ABSTRACT

The Joni Wreck:
An Archaeological Study of Late Roman Trade Patterns in the Adriatic Sea

by

Gregory Owen Stratton

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Director: Dr. Bradley A. Rodgers, PHD

Department of History, Program in Maritime Studies

Current data sets for analyzing Late Roman maritime trade and economic patterns have many gaps in them regarding the Adriatic Sea. While there have been many studies of terrestrial sites and their significance, maritime archaeology has been largely absent. This thesis, as part of the Illyrian Coastal Exploration Project (ICEP), will show that the Adriatic Sea was part of a thriving trade route for the Roman Empire. The paper will use previous studies of terrestrial archaeological finds in conjunction with evidence from a fourth century A.D. merchant vessel to establish new thoughts on patterns of trade, while using innovative techniques to describe how the vessel was loaded. The study will be one of the first multi-disciplinary collaborations in the southeast Adriatic to include amphora investigations, analysis of evolving trade patterns within the Late Roman Empire, and research on the ecological impacts of artifact introduction to ecosystems, while taking part in the development of non-invasive site tests.

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Gregory Owen Stratton

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Gregory Owen Stratton

APPROVED BY:

DIRECTOR OF THESIS:____

Dr. Brad Rodgers, PhD

COMMITTEE MEMBER:____

Dr. Frank Romer, PhD

COMMITTEE MEMBER:____

Dr. Jeffrey Royal, PhD

COMMITTEE MEMBER:____

Dr. Wade Dudley, PhD

CHAIR OF THE DEPARTMENT OF HISTORY:__________________________

Dr. Gerald J. Prokopowicz, PhD

DEAN OF THE GRADUATE SCHOOL:________________________________

Dr. Paul J. Gemperline, PhD

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CHAPTER 1: INTRODUCTION

Throughout the Mediterranean world, significant changes occurred during the 4th century A.D. The Roman Empire's administration was divided between the capitals of Milan and Constantinople, and after the disastrous Roman defeat at Adrianople in A.D. 378, Gothic and Vandal migrations produced significant threats throughout the Empire. Within the Roman imperial provinces of Illyricum and Epirus – now modern-day Albania, Montenegro, and Croatia – the political power base shifted from the West at Milan to the East at Constantinople. These socio-political changes greatly impacted trade patterns in the western and eastern parts of the Mediterranean through the allocations of the *annona* (a redistribution of empire wide collected taxes used to feed the citizens of Rome) while splitting the administration of the Adriatic provinces. Scholars have not achieved a deep understanding of these changes in the Adriatic region due to the aforementioned split in administration in antiquity and a lack of archaeological research along the eastern shoreline in modern times. Until the RPM Nautical Foundation (RPMNF), in conjunction with the Albanian government, engaged in the first underwater study in 2007, researchers had conducted no systematic maritime archaeological investigation in the eastern Adriatic or Ionian seas. Subsequently, the current understanding of trade and transportation connections in the Adriatic region is severely limited. The Albanian coast has been spared the ravages of looting, and many sites exist in their original contexts after being protected by the illegality of diving under the previous communist government.

This thesis will address the aforementioned gap in knowledge through examination of one such site, the Joni wreck, a late 4th century A.D. Roman shipwreck off the coast of modern Albania. The shipwreck is located approximately 25 km north of Sarande, Albania, and approximately 900 m from shore. Undisturbed by fishing nets, the main site sits at a depth of

22-24 m and contains approximately 200 amphoras of six different typologies visible in the surface layers, with a spill pile of approximately 100 broken amphoras, approximately 15 m northeast of the main site at a depth of 28 m (Figure 1).

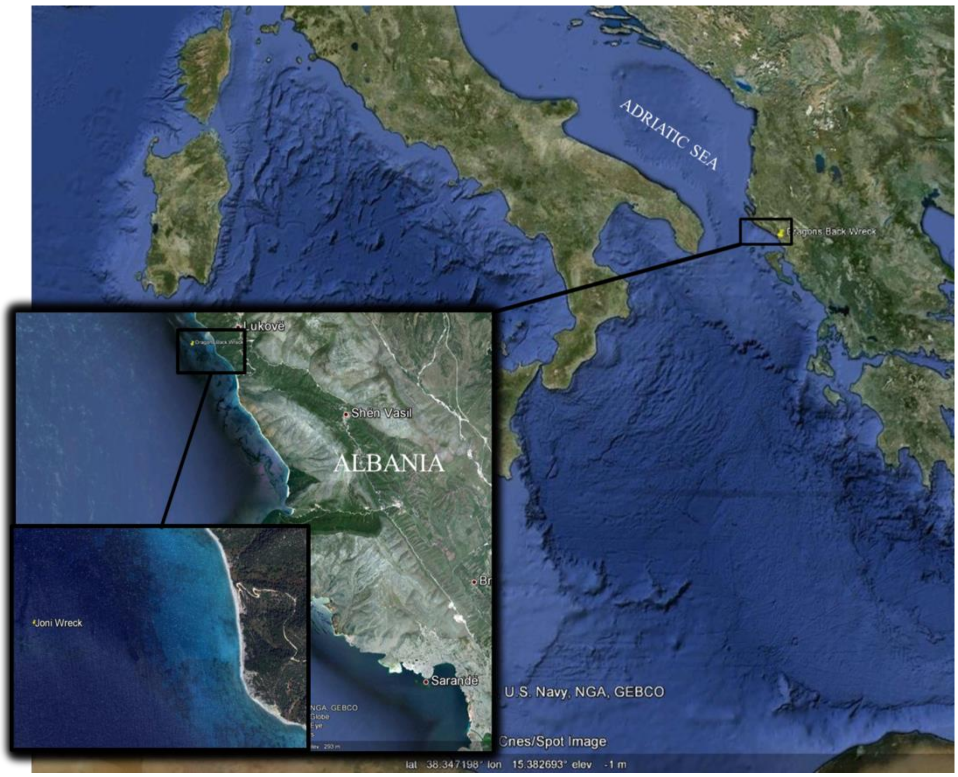

FIGURE 1. Joni wreck site. (Author and Google Earth 2013).

The amphoras in the main pile remain stacked much as they were when the ship sank to the seafloor, while the amphoras in the spill pile are mostly scattered and broken over an area of approximately 30 m^2 (Figures 2 and 40). The intact amphora pile suggests that a preserved hull likely remains, such as exists under other ancient Mediterranean shipwreck sites.

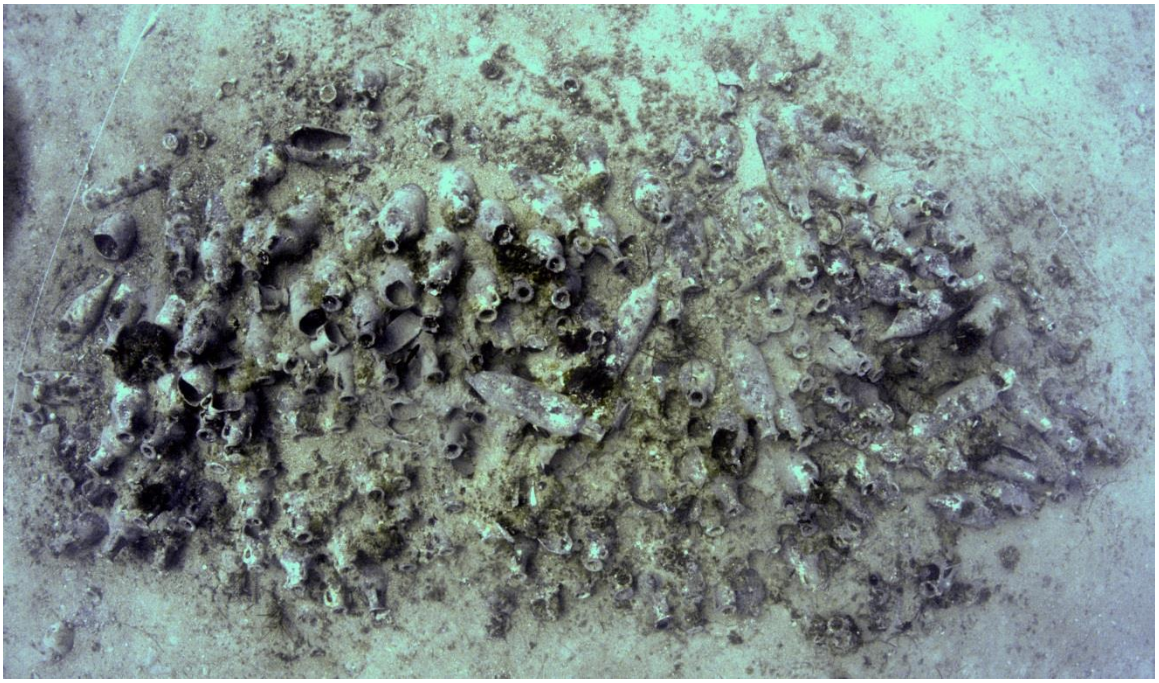

FIGURE 2. Joni wreck site plan view (Photograph by Derek Smith 2010).

The amphoras that are recognizable on the wreck site offer an interesting mix of typologies. Scholars have identified the amphoras in the upper layers of the site as African 3A, 3B, and 3C (Keay 25), Late Roman Amphora 2, and a possible Cretan amphora (still under investigation). Collectively, the amphoras place the date of the vessel's sinking in the second half of the 4th century A.D. (Royal 2012:416-421). Production centers for African 3 (Keay 25) type amphoras were located in various ancient city sites throughout modern eastern Tunisia (Keay1984). Late Roman 2 type amphoras originated in the eastern Aegean and the Argolid regions (Opait 2005; Figure 3).

FIGURE 3. Greek and Cretan manufacturing sites (Drawing by Author 2014).

The Cretan and Late Roman Amphora 2 jars are located on the outer edges of the main wreck and in the spill pile downslope of the main pile, which points to their likely being loaded atop the cargo of African 3 amphoras.

This rarely found amphora assemblage, comprising jars from North Africa, Greece, and possibly Crete, represents an excellent opportunity to examine Late Roman trade in a region where researchers have conducted few studies. This small consignment of Eastern Mediterranean amphoras is particularly intriguing, as it offers the possibility to examine pan-Mediterranean trading processes during a period of economic, political, and military flux. The most likely scenario is that it constitutes a secondary cargo, which was possibly loaded at a port along the coast of Sicily, Italy, or the southwest coast of Greece. Whatever the route taken, the merchant vessel was sailing the eastern Adriatic Sea, when it sank off the Albanian coast just north of modern Sarande.

During the summer of 2012, a team from East Carolina University surveyed the wreck site. During this time, the team recorded the entire main amphora pile in Site Recorder 4, a computer mapping program that creates a point cloud in X,Y,Z, coordinates, and took pictures to later create an entire site photomosaic. The team also gathered samples of the various amphora types for further laboratory analysis, such as petrology.

This thesis work forms part of one of the first multidisciplinary studies in the southeast Adriatic Sea to include amphora analysis from shipwrecks, broadening the data set on trade patterns within the late Roman Empire. Along with research on the ecological impacts of artifact introduction to ecosystems, this study also furthers the development of non-invasive site surveying. Additionally, it includes input and resources from the Albanian government, East Carolina University, Southampton University, the University of Washington, Albanian Nautical Archaeology students, and the RPM Nautical Foundation. Neither Albania nor any other Balkan country has ever before given permission for such a field intensive study of a broadly encompassing set of topics. Thus, the Joni site offers a unique location at which to examine late Roman trade in the Adriatic Sea while approaching the following research questions.

Research Questions

A growing body of evidence has emerged suggesting that previous assumptions about amphora contents have created a possibly false representation of minimal movement of actual trade goods within the ancient Adriatic Sea and commodities being moved during the Late Roman period (Reynolds 1995, 2004, Opait 2005 and Royal 2012). This thesis will address these issues by attempting to answer the following research questions, based on two broad categories: amphoras and trade.

Amphoras:

1) Where did the amphoras on the Joni wreck originate?
2) What were the amphoras carrying?
3) Approximately how many amphoras were there of each type?
4) How does this number compare to that of other known sites of the same era?
5) Was this type of mixed cargo normal in the Late Roman period?

Trade:

1) What are the methods and mechanisms of trade?
2) What were the 4th century types of traders?
3) What was the ship's route and likely ports of call?
4) What does the Joni wreck tell us about trade in the Adriatic Seas during the 4th century A.D.?
5) What does the Joni wreck tell us about Illyrian trade in the 4th century A.D.?

The largest obstacle in answering the research questions comes from the lack of data specific to the Adriatic and Ionian seas during the late 4th century A.D. Researchers have conducted few underwater surveys and performed an even smaller number of excavations on known sites. Any type of surveying or excavating is very expensive, especially in Albania, where no diving operations are available. The organization doing the work must bring all of its needed gear into the area. With the help of RPM Nautical Foundation, a National Geographic Waitt grant, and the Albanian government, this thesis will add to a slowly growing data set.

CHAPTER 2: HISTORY OF ROMAN INTERVENTION IN ILLYRICUM

Illyria has had a long and rich history through the many changes in its political landscape. It has been a collection of tribal confederations, a large area under its own rule, part of an empire, and small to large pieces of several countries as the world expanded into the 20th century. However, it has not accrued the lasting memory of greatness that its immediate neighbors have. Early in Illyria's history, Greek city-states to the south eclipsed the region, and then the Roman Empire spread its power to the east by way of martial prowess (Figure 4).

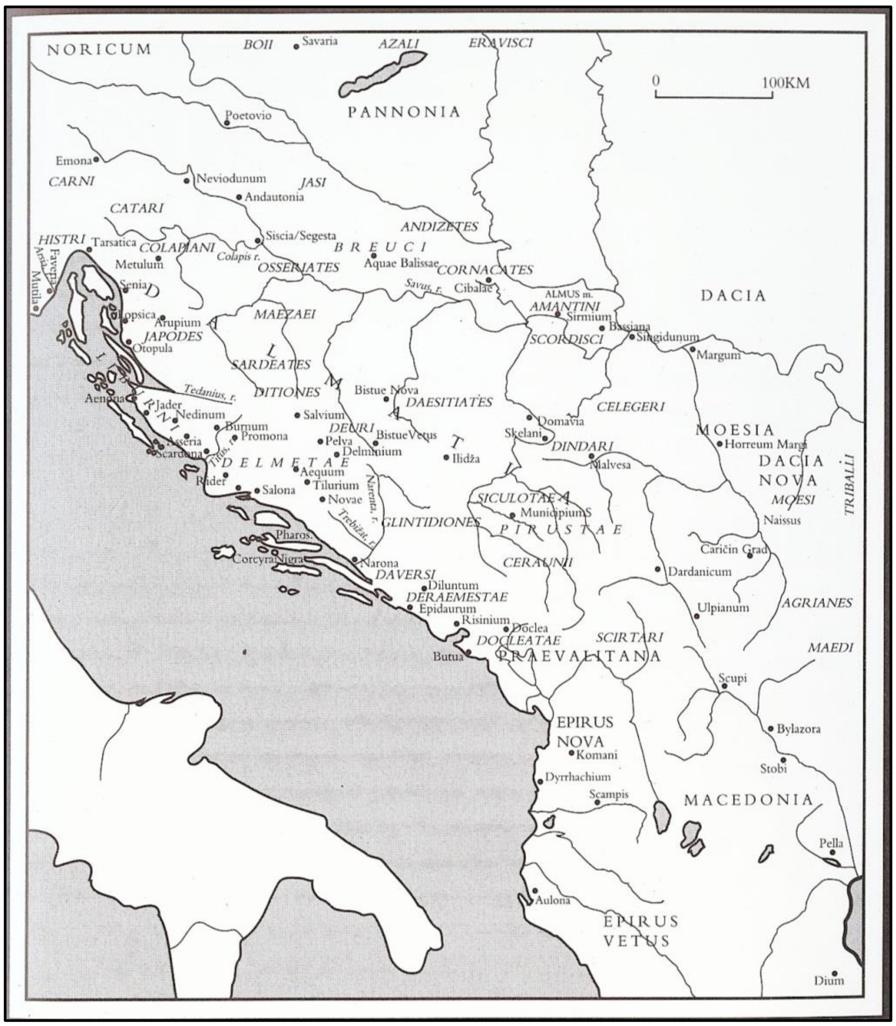

FIGURE 4. Roman Illyricum. (Wilkes 1994:XXi).

By the 3rd and 4th centuries A.D., emperors who had been born in the Illyrian province ruled Rome, yet outsiders did not hold Illyricum in great esteem (Syme 1973:314-315). As Western Roman power waned, and the East rose to power in Constantinople, Illyricum was not to be included in much of its gained wealth and industry. Instead, it would be known as a borderland buffering Constantinople from the Gothic tribes to the west and north.

Ancient Illyria began as a collection of separate tribes with no recognized specific genetic background. Wilkes (1992:3) states, “In general the Illyrians have tended to be recognized from a negative standpoint, in that they were manifestly not Celts, Dacians or Thracians, or Greeks or Macedonians, their neighbors to the north, east and south respectively.” History has largely been defined by the winners of conflicts, thereby possibly denying Illyria a greater role, as the region was generally on the losing side of conflicts with its more powerful neighbors. By the 3rd century B.C. intervention of Rome, the lands known as Illyria had formed into various kingdoms or leagues of interest (Pollo and Pluto 1981:16-19).

As Rome started to expand during and after its first war with Carthage (264-241 B.C.), it was then that Rome looked straight across the Adriatic Sea at the Illyrians. The Romans established Brundisium on the east coast of the Italic peninsula in 246 B.C. as a watch guard and possible rallying point for future invasions across the Adriatic Sea. Illyria’s alleged propensity for piracy ‘justified’ Roman intervention. Polybius (Polybius 2.3 as quoted in Wilkes 1992:158) writes, “From time Immemorial Illyrians had attacked and robbed ships sailing to Italy.” Whether the Illyrians were truly any more piratical than any other group or piracy simply provided a convenient pretext for Roman invasion remains an open question. Either way, Illyrian depredations led to the first Roman invasion in 229 B.C., while setting the stage for future invasions that culminated with the imperial campaign of Augustus from A.D. 6 to A.D. 10, during which Illyria became a Roman province – Illyricum (Pollo and Puto 1981:18).

