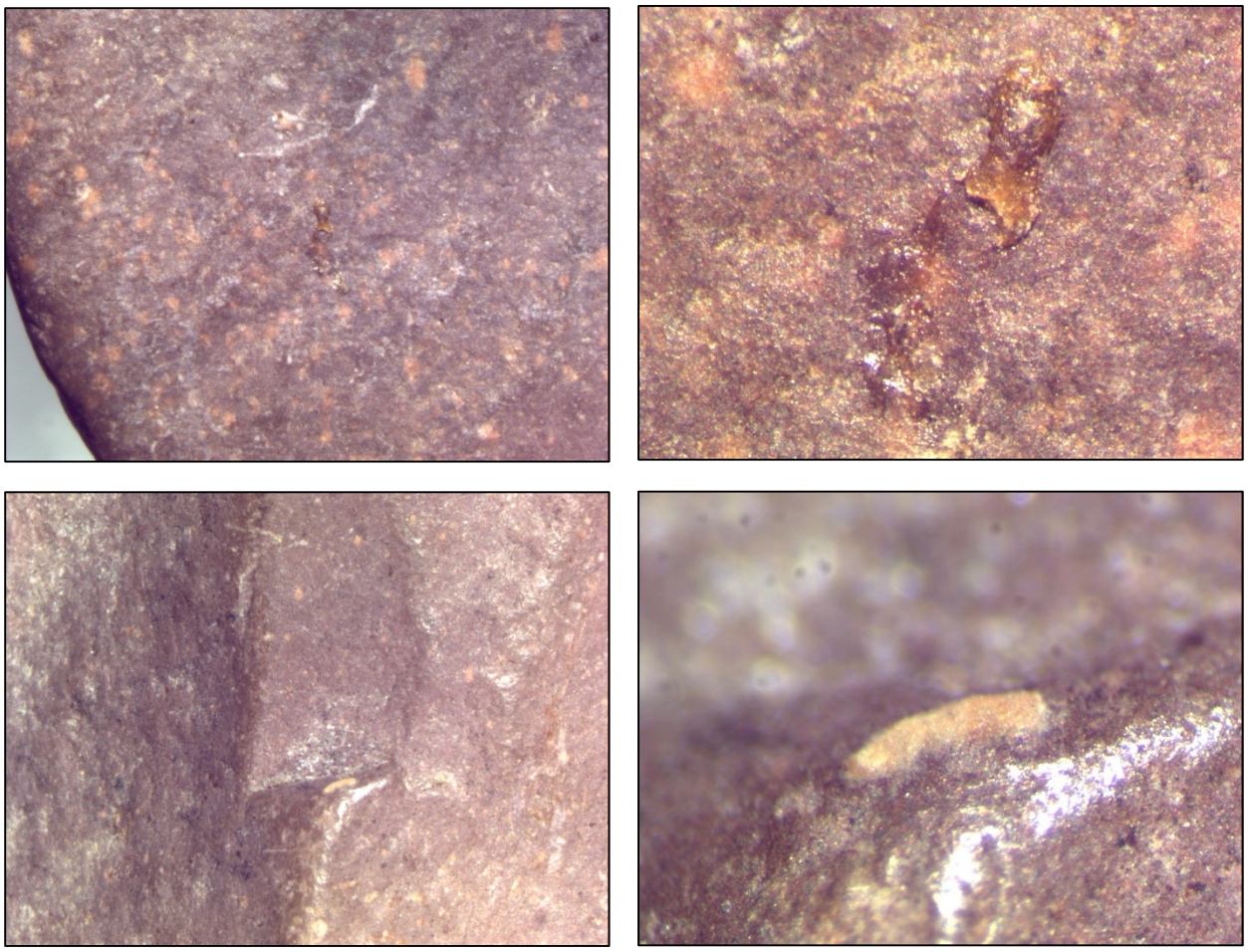
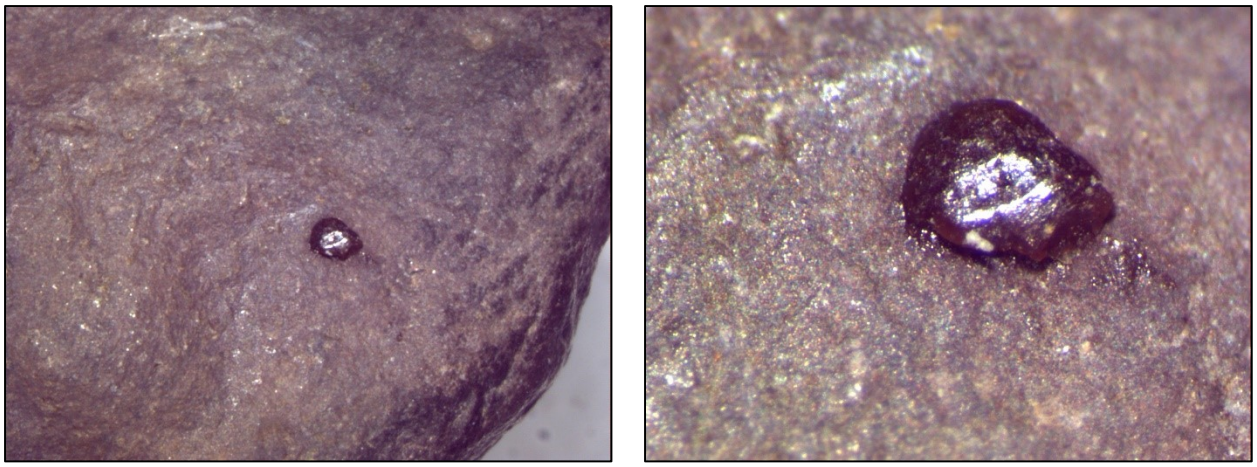


Figure 0.43 DeJj-8(1) Microscopy



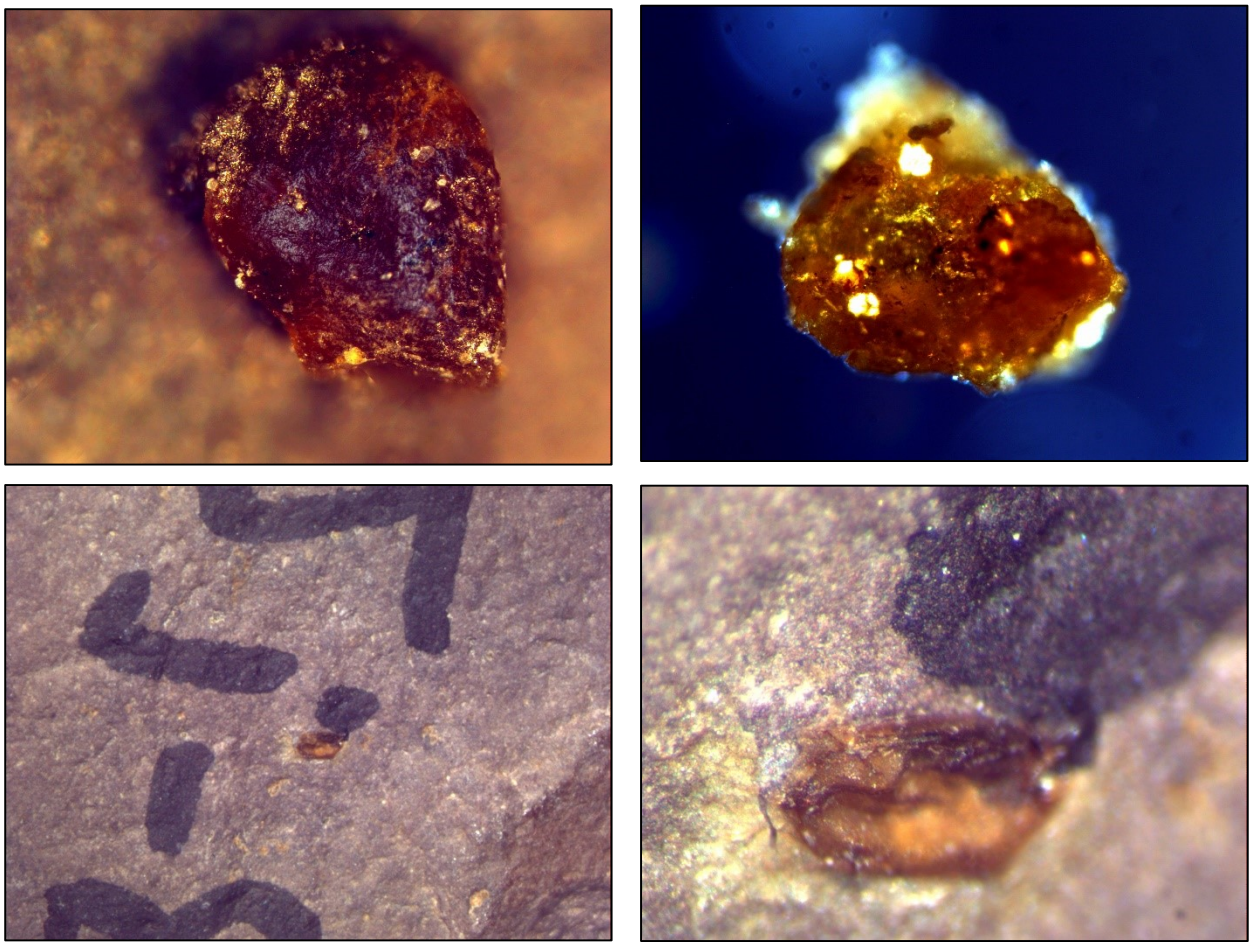


Figure 0.44 DeJj-8(2) Microscopy

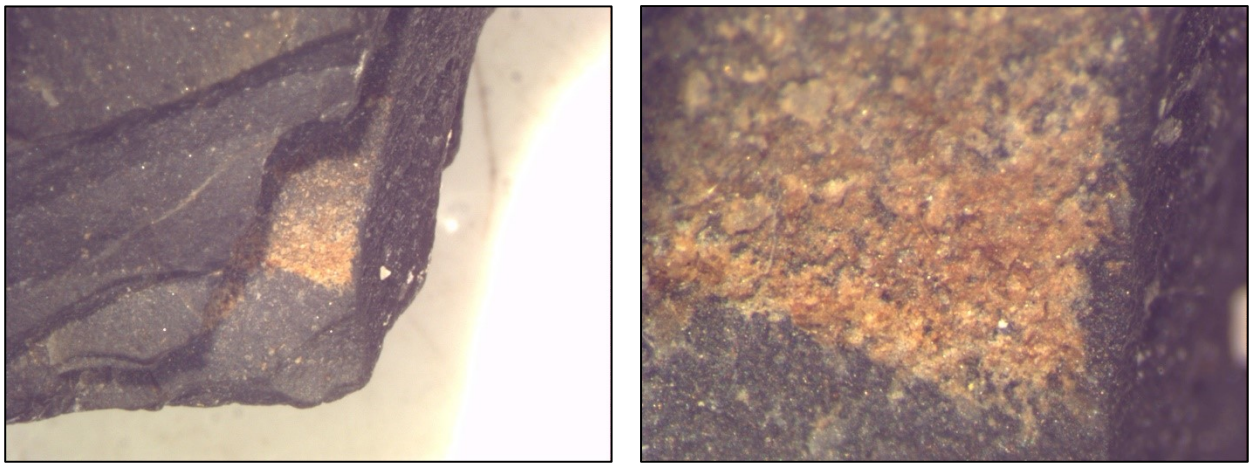


Figure 0.45 DeJj-8(3) Microscopy

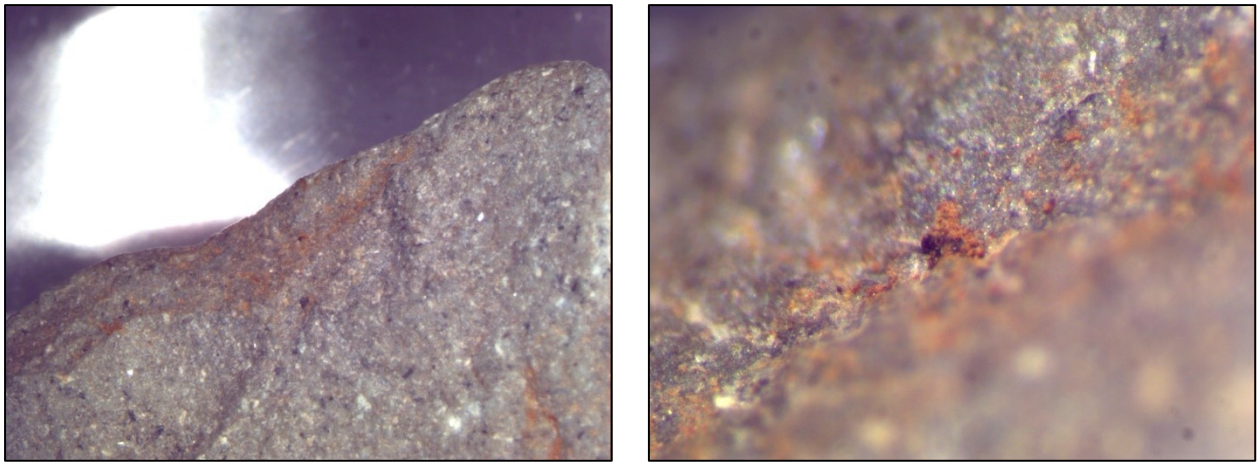
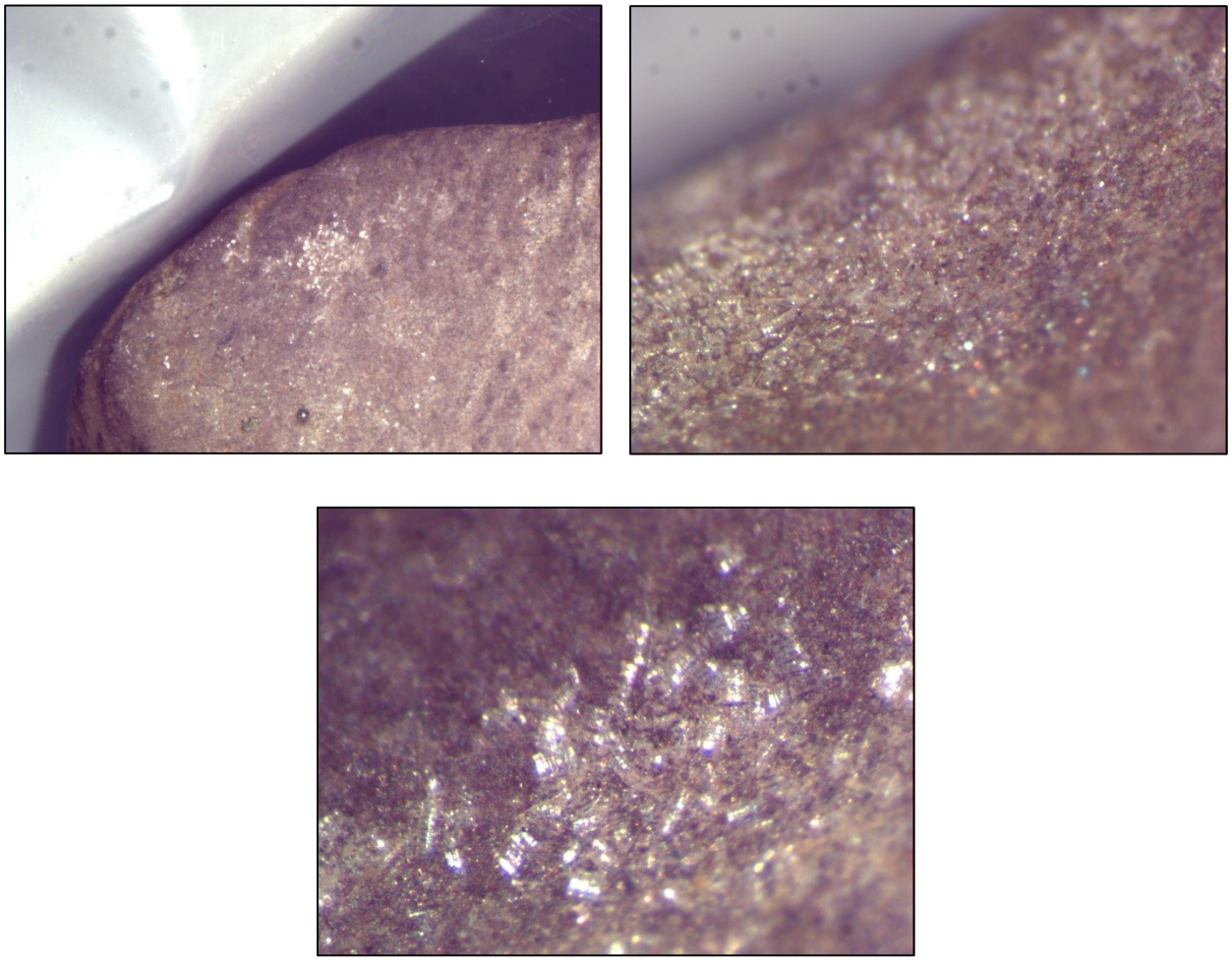