Illyricum was a quiet region through the next three centuries. The reign of Diocletian saw a reorganization of the Empire in which Illyricum would play a more important role. The province itself did not assume a traditional power role, but rather, the individuals it produced did. Roman emperors with Illyrian backgrounds during the 3rd and 4th centuries included Aurelianus, Constantine, Galerius, and Valentinian. Illyricum at that time also included many ports, roads, and inland waterways, which Rome used as it spread its trading power and military might and after AD 3337, its socio-economic center at the new capital, Constantinople, to the East. These trade routes would help the Eastern Roman Empire persist until the 15th century.

Ancient Illyria to Roman Intervention

Before the middle of the 5th century B.C., Illyrian history is very vague. Borders, kingdoms, or a common language are virtually non-existent in written evidence. Not until Herodotus delineated geographical outlines from Athens in the 5th century B.C. and the publication of the *Periplus of the Erythraean Sea* in the mid-1st century A.D. did Illyria become geographically defined (Dzino 2010:22-24). *Periplus of the Erythraean Sea* provides an account of a sailor who circumnavigated the Indian Ocean, the Red Sea, and the Mediterranean Sea describing the peoples and places he saw. While the written record is somewhat ill defined, it does suggest that the region was settled or, in fact, became prosperous certainly by the mid-1st century A.D.(pers. comm. F.E. Romer). Archaeology has uncovered a rich material culture of approximately twenty known peoples or tribes, dominated by a warrior class that served as local elite, evolving through the Iron Age (1200 B.C.-1 B.C.). The Illyrians were an agricultural and herding society that, for the most part, provided a sedentary lifestyle (Wilkes 1992:43,44,65). The Illyrians traded agricultural products with their southern neighbors for finer quality goods and weapons during the 6th and 5th centuries B.C. . In the 5^{th} century, according to Thucydides, Illyria had no city-states or civilization and was still steeped in primitive, barbaric ways The exchange of agricultural products for manufactured goods stopped in the 4th century B.C. for unknown reasons, although the rise of Greek power was a likely source of strife between the neighboring groups. During the 4th century, Greece became a major power in the Adriatic region through the incorporation of city-states and colonies, including those started along the coastlines of Illyria and the southern Italian peninsula (Thucydides as quoted in Wilkes 1992:103).

The Road to Illyricum

The 3rd century B.C. brought many changes to the eastern Adriatic region. New kingdoms started to form, and the growing power in Rome needed to expand. A powerful new state arose with a more centralized authority, both on land and at sea, than had previously been the case in Illyria (Pollo and Puto 1981:17). Agron, as king of this new state from 250 B.C. to 231 B.C., effected unprecedented changes. Agron came to power along the borderlands with Macedonia by taking advantage of the technology and tactics Alexander the Great championed. Alexander's empire's splitting apart left power vacuums, and Agron took advantage. He made treaties with Macedonia and Thrace while conquering as far north as the Dalmatian coast. Agron's combination of seagoing warships capable of carrying 50 troops and land based forces being brought to the same battlefield was unknown before in the Adriatic Sea (Wilkes 1992:156,157). Polybius (Polybius 2.3 in Wilkes 1992:157,158) describes a battle in which the Illyrians used a seaborne attack between 232 B.C. and 231 B.C. to rout the Aetolians and raise the siege at Medion. This battle brought prestige to the previously unknown Illyrian king, Agron. The Greeks had previously viewed the Illyrians as barbarians, but now they had to reform their opinions.

Upon Agron's death in 231 B.C., his wife Teuta reigned as regent for their young son from Agron's previous marriage, Pinnes. Teuta built on her husband's successes, even improving upon them. She raided the entire Adriatic coast, bringing many new peoples under her power. Teuta even raided into the Peloponnese, attacking and pillaging the cities of Elis and Messenia (Pollo and Puto 1981:17). The success of these battles and Teuta's giving license to her ships' captains to raid at will brought about the conflict with Rome.

The three main literary sources for the Illyrian world, Appian, Cassius Dio, and Polybius, gave somewhat different accounts of the conflict between Rome and the Illyrians. Appian and Cassius Dio assert that envoys sent from Rome to negotiate an end to piracy and begin trade relations were attacked and killed under Agron's rule, while Polybius claims that Teuta was regent at the time and ordered the envoys' deaths (as quoted in Dzino 2010:47). Either case may be true, but the results were the same: The envoys' deaths, in conjunction with merchant losses from Illyrian piracy, pushed Rome into battle and served as the final episode of troubles between Rome and the Illyrians.

After the first Carthaginian war (264-241 B.C.), Rome began to look outside of the Italian peninsula for possible expansion. Traders had routinely crossed the Adriatic Sea for natural resources that the region possessed, such as wine, timber, cattle, and silver. The Illyrian piratical depredations upon these merchants, combined with the envoys' murders, gave Rome reason to invade. The Illyrians were in the process of raiding Corcyra (modern Corfu) and besieging the Greek colony of Epidamnus (later Roman Dyrrhachium, modern Dürres) when

Roman forces crossed the Adriatic Sea in 229 B.C. to punish them. This would appear to show how powerful Teuta thought she was. She ordered the murder of the Roman envoys and feared no repercussions. Instead of putting her fleets in a defensive posture, she sent them to raid and pillage.

The Roman invasion was two pronged. In the first stage, Consul Fulvius took 200 ships to relieve Corcyra, while in the second; Consul Postumius sent 22,000 troops from Brundisium across the Adriatic Sea to Apollonia. The Corcyra expedition succeeded through betrayal; Demetrius, a high ranking Illyrian noble who had fallen out of favor with Teuta and became an ally of the Romans, facilitated the surrender of Corcyra to Fulvius. Postumius's invasion was an overwhelming success. Teuta was completely surprised and therefore unprepared to resist. Postumius raised the siege of Epidamnus and the blockade of Issus and granted the surrender of many tribes that Teuta had oppressed. Only as they went inland did the Romans meet strong resistance and thereafter concentrated their troops along the coastlines (Wilkes 1992:160,161,162).

The Romans then turned over control of Illyria to Demetrius, who had helped them throughout the campaign. The Romans left troops and ships in many coastal cities to watch over their "Protectorate," a new concept for Rome (Dzino 2010:50). This ended the First Illyrian War (229-228 B.C.) and started a continued Roman presence in the eastern Adriatic region.

Peace in the area did not last long. Demetrius married the mother of Agron's son Pinnes and declared himself regent. He then continued Teuta's policies, which had led to the first Roman invasion: engaging in piracy, conquering neighbors, and making treaties with the Macedonians. The Romans knew they had another possible war with Carthage looming and decided to rid themselves of the Adriatic problem quickly. In 219 B.C., the Romans invaded again, and, after a short successful siege at Dimale, they went straight after Demetrius's home island of Pharos. Roman Consul Aemilius tricked Demetrius into thinking he only had a small force brought by ship, when instead he had many troops hidden in nearby woods. The result was Demetrius's deserting his forces and fleeing to Macedonia for protection (Wilkes 1992:164; Dzino 2010:52). This defeat ended the Second Illyrian War (219-218 B.C.).

The next 40 years saw Illyria used as a pawn in dynastic struggles among Rome, Carthage, and Macedonia. Illyria's rulers could control territories and increase their power as long as the province remained loyal to Rome. The dynamics changed in 168 B.C., when Rome invaded Macedonia, and Perseus of Macedonia convinced the Illyrian king Gentius to help him against Rome. Gentius raised an army of approximately 20,000 troops and sent his naval vessels in search of Roman merchant vessels to capture. After recording the start of the Third Illyrian War (168 B.C.), ancient written sources are silent. The end results are recorded, though, and tell of the total defeat of Gentius in only 30 days (Wilkes 1992:174). After the defeat, Rome rewarded the peoples of Illyria who had allied with them against Gentius, but split their domains into three more manageable areas.

In 167 B.C., the Romans decided against creating new provinces in Illyria such as they had done in Macedonia that same year, but instead relied on local regimes that had supported them in the defeat of Gentius. These protectorates posed a challenge for the next 100 years as Rome tried to balance power in the area between its province in Macedonia and its increasing expansion to the east. The Romans had, in the past, effectively controlled the coastline, but they struggled when they moved inland. Not until the reign of Augustus did Rome rule all of Illyria.

Establishing Roman Illyricum

The actual date when Rome established Illyricum as a province is not known. According to the *Lex Vatiana*, Julius Caesar received an imperium of Cisalpine Gaul and Illyricum in 59 B.C., but scholars have reached no true consensus that this was the date of provincial establishment (Dzino 2010:101). During the civil war (49-48 B.C.) between Caesar and Pompey, Illyrian loyalty was split. The northern region of Dalmatae supported Pompey, while many of the other tribes supported Caesar (Wilkes 1992:196; Dzino 2010:90,91). Throughout the Roman civil wars and after Caesar's victory at Pharsalus, Dalmatae continued to be a source of problems for Rome; these troubles eventually brought Caesar's adopted son and heir, Octavian, to the area from 35 B.C. to 33 B.C.

Octavian first invaded in 35 B.C. in a strategic attempt to extend his power. The northern area of Illyricum had easy land access from northern Italy, and the peoples there had been traditional allies of Rome until the power struggles between Caesar and Pompey. This would also allow Octavian to avenge the losses incurred during the wars after Caesar's death. Octavian brought overwhelming forces in this largest invasion of Illyria to date. This campaign went well, and Octavian made plans for a continued invasion in 34 B.C. This invasion had the specific purpose of conquering Dalmatae once and for all. The campaign was limited in its success. Octavian did conquer Dalmatae, but not in the overwhelming sense that was his initial goal. Dio (Dio in Foster 1914) and Appian (Appian in White, Denniston and Robson 1912) do not clearly state why Octavian fell short of his goals, only that he met with limited success. The Dalmatae, however, were later to be the source of complete Roman domination in the area. The campaigns of 34-33 B.C. led to a period of relative peace for Illyricum. The only major troubles came in the far north with the Pannonians, which led to campaigns from 14 B.C. to 8 B.C. Most of Illyricum stayed peaceful and prosperous until A.D. 6, when the same Pannonian peoples revolted in what became known to Rome as the worst crisis since Hannibal (Wilkes 1992:207; Dzino 2010:142-145). No known spark started the revolt, but a sub king named Bato defeated local Roman forces in the area of the Daesitiates, which led to many tribes joining his rebellion. The army officer and writer Velleius states that 200,000 foot soldiers and 9,000 cavalry were raised to defeat Rome, (Velleius as quoted in Dzino 2010:146), but Dzino estimates that it could have been no more than 100,000 troops given the available population. Either way, the rebellion was serious enough that Augustus wrote, “If defense procedures were not taken in ten days, the enemy could enter the city” (Pollo and Puto 1981:19). This could have been a ruse to get the senate behind him or an actual threat to the Italian peninsula, but sources are not clear on the reality of the situation. By the time Rome could bring its resources to the area, Bato had gained control of the Illyrian hinterland and was vying for control of the coastal ports. Rome sent the future emperor Tiberius with an army from Germany, while also ordering Germanicus into the conflict with another army (Dzino 2010:150). This was an overwhelming number of troops, and Tiberius used them to suffocate the rebellion. In A.D. 6, Bato surrendered his starving people, and Tiberius eventually left him in charge of the area after two more years of hit and run warfare by tribes that did not want to surrender. Not until the summer of A.D. 9 did Rome have complete control over Illyricum. All Illyrians were now subject to Roman rule (Wilkes 1992:207).

Centuries of Peace

From A.D. 9 onward, Illyria needed to recover both the manpower and sustenance lost during the rebellions. Rome split the area into two provinces. The first was Dalmatia in the south, bordered by the rivers Mat and Istria. Two full legions quartered there to keep control of the area. Pannonia was established in the north with its northern border at the Danube. Three legions were quartered here. Rome was very generous in dealing with the Illyrians. Magistrates were established for civil and judicial control, but, in accordance with Roman policy, in many conquered lands, they were lax in establishing policy that would intrude on ancient customs (Pollo and Puto 1981:20; Wilkes 1992:208,209).

For the next 200 years, the Empire used Illyricum primarily for its natural resources. Coastal towns such as Dyrrhachium, Salona, and Mutilia, grew in strengthen and became important hubs for roads leading to the east. Dyrrhachium in particular became an important trading center. Men were either conscripted or volunteered as auxiliaries for the Empire's armies and navies. Exports of products such as wine, cheese, mead, and jewelry in gold and silver were much sought after. By the end of the 1st century A.D., cities had started to become as prevalent inland as they had been along the coastlines. Rome encouraged the development of these cities by natives, while also populating them with veterans at the end of their enlistments. Natives established these cities along trade routes to the east, such as Bassiana in Pannonia; near mining centers, such as Domavia; or at strategic military sites, such as Naissus. Allowing for the establishment of these cities in the hinterland was a sound strategy for Rome. It brought peoples into closer proximity, thereby facilitating civil control. Taxes were easier to collect when locals did not have far to go. The Romanization of locals occurred through their being in close proximity to Roman veterans, who often married into local families, and merchants who could eventually bring new wealth to the areas. Finally, rebellion was much easier to foresee or control when the principal instigators were trapped in the confines of a walled city.

Rome had learned valuable lessons in the Pannonian rebellions about the difficulties of traversing Illyrian lands. To combat this problem, the legions stationed in Illyricum during the next few decades built roads connecting important cities and trade routes (Figure 5).

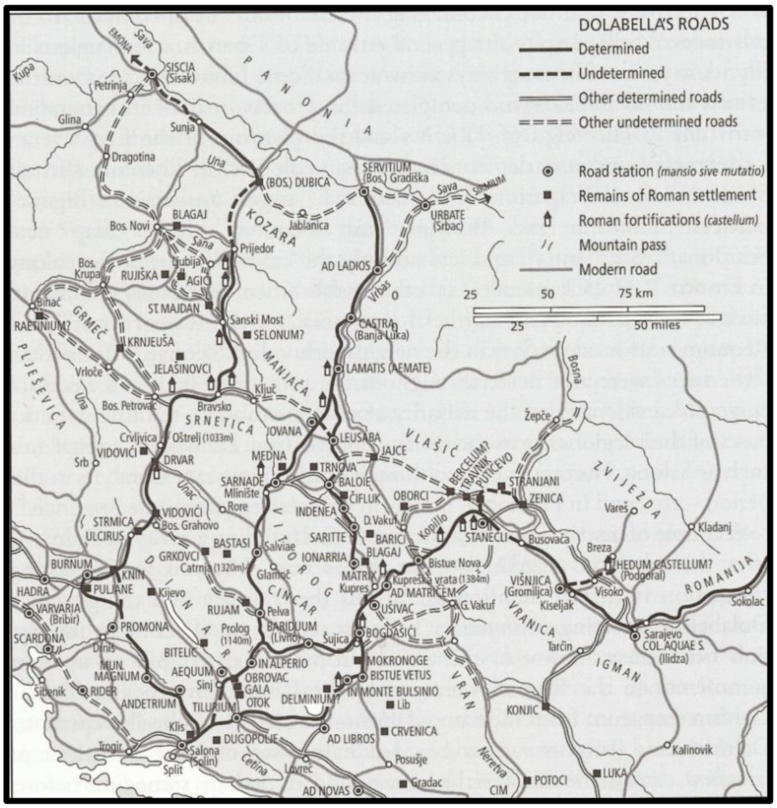

FIGURE 5. Map of Dolabella's roads. (Dzino 2010:170).

By A.D. 17, roads connected the administrative center of Salona on the coast to Andetrium in the east and to the Sava River in the north. These roads totaled approximately 450 km. By A.D. 20, they had completed another set of roads connecting Salona to all major areas in southern Pannonia. During the 1st century A.D., the Roman veterans also completed the major roads connecting Illyria to the Italian peninsula, by way of the northern Adriatic Sea, and Byzantium through the Via Egnatia. The Via Egnatia was a major engineering feat that ran from Dyrrhachium in the west to Byzantium in the east. It was fully fortified, with extensions to major legionary camps at Burnum and Tilurium for quick access to troops.

These roads supported socio-economic development and military control. They allowed trade access throughout the province that took days or weeks along smooth roads instead of months through the rough mountain passes. Goods and people could also move throughout the year, as opposed to travelling only during periods of good weather. Such ease of movement benefited not only Illyricum but also Rome itself, as it facilitated greater eastern expansion. The prosperity and easy governance of the province were to last until the beginning of the 3rd century A.D.

Illyrian Power

Illyricum stopped being a backwater province in A.D. 192. Commodus's death and Severus's rise changed Illyricum forever. Severus was proclaimed emperor in April of A.D. 193 while acting as the governor of upper Pannonia. His first major change was to dismiss the current Praetorian Guard and replace them with 10,000 troops from Pannonia and the surrounding provinces (Wilkes 1992:259,260). Severus was the first of many emperors from Illyricum, including several in the 4th century who were native to the area. Severus himself was not a native Illyrian, but had the loyalty of the local troops, which propelled him into the purple. By the end of the Severan dynasty in A.D. 235, Illyricum had developed a powerful voice among the armies of the east. They formed the front line defense against Gothic migrations coming from north of the Danube River. The succeeding emperor was Maximus, a native of northern Illyricum. Maximus, though, was only emperor for three short years, as the Roman Senate considered him a usurper and replaced him in A.D. 238 (Wilkes 1992:262). Though short-lived, his reign did set a precedent for future emperors who were native to Illyricum. The next Illyrian emperor proved to be a more powerful force. In A.D. 270, Aurelianus, possibly native to eastern Illyricum in Sirmium, was chosen emperor by his troops and proceeded to restore cohesion to the Empire. The next 14 years saw three more Illyrian emperors who experienced varying degrees of success. The Illyrian born general elected emperor in A.D. 284 though changed the very foundations of the Empire.

Diocletian was originally from the important administrative center of Salona (modern Solin, near Split, Croatia) and had trained under Aurelianus. Diocletian knew from experience that the Empire could not be ruled efficiently by one man, so he selected an army colleague, Maximianus, as co-emperor. They ruled the empire together as Augusti until A.D. 293, when they chose two others as Caesares (emperors-in-training), Galerius and Constantius. All four of the men, known as the Tetrarchy, came from Illyricum (Wilkes 1992:263). These four men strengthened the Empire by updating the frontier forts, changing the shape of provinces to make them easier to govern, devising a system for efficient tax collection, and instituting a commodities price regulation. However, this latter attempt at reform failed miserably. Diocletian's most controversial reform in A.D. 286-293 was to split the Empire into eastern and western regions ruled individually by himself and Maximianus.

After Diocletian's retirement in A.D. 305, the rule of four brought the empire to civil war again when the sons of Maximianus and Constantius fought each other for control of the Western Empire. The winner, Constantine, son of Constantius, went on to defeat Licinius in A.D. 324, thereby gaining control of the entire Empire (Barnes 1982:198). The 4th century under

Constantine and his successors witnessed sweeping changes in religion and power bases that eventually led to the downfall of the Western Empire and with it Illyrian power (Figure 6).

FIGURE 6. Illyricum administration changes in the late 4th century. (Author 2013).

The 4th Century in Illyricum

Cities, ports and roads

At the time of the fracturing of the Empire, during the late 3rd and into the 4th centuries, Illyricum was an important province. The region not only produced many emperors but also stood at the crossroads to the east and offered (through its ports) direct routes to the Danubian and eastern provinces. The eastern shores of the Adriatic Sea held many ports, but this thesis will focus on three: Dyrrhachium in the south, Solana in the center, and Aquileia in the far north (Figure 6). Each of these was important in different ways. Dyrrhachium was situated in the southern portion of Illyricum and, as such, would have been one of the first major ports for merchants to enter after leaving Macedonia. Given its location, Dyrrhachium would have facilitated more efficient travel, saving a merchant time and money. The proximity to Macedonia would also have offered access to a variety of trade goods possibly not available farther north. Dyrrhachium had become a major hub in the south because of its access to many roads. The Via Egnatia led east toward Thrace and eventually to Byzantium, while coastal roads led north to Aquileia and south to Buthroton. Another road led through the mountains to the remote interior villages (Porto and Pollo 1982:21). Salona, situated on the central coast of Illyricum, served as the provincial capital. Dolabella's 1st century governance started generations of road building with Salona as the hub. Salona was the midpoint from Dyrrhachium to Aquileia and a coastal connection to the important interior city of Sirmium. As such, Salona became the major trading and administrative center for Illyricum. Unlike Dyrrhachium and Salona, which had begun as Greek colonies, Aquileia was originally a Roman colony, founded in approximately 180 B.C. It served originally as a military outpost to protect trade routes from northern barbarian incursions and evolved into a civilian administrative center as Rome started its expansions eastward (Dzino 2010:29). As Rome grew to the east, so too did Aquileia's importance. It provided a direct connection from the Italian peninsula to the Danubian and Byzantine provinces and eventually became the major port in the north. Under Diocletian's and Constantine's reforms, it also became a provincial capital.

These three ports, as well as smaller ones along the entire eastern coastline of the Adriatic Sea, will become important when discussing maritime trade in future sections. Any 4th century merchant vessel trading in the Adriatic Sea would more than likely have called at one of these three ports, if not all of them. Aquileia was considered a distribution point for the military *annona* going to the Danubian troops, while also serving as a route into the northern Italia-

Ravenna populations. Salona represented the hub of an excellent road system that could distribute goods into the countryside, while also serving as a staging area for exports. Dyrrhachium was important as the confluence of western administratively controlled Illyricum and eastern administratively controlled Macedonia and Epirus.

Political Changes and the Fall of Illyricum

After Constantine defeated Licinius in A.D. 324 and brought the Empire under one emperor again, he continued many of Diocletian's administrative reforms. He added two key additional reforms: ending the persecution of Christians and shifting the power of the Empire to the east at Byzantium (Cameron 1993:63). Stopping the persecution of Christians did not have serious effects on Illyricum, but the shift in power to the east was to have severe consequences on the province. By the 4th century, Diocletian's reforms had divided Illyricum into several dioceses. Much of the province was split into the Dioceses of Macedonia and Illyricum, with smaller provinces' being established within the two. The smaller provinces, combined with the large amount of road construction, led to a much more organized and efficient administration.

Constantine dedicated his new city of Constantinople in A.D. 330, but that did not immediately lead to a shift of control from the capital in the West. It started more of a socio-economic shift in power, as Rome still retained its senators and leadership roles, but Constantine kept his court in the new city. When Constantine died in A.D. 337, he left the Empire to be equally split between his three sons: Constantius II, Constans, and Constantine II. This arrangement did not last long. Constantine II died invading Constans's territory, and Constans was assassinated, leaving Constantius II as sole emperor by A.D. 353 (Cameron 1993:85). By A.D. 361, Constantius was trying to conquer Persia, and his cousin Julian had been left as

Caesar. Julian had been a successful general in Gaul and now desired the purple himself. He persuaded Sirmium and Aquileia to support him against Constantius; however, Julian never took the field against Constantius. In A.D. 361, Constantius died suddenly while returning from Persia to meet Julian's threat. Julian was only to rule for two years before dying in A.D. 363. His death led to the election of two more succeeding Illyrians, Jovianus from Singidunum and Valentinian of Pannonia. Valentinian elevated his brother Valens to Augustus in A.D. 365, leaving him in charge of the eastern half of the Empire (Wilkes 1992:264; Cameron 1993:93). Valens eventually brought about the end of Illyricum and Rome itself.

Valens overturned the standard policy established by Diocletian of treating the Danube River as a northern border and not allowing the Gothic tribes north of the river access south. In a reversal of centuries of administrative policy, Valens invited the Goths across the Danube River, thinking he could raise tribute from them to support his armies (Cameron 1993:136,137). What Valens possibly did not know was that the Goths did not want to just raid; the Huns were pushing them out of their lands, so they needed to migrate to survive. The Gothic auxiliaries waited only two short years before they rebelled. Valens took the field against them in A.D. 378. The ensuing battle at Adrianople in Thrace devastated Rome. Valens and most of his army were annihilated during the battle and aftermath. The Gothic tribes then proceeded south and west, bringing whole tribes to settle, not just warrior bands. Within a few short years, most of Pannonia was in Gothic hands. St. Jerome writes in A.D. 380 that his hometown, Stridon, on the border of Pannonia and Dalmatia, is in ruins and a few years later, that everything has perished (Wilkes 1992:265). As the Empire fell apart over the next century, Illyricum remained part of the Western Empire, although it was never considered more than an inconsequential borderland, while the Eastern Empire annexed Macedonia.

Conclusions

Illyria in ancient times had the advantages of a coastline, temperate weather, and a large population, but could never evolve into a powerful state on its own. Over time, Greece, Thrace, Rome, and Byzantium in turn controlled (to varying degrees) the region. While the Roman conquests would probably have happened no matter what, Illyria gave the Romans an invitation to invade: Agron's and Teuta's piracy and arrogance. Thus began the Roman role in Illyria that did not stop until the Ottoman invasions of the 1400s.

After Augustus defeated the rebellions of the 1st century A.D., Illyria experienced a long period of relative peace and prosperity. Cities, ports, and roads were built that created trade links throughout the new province of Illyricum, while connecting it to the farthest ends of the Empire. By the 2nd century, Illyricum was contributing manpower to the armies, silver for minting, and excellent trade goods to the market. During the 3rd century, Illyricum produced not only troops for the armies but also generals whom the troops later supported as emperors.

Throughout the 4th century, Illyricum continued to prosper even as the Empire was split apart by native Illyrian emperors. The ports and roads contributed to administrative cohesion and kept trade moving. This all changed with the disastrous Roman defeat at Adrianople in A.D. 378. The entire area was split apart and was no longer a viable province. Instead it was divided administratively, with Illyricum's still being administered by Rome, while Macedonia to the south was administered by the new power in Constantinople.

CHAPTER 3: FIELDWORK IN THE ADRIATIC SEA

After the Joni wreck's initial discovery, in 2009, researchers engaged in very limited field work until this thesis project began (in 2012). During 2009, a remotely operated underwater vehicle (ROV) recorded the site on video, while divers recorded parts of the site with still photography. The 2010 field season incorporated a more thorough recording. Divers recorded the site in its entirety with still photography and video. Researchers then used the stills to create profile view and plan view photo mosaics (Figure 7).

FIGURE 7. Main pile from the North. (Mosaic by Derek Smith 2011).

These mosaics were then used during the planning for the 2012 project. During 2010, divers also recorded amphora measurements from each of the typologies that were found on the main pile (Royal 2012:116).

Fieldwork for this thesis involved recording the entire site using the 3D computer mapping program Site Recorder 4. The methodology for recording the Joni Wreck was divided into two phases: 1) preplanning and testing of the software on land to determine the most efficient practices and parameters and 2) recording of the site under water based on land experiments while adapting techniques according to environmental conditions on site. The first phase began at East Carolina University's campus in Greenville, NC, where the recording team constructed a model of the site. Using photographs from previous seasons and data from the original multi-beam survey, the amphora pile's approximate length and beam were outlined on the ground. Various objects with similar sizes and shapes to amphoras were used to simulate the layout of the site's cargo and provide approximations for how and where team members were to take measurements on the amphoras.

The team conducted several "run-throughs" recording the simulated shipwreck over several days. This allowed the team to develop and hone their surveying teamwork skills and methodologies. The data they collected from these tests also allowed them to become more familiar with utilizing Site Recorder 4's spatial analysis tools. They identified and corrected for errors that would have been time-consuming in actual practice, creating a more efficient process during the second phase of the project.

The equipment needed for the project was split into two sections: items that could be taken on a plane as luggage and those that would need to be purchased in Albania. The team decided that Site Recorder 4's control points should be rebar because the control points needed to remain rigidly anchored throughout the project. They selected rebar, as the material was readily available in Albania. They discovered that rebar 2 m long and 1.5 cm or 2 cm thick brought the best results in testing. Smaller diameters ran the risk of bending as measurements were made, while larger sizes could lead to an unwieldy weight under water. The team needed to purchase only the rebar, along with a sledgehammer to drive it into the seafloor, and 10 m metal tape measures in Albania. The team attached zip ties, which are lightweight and easily carried to the bottom, to the rebar to aid in measuring from the exact same point every time. They used 10 m tape measures, as these tape measures were long enough to reach each end of the amphora pile from any control point, while also being small enough to be easily handled.

The second phase, the recording of the Joni Wreck, began at the end of July 2012. After the purchase of the necessary materials, the team began operations on site, conducting an initial reconnaissance dive to familiarize team members with the site, water conditions, and the SCUBA equipment, which RPMNF donated. Over the next 17 days, the team members conducted 42 working dives, lasting from 30 to 38 minutes each, depending upon depth and the amount of work being done.

Wreck site

This section will discuss the physical remains and the formation processes that have affected the wreck from when it sank in the late-4th century to its discovery in 2009. In 2009, RPM Nautical Foundation, on contract for the Albanian government, located the Joni site while surveying the coastline out to a 50 m depth zone. In 2010, a small reconnaissance team conducted a limited Phase I survey to determine the overall integrity of the site and ascertain whether the site warranted further documentation. Due to its relatively intact nature, they decided that the Joni wreck would be a useful case study to possibly illuminate coastal trading patterns and practices along the Illyrian coast. The wreck lies approximately 19 km north of the modern Albanian port of Sarande. It is approximately 860 m from the modern coastline with the main pile of amphoras resting at a depth of approximately 22.5 m (Figure 8). The site comprises two sections: the main section, which is mostly intact and appears to contain the majority of the amphoras, and a spill pile to the north with scattered remains of amphoras.

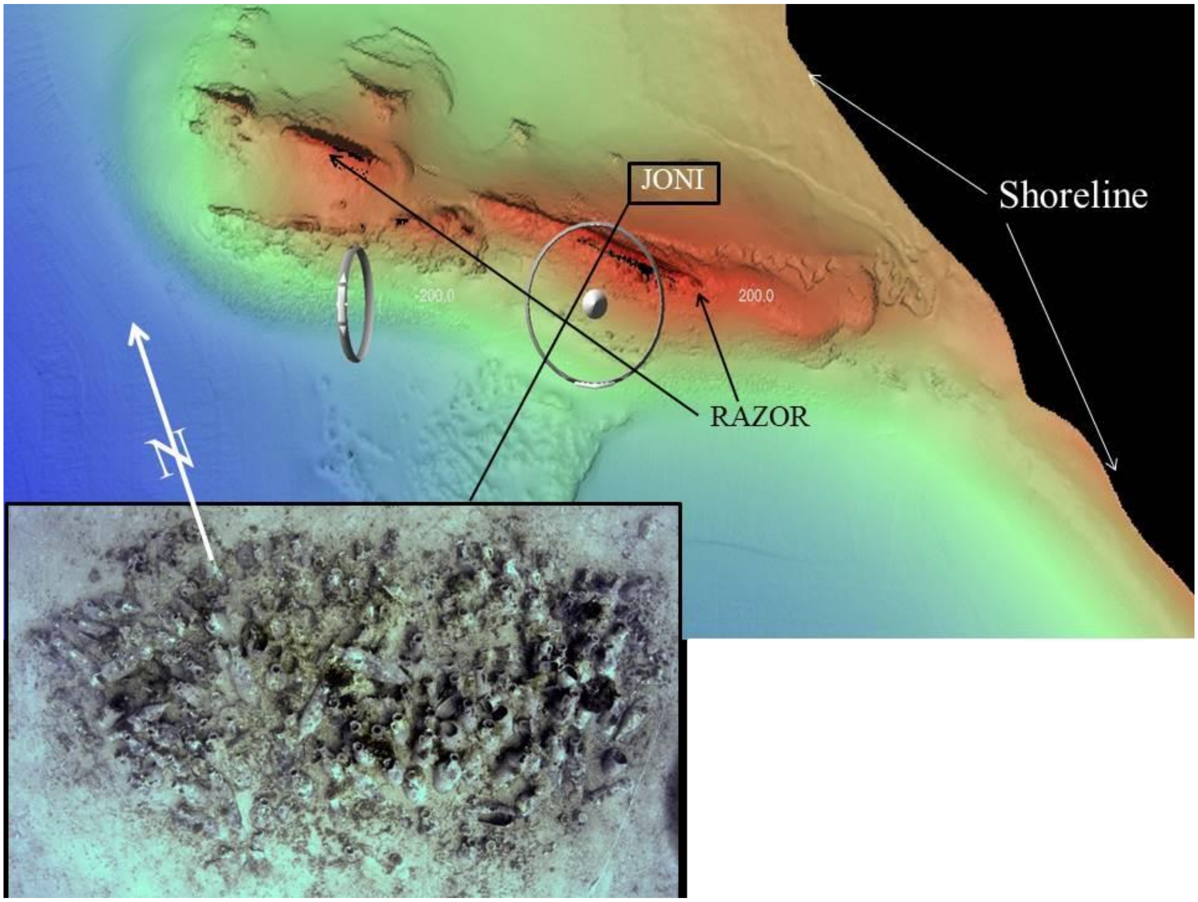

FIGURE 8. Wreck site (RPM Nautical Foundation and Author 2013).

The exposed amphora pile is 9.1 m long by 4.4 m wide and 1.2 m high, with most of the amphoras lying over on their sides facing a north by northwest heading. Over 210 amphora mouths were visible above the sand when first discovered in 2009. A second section, the spill pile, lies 23 m to the north of the main pile on a surface that slopes gently down to a depth of 28m – 30m amidst a long running section of stones and boulders. The amphoras in this section are mostly broken and scattered over an area of approximately 30 m by 4 m. No visible amphora remnants are visible on the seafloor between the two piles. This does not mean that none are there, just that none are visible. The seafloor is comprised of loose grainy sandy particles with a small amount of thick sea grass.

The site lies approximately 75 m north of a submerged geological feature nicknamed the "Razor," which is part of the Gjergjantas Bank. The Razor is a stone outcropping that rises from the seafloor, beginning at the coastline and running over 2 km out to sea in a north by northwest direction (Figure 9). The base of the formation is 22m – 25m wide at some points along the seafloor (Figure 10).

FIGURE 9. Razor from the surface (Photograph by Derek Smith 2010).

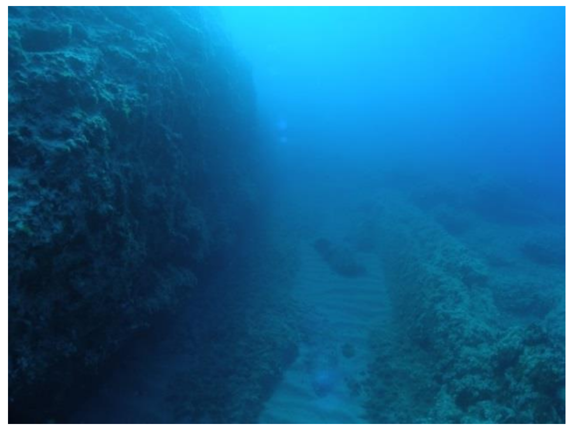

FIGURE 10. Razor at the seafloor (Photograph by Derek Smith 2010).

The water surface in the 4th century could have been as much as 1.2 m lower than that in modern times, which would have placed some of the Razor's top spines only 1-1.2m below the water surface, well within striking distance of a heavily laden vessel, especially in a possibly turbulent sea (Lambeck et al. 2004:568,569-574). While no one can say definitively what caused the wreck, a catastrophic event involving the Razor likely caused the ship to sink with its entire cargo of amphoras.

Over 210 amphora mouths were visible above the sand when the wreck was first discovered in 2009. The 2012 team counted them using a mosaic photograph that RPM Nautical Foundation and Derek Smith provided (Figure 11).