Figure 0.46 DeJj-8(4) Microscopy



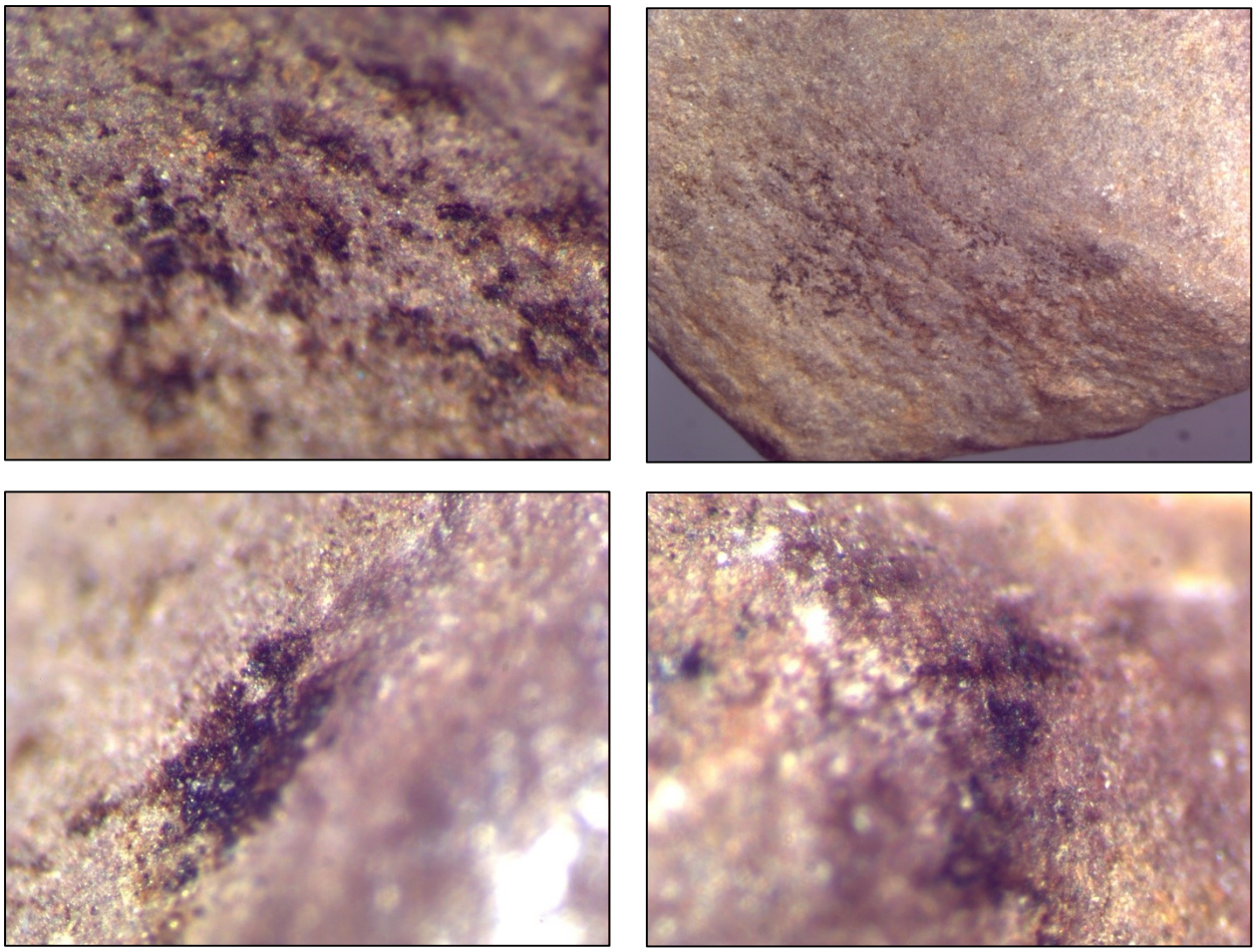
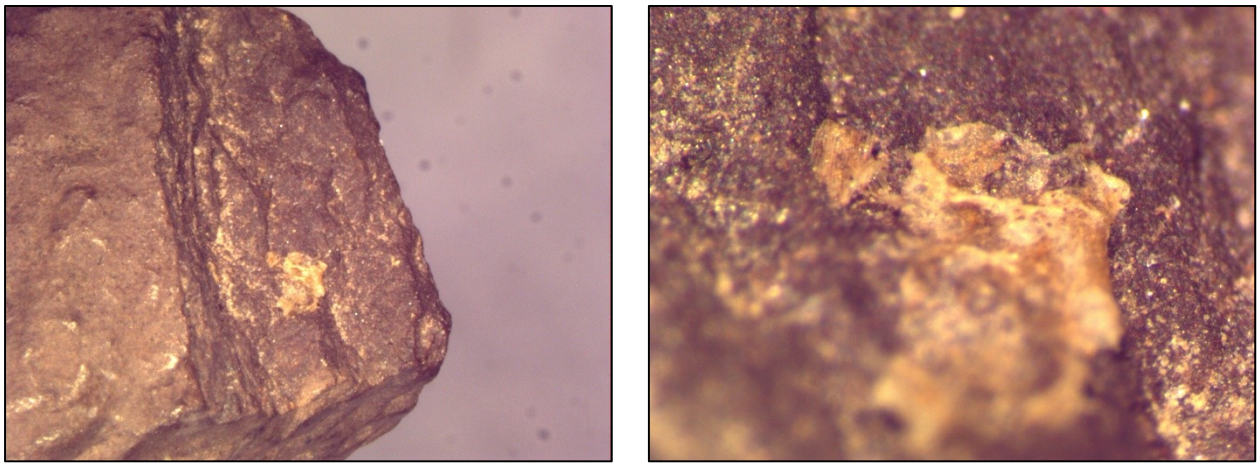


Figure 0.47 Dejj-8(5) Microscopy



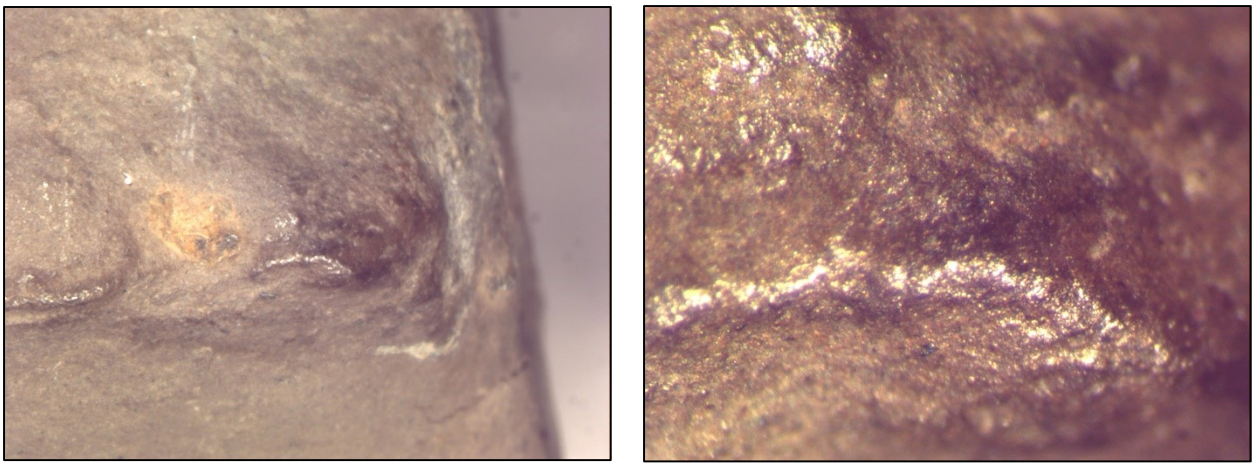


Figure 0.48 DeJj-8(6) Microscopy

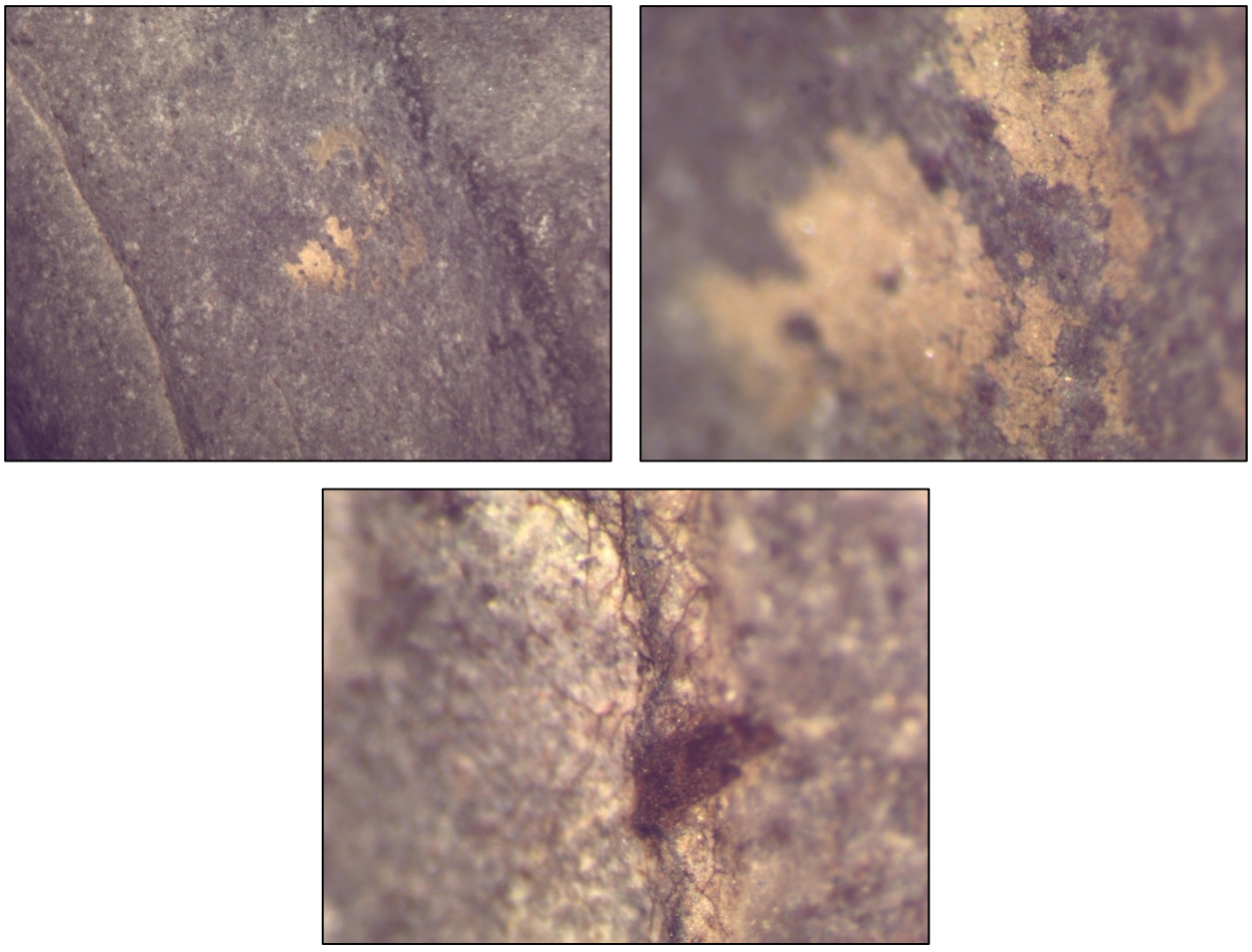


Figure 0.49 DeJj-8(7) Microscopy

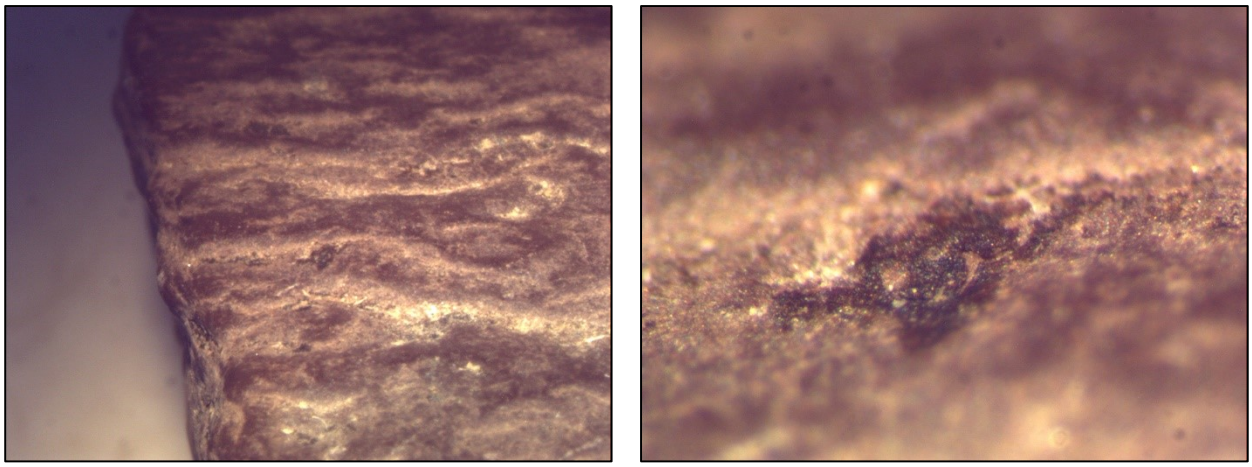
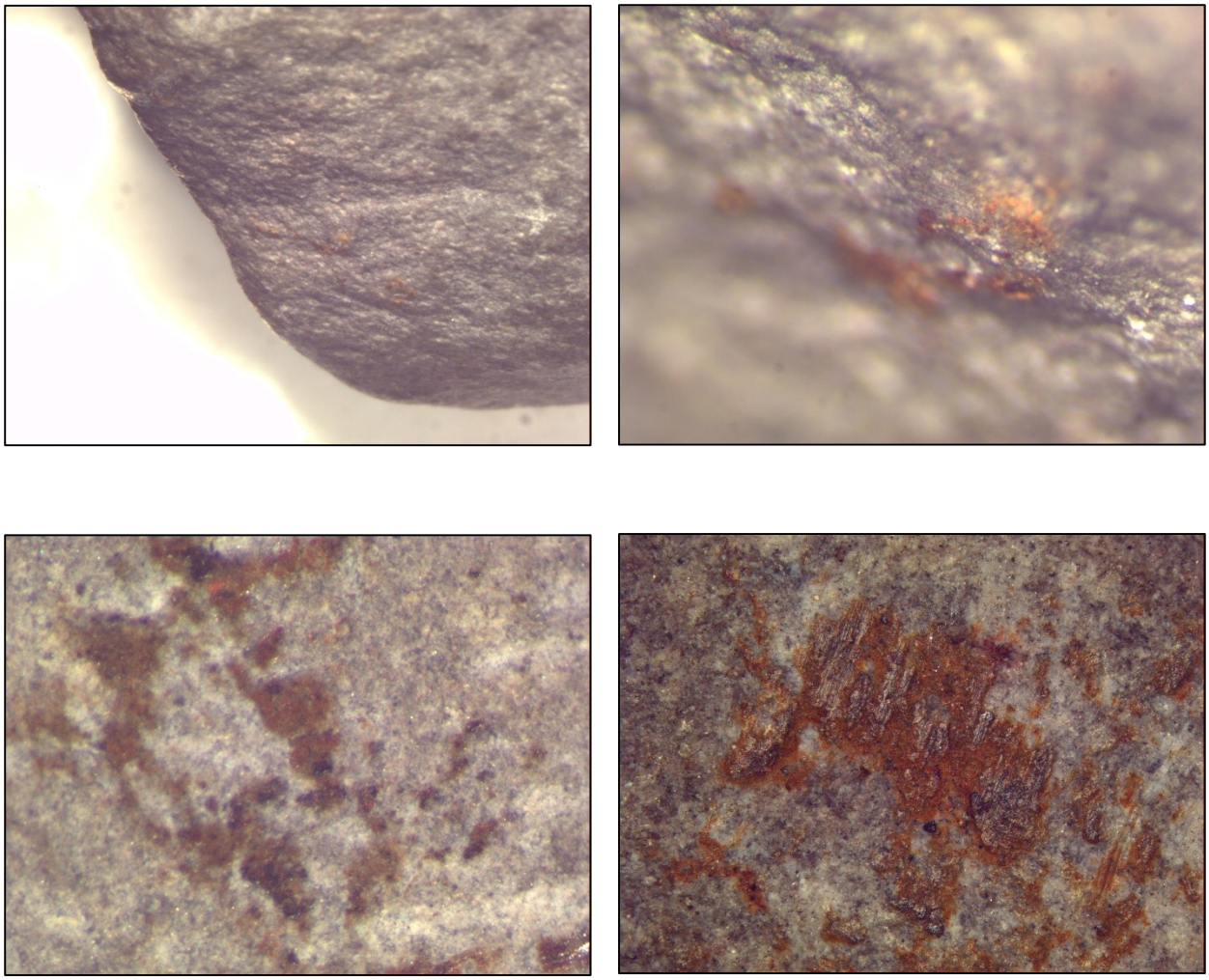
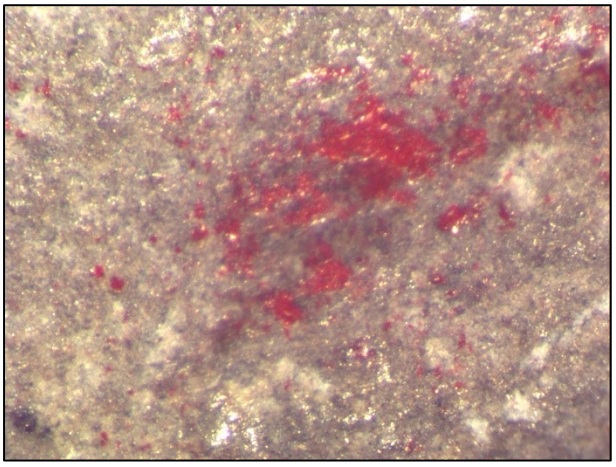
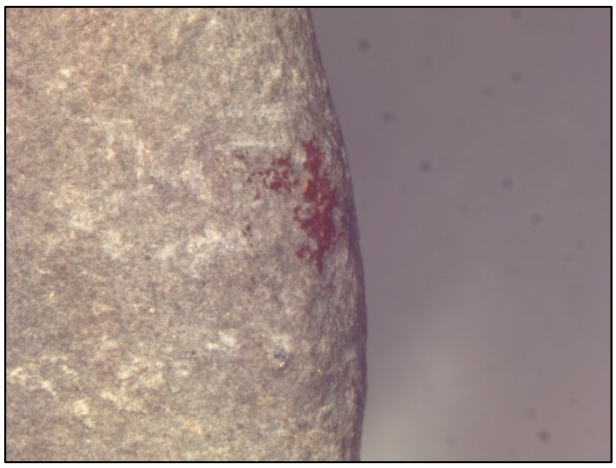
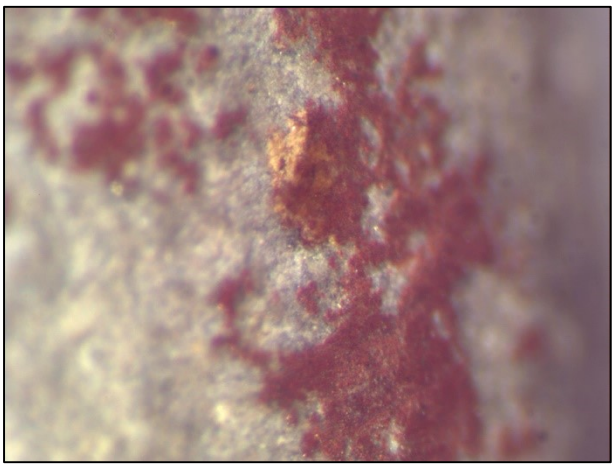