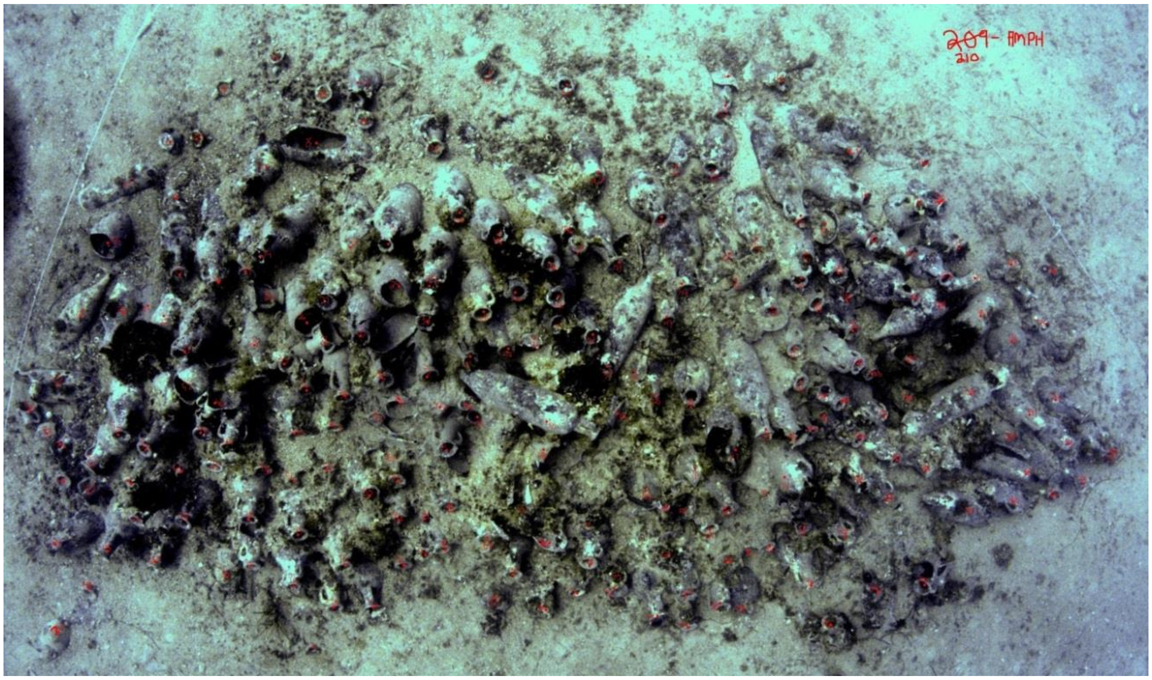

FIGURE 11. Main pile as counted from original photographs (Photograph by Derek Smith, data added by Author 2010).

Without excavating the entire site, no one could determine the exact number of amphoras. A total between 600 and 700 is not out of the realm of possibility considering the vessel's probable size of 15m by 5m, based upon the shape and size of the main amphora pile. This size is similar to that of many of the cargo vessels that have been found in the Mediterranean, such as at Yassi Adda (Van Alfen 1995).The amphoras in the main pile are mostly intact and do not appear to have been dragged by fishermen, as no modern nets, hooks, weights, or lines were discovered on site.

The spill pile consists of a large debris field of scattered amphoras. This is where most of the Late Roman 2 and the unknown amphoras are found, together with more North African jars. The spill site is approximately 250-300 m^2 running in a southeast to northwest direction. There is a rocky edge along the south side at a depth of 27.5 m that tapers away to the north to a depth of approximately 30 m. More than 60 scattered amphoras are visible in the pile, mostly broken.

The team did not take measurements of the spill pile with the site recorder due to time restraints, but divers recorded it using still photography with a 30 m baseline running along the length of the pile with 5 m wide offsets. The conditions are different for the two piles (Figure 12).

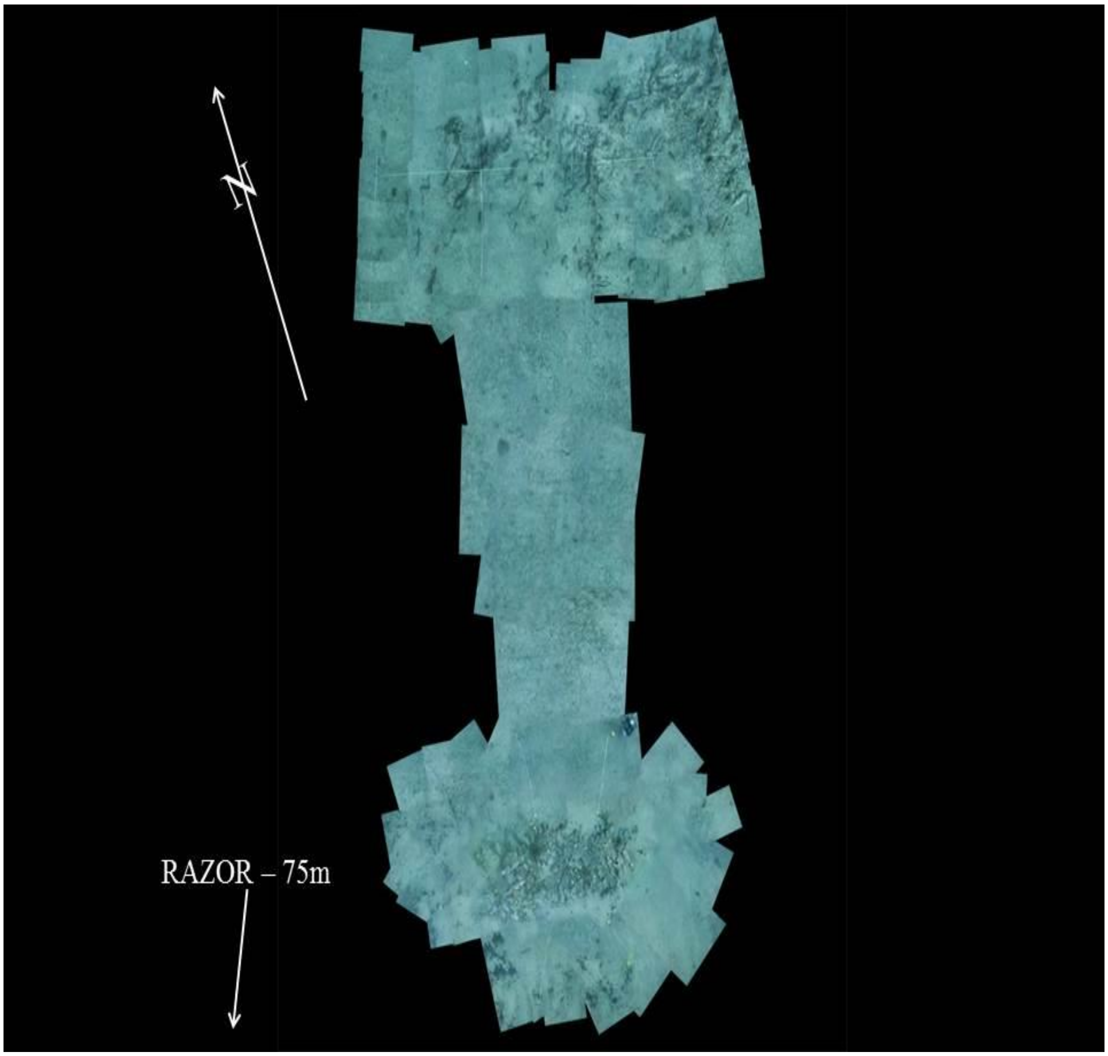

FIGURE 12. Entire site and pile (Photographs by Howard Phoenix, mosaic by Joseph Hoyt 2013).

The main pile amphoras were clear of most organic materials, such as the grasses and light algae seen in the spill pile, although several did have some gelatinous sponge growth on them. The biggest difference in the two sites was that the main pile was completely concreted into one large mass, which rendered the original plan of recording each mouth and toe impossible, as most of the toes were buried under one other. The main pile in 2013 has been reported to be covered in an algae type growth, which from 2009 to 2012 was not present. This growth, along with the fibrous roots under and between amphoras, leads to the hypothesis that the main pile might have been covered and uncovered over the centuries by the sand surrounding it. The spill pile amphoras, though, were scattered over a larger area, which made them easy to pick up and record, although every one of them was broken in some way.

The site was also surveyed using a handheld metal detector. This was done to ascertain the possibility that the ship's hull could be under the amphora pile. A metal detector could locate potential small ferrous pieces of nails or other types of fasteners, such as found in the Kyrenia, Yassi Adda, and Levanto I sites, while also identifying possible lead anchor stocks around the wreck. However, the detector only picked up hits in one small area, inside amphora 3-0024. This amphora was on the southeast edge of the pile, which allowed it to be partially dug out, verifying that it was the amphora and not an anomaly. With the government's permission, the 2012 team tried to raise the amphora to the surface to investigate what was inside, but unfortunately the amphora was solidly concreted to its neighbors and could not be dislodged without the possibility of breaking it open. Therefore, the team left it in place.

How the ship came to its resting place will never be known for certain. After identifying the cargo and the way it was loaded, the team presumed that the ship was running in a northerly direction when it went down. This is due to prevalent northerly current direction and that the only other vessel found with the same type cargo was far north of this site. A storm or high winds in the area likely blew the ship very close to shore. If the ship was running north, it would have been farther west to clear the point at Kepi I Palermo. There are two possibilities for this: the ship had made it closer to shore and tried to throw out an anchor, but was dragged out into the spines of the Razor, or the ship hit the Razor going north, which breached the hull (Figure 13).

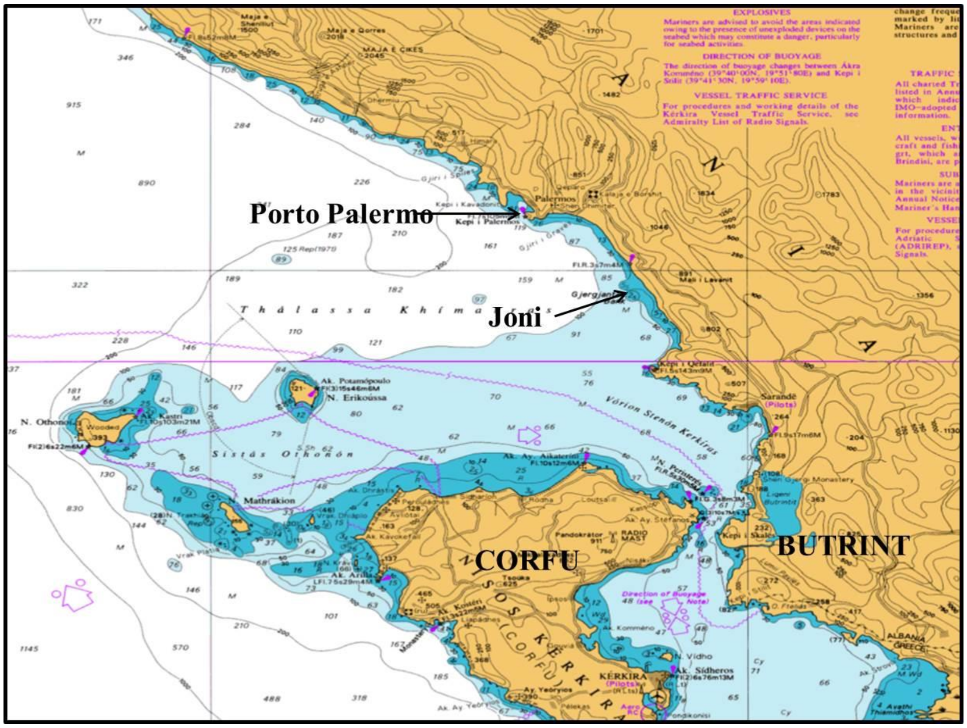

FIGURE 13. Porto Palermo approximation (Graphics by Author 2013).

Either way, from the physical evidence of the two amphora sites, the ship could have rolled over to a point that the upper cargo of amphoras, most from the Aegean and Crete along with some from Africa, was dislodged and fell overboard, forming the spill pile. This might have temporarily righted the ship before it sank beneath the waves with the deck's facing up again. Alternately, the crew might have thrown the upper amphoras overboard to try to lighten the load after being holed below the waterline, but the damage to the hull was too great and it sank anyway. The large size and longitudinal shape of the spill pile could be interpreted in this way, but the sheer number of amphoras suggests that it would have been very difficult to achieve. The ship then sank fairly upright to the bottom, where she rolled over to one side and settled in.

The team began setting up Site Recorder 4 by probing the sand with 1 m long by 2.5 mm diameter fiberglass rods. They did so to ensure that no subsurface amphoras would be damaged when the rebar control points were driven into the sediment, while simultaneously creating a perimeter that guided the setup of control points. Next, nine rebar control points were established around the wreck site, and driven 1 m into the sediment and 1 m outside the perimeter established by the fiberglass "probing" sticks. This served as another measure to avoid unintentional destruction of unseen subsurface artifacts. The team marked all the rebar with plastic yellow tags, secured it with zip ties, and demarcated it with the letters A-K to establish a unique identifier for each control point. They attached additional zip ties to each piece of rebar 25 cm from the top to ensure that they would use the exact same point for all measurements (Figure 14).

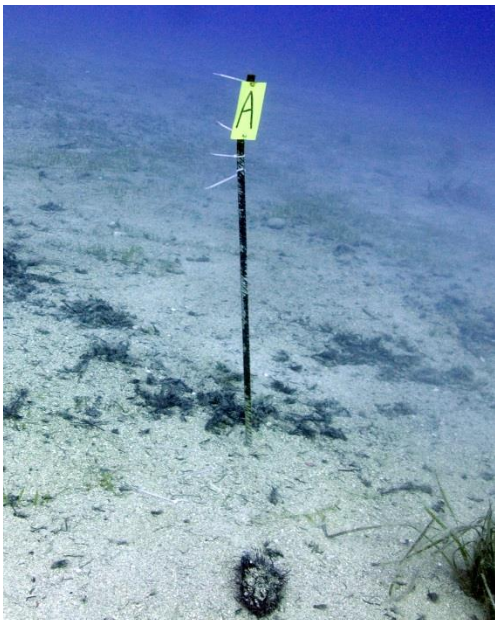

FIGURE 14. Rebar with zip tie and tag (Photograph by Author 2012).

The next task was to set up tape measures. The team accomplished this by zip tying the 0 end of a tape to each data point, approximately 30 cm from the top. This afforded the team precision in that every measurement was taken from the exact same point.

Before the team began recording, they needed to tag each of the amphoras with the site number and amphora number. Although the team had originally planned to divide the site into four sections and apply marking tags accordingly, reducing this by half, to east and west, offered greater efficiency and clarity. AB09AA is the RPMNF official designation for the site. The team marked the amphoras on the western half of the site thusly: AB09AA **1**-XXXX, where XXXX denotes a running number beginning with 0001. They marked those on the eastern half in the following way: AB09AA **3**-XXXX. After dredging, the team designated the newly exposed amphoras AB09AA 4-XXXX so that they could be distinguished during post-processing. (Figure 15).

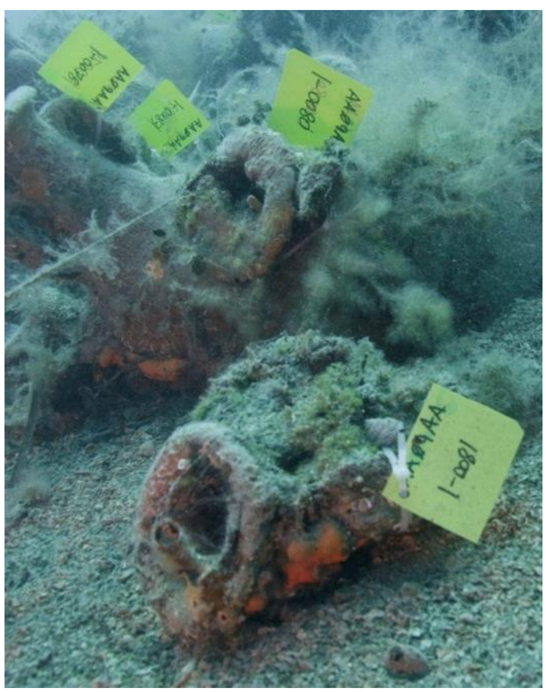

FIGURE 15. Amphoras with tags (Photograph by Author 2013).

In recording the amphoras, the condition of the amphoras required additional adaptations to the initial strategy. During training at ECU, the team had practiced recording three locations on each amphora to provide its location and orientation: 1) at the center of the mouth, 2) at one of the handles at the apex of its downturn, and 3) at the center of the toe. Unfortunately the site did not allow for this because the amphoras were concreted so solidly that the toes of most of amphoras, 185 out of 189, were inaccessible for measurement. Therefore, the team adapted the strategy to utilize the center of the mouth along with the apex in the curve of both handles. However, this was not an optimal strategy because of the error involved in using only the handles rather than a point near the bottom of the jar. The mouth of the jar and the point of the toe are in almost exact alignment, and when imported into Rhinoceros 4 would have given a perfect match to what was on the seafloor. The two handle measurements, on the other hand, introduced some error. Team members tried to take measurements from the exact same place, but finding the exact same spot on both handles was challenging. Despite this issue, the mouth and handle arrangement provided enough information to orient each amphora as closely as possible during post-processing.

Site Recorder 4 is a very manageable, non-invasive recording tool that renders measurements into an X-Y-Z coordinate system capable of producing 3D plans. Researchers have used the device successfully on maritime projects in the past, such as the *Mary Rose* (those researchers used a precursor to Site Recorder 4) project in England and Kizilburun, Turkey (www.3hconsulting.com/case studies). The degree of accuracy comes from taking precise measurements on fixed control points. Each of the control points is first measured to all other control points, A-B, A-C, A-D, and so on, to create a network of known locations from which the locations of unknown points can be calculated. This is done by taking at least three measurements from different control points to any object that needs to be recorded; however, four measurements provide the best accuracy if they can be properly recorded. For example, to record the mouth of amphora number 0045, an archaeologist would record it with measurements from four different control points. This was done on every mouth and handle that could be properly measured (Figure 16).

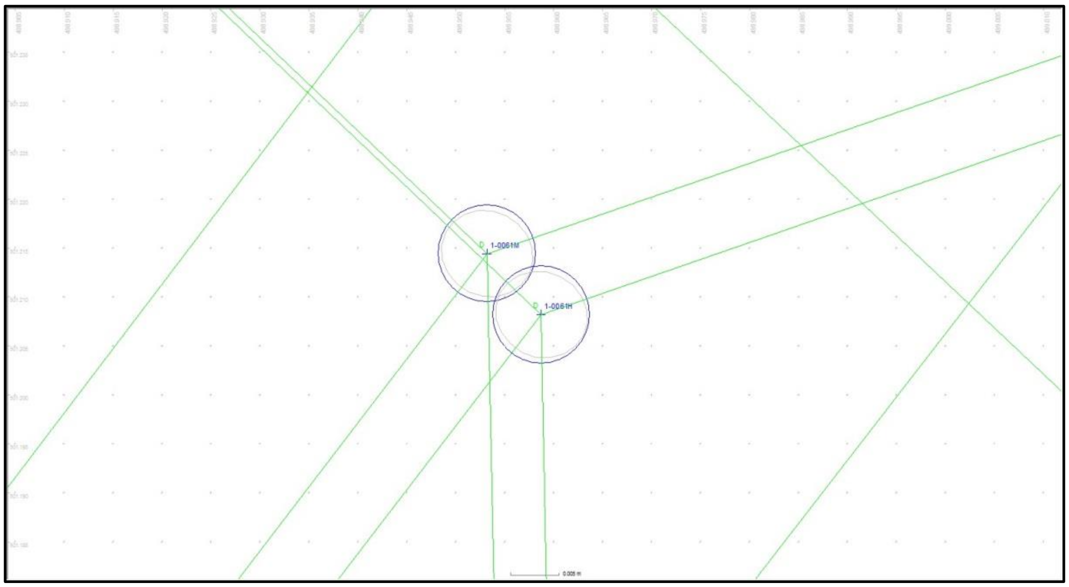

FIGURE 16. Site Recorder. (Author 2012).

When site recording commenced, the team was split into two dive buddy pairs, with one group taking measurements in the western section and the other in the eastern section. Each member of the pair was in charge of two tape measures and his slate with proformas on it. The pair faced each other and recorded each amphora point together. The first diver would take two measurements to the mouth, and the second diver would take two measurements to the same point. They continued in this manner, taking four measurements on each amphora handle and four measurements to the mouth. This was found to be the most efficient use of measuring time. For best results in Site Recorder 4, the object being measured needed to be at the center of an X-shaped measuring pattern, with the measuring tapes brought in from four different control points in a pattern approximating an X. The angles needed to be 70-110 degrees from each other for the algorithm to produce the most accurate results.

Within the first few days, the team had worked out all of the problems encountered, such as determining dive times, fixing gear malfunctions, and finding the proper patterns to record. Overall, they took 1,789 measurements on 189 amphoras. The next stage of the project involved post-processing all of the information into usable data for Site Recorder 4 and Rhinoceros. (Figure 17).

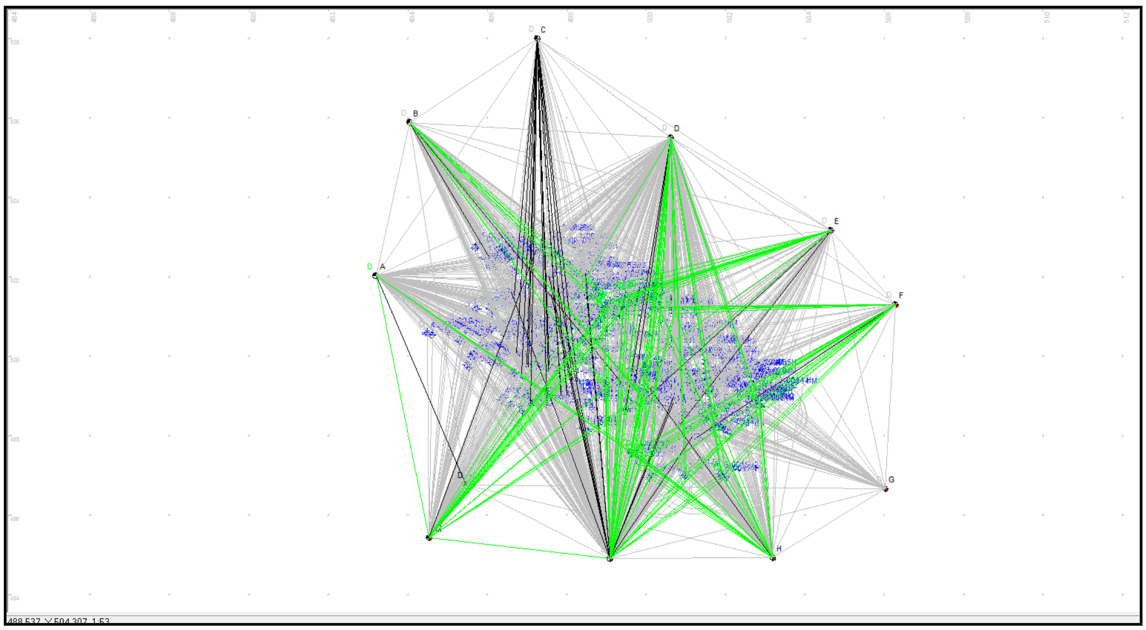

FIGURE 17. Entire site in site recorder (Author 2013).

After each dive the team took the written measurements and notes from an underwater slate each member had, input the four measurements for each point of contact into Site Recorder 4, and then awaited the algorithm's results to see if any needed re-measuring. I printed out scans of the layers each day so that individual points could be identified after being exported into Rhinoceros 4.

The depths, and relatively short time window to work, limited the creation of a traditional grid of 1 m by 1 m work squares, where team members would have recorded each amphora by hand. Site Recorder 4 allowed for the creation of different internal computer layers for each day that measurements were recorded. This allowed the team to work in post-processing on each individual day's work without the clutter of all data from the site. When needed, all layers of the site could be turned on to create a complete site plan. At the end of each day, team members inputted all measurements into the computer program, and the algorithm calculated the location of the unknown points and gave feedback concerning measurement accuracy. The algorithm provides feedback in the form of colored lines. A green line indicates that the measurement lies within the specified tolerance and therefore does not need to be retaken. Red and blue, on the other hand, show that the measurement is either too long or too short, respectively, and must be re-measured. For this project, the team specified a tolerance of 5 mm. A higher tolerance might result in a site plan that was not as accurate, while a lower tolerance might lead to retaking many measurements.

Site Evolution

When discussing what has happened to the site over the intervening 1,675 or so years, Muckelyroy's Maritime Archaeology (1978), Schiffer's Toward the Identification of Formation Processes (1983), and Gibb's Cultural site formation processes in maritime archaeology: Disaster response, Salvage and Muckelroy 30 years on (2006), outline the site formation processes that make the vessel part of the archaeological record. Site formation process theory focuses on cultural and natural forces acting upon the sites and assemblages in a filtering (extracting) or scrambling (rearranging or materials) type of effects (Gibbs 2006:2-3). This thesis will follow that pattern.

The natural processes that act upon a shipwreck include biological, environmental, ecological, and physical changes. On the Joni site, the grass type fibers growing under the main pile, the sponges growing on the amphoras, and the possible covering and uncovering of the site are all natural processes that must be considered when trying to interpret any changes over time. Another natural filter in ancient shipwrecks is that no wooden remains of the ship are visible on the seafloor. This is especially prevalent in the warm waters of the Mediterranean, which are a perfect host for mollusks of the family Teredinidae or Teredo worms. These worms bore into the hull and devour the wood, leaving no remains above the seafloor (Stewart 1999:578). This activity is only hindered by the remains' being submerged beneath the sand of the seafloor in an anaerobic environment that does not allow either the worms or oxygen to contaminate the wood and start the decomposition process. The Joni wreck is typical in that, as explained, no wooden remains are visible above the seafloor, and the team's attempts to find the hull using a dredge failed due to the previously discussed grass fibers.

Another filter is the scrambling filter, which affects how artifacts move around the site after the wrecking event (Bowen 2009:28-30). Natural effects, such as tides, currents, and storms, cause movement, but so do humans or animals. The Joni site has been affected by both natural processes and human contact. The 2009 team recorded over 210 visible amphoras, but the 2012 team recorded only 188, showing that amphoras had been looted from the site. There were 4 LRA-2 amphoras on the outside edges of the main pile, while there were intact African amphoras in several places. When the 2012 team arrived, they noticed that all 4 of the previously seen LRA-2 had disappeared, and that any intact amphora on the pile, not concreted to others, had also disappeared. Although fishing nets could have been involved, the more plausible suggestion is that of looting, as the team found no intact amphoras outside of the main pile in any direction, and the site is only 22.5 m in depth, a depth easily attainable by local free divers.

Another scrambling effect is the action of sea animals, in particular the octopus. Almost every site report in the Mediterranean has mentioned octopuses. They can move small items around a site, thereby confusing the provenance of found artifacts. The team found a small octopus living in one of the amphoras on the main pile. This octopus could have removed or hidden small artifacts around the site, as the team found no small wares or personal items on site or while dredging.

Other natural filters, such as currents and tides, presented fewer prevalent effects than human interaction. The tide in the Adriatic Sea is approximately 18 cm a day, which is not a great amount of water movement, especially at a depth of 22.5 m, while the small current in this part of the Adriatic Sea would affect the biological and ecological elements of the site much more than the physical placement of artifacts.

Dredging

The team conducted dredging operations on the site for two reasons: to attempt to expose any hull remains underneath the amphora pile and to discern as many layers of the amphoras as possible to provide an accurate count. Several issues arose during operations that precluded either goal from being fully realized.

Dredging at 22.5 m depth is very challenging due to limited working times. For this project, a 10 horsepower engine powered the dredge rig, which consisted of two 30 m by 8 mm fire hoses, a bronze 15 cm dredge head, an 8 cm stainless steel dredge head, and various intake and exhaust hoses. The team attached a 15 cm by 6m vinyl hose to a 75 liter trash can and used the exhaust to catch any small artifacts that might have been accidentally swept up (Figure 18).

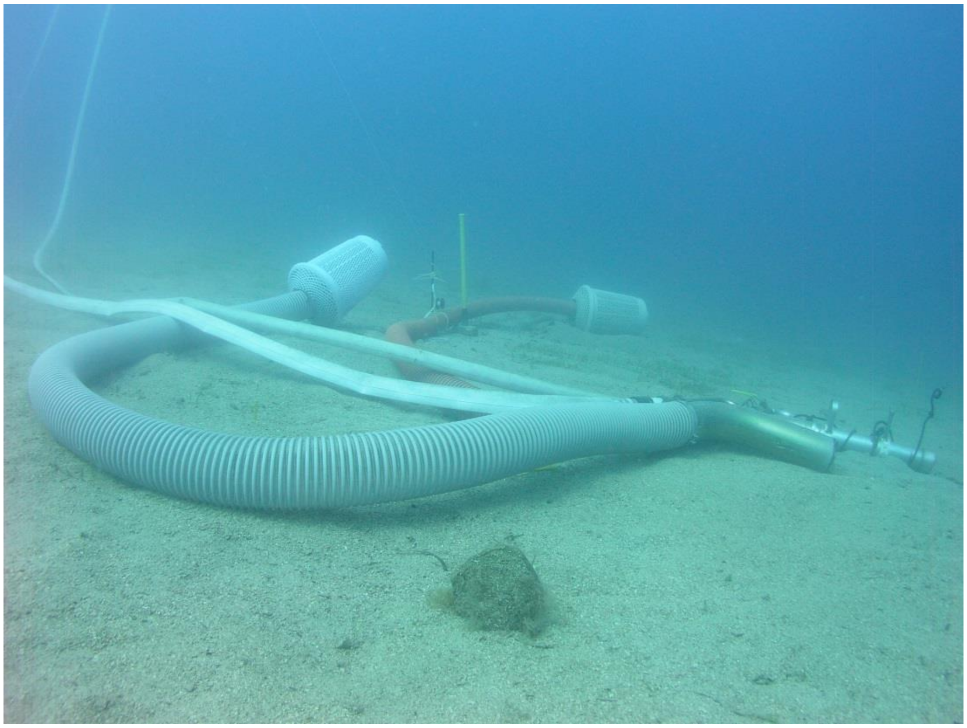

FIGURE 18. Dredging equipment. (Photograph by author 2012).

The dredge teams worked in three groups of two and rotated out every 30 minutes, allowing for continuous operations of one group while the other two groups were on their surface intervals. Dredging operations were timed so that a new group submerged and took over when the working group had spent 25 minutes underwater.

The team encountered the first problem after dredging through the first 50 cm of sand, when they hit an unexpected layer of thick fibrous grass (Figure 19). It was so thick and strong that the dredge could not tear it out of the seafloor; instead, the team had to cut their way through it with dive knives. This was a time-consuming process and led to the decision to cease dredging after three days with only a rectangle approximately 3m x 5m exposed.

FIGURE 19. Fibrous grass found on site (Photograph by Author 2012).

Overall, dredging proved to be a mixed success. It exposed another two layers of amphoras, which helped to provide a more accurate count of the total amphoras carried by the ship. However, the thick layer of sea grass thwarted the search for the hull remains.

Rhinoceros 4

The team used Rhinoceros 4 to create a 3D plan of the recorded amphora. Three dimensional plans represent an exciting development for archaeology, allowing viewers to explore what a site looks like under the sand or amidst the cargo pile. They also allow for the use of color and texture to highlight different features on the site plan. This is a tremendous aid to a project such as the Joni wreck, as it allows each individual amphora type to be given its own unique identifying characteristics, which is extremely useful when attempting to interpret patterns of amphoras loaded aboard the vessel.

In Rhinoceros 4, the first task was to create models of each of the six amphora typologies present on the site (Figure 20).

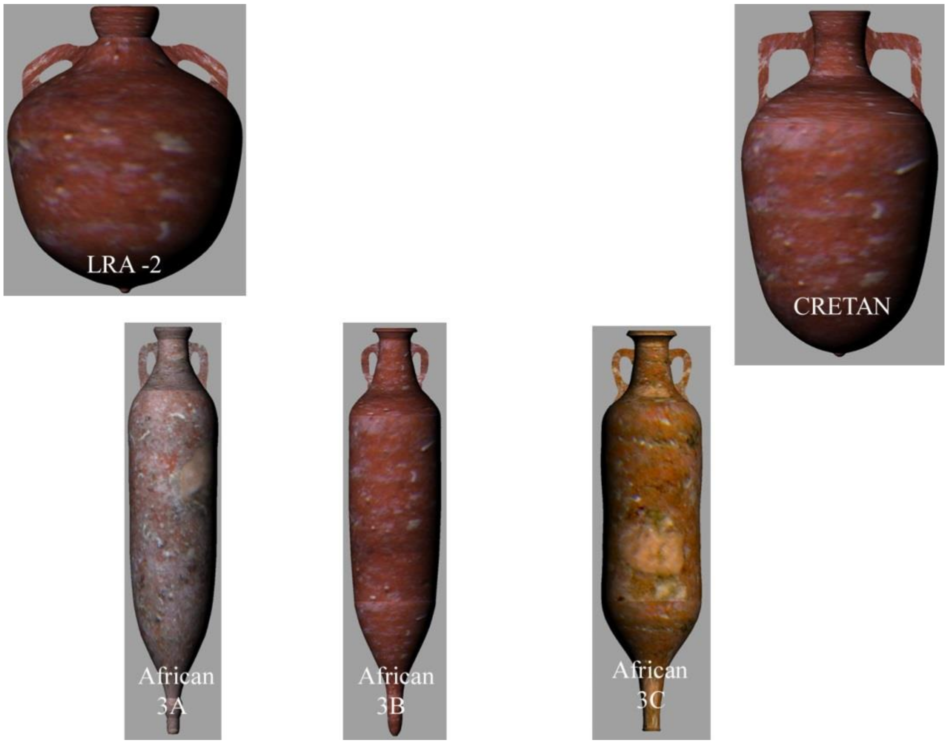

FIGURE 20. Amphora models in Rhinoceros. (Author 2013).

To accomplish this, the team imported a drawing of each amphora type as a bitmap, scaled to the proper size, and digitized its profile by adding multiple points along the outside edge of the shape represented by the profile so that they could create an accurate model. The team used Rhinoceros 4's "revolve" command to transform the digitized profile into a hollow 3D model. They created handles separately and attached the handles to the bodies. In addition to whole jars, the team created broken and partially observable amphoras so that the site map would be as accurate as possible. The last step involved texturing and coloring each of the different typological models so that the models could be rendered as virtually photorealistic depictions of the originals. The team used photographs of the actual amphora types taken on the seabed and attached them to each model in Rhinoceros 4.

After creating the amphora models, the team imported the point cloud data from Site Recorder 4. Rhinoceros 4 is capable of importing data in most commonly used graphics file formats, between software components with the setup's being completed mostly in Site Recorder 4. After importing the data from Site Recorder 4, the team cross-referenced the information attached to each point with the field notes to ensure that each computer generated reference point had not been improperly input into the computer. After importing the data into Rhinoceros 4, there were so many points in each layer that the properties of each had to be individually written to ensure that the proper point name was attached, as these properties were not part of the import software algorithm.

The team imported the amphoras into layers according to the date of measurement and typology. They had previously prepared an Excel spreadsheet to include the X, Y, and Z coordinates, the typology, and the tag number for every amphora to make cross-referencing information easier. The team had to import each amphora model into Rhinoceros 4 individually so that it could be correctly oriented to the points imported from Site Recorder 4. They had labeled the points "mouth," "handle," or "toe" (only three amphora toes were recordable) in Site Recorder 4 and attached the labels to the corresponding points on each model. This proved to be an arduous and time-consuming task, as the models were all one scale and size, while the actual amphoras differed in dimensions by as much as 5 cm.

Photographs of the site assisted in accurately recreating the location, orientation, and relationship of each amphora. The overall rendering came together one amphora and one layer at a time. Additionally, the team incorporated the sandy seafloor into the rendering around the amphoras. The final product from Rhinoceros 4 was an accurately rendered site plan that was used to answer research questions regarding the lading process, which, in turn, assisted in hypothesizing the route and possible trade patterns of the vessel.

Petrographic Analysis

Small samples of several broken amphoras were taken for petrographic analysis to determine amphora production sites. As there are no conservation facilities in Albania, the team took samples of each amphora type and then placed it back on the seafloor. Without proper conservation and storage facilities, any amphora kept out of the water for any length of time could suffer irreparable damage. The team selected pieces of amphoras in each type and brought them to the surface, where they removed a small section for analysis. They photographed and tagged each amphora before removal, which will help in future analysis of the overall site. They selected broken amphoras for sampling so that they would not cause any further damage than had already occurred (Figure 21).