Figure 0.50 DeJj-8(8) Microscopy









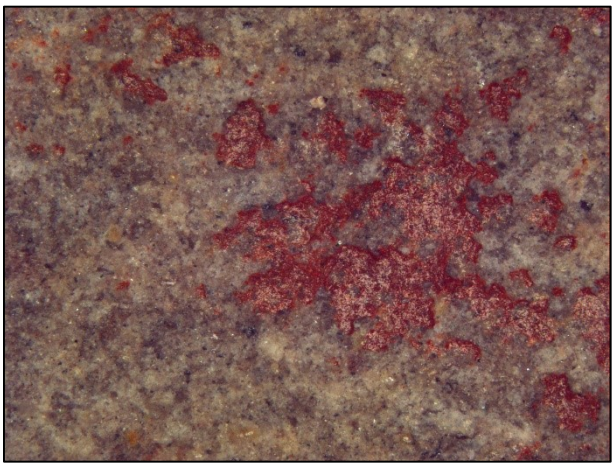


Figure 0.51 DeJj-8(9) Microscopy

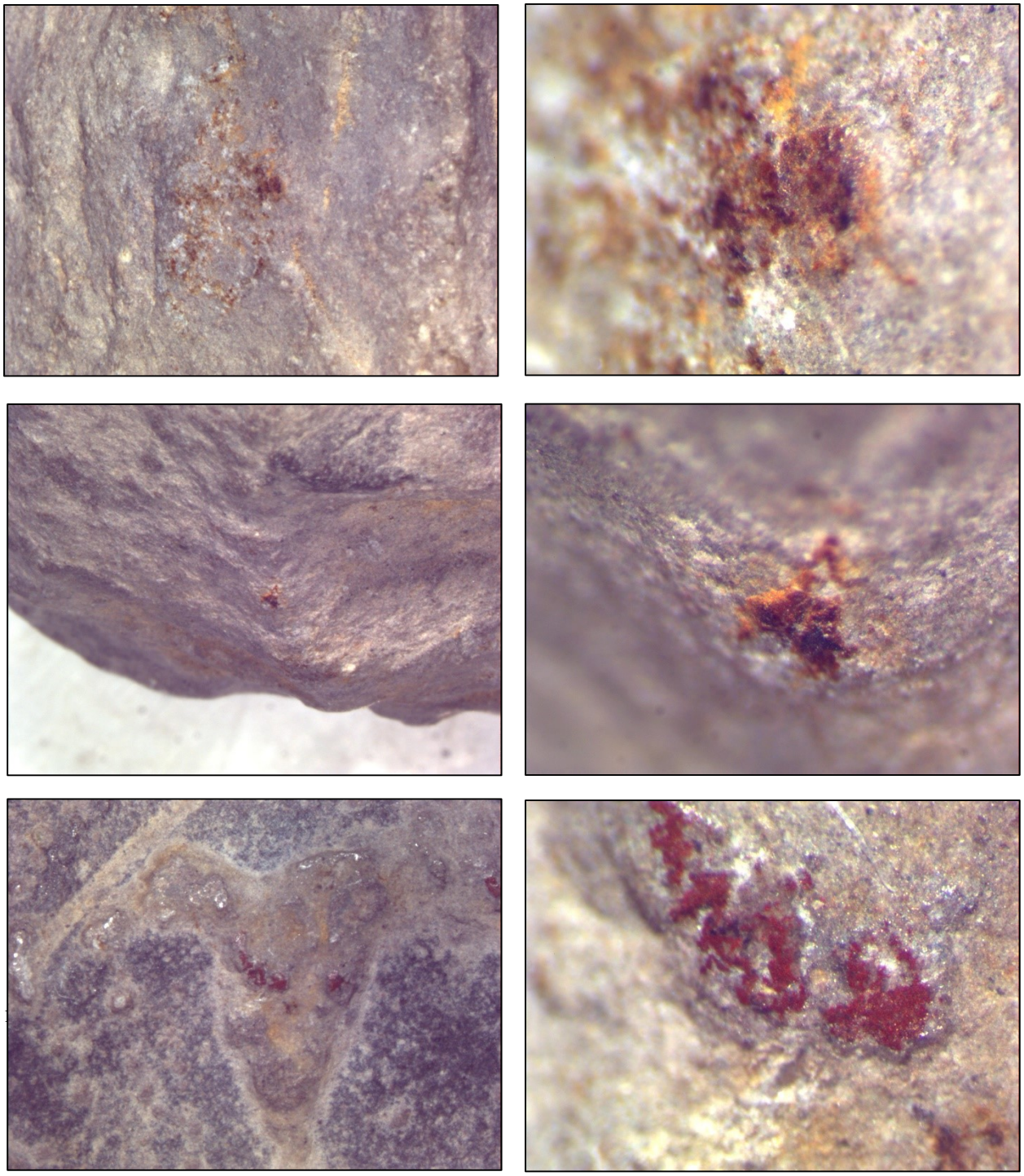


Figure 0.52 DeJj-9(10) Microscopy

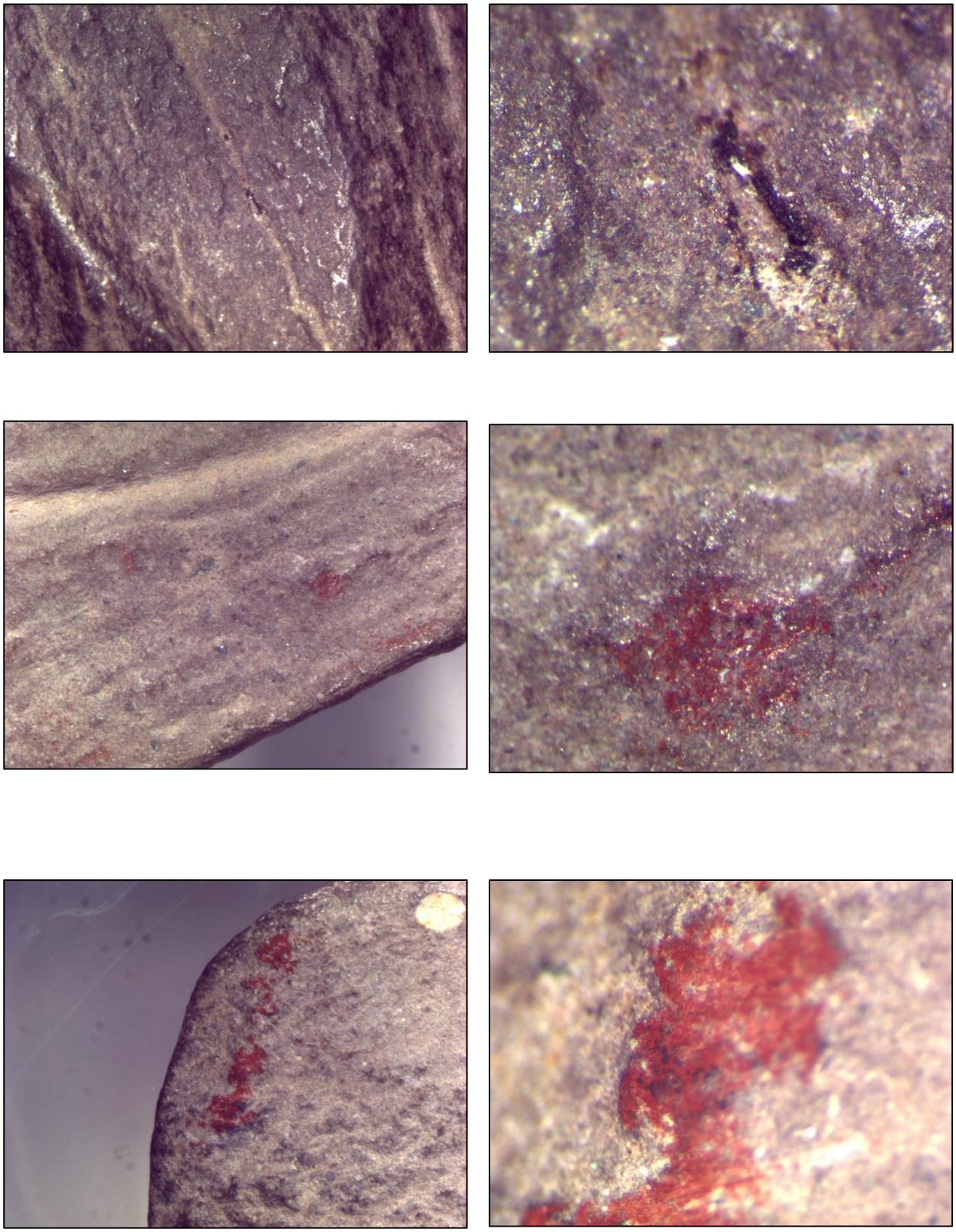


Figure 0.53 DeJj-1(1) Microscopy

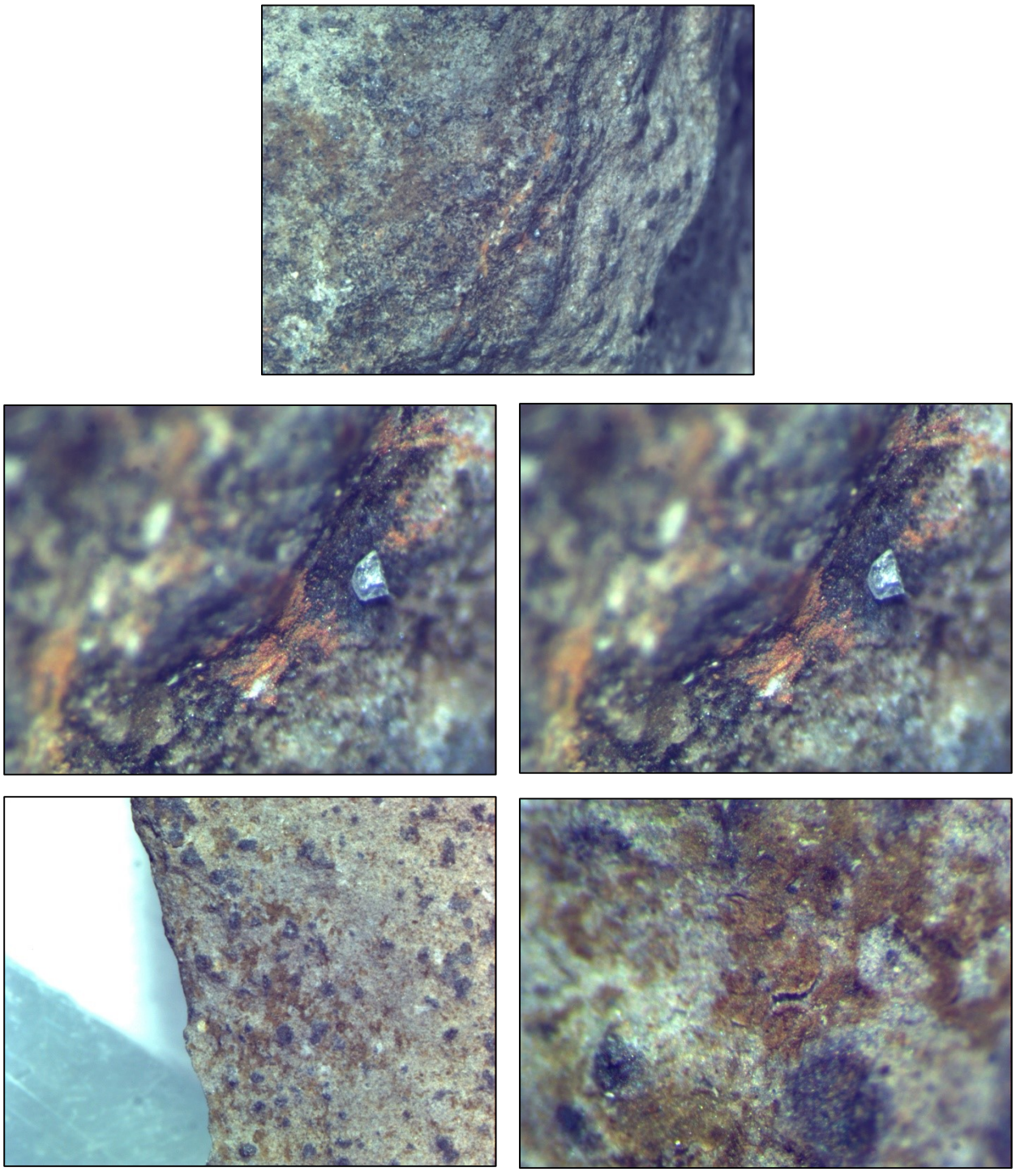


Figure 0.54 DeJj-1(2) Microscopy

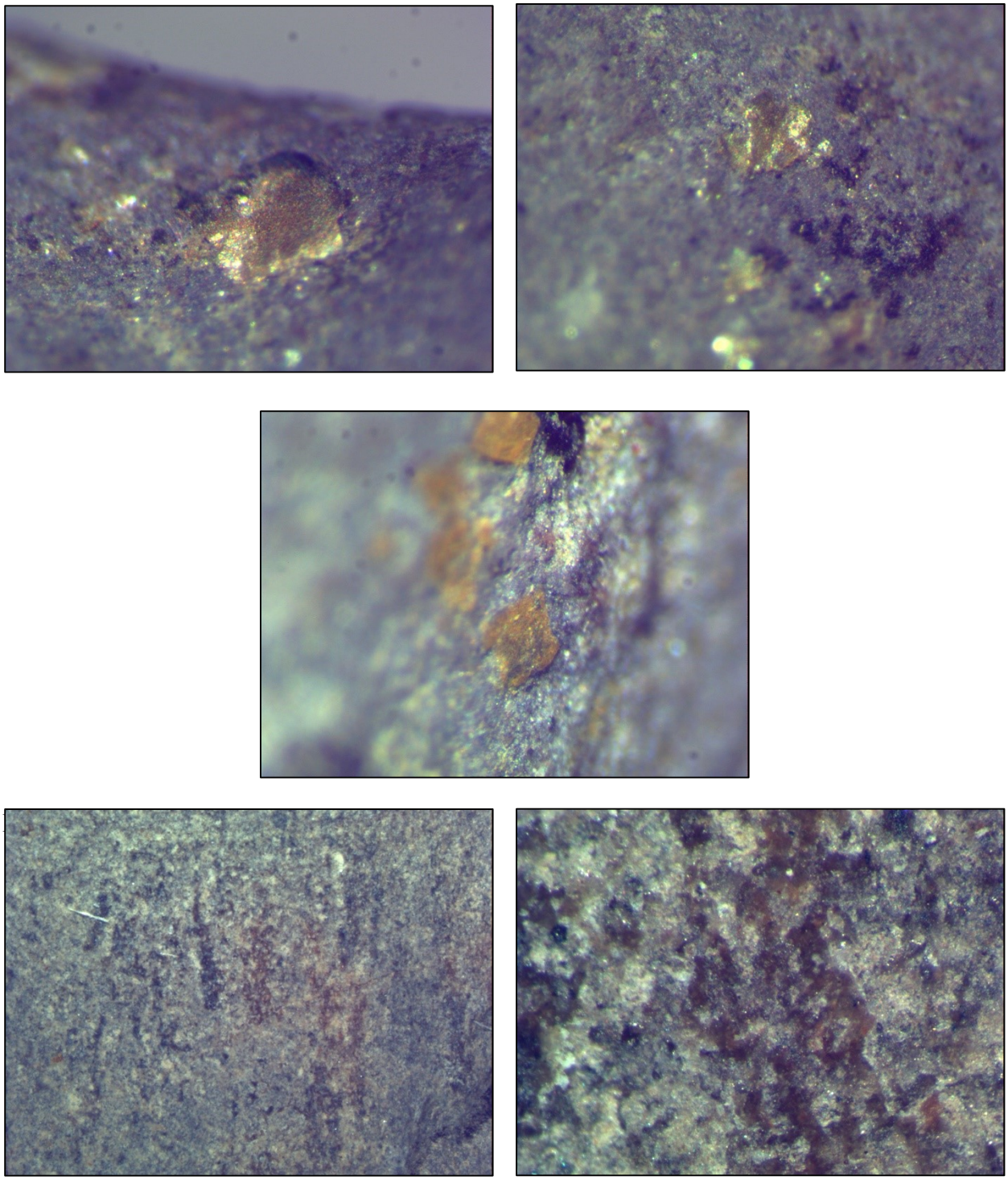


Figure 0.55 DfJi-21 Microscopy

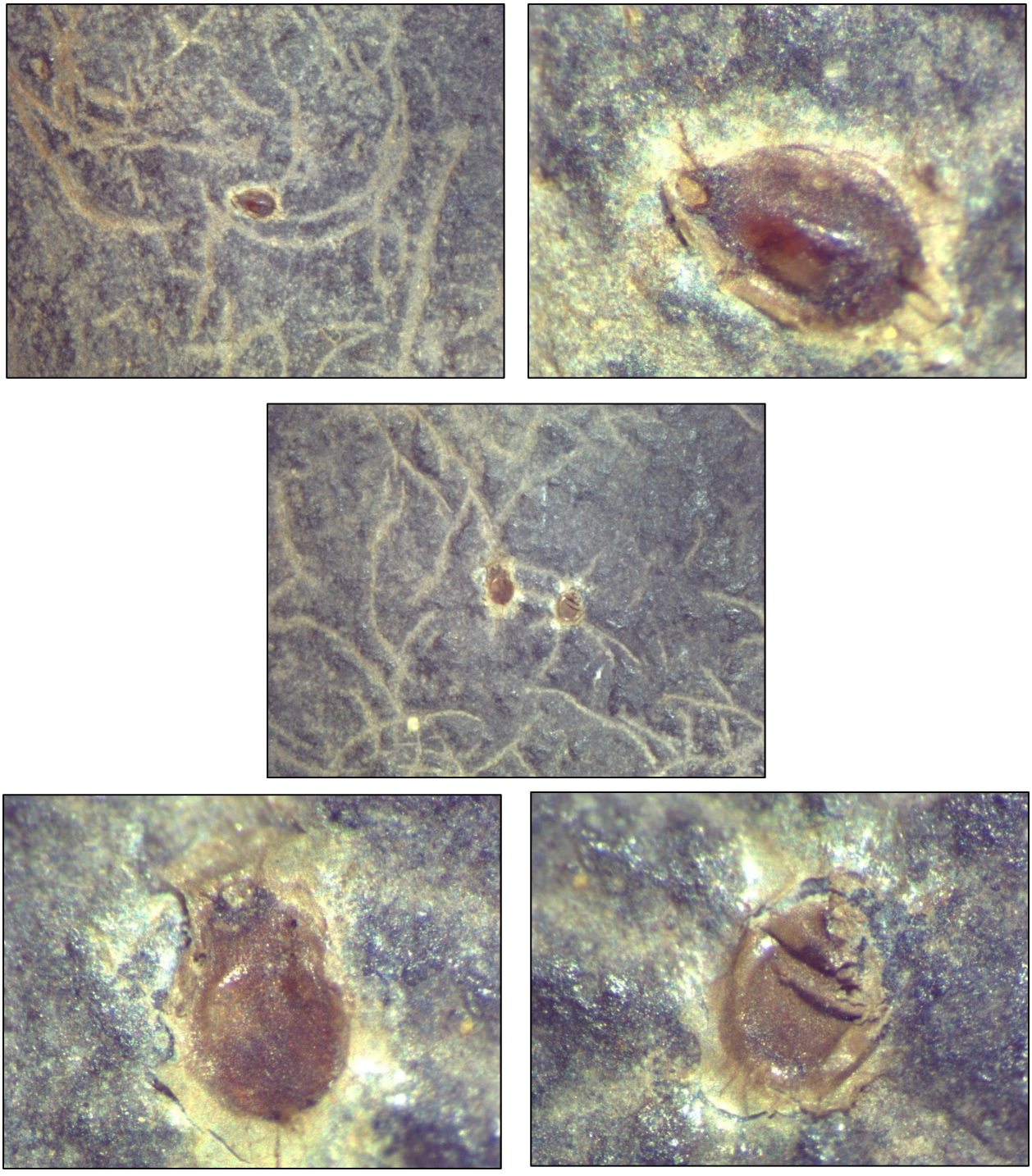


Figure 0.56 DeJj-2(1) Microscopy

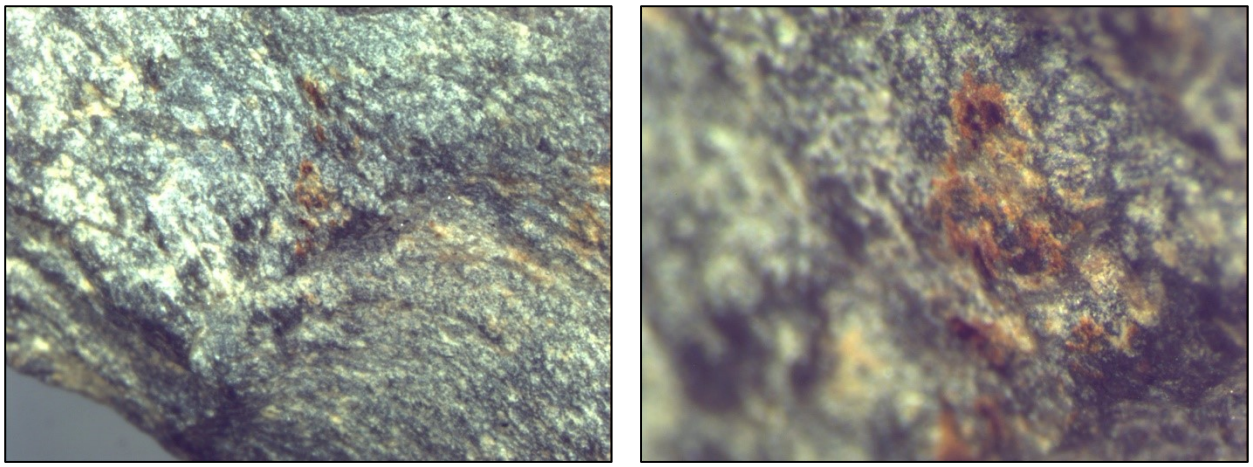
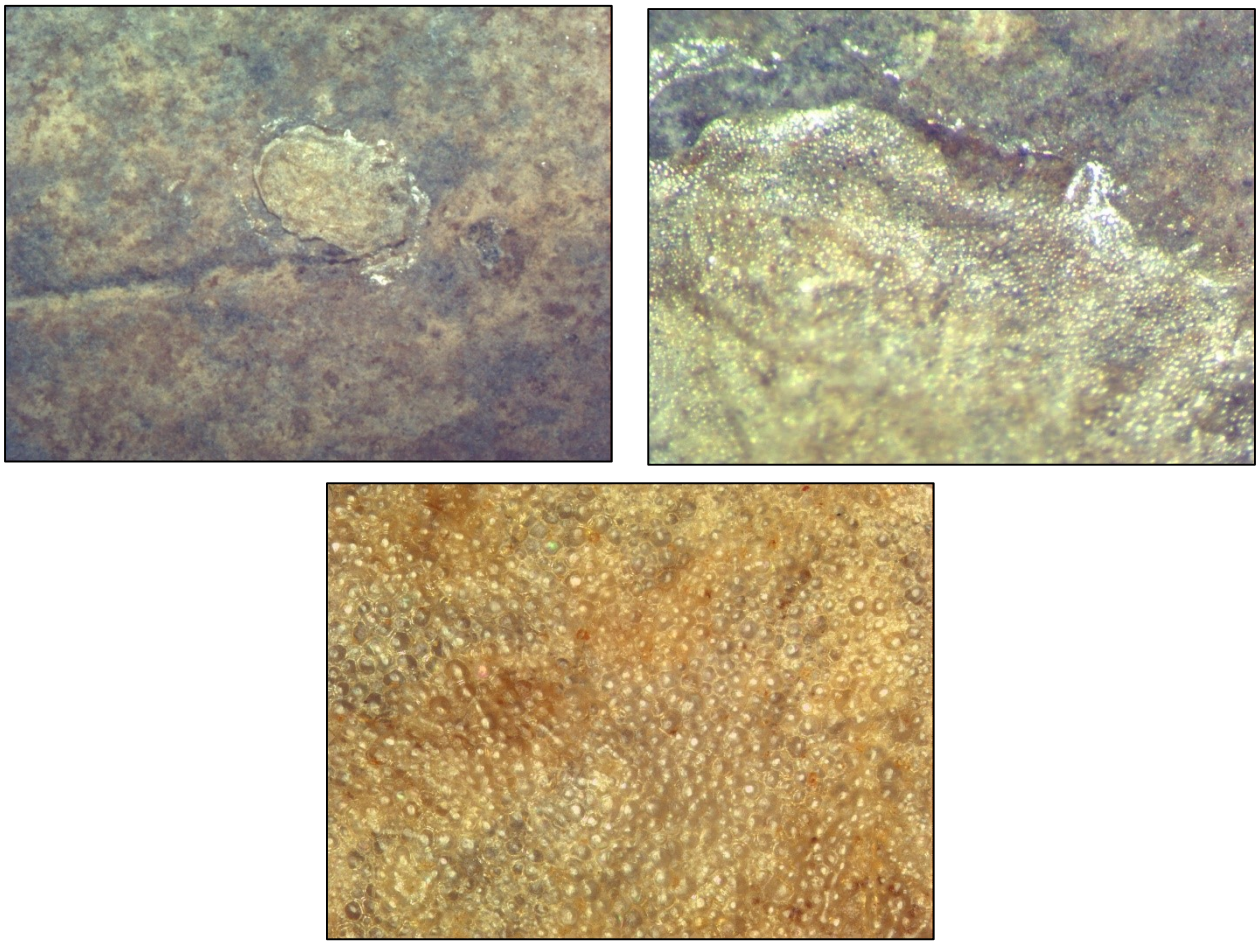
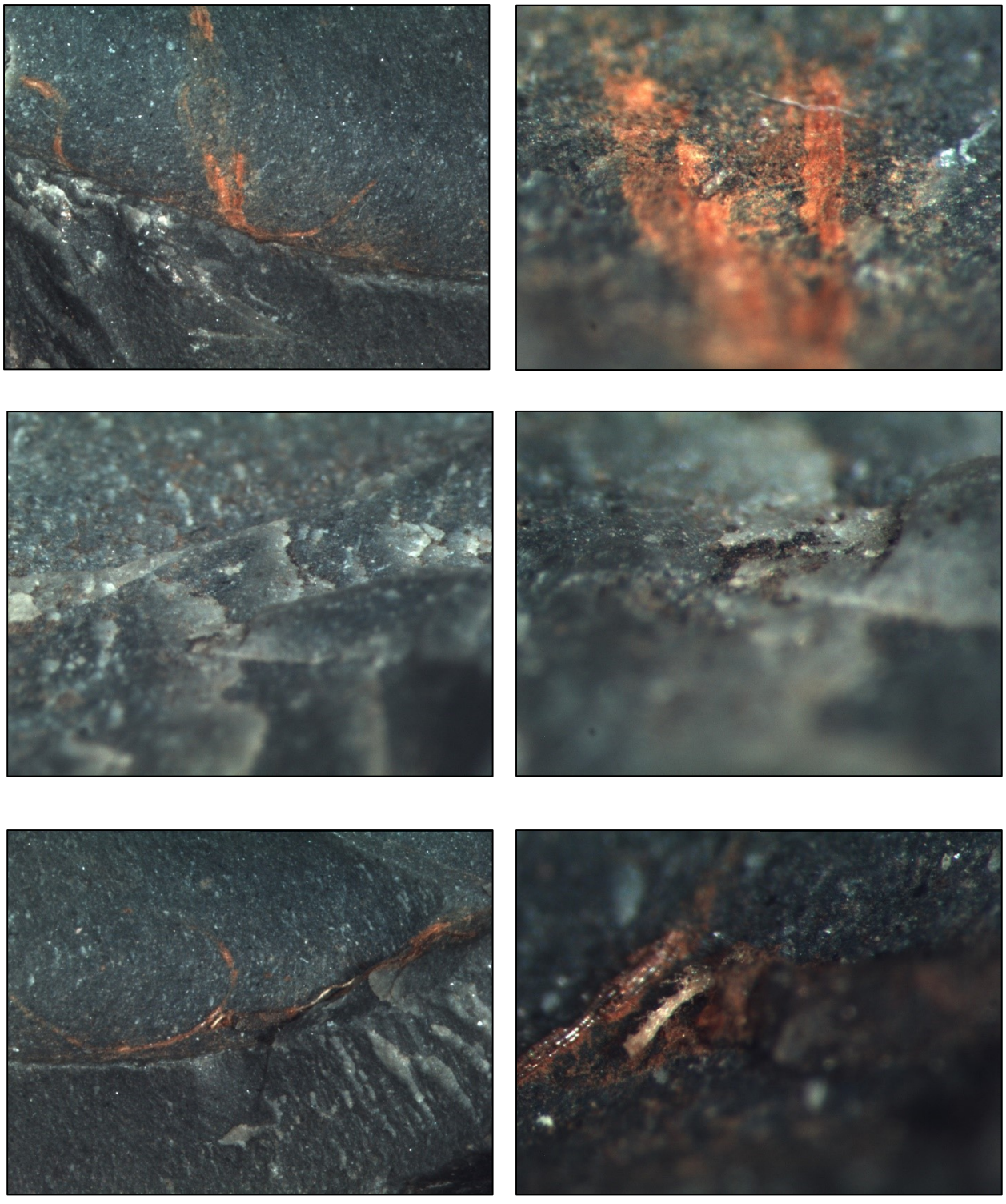