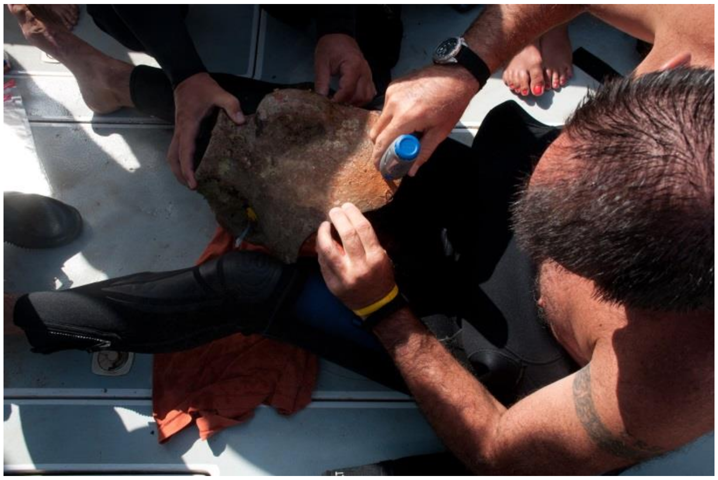

FIGURE 21. Author taking samples (Photograph by Bernard Howard 2012).

In pre-deployment testing, the team found that a Dremel tool with a ceramic blade could be used to cut precise shapes. In the amphoras for testing, the team needed the samples to be approximately 2.5 cm by 4-6 cm, and they thought the precision of the Dremel would suffice. Unfortunately, the fabrics of the 1,600-year-old amphoras proved to be much more durable than the modern ceramic pots used in testing; the Dremel tool burnt up its motor within two cuts. After the failure of the Dremel tool, the team used pliers to extract pieces with as much precision as possible. In all, they took 13 samples, with each typology represented at least twice. They documented each sample with photography and then placed each in a sample bag to be sent to the University of Southampton, England, for processing.

The petrology report, however, has been a great asset in the interpretation of the cargo, especially for the unknown amphora type. Due to budgetary constraints, only petrographic analysis was conducted. Other types of analysis that can be done are: Thermoluminescence for dating, Mass Spectrometry for content analysis, and (in its infancy), using DNA to not only analyze the contents of an amphora, but where that content was produced.

Summary

Surveying and rendering the site as this chapter describes offers many benefits. It allowed for the creation of an accurate site plan, which will form the basis for the interpretations described in subsequent chapters. Moreover, an accurate recording of every amphora in situ is critical in the event that damage, theft, or destruction of the site occurs at a later time. Although long untouched by looting, such problems are beginning to occur in Albanian waters. By comparing images of the site from the 2009 and 2010 fieldwork to that of the 2012 survey, the team discovered that many of the intact amphoras are no longer at the site. Looters apparently stole these in just the past two years.

CHAPTER 4: THE AMPHORAS: THEIR TYPOLOGIES and CONTENTS

This chapter addresses the amphoras of the Joni wreck site, particularly their relevance to past, ongoing, and future Mediterranean amphora studies. The six types of amphoras will be broken down by origin, contents, and the number of each type represented. The Joni site will also be compared with other wreck sites to compare typologies and determine if the mixed cargo was typical of 4th century vessels.

For thousands of years, the most efficient way to move any type of bulk trade goods has been by water. Whether over river, lake, or ocean, waterborne movement is cost effective for a trader. Using the A.D. 301 Edict of Diocletian for monetary guidelines, A.H.M. Jones states, “It was cheaper to ship grain from one end of the Mediterranean to the other, than cart it 75 miles” (Jones as quoted in Rickman 1980:262). By the time of the Roman Empire, trading was a for-profit endeavor, and possessing the most efficient means of storing and transporting products was the key to profitability. In the ancient world, ships served as the most economical means of transportation; and amphoras, an efficient shipping container.

Potters created amphoras in a multitude of shapes and sizes, but generally in the Late Roman period had globular or cylindrical bodies, narrow cylindrical necks, and two handles that rose from the shoulders or body toward the mouth. Transport amphoras were ceramic jars made to efficiently carry the mercantile products of ancient society. Potters constructed them from natural clays on a traditional potter’s wheel, spinning the round, globular, or tubular shape for the main body first. Then, they spun and attached the shoulders, neck, and rim. They shaped the handles individually by hand and attached them and then fired the amphora in a kiln to harden it. Many potters lined amphoras inside with resin or pitch to make them waterproof for shipping liquid products, such as wine and fish sauce. Containers for olive oil did not need this treatment, as the oil was thick enough to not seep through the fired clay, while being stoppered with a round clay insert. Transport amphoras were very sturdy and could also be used repeatedly. Archaeological field work has placed the first amphoras being used at approximately 1,500 B.C. They remained popular through the late medieval period (University of Southampton Archaeology 2005).

Transport amphoras, and the shipwrecks in which researchers find them, provide a unique insight into history. They are true time capsules as to what was being traded on the day that a ship sank. The wrecks, especially when found in situ and not scattered on the seafloor, can provide researchers with invaluable archaeological data. Such data include dates of wrecking, origins of the goods onboard, and sizes of cargos. Amphoras can tell many things, but their value to a nautical archaeologist extends beyond the actual contents. For example, the weight of the full amphoras in a sunken vessel drives the ship's timbers deep into the sandy seafloor, thereby providing an anaerobic environment. This helps to protect the wood of ancient ships from Teredo worms and other harmful organisms, which can cause total destruction of a wooden wreck.

Amphoras also further knowledge of ancient trade routes. Through petrological analysis of the clay materials, mass spectrometry, and the study of contents, researchers can often hypothesize where a ship began its voyage, where it might have stopped en route, and its ultimate destination. Even the order in which the amphoras are stacked in the hold reveals information about the route taken. Usually, a cargo that is below another in the hold was loaded first, possibly indicating an earlier stop on the voyage. This need not have been the case every time, but holds true in most cases, as a captain would not want to load and unload cargo on multiple stops.

Amphora Typology

Amphora classification is based upon morphological characteristics. The shapes of the rim, neck, handle, shoulder, body and base, or toe, are used to place amphoras into groups with shared characteristics (Figure 22).

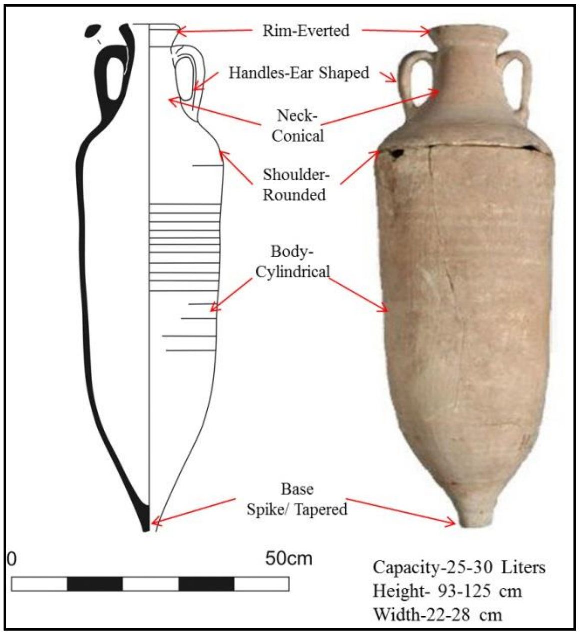

FIGURE 22. Physical descriptors for amphoras (University of Southampton, Author, 2013).

These groups, in turn, provide the basis for regional and chronological typologies. When measuring amphoras, these same terms are used to reference the relevant parts. Heinrich Dressel presented one of the first typological studies to scholars when he first published his signature synopsis of Roman amphoras in 1899. His studies and exacting notes led to a new way of categorizing amphoras. He not only described the provenance of the amphoras but also the exact shape of each part. Amphora shapes are numerous, and Dressel started to sort and name them using exact, well documented descriptions (Paterson 1982:146-150; Figure 23).

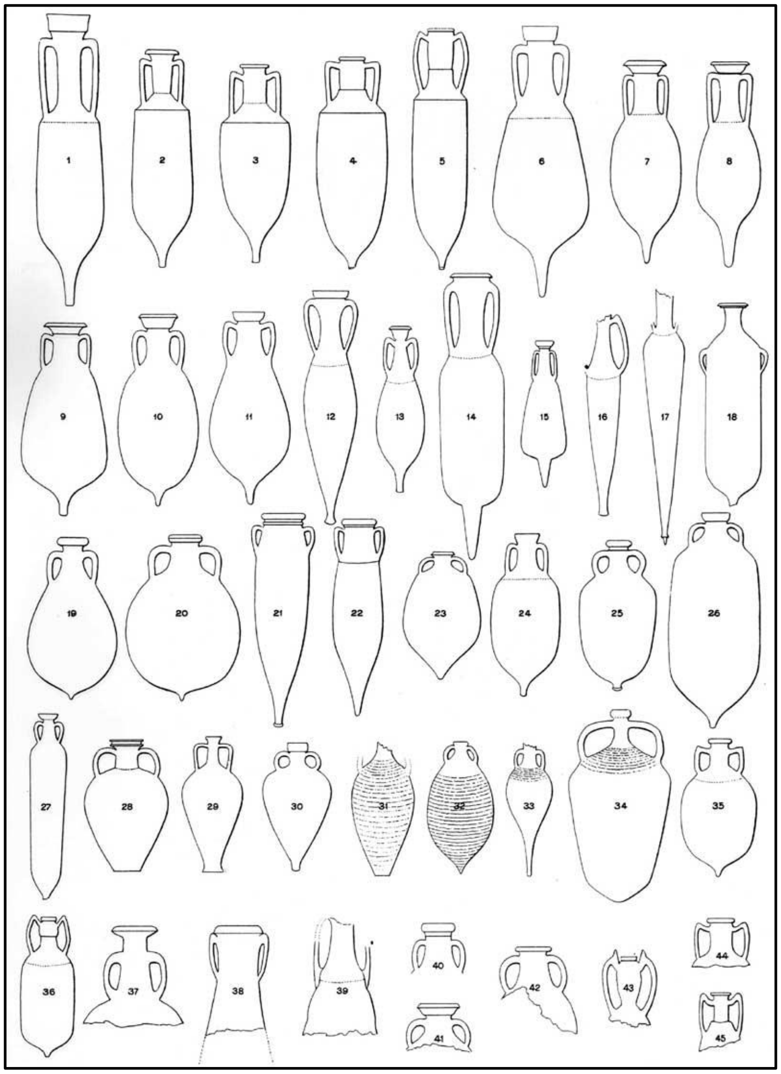

FIGURE 23. Dressel typology chart (hcmc.uvic.ua).

Since Dressel's time, the overwhelming number of amphora studies has resulted in some classificatory overlap; hence, a Late Roman 2 amphora is also the same as a Keay 53 and Peacock-Williams 44. By the same token, amphora typologies have been subdivided into an ever increasing number of sub-types. Keay (1984), for example, has a type XXV with 30 sub typologies. The differences in many classifications are minute, and a detailed study of each part, often combined with expert consultation, is needed to determine proper classification.

The Dressel 1 was, at the time, thought to be one of the earliest known amphoras of the Roman republic with a date of 160-150 B.C. In the early days of amphora studies, dates came primarily from relative dating methods, which derive a chronological order based upon the stratigraphic levels in which artifacts are found. The premise is that, if artifact A is found beneath artifact B in an archaeological context, then it is older. A caution to that premise, though, is in analyzing artifacts that could have been reused repeatedly, such as transport amphoras; their place in a stratigraphic layer could be slightly misleading. Chronometric dates, which provide a numerical value rather than an order based on relative position, can be used to refine relative dating typologies. Early chronometric dates came from datable objects, such as coins, that were found in the same stratigraphic layer with amphoras or by comparison to known historical chronologies. Relative dating served as the primary source of dating amphoras until the 1950s, when radiocarbon dating in conjunction with stratigraphy became the norm. Since Dressel's time, many typological classifications have been done. Significant studies include Riley (1974), Keay (1984), Peacock and Williams (1986), Opait (2004), Bonifay (2007), and Reynolds (2010). All of these have led to a truly overwhelming amount of data.

Joni Wreck Amphora Typology

The amphoras found on the Joni wreck offer a unique mix of typologies. The main cargo included six different types or subtypes, from three distinctly different geographical origins: North Africa, Greece, and possibly Crete. When first discovered in 2009, 211 amphoras were visible in an ovoid shaped mound measuring 10.8 m in length, 4.6 m in width, and 1.1 m in height. Most of these amphoras were intact and concentrated in a pile with minimal scattering. The 2012 team took measurements for 199 amphoras in the main mound. The amphoras were broken down into the following types and counts: African 3A-17, African 3B-78, African 3C-85, Unknown-6, and corrupted data leading to no images-13. Also added, were three LRA-2 amphoras seen in the 2010 mosaic into the site plan. Dredging the west end of the mound exposed more amphoras, at least two more layers of amphoras, possibly three. All of this evidence would suggest a total count of 600-800 amphoras, which as mentioned would be in line with other wrecks of this size that have been excavated, such as the 4th century Yassi Adda and Duboka Cove sites (Jurisic 2000:47). The team noted a scattering of amphoras, the spill pile, measuring approximately 30 m by 15 m downslope of the main pile and 15 m to the north. This section, which includes all five types, contains approximately 50-75 broken amphoras scattered across a rocky outcropping.

The main site includes amphoras from each of the six variants, although the majority is of the Keay XXV/ African 3 types. Keay (1984:414-417) originally identified this type as North African in origin and includes 28 different subcategories in all.

The African 3A has a cylindrical body with a cone shaped neck, a rounded shoulder, a solid spiked toe, ear shaped handles, and an everted rim. This type makes up approximately 12% of the total amphoras between both piles. While the body is shaped much like the 3B and 3C variants, a distinctive slight step at the rim and the knob at the tip of the toe help identify this particular sub-type (Royal 2012:417). The Joni wreck African 3A amphoras are of medium size with a height of 98-108cm and a diameter of 22-24cm. The necks are shorter than those of the 3B and 3C (9.9cm vs. 12.2-17.2cm). The University of Southampton (University of Southampton 2005) database shows them ranging between 93 cm and 125 cm in height and between 22 cm and 28 cm in diameter, with a carrying capacity of between 25 and 30 liters. Petrographic analysis (Appendix A) shows that the Joni wreck amphora sample was produced at ancient Sullecthum, a city on the central Tunisian coast (Figure 24)

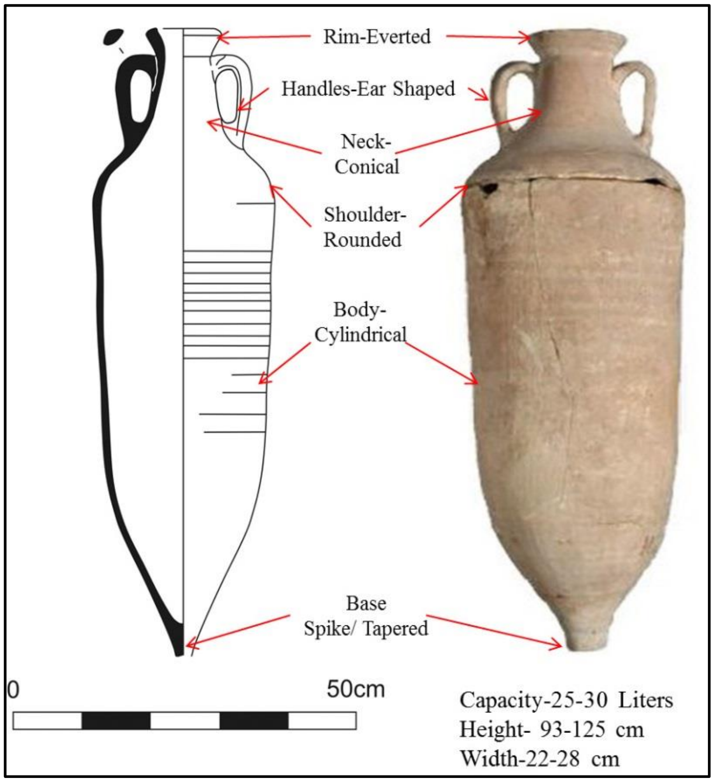

FIGURE 24. African 3A (University of Southampton and Author 2013).

This subtype mainly dates to the 4th century A.D. (University of Southampton Archaeology, Roman Amphorae; 2005). A sample of this type proved to be lined with pitch. This likely indicates a cargo of wine or fish sauce, rather than the olive oil that Keay (1984:458) suggested as their contents. Sullecthum is believed to have been a producer of fish sauce (Reynolds 1995:50) and is confirmed as the manufacturing point for the 3A samples; therefore, the 3As likely carried garum (fish sauce). The pitch also suggests wine could have been their contents, but North Africa was not known as an exporter of wine, so garum would be much more likely.

The 3B sub-type is similar in height, diameter, and carrying capacity to the 3A (Figure 25).