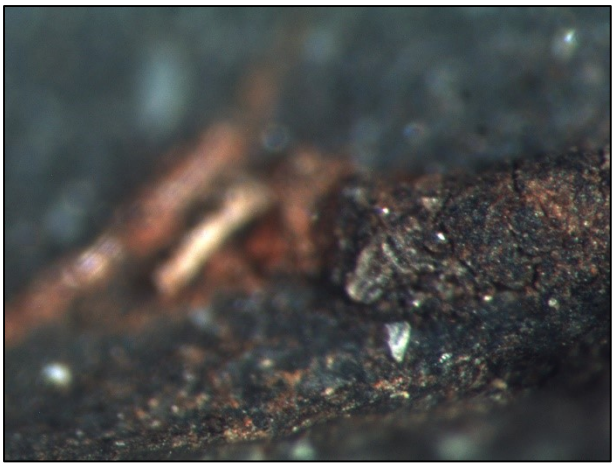
Figure 0.57 DeJj-2(2) Microscopy

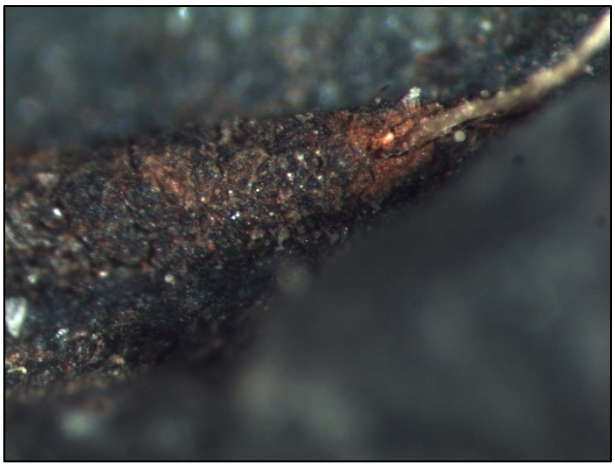


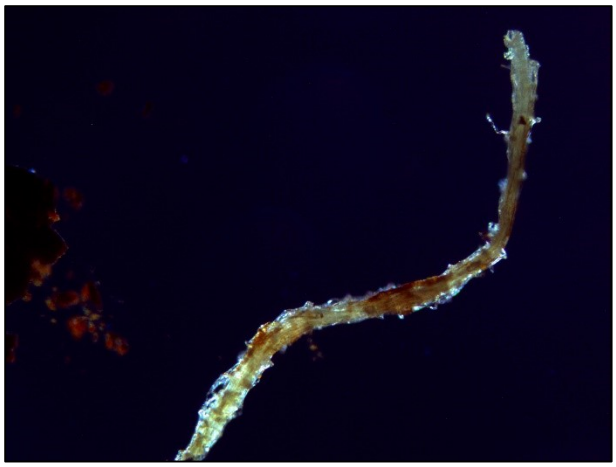
Appendix D.2 Sample Set 2

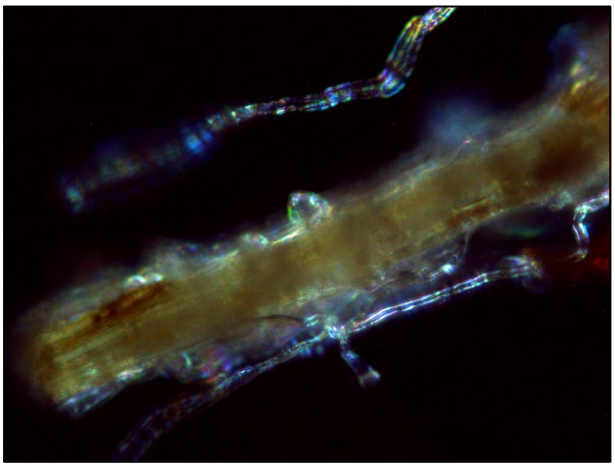
Figure 0.58 DcJi-1(1) Microscopy

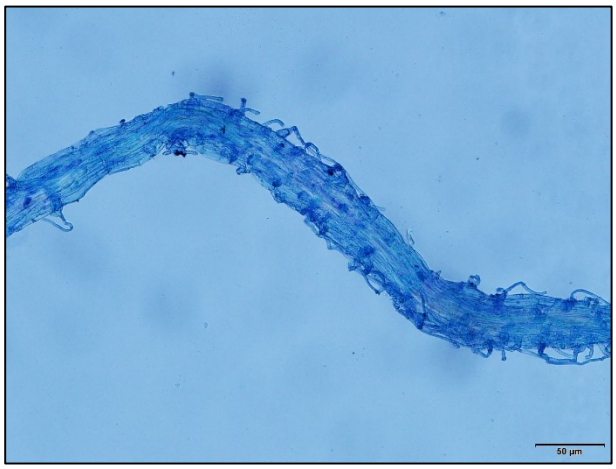











50 µm

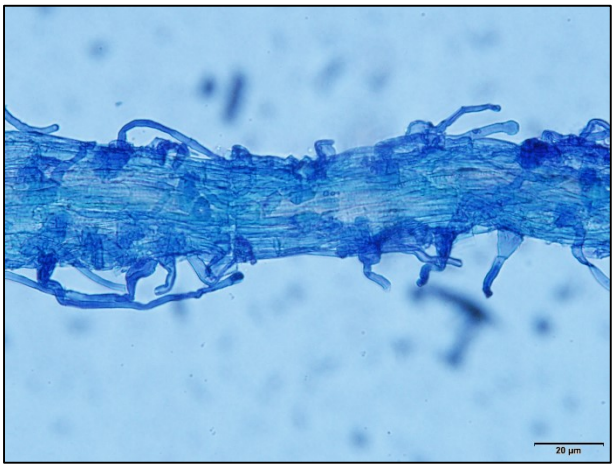

20 µm

Figure 0.59 DcJi-1(2) Microscopy

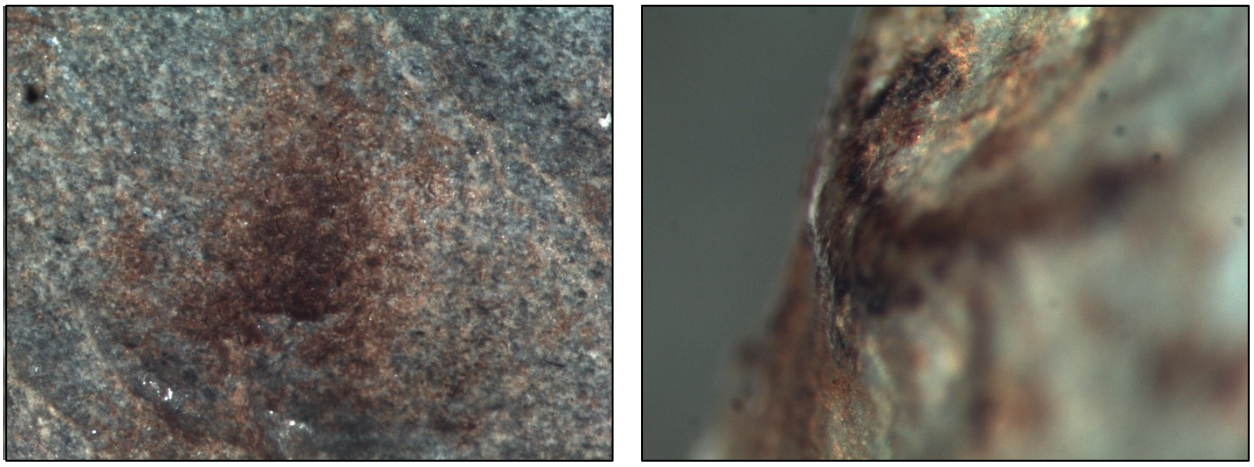


Figure 0.60 DeJj-2(3) Microscopy

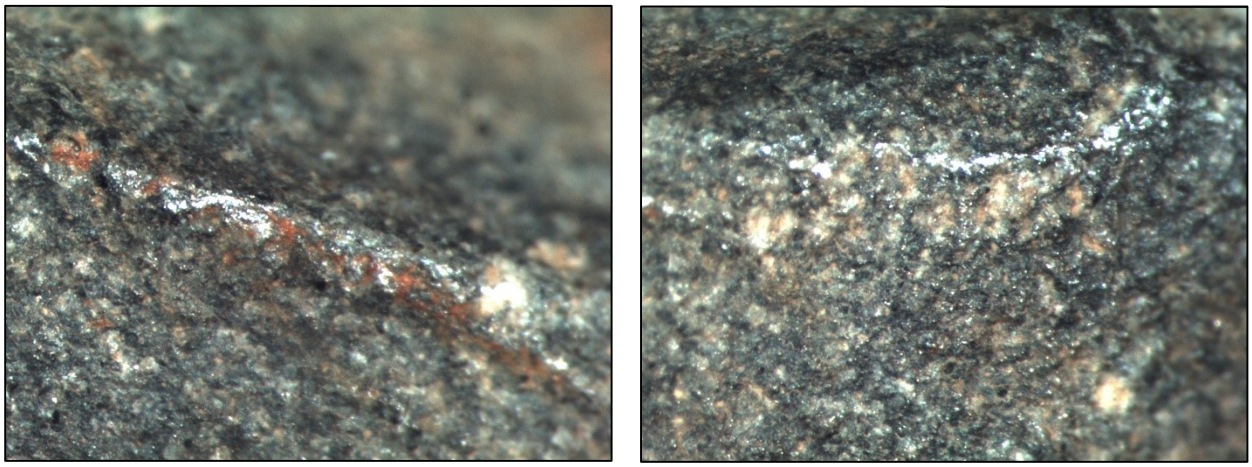


Figure 0.61 DeJj-18 Microscopy

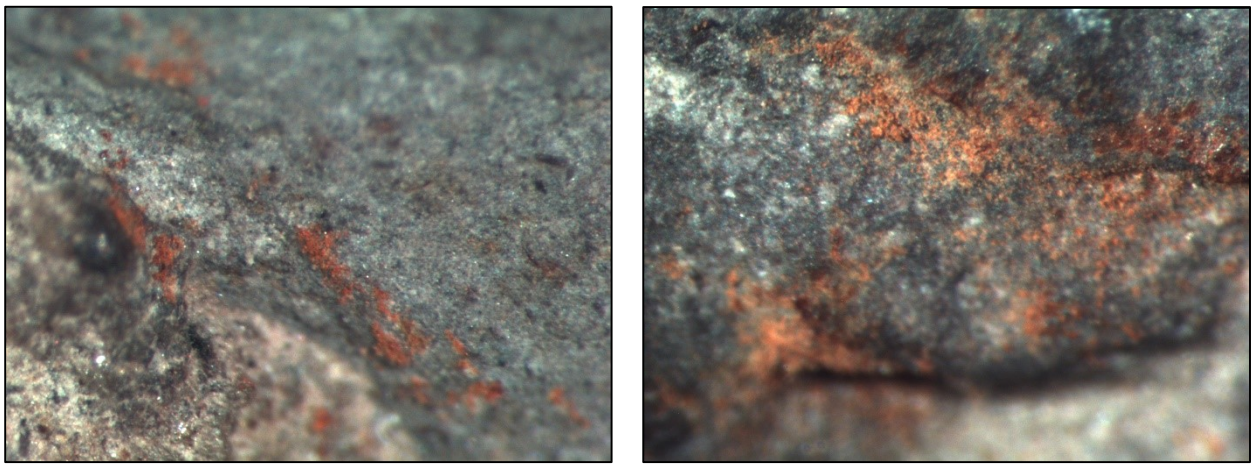
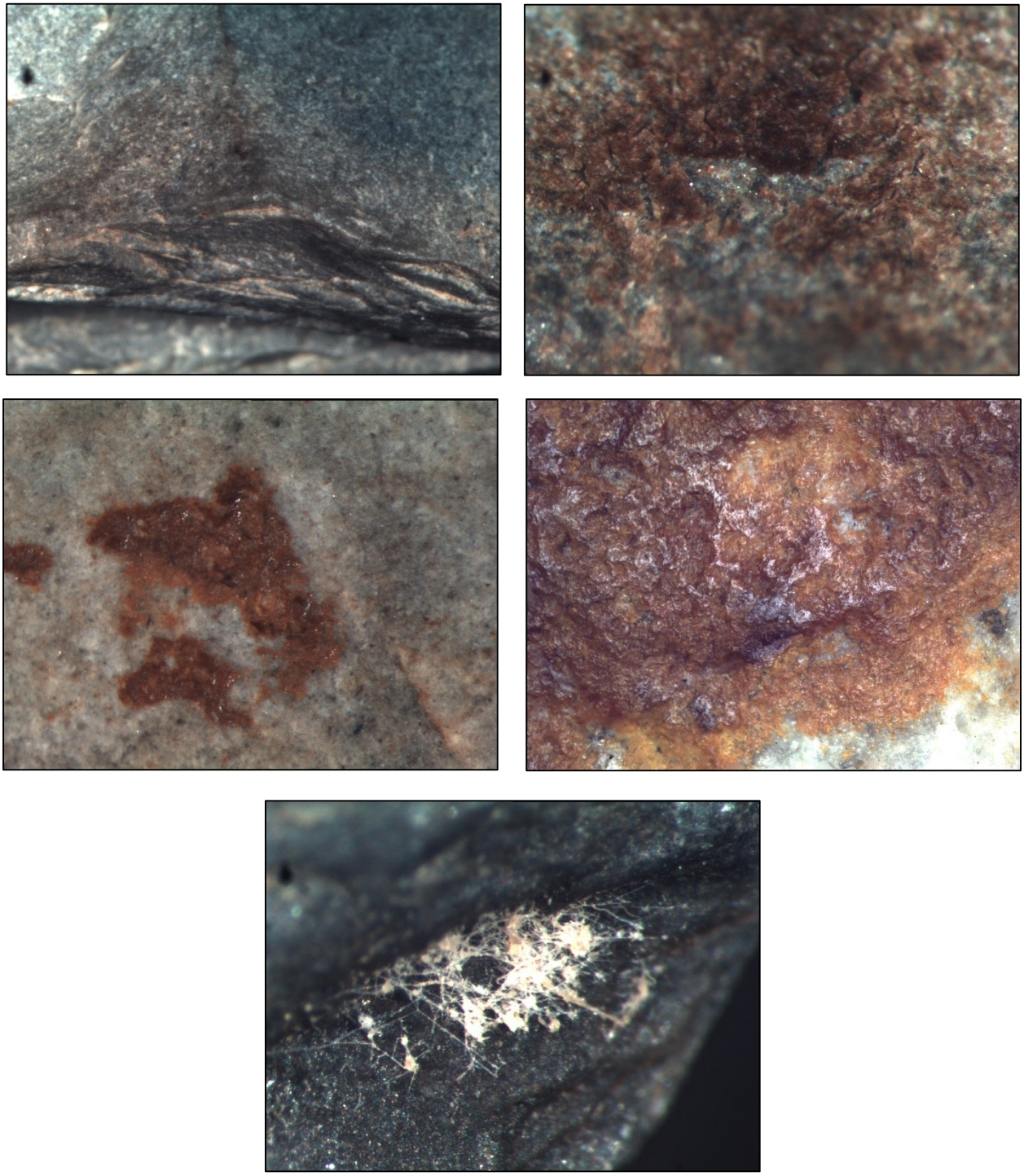


Figure 0.62 DeJj-4(6) Microscopy



Appendix D.3 Sample Set 3

Figure 0.63 DeJj-4(1) Microscopy

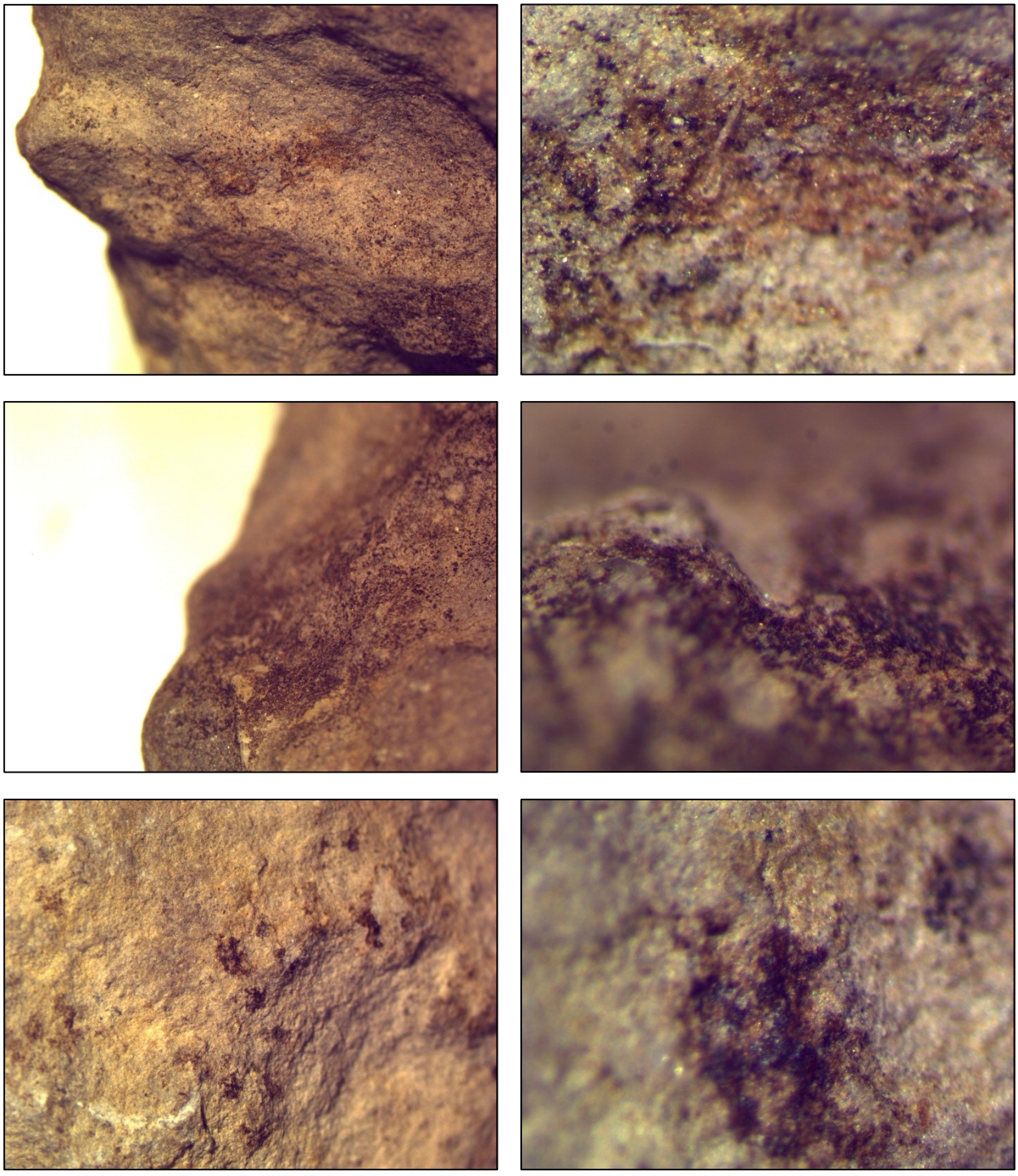
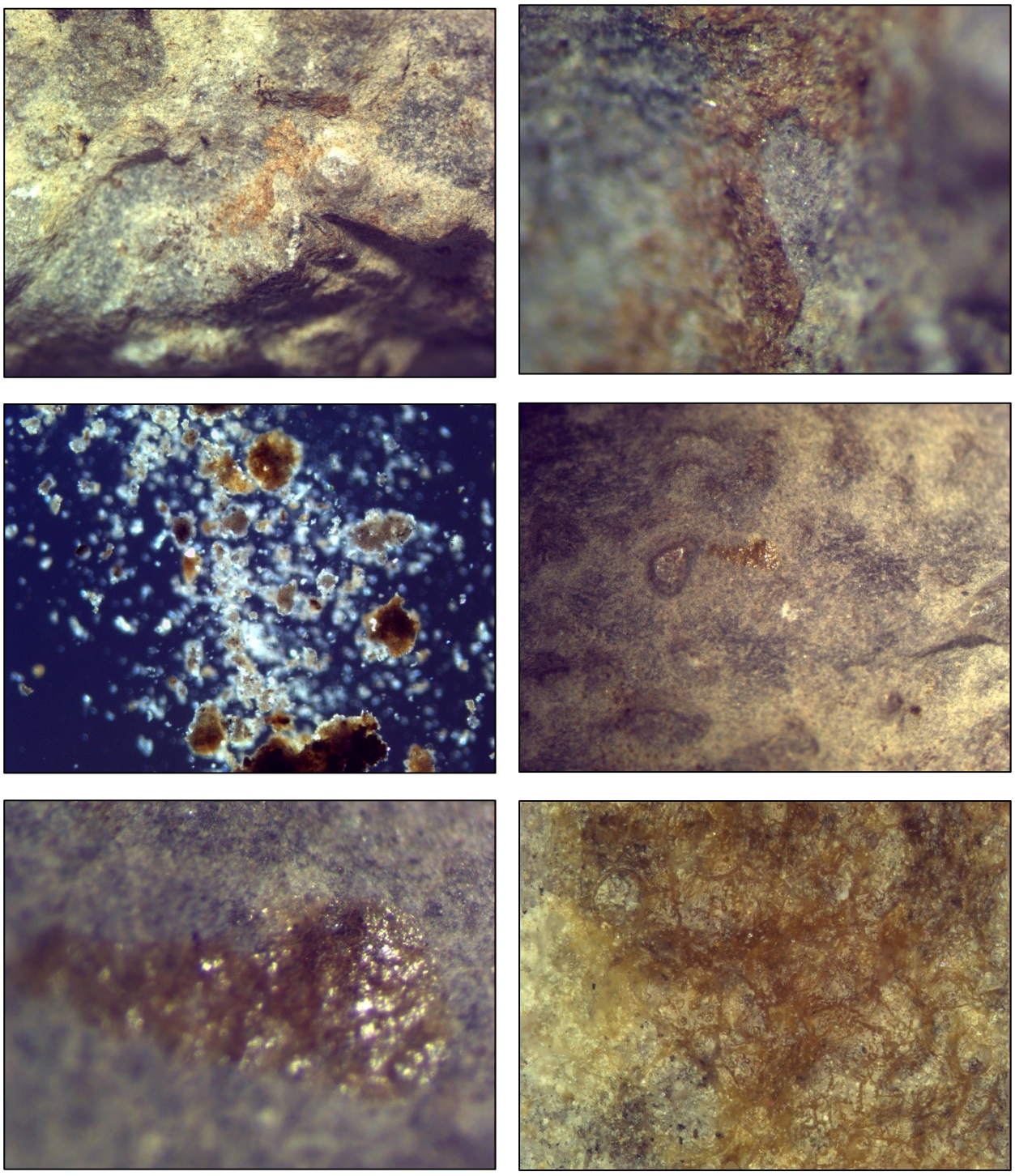


Figure 0.64 DeJj-4(2) Microscopy



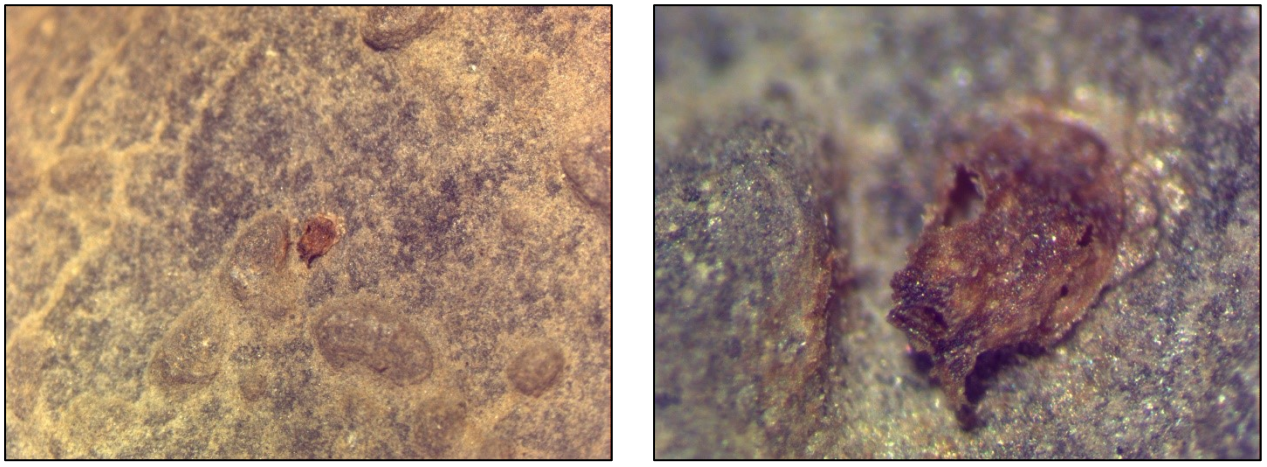


Figure 0.65 DeJj-4(3) Microscopy

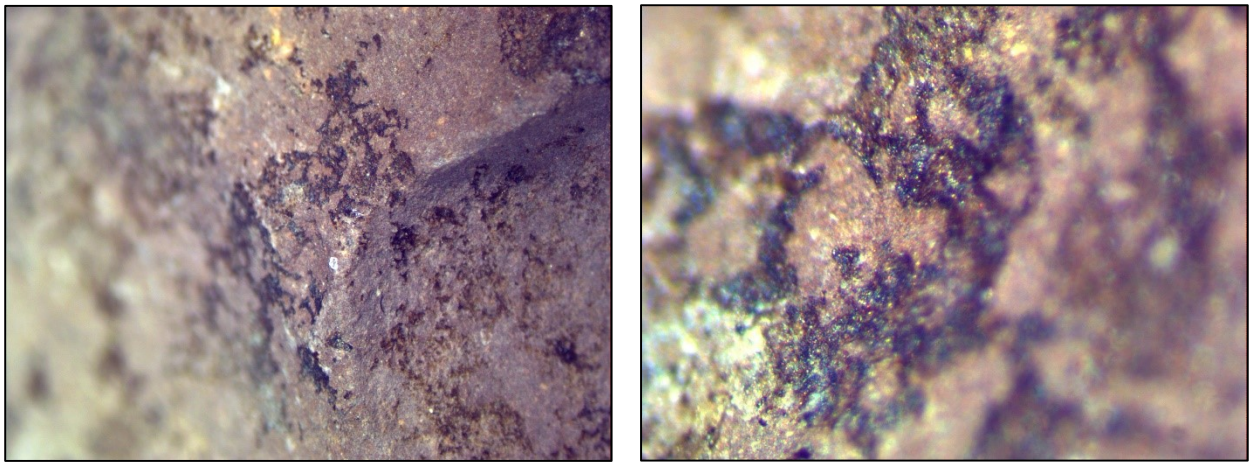
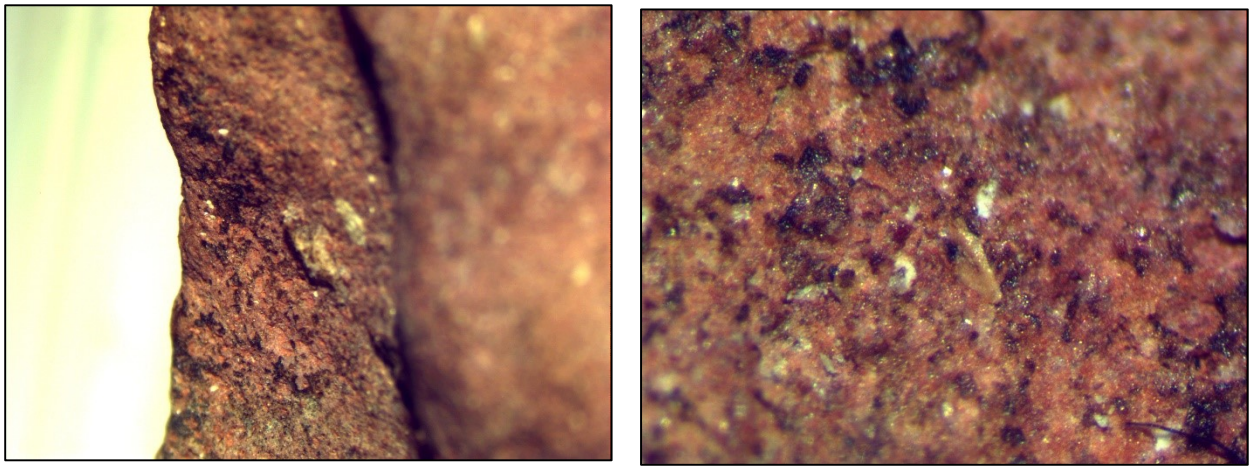
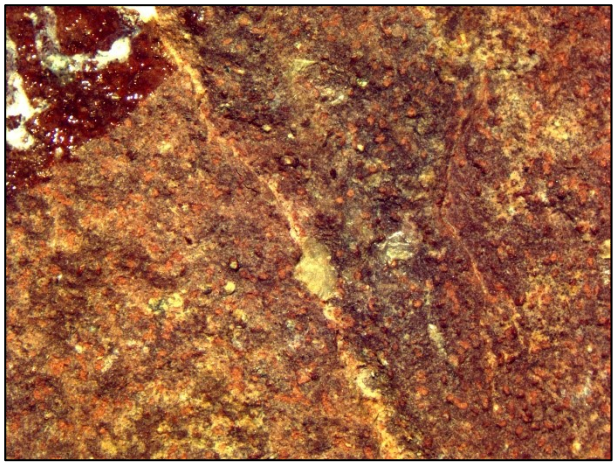
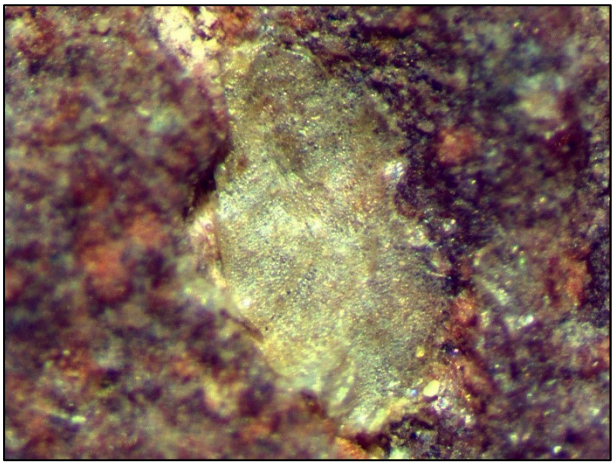
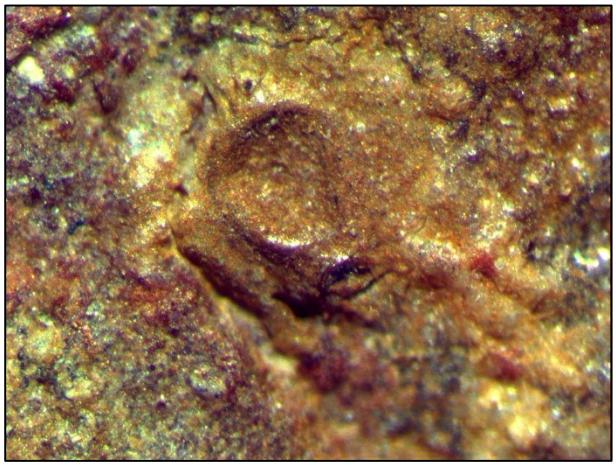


Figure 0.66 DeJj-4(4) Microscopy



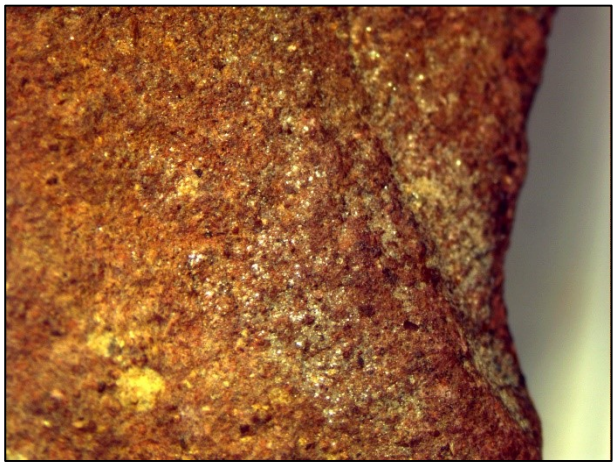
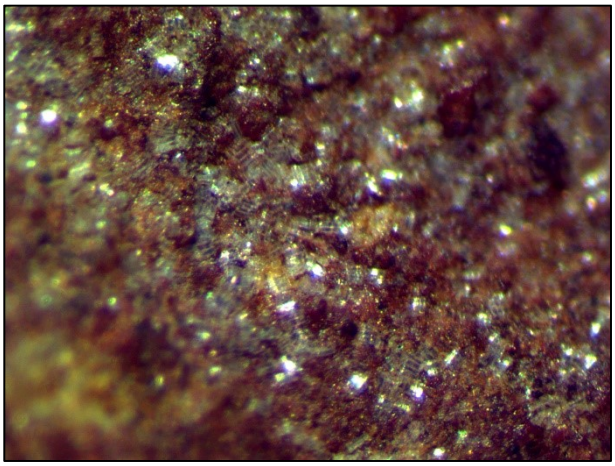