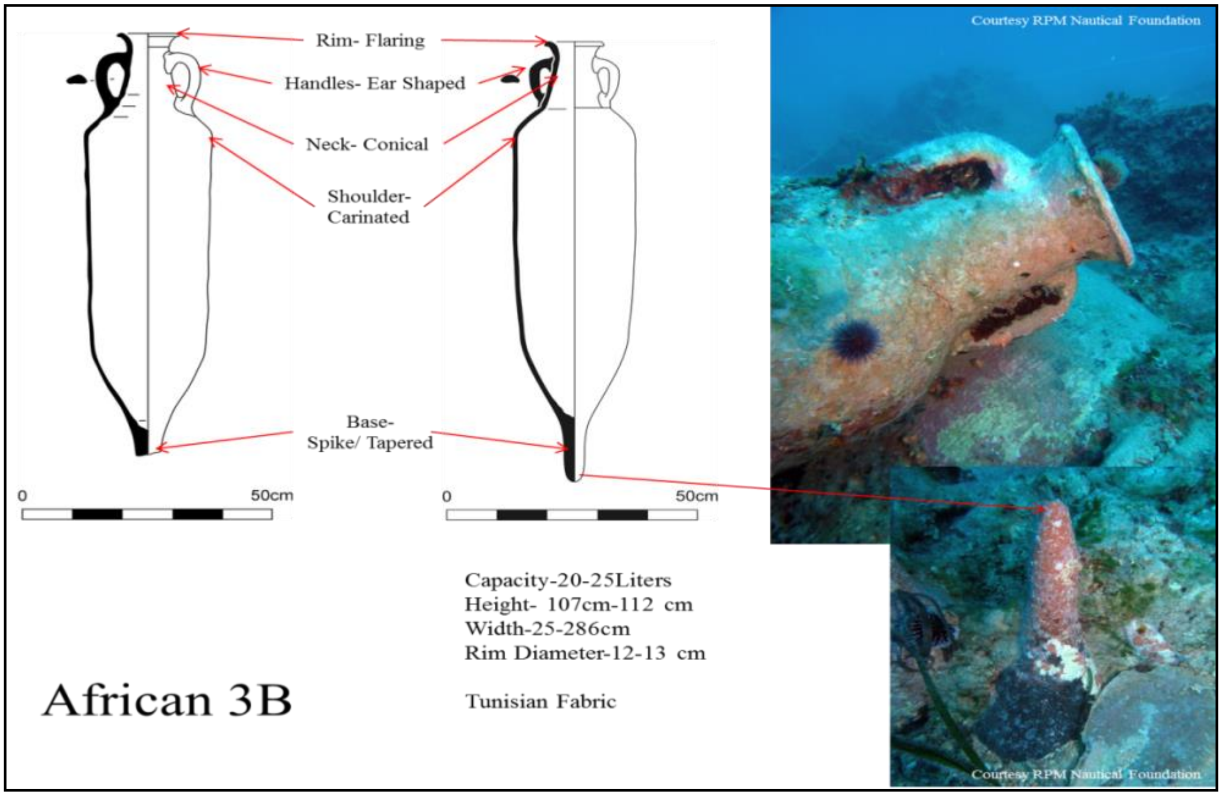

FIGURE 25. African 3B (University of Southampton and Author 2013).

The differences between types come at the rim. The 3B is more flared and rolled. The neck is longer (11.2-15.5 cm vs. 10-12 cm for those on the Joni wreck). The shoulder has a distinct carination, and the toe forms a solid spike. Pitch could not be verified in any of the samples; therefore, the contents could have been wine, fish sauce, or olive oil, with olive oil's being the most likely because North Africa was the Empire's biggest exporter of olive oil in 4th century A.D. This type makes up approximately 35% of the cargo.

The 3C sub-type again features a cylindrical body and neck, the same approximate physical description as the 3A, with the main differences from shoulder to rim (Figure 26).

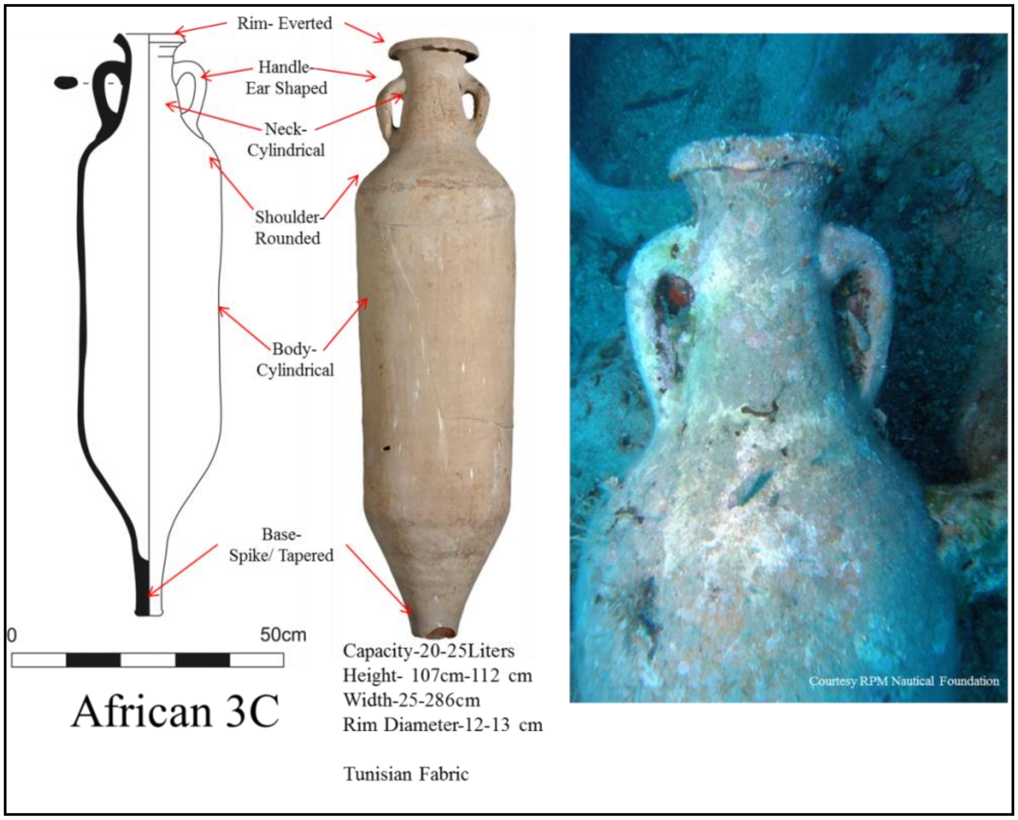

FIGURE 26. African 3C (Author, Southampton University, RPM Nautical Foundation2013).

The rim is everted and rolled such as on the 3B, but is slightly wider and thicker. The handles are longer, with a more pronounced ear shape. Heights range from 105 cm to 110 cm and diameters from 23 cm to 26 cm. As with the 3B samples, pitch could not be detected. Therefore, the contents could have been wine or fish sauce (if pitch is present), and olive oil. This type also makes up approximately 35% of the known cargo.

The Late Roman 2 (LRA-2) amphoras form a completely different type in both characteristics and origin. They have a globular shape with exaggerated riling and a short conical neck that is splayed out, although perhaps not enough to call it everted (Southampton University Archaeology: Roman Amphorae, a digital resource 2005).

They are much shorter than the African amphoras, but much wider. They range between 51 cm and 74 cm in height and between 42 cm and 55 cm in diameter, with a large carrying capacity of between 40 liters and 45 liters (Figure 27).

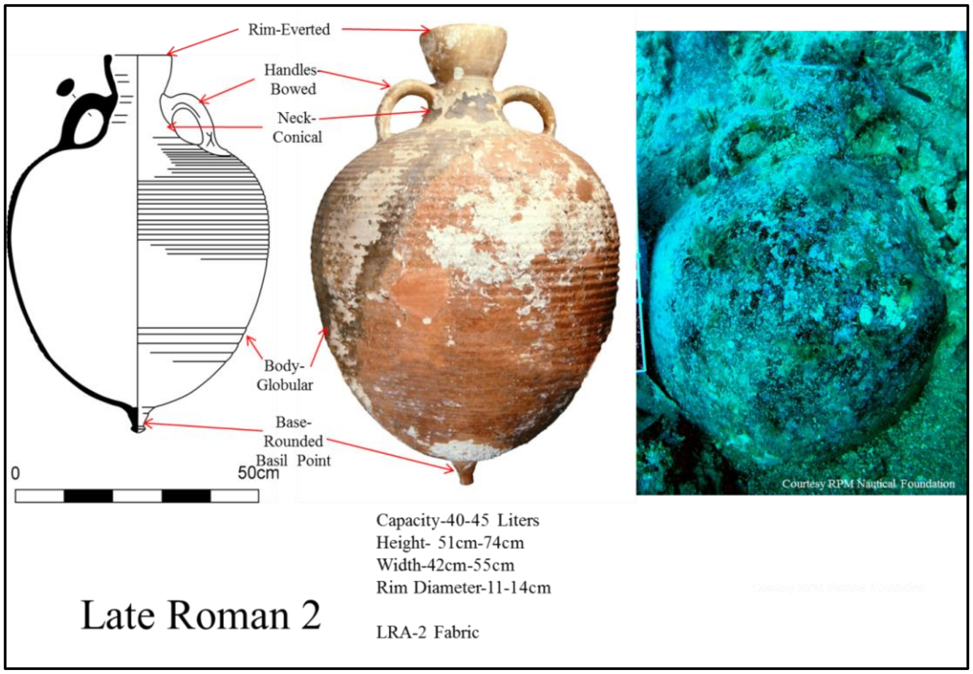

FIGURE 27. Late Roman 2. (Author, Southampton University and RPM Nautical Foundation2013).

Unfortunately, the intact LRA-2 amphoras from the Joni site were looted before any could be fully recorded. The LRA-2s that were found on site were located primarily in the spill pile. The 2010 photomosaic shows three intact amphoras located in the main pile, but these three were looted before the 2012 fieldwork.

LAR-2 amphoras were produced in great quantities from the 4th through 7th centuries A.D. Both wine and olive oil were carried in this type. This amphora type was produced for over 400 years, but has not been found in a firmly datable context west of the Adriatic Sea, before the year A.D. 420 (Keay1984, Reynolds 2010, Opait 2007).

The final cargo amphora type found in the main and spill pile is somewhat of a mystery. Its physical makeup is different from the other typologies on site. It has a thickened rim, short arched handles, an hourglass neck, a piriform body, and a rounded basil point. This type measures between 55 cm and 75 cm in height with a diameter of between 30 cm and 45 cm and would have held between 35 liters and 50 liters. When the site was first discovered, and again when the team surveyed the site, it was considered to be a Late Roman 1 example. Recent research, however, has cast doubt on this interpretation. Recently, Dr. Jeffrey Royal presented photographs of this amphora to a group of amphora specialists. The consensus was that an Aegean origin, such as Crete, is a strong possibility, due to its close appearance to other Cretan amphoras. Petrographic analysis also indicated the Aegean area as a possible origin (Figure 28).

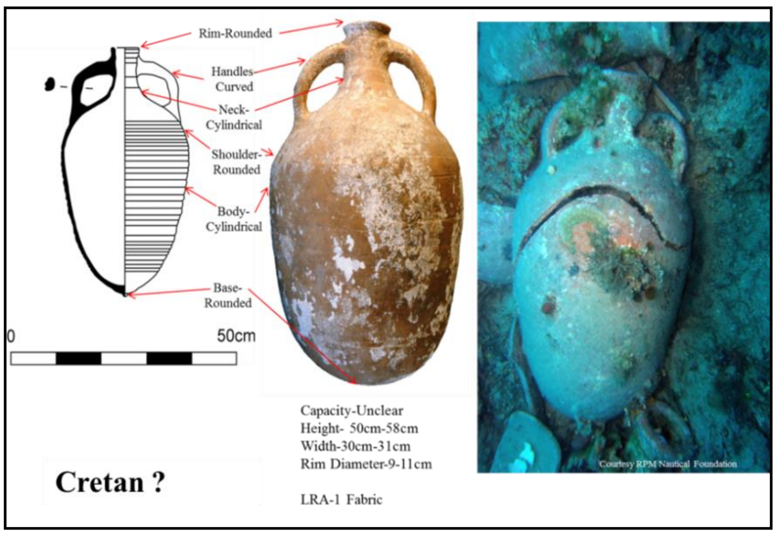

FIGURE 28. Possible Cretan Amphora (Author, RPM Nautical Foundation and University of Southampton).

This seems to be, an as yet, unidentified amphora type with no previously parallels. The amphora is not LRA-1 type as the fabrics are different in origin. They bear some similarity to a Cretoise 2E type (University of Southampton 2005) because of similar inclusion patterns and dating ranges from the 3rd through the 5th centuries A.D., but the evidence is insufficient to pinpoint the exact type. At present, this type remains unidentified, though it is likely to be of Aegean or Cretan origin.

A single amphora of a different type than the rest was also found. It has been tentatively identified as an African 2C- or Keay VI type (Michel Bonifay elec. comm, Jeff Royal elec. comm.). It sits in the middle of the site and is concreted to the amphoras around it, leaving only the top of the handles and rim for identification (Figure 29).

FIGURE 29. African 2 amphora. (Photograph by Author 2012).

The start of a cylindrical body type, conical neck, short elliptical ear-shaped handles, rounded shoulders, and a large, very distinct, rounded rim can be discerned. Verification of size could not be ascertained on this site, but African 2C amphoras typically ranged in size from 107 cm to 121 cm in length with a diameter of between 25 cm and 38 cm and a carrying capacity of between 55 liters and 60 liters, making them very large amphora. They originated at Neapolis, Tunisia, based upon stamps found on terrestrial examples (Keay 1984:119).

The contents of the African 2C have been traditionally ascribed as fish sauce due to pitch's being found in some samples. The single amphora on this site, though, is very intriguing. Being a single example with no other amphoras of this type seen on the surface of the pile, one could hypothesize that the amphora held fresh water or wine for the crew, although this would appear unlikely as the amphora would have been difficult to access, due to its location in the middle of the other cargo. A more likely scenario is that it held a valuable commodity that was to be kept hidden or the captain's private trading goods. Unfortunately, the amphora was concreted to others and could not be examined for contents. Several other Mediterranean shipwreck sites, however, feature single amphoras that may help shed light on the example found on the Joni wreck. At Bozburun, a jar was found to contain the pits of olives, leading to the hypothesis that it held the crew's personal foodstuffs (Stewart pers.comm. 2012,2014). At Serçe Limani (Pulak et al.1987:31-57), a single amphora formed part of an assemblage that included several personal items, including a chess board, gaming pieces, and toiletry items, which has led to a hypothesis that the ship could have been carrying passengers. These hypotheses stem from the amphora's being overly large, consisting of a single typological example, and dating much earlier than other amphoras of the late 3rd century.

Lading Interpretations

One research question asked if the remains of the Joni vessel provide evidence for how the vessel was loaded and if the amphoras were loaded according to typology. The results indicate that the amphoras of the African 3B and 3C types were possibly loaded in a port and starboard pattern, with the 3B on the starboard side and the 3C on the port side. The team could not discern the bow or stern ends and can only postulate that the east end is the bow for interpretations. The site plan shows that the 3Bs trend to the southern side of the site while lying on top of many 3C amphoras. This could be interpreted as the 3Bs' being loaded on either the starboard or port side and partially lying atop the 3Cs after the vessel settled onto its side on the seafloor. There does, however, appear to be a section of the vessel more dedicated to the African 3A types. They are mostly gathered on the west end of the site, but have the other typologies mixed with them. The 3A was also one of the amphoras with origins pinpointed to Sullecthum, which was known for its fish sauce exports (Reynolds 1995:50; Figure 30).

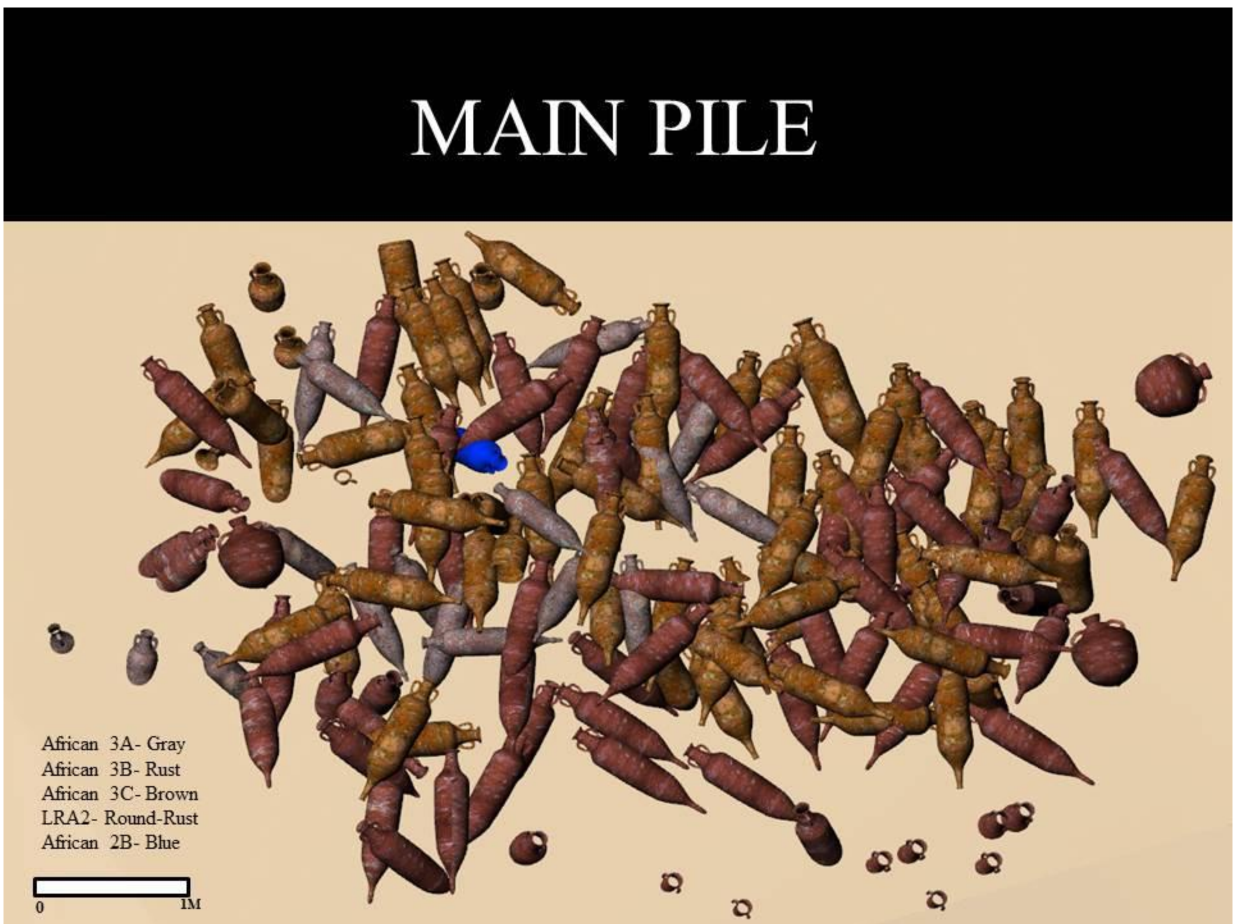

FIGURE 30. Main pile colorized from Rhino. (Author 2013).