Figure 0.67 DeJj-4(5) Microscopy

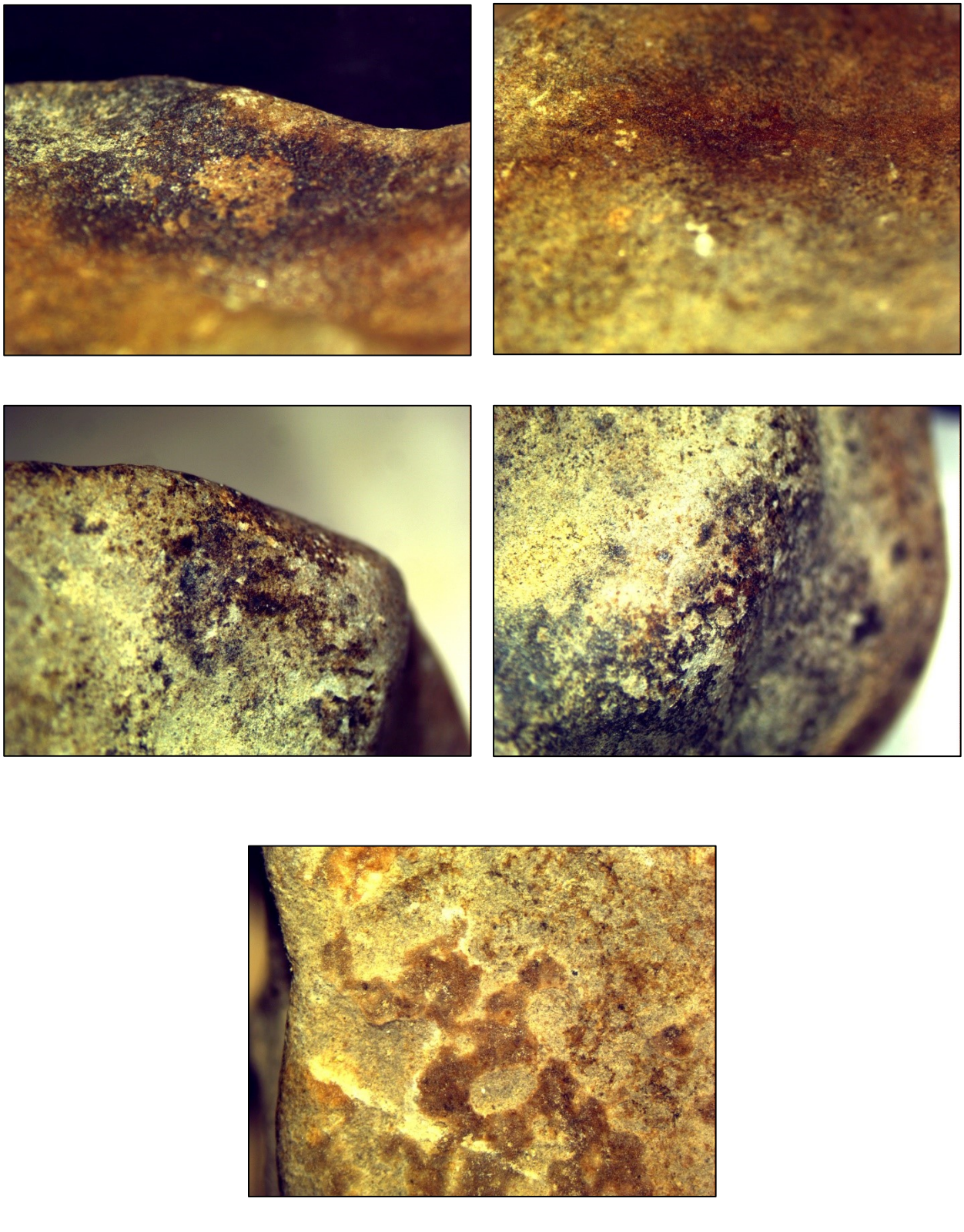


Figure 0.68 DeJj-8(12) Microscopy

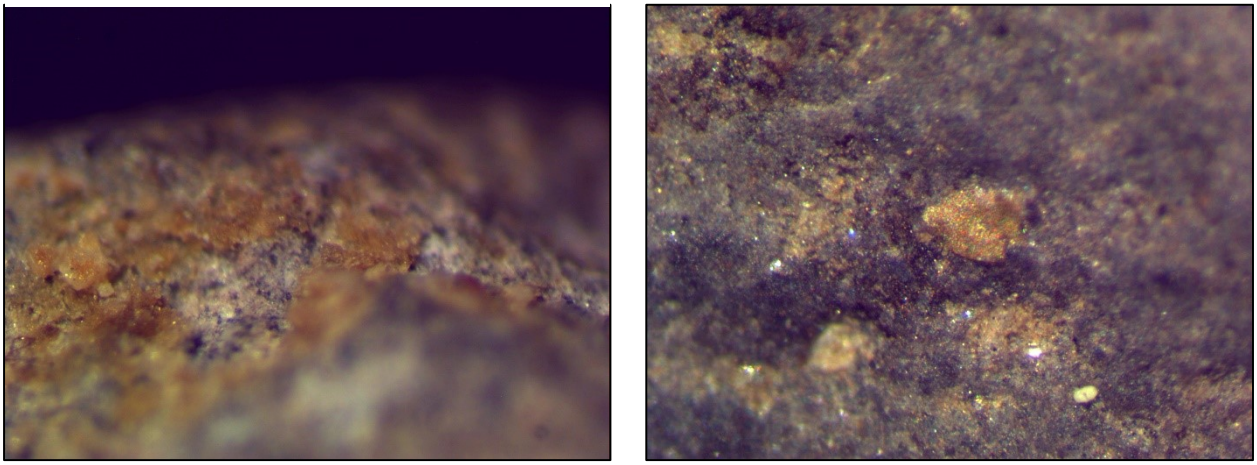


Figure 0.69 DeJj-8(13) Microscopy

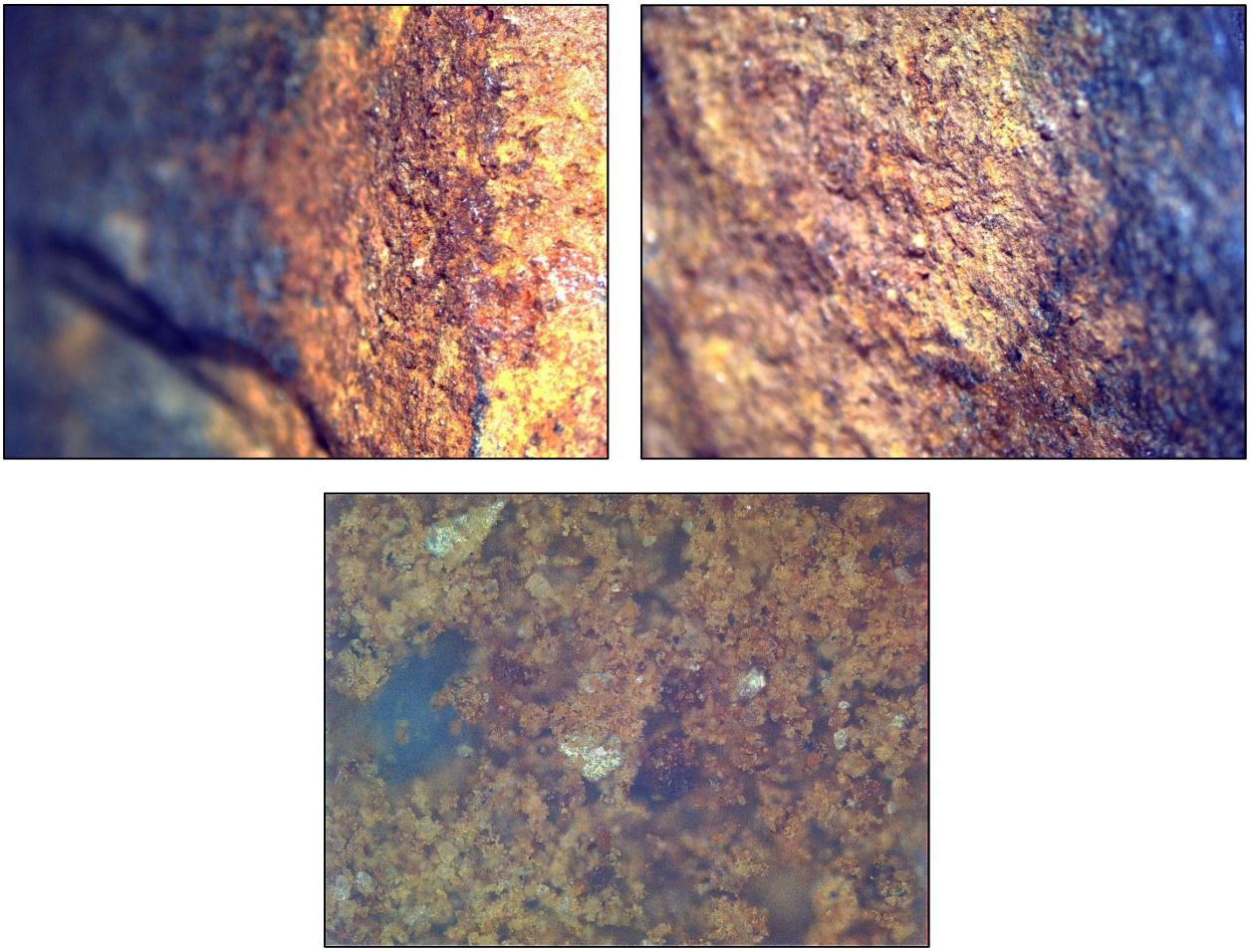


Figure 0.70 DeJj-8(14) Microscopy

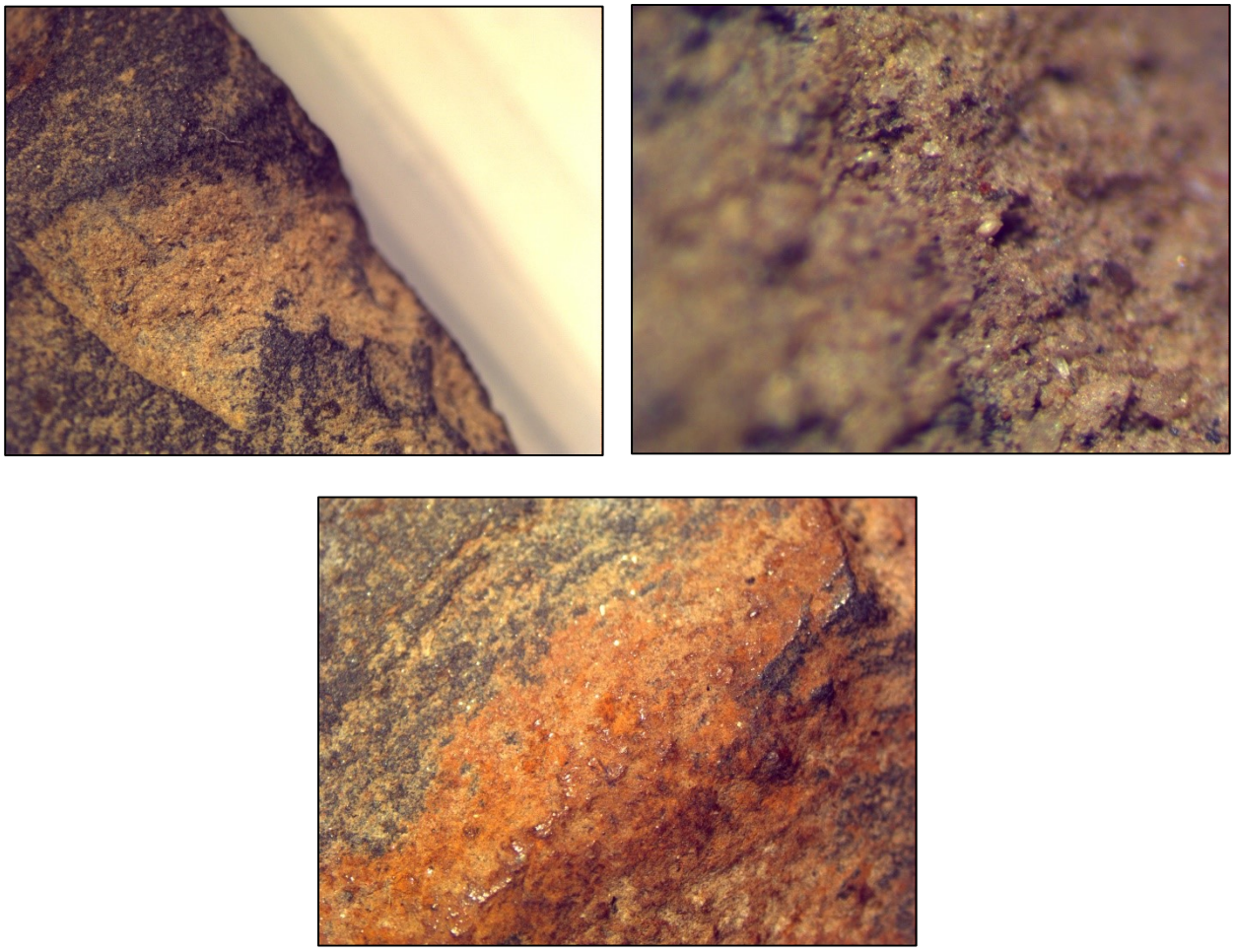
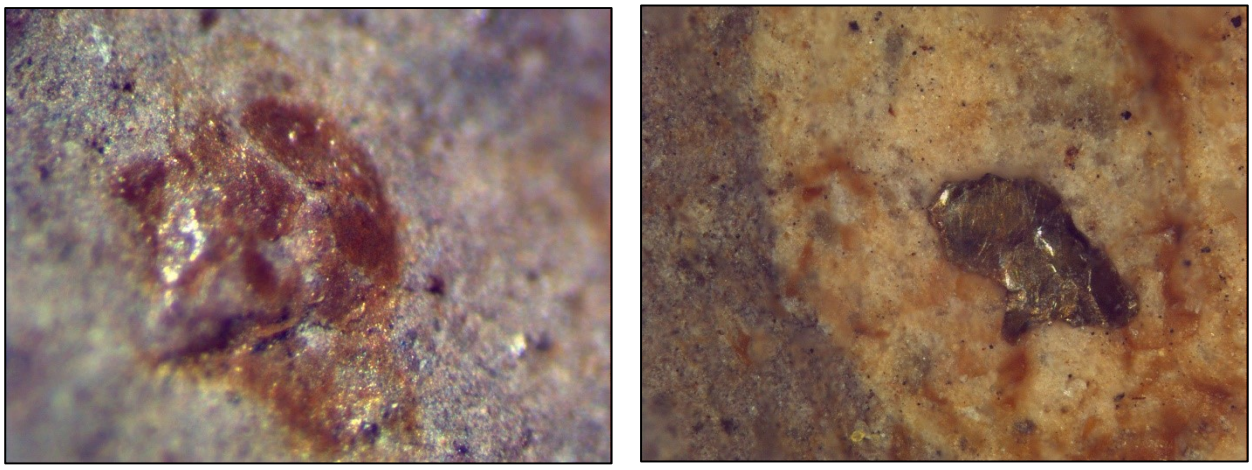


Figure 0.71 DeJj-8(15) Microscopy



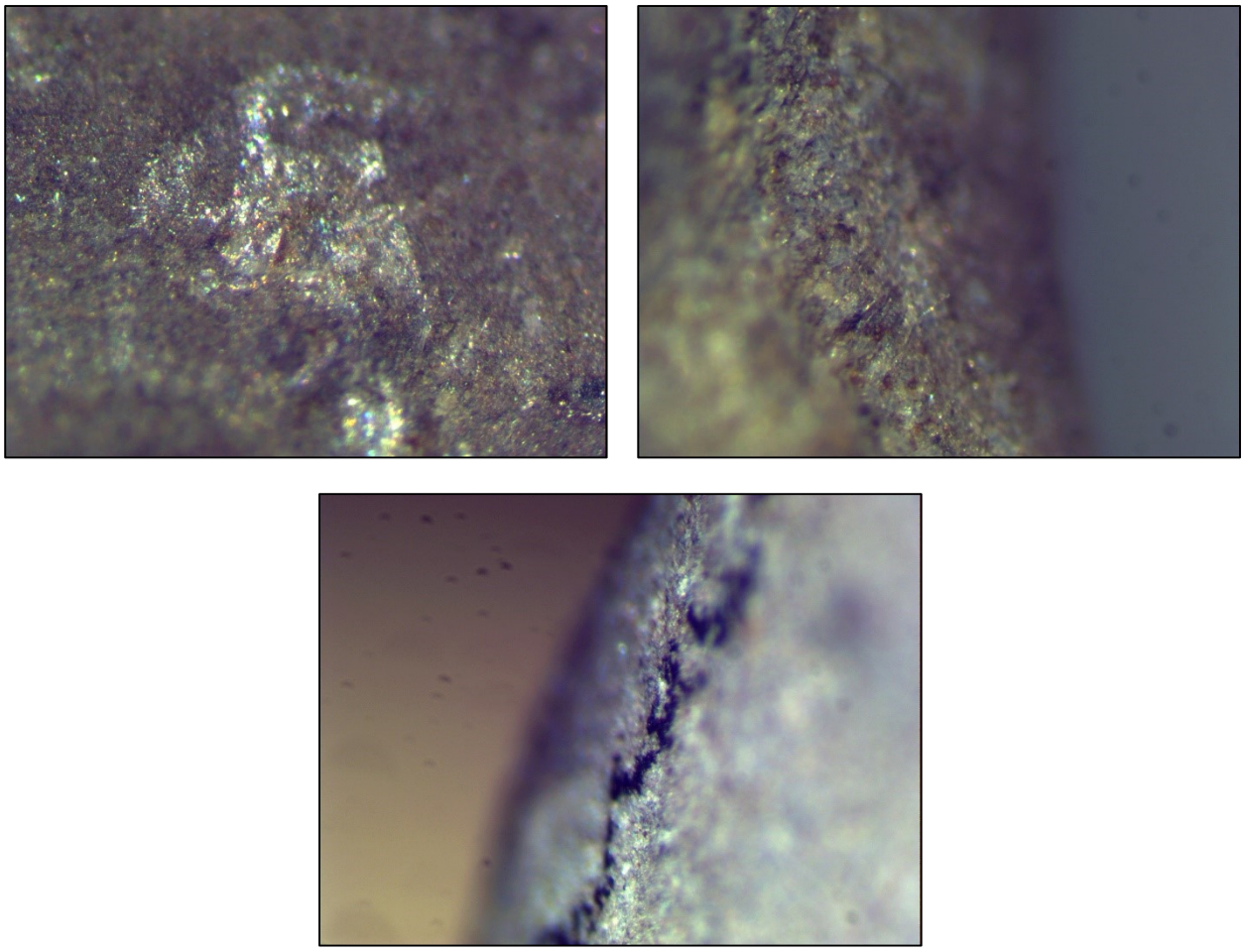


Figure 0.72 DeJj-21(1) Microscopy

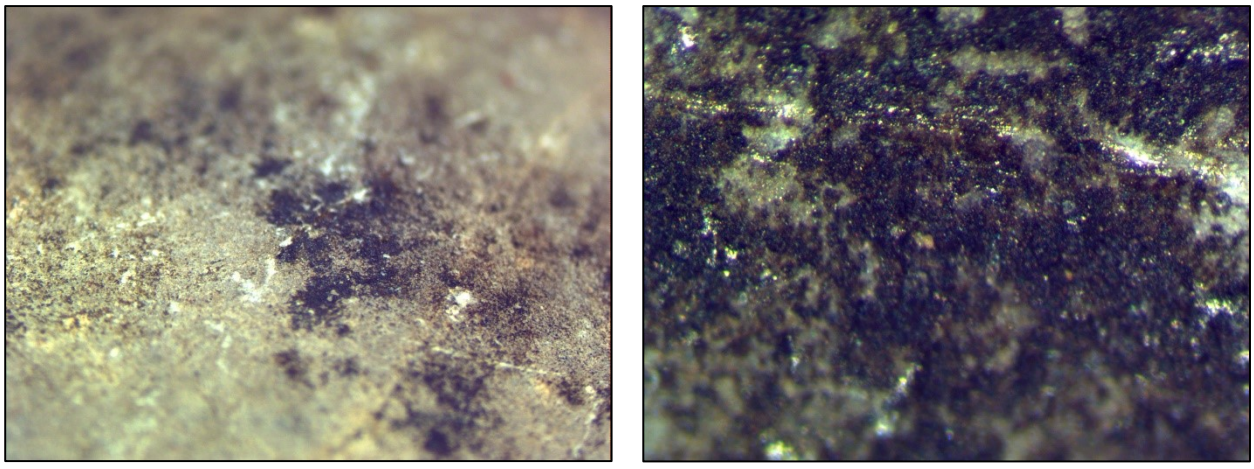
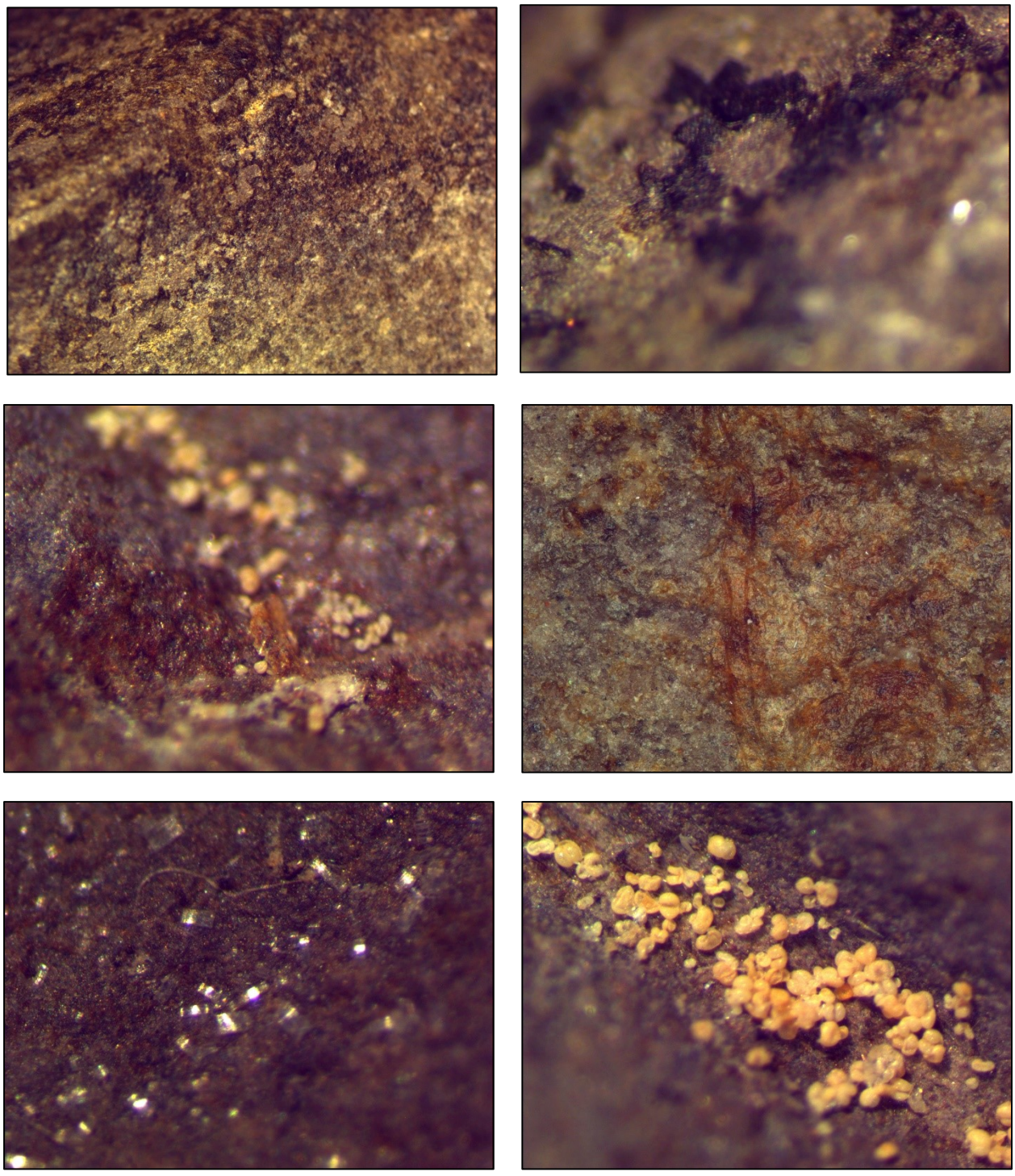


Figure 0.73 DeJj-21(2) microscopy



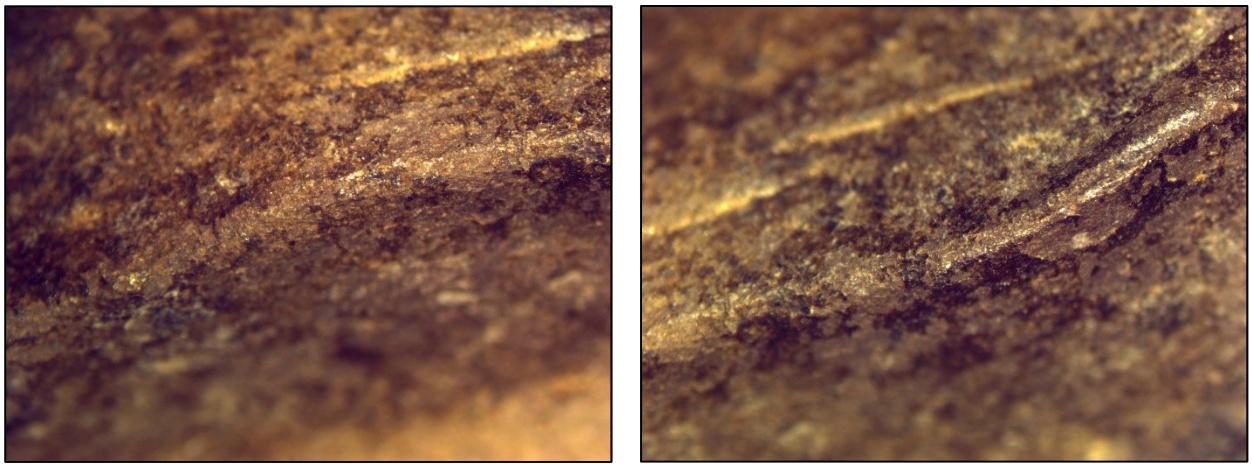


Figure 0.74 DdJf-9 Microscopy

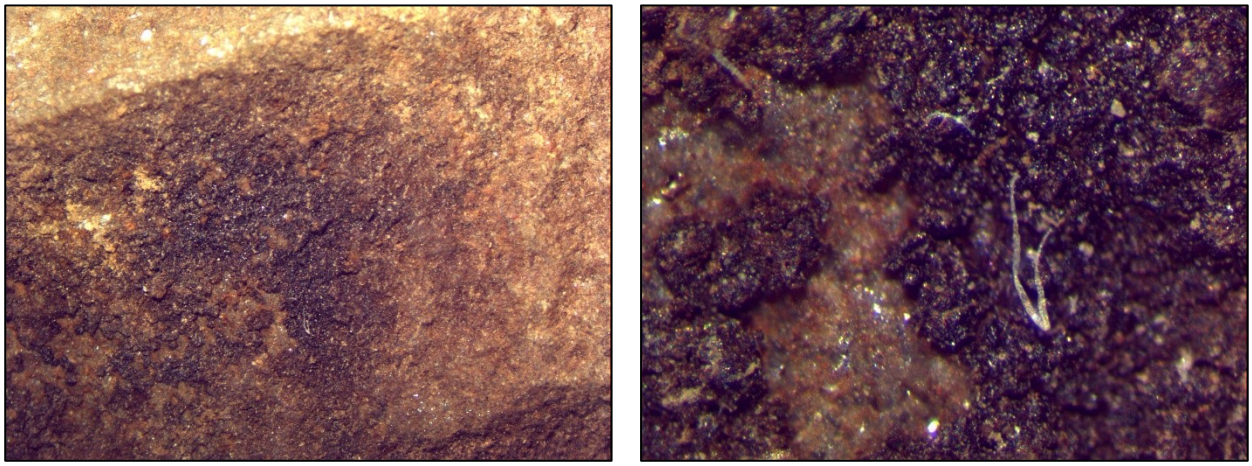


Figure 0.75 DdJf-3 Microscopy

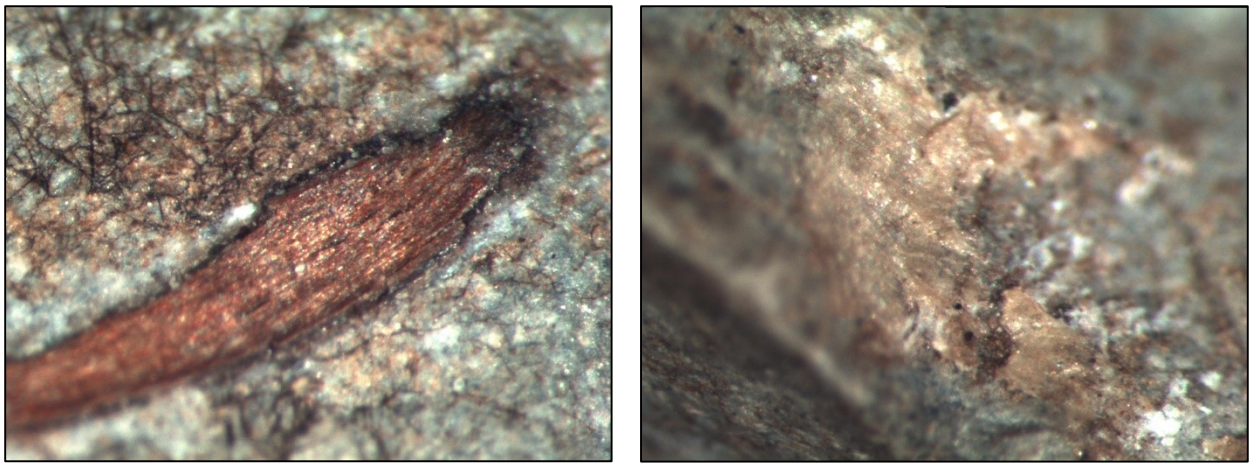
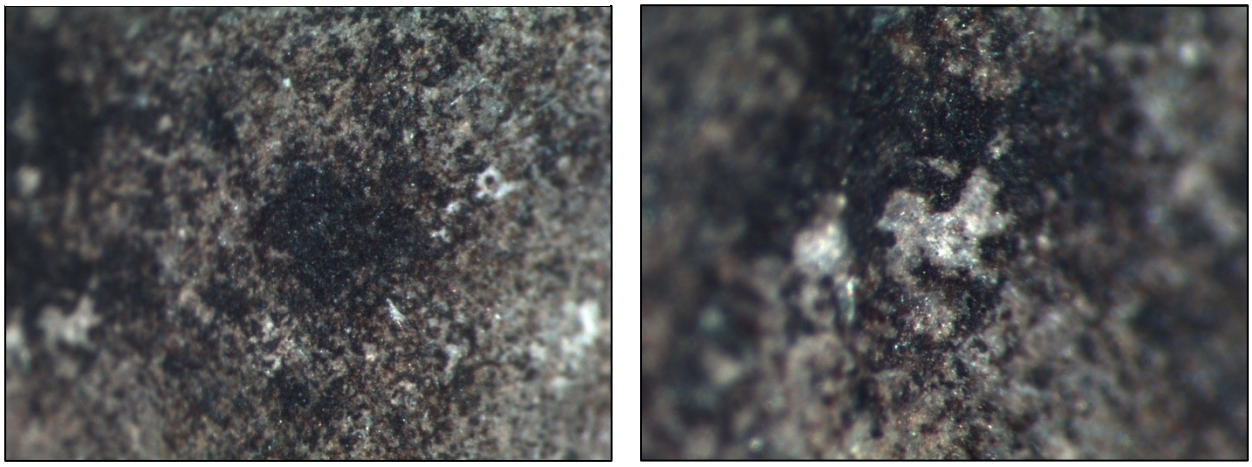


Figure 0.76 DeJj-14 Microscopy



Appendix D.4 Sample Set 4

Figure 0.77 EaKa-49 Microscopy

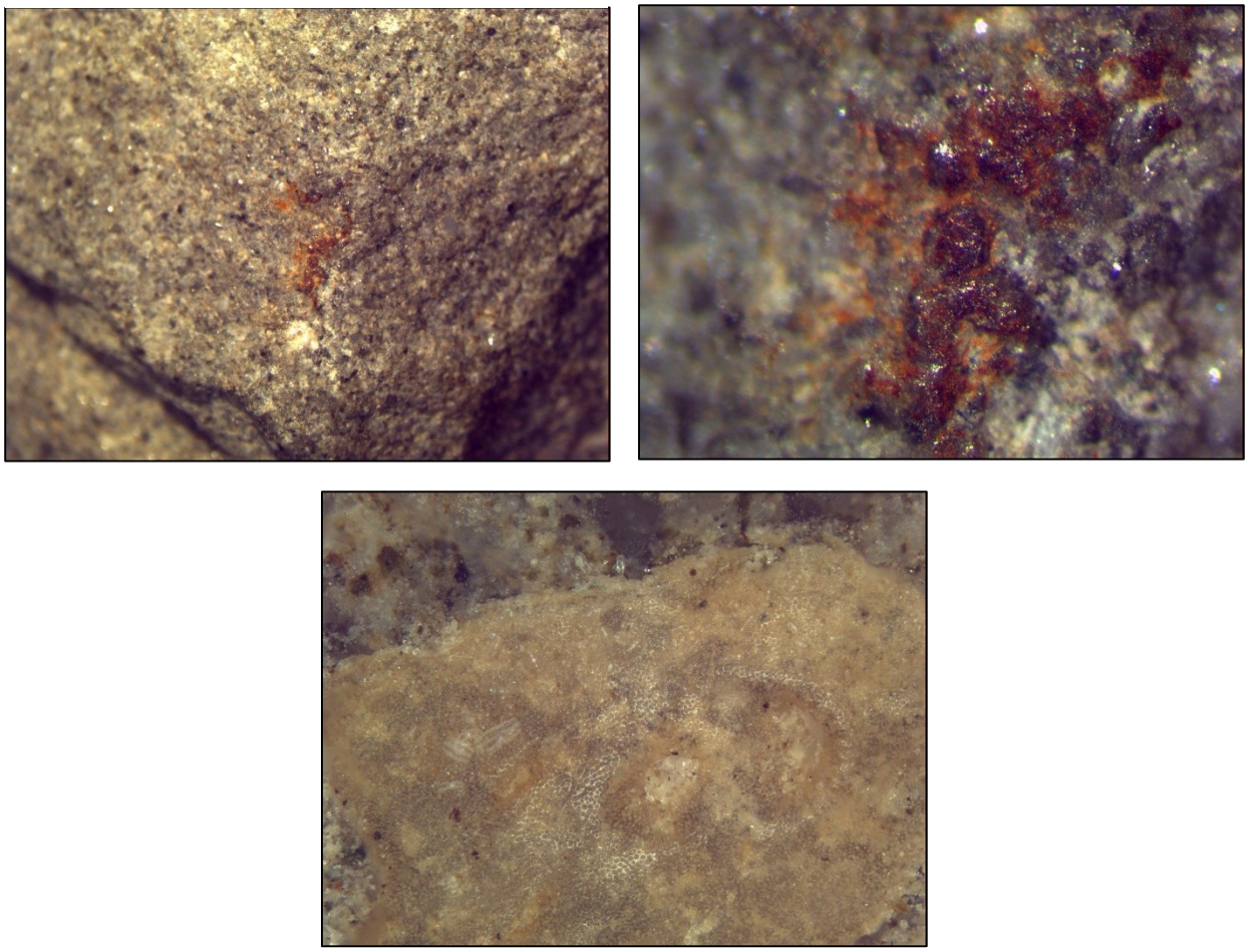
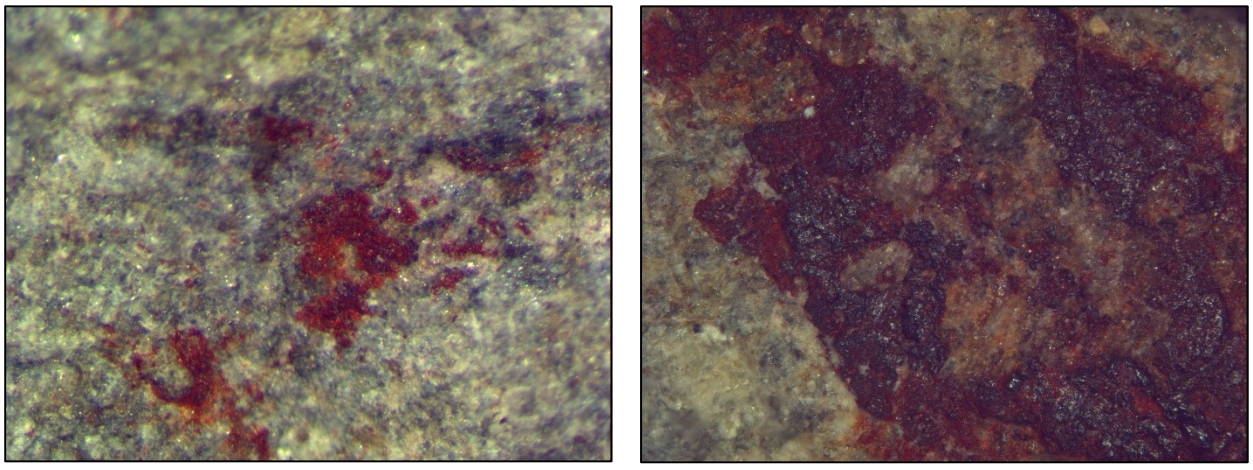


Figure 0.78 EaKa-6 Microscopy



Appendix D.5 Sample Set 5

Figure 0.79 DbJs-8 Microscopy

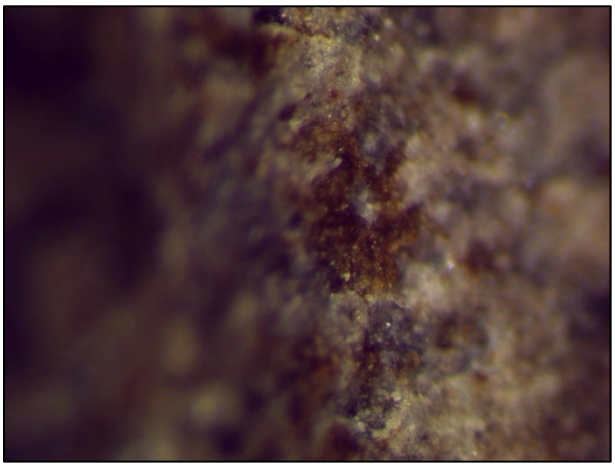


Figure 0.80 DeJj-8(16) Microscopy