Origins and Distribution

The African amphoras from the Joni wreck have been identified as being manufactured in North Africa, and Tunisia in particular. The African 3A amphoras have been further narrowed to the production center at Sullecthum, a coastal port on the east coast of Tunisia, and an important trading partner of the imperial port of Portus outside of Rome. Potters from Sullecthum produced amphoras from the 2nd through the 4th centuries. The sub-types 3B and 3C could not be pinpointed to an exact manufacturing point, but were narrowed to an area in north-eastern Tunisia, with possible manufacturing centers at Sullecthum, and Thaenae, Tunisia, in the 4th and into the 5th centuries (Bonifay 2004, University of Southampton 2005). The known kiln sites of Neapolis and Carthage were also in this area and may be considered as possible production sites for the Joni amphoras (Figure 31).

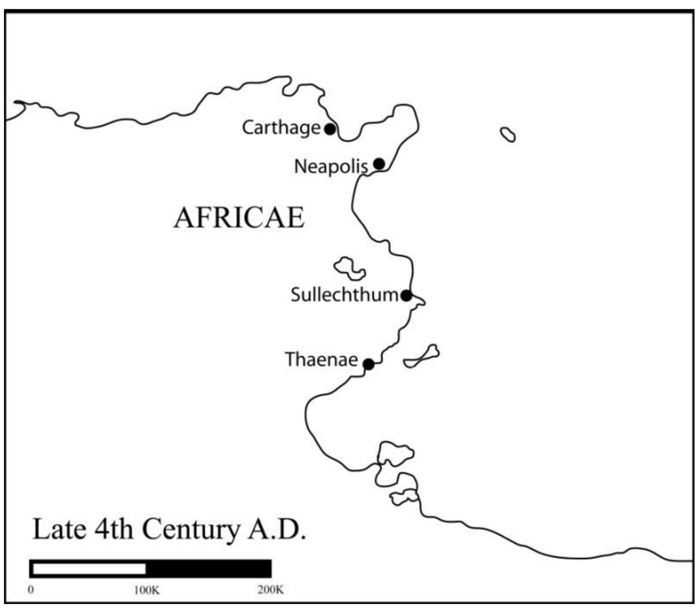

FIGURE 31. North African manufacturing centers. (Author 2012).

Distribution of these three African amphora types is generally considered to have spread across the Mediterranean, with Carthage as a staging area. Keay XXV types have been found in Spain, France, Portugal, Greece, Turkey, Germany, and Italy (Keay 1984:648-650). Examples have also been found at various sites along the eastern shoreline of the Adriatic Sea, including modern Albania, Montenegro, and Croatia, although in much smaller numbers. The small number of shipwrecks that have been documented in the Adriatic Sea do not differentiate between African 3A, 3B, and 3C varieties and are usually listed as Keay XXV (Parker1992:39-460, Jurišić2000:10-46).

The petrology report, based upon samples taken in 2012, along with the supplemental report from Andre Opait (elec. Comm. 2013), show the LRA-2s to be of Aegean origin, which is consistent with known production centers at Kounoupi in the Argolid, Knidos, and the island of Chios (Opait 2004:295-296 and Munn 1985 in Royal 2012:420; Figure 32).

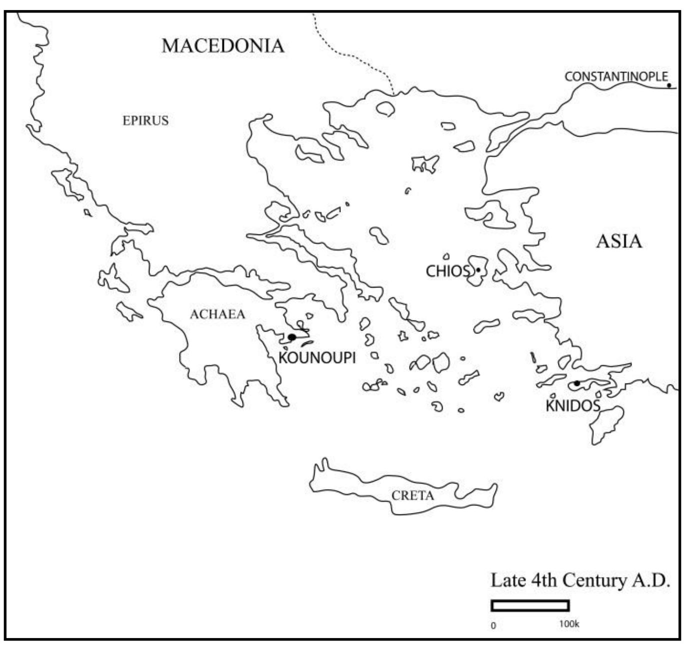

FIGURE 32. LRA 2 manufacturing centers (Drawing by Author 2012).

The long period of production and the various hypotheses on contents suggest that the amphoras were produced at multiple locations throughout the Aegean. From their origins in the Aegean, traders spread these amphoras west and east across the Mediterranean over the next four centuries. They are found in Corinth in the 4th century A.D., Tunisian North Africa in the 5th century, and at Benghazi in the late-6th century (Keay 1984:406-433). They were also found throughout the Black Sea over several centuries and were produced there as well (University of Southampton Archaeology, Roman Amphorae; A Digital Resource).

The origins of the possibly Cretan amphora cannot be determined as yet. Petrology suggests Crete and the Black Sea as possibilities; however, it seems probable that this type, like the similar LRA-2, originated somewhere in the Aegean.

Amphora Contents

Seaborne trade in the Late Roman period revolved around three main staples: olive oil, wine, and fish sauce (garum). Other trade goods included beef and pork products, building materials, and luxury items from different corners of the Empire, but the aforementioned trio dominates the archaeological record.

Olive oil was one of the most important trade goods in the Roman Empire. Everyone from plebeian and soldier to emperor used it. There is not much evidence of large-scale production until the middle of the 2nd century A.D. Before this, much of the North African wealth came from shipping grain. Not until the African provinces came under Roman control in the reign of Hadrian (117-138) did olive oil production rise; the region became a dominant producer by the 3rd century. After Constantine shifted the socio-political power base to the east in A.D. 331, Africa became the greatest supplier to Rome, while the supplies from Egypt were diverted to the eastern power of Constantinople after A.D. 363 (Keay 1984:409-412). That is not to say that garum and wine were not also shipped, but simply that the oldest recorded evidence mostly refers to olive oil.

As a staple in the Roman Empire, olive oil was used not only as a food source but also as a lubricant for machinery, for lighting, for soap, for a cleaning solution while in the baths, and as a medicine infused with herbs, just to name a few examples. The olive tree, at least since the late Neolithic, has been cultivated for multiple millennia because of its hardy core structure. It is resistant to inclement weather and can withstand the heat of Mediterranean summers. Romans produced olive oil in a machine process called a *trapetum* (Tyree 1996:171), which consisted of a round stone basin with two large stone rollers atop it. The rollers crushed the skin around the inner nut, but not enough to break the nut and cause bitterness (Tyree, 1996:171-172). The pulp was then put into an open weaved container, stacked with other containers, and pressed with a vise-like machine. The olive oil then drained through the bottom of the woven containers into storage vats, where it was poured into amphoras for shipment.

Garum, another amphora content, is a fish sauce used much like a modern Worcestershire sauce. It was mixed with other ingredients, rather than being used as a dipping sauce or spread over the top of a finished food. *The Geoponica*, a Roman cookbook, describes four ways to prepare it: "Take small fishes: chiefly atherinae, or anchovies, or any kind of small fish. Salt them all and leave them to mature in the sun, but turn regularly. When they have completely fermented in the sun, Garum is extracted the following way. Place a deep fine woven basket in a vessel and pour in the fish. Press the Garum out of the basket. Catch the fluid that escapes from the basket. This is called liquamen (the actual sauce). What remains in the basket is called

‘Allec’” (Faas 2005:143). Romans used garum on a daily basis, and it was a staple in most contemporaneous cookbooks (Figure 33).

FIGURE 33. Garum being processed. (Coquinaria.com).

Wine, much like olive oil, was an import more than an export at Rome. Through the 4th century, wine, olive oil, and grain exports from Tunisia, Greece, and Crete were shipped throughout the Empire in greater quantities than that of Italy (Reynolds 1995:104-105). After the rise of Constantinople, North Africa supplied almost all of the food imports to Rome (Keay 1984:412). Maritime scholarly sources in the Adriatic region are severely limited as to where the cargos were going or what was in them (Bowden 2005:134).

Conclusions

There have been many terrestrial examples of the amphora types found on the Joni, from widely scattered sites around the Mediterranean basin, including Marseilles, Barcelona, Modena, Southern Italy, Brundisium, and Butrint. Mixing regionally diverse Late Roman typological cargos with African amphoras is not an anomaly, as there have been surveyed sites that show cargos with mixed typologies and manufacturing areas. There is, however, only one other underwater site in the Adriatic Sea with the same typologies as in the Joni wreck. The Joni wreck shows that the Adriatic Sea ports were also destination points for these types of mixed cargos. Interpretations from the many variant physical remains of the Joni wreck will allow the research questions of this thesis to be addressed, while adding to the small data set available on Late Roman trade in the Adriatic.

CHAPTER 5: THE JONI WRECK AND LATE ROMAN TRADE

Before it sank, the ship now known as the Joni wreck most likely participated in the trade system that fed the Roman Empire, the *annona*. Given the complexity of this system, an understanding of how the Joni ship contributed to the transport of commodities requires a discussion of the following aspects: the theories of trade, the components of the Roman trade systems, the fourth-century maritime trade happening when the Joni ship sank, and the aforementioned redistribution of collected taxes known as the *annona*,. Research on both terrestrial and maritime sites must be incorporated to recognize patterns in trade, such as locations of manufacturing centers, great trading ports as opposed to little used ports, and eventual end user sites, as well as understanding the winds, currents, and obstacles to navigation found in the Adriatic Sea.   By matching shipwreck data sets of amphora finds with possible manufacturing centers and transshipping points, it might be possible to trace a ship and cargo across the Mediterranean and so determine trade routes. From this information, the Joni Wreck can be analyzed and the data interpreted to provide assessment of trade in the Adriatic Sea during Late Antiquity.

Mechanisms of Exchange

Trade, in its simplest form, is the buying, selling, giving, and receiving of goods. These commodities could take the form of tangible trade goods, one-way gift exchanges, gifts for future consideration, or possibly considerations themselves, such as allowing a merchant to travel through another country's waters. These trade processes and mechanisms, as understood by archaeologists, first need to be examined to provide a context for the interpretation of the Joni wreck. By first looking at archaeologists' and anthropologists' theories concerning how trade systems operated, one can then analyze the specifics of 4th century trade.

Archaeological Studies of Exchange

Archaeologists, through the analysis of myriad long-term cultural studies, have identified and examined exchange systems. These exchange systems adhere to three different mechanisms: reciprocity, redistribution, and market trading (in some form). "In a complex society all three are needed, but one can be more dominant than the others" (Peacock and Williams 1986:56).

Reciprocity is the exchange of commodities by social equals without the expectation of an exactly equal exchange or even the expectation of an exchange at the time of the initial giving (Kottack 2003:101). The exchanges could be gifts in exchange for housing considerations, gifts between two friends or families, or even just the use of a house or village with the expectation of a reciprocal invitation later. Numerous exchanges occur without the expectation of profit, but rather for the obligation, or social profit, the receiver would feel toward the giver. Reciprocity can be very local and would most likely have been the mechanism used in early egalitarian antiquity, before the advent of long distance transport in the form of shipping.

Redistribution is the mechanism whereby a central local or authority figure collects taxes, in the form of goods, and then recirculates those taxes in an economy. The perceived and real needs of the peoples living under the central authority guided how redistribution occurred. These goods would take the form of commodities and goods collected in lieu of monies, real cash monies, and sometimes a physical service instead of materials. This form of exchange appeared in rigidly controlled societies without free market enterprise. The collection of goods might not have been voluntary. In fact, the strong presence of some type of force could have been used to collect taxes. The Minoan-Mycenaean palace commerce system and the Roman *annona* system were both redistribution mechanisms (Renfrew 1972:463; Peacock and Williams 1986:57-59).

The last mechanism is market exchange, either free trade or direct trade. This is an exchange of goods, usually for some type of profit, in a supply and demand economy. Such a free market society included contracts between individual merchants and contracts between a central government and a single merchant, as well as permanent open central markets and the daily trader, who moved frequently, depending on where he thought he would derive the greatest profit. These exchanges could take the form of a single product or a large variety of goods.

Theoretical Studies of Exchange

Within the ancient Mediterranean, archaeologists have applied the above concepts in a long-term analysis of exchange. One such scholar is Colin Renfrew (1972:440-473), who provides an excellent guide to mechanisms of trade. He discusses four exchange systems: the prestige chain, where goods are found in abundance far from their original source; freelance commercial trade, where traders use local market professionals who know the trade goods needed in their area; directional commercial trade, where goods are traded to specific locales or transshipment points; and, finally, “down the line exchange.” This last method is the study of artifacts. Scholars determine how cultures used and spread the artifacts to other cultures, examine their numbers in the discovery area, and observe the omni-directional patterns of diffusion from the manufacturing center in which they are found. Because down the line exchange is the study of an original commodity’s byproducts, maritime archaeologists have difficulty applying this method, as the shipwrecks we have found might or might not be the only sources of artifacts in an area. These four types of trade all leave evidence in the archaeological record and document how material culture in the form of trade goods can be used to define how cultures spread.

By using these types of methods, in conjunction with the analysis of material culture patterns, the importance of trade as a society expanded through contact with others becomes evident. As Sherratt and Sherratt (1991:354) states, “Material goods are an essential part of cultural structures of meaning and symbolism.”

Types of Traders

The study of trade in the ancient Mediterranean world constantly evolves as scholars study new sites and add data to what is now known. By the late 4th century, the bulk of trade occurred through the auspices of the *annona*, an empire-wide redistribution of goods. The *annona* had specific guidelines, determined by legislation in Rome, for the control of merchants employed in the system. While merchants with government contracts formed much of the trade in the Mediterranean, this was not the only type of trading. Merchants also traded directly with other merchants and ports following supply and demand. This section will discuss the types of traders within the Empire including merchant contractors, *annona* contractors, those who formed contracts to transshipment points, and those who practiced cabotage.

Contracted for the Annona; Civica and Militaris

The Roman government collected taxes in various forms: real coinage; commodities like grain, olive oil, and wine; and manual labor. They then redistributed the goods based on needs, both real and perceived. They distributed these goods to citizens in the capital, outlying provinces in need, and soldiers in the armies. This system of feeding the populace became a driving force behind trade in the Empire. The *annona* originated as a grain subsidy in the 2nd century B.C. during the Late Republic after the city of Rome had depleted the local resources required to feed its citizens. In an effort that may have been a political ploy, Gaius Gracchus (154–121 B.C.) passed the Lex Frumentaria, which, through subsidization, brought large supplies of grain into the city (Erdkamp 2000:53-58).

Over the centuries, different emperors instituted changes in their attempts to gain political power with the plebian mob in Rome. The original subsidization of grain pricing eventually turned into an issue of free grain for citizens as a way to buy votes and sway influence. After four centuries of the *annona*, Septimius Severus (A.D. 193-211) effected perhaps the most dramatic regulatory change. He made olive oil free of charge to anyone who was already receiving an allotment of grain. Consequently, this mandate stimulated increased demand for more suppliers, many of which were contracted in North Africa. Archaeological studies of amphorae at the port of Roma at Ostia show a tremendous rise in amphora typologies, up to 85% of the totals, originating in North African olive oil laden jars from approximately A.D. 220 until the late 4th century. This rise corresponds to the change Severus made to the *annona*. Aurelian (270-275) added to Severus' changes by including a free ration of pork and the guarantee of cheap wine, which added to the amount of cargo shipping for the *annona* (Reynolds 1995:105-109).

By the 4th century, the *annona* became an all-encompassing trade component of the Empire. It had grown from a grain pricing subsidy Gracchus started to a free allotment of grain, olive oil, wine, and other products. From the 2nd century until the Vandal conquests in the 5th century, North Africa had become the chief supplier for the western Roman *annona,* with the farmer absorbing the cost of production as part of his tax. The imperial treasury heavily influenced trade under the *annona* system through tax breaks, tax exemptions, customs exemptions, and reduced harbor fees to obtain merchant services (Wilson 2011:37-40). These benefits made participation in the *annona* lucrative and included an exemption from port fees on not only *annona* supplies but also goods that merchants brought in for their own personal trade. By the 4th century, with two capitals to supply, *annona* ships sailed the entire Mediterranean.

The 4th century produced a radical change in the *annona* when Constantine shifted the socio-economic capital of the Empire to his newly rebuilt and renamed city of Constantinople. He also made sweeping changes in the way imperial officials collected and distributed taxes. Up until then, the *annona* was set up to funnel most goods to Rome. After A.D. 331, Constantine now needed to feed his new capital also. Thereafter, Egypt and the provinces in the east were to supply Constantinople, while North Africa, and the western provinces would continue to supply Rome itself. One notable difference in the *annona* system for the two capitals was that Constantinople offered a free grain dole, but not free olive oil, as in Rome. These sources for Rome and Constantinople would last until the Vandal invasions of North Africa in the 5th century and the Persian capture of Alexandria in the 7th century, respectively (Reynolds 2010:74).

When Septimius Severus took the purple in A.D. 193, he immediately started to change and reorganize the Empire. His direct effects on trade were to make olive oil free for the first time as part of the *annona*, to make his home province of North Africa the dominant supplier of olive oil, and to implement an *annona militaris*. As a new emperor, Severus was expected to make a donative, or bribe, to the troops to gain their loyalty. Unfortunately, the civil wars had drained the treasury, and Severus had no cash to distribute. Severus found another way to make this donative. He formulated and implemented the *annona militaris*, which redistributed the collected taxes to the troops in the form of free food. Up until this point, imperial officials deducted the money for a legionnaire's food and gear from his pay, or the legionnaire had to buy food from a local merchant. Severus halted these deductions and declared that the Empire would pay for food going to the troops. This accomplished two things: Severus did not have to pay out huge sums of money, and the troops had another 40-50 sesterces a month in usable cash (Develin 1971:698-695). The *annona militaris* was kept in place for both the western and eastern Empires when Constantine changed the way that the *annona* was distributed (Reynolds 1995:109).

Direct Contractors

Direct contractors are merchants dealing directly with an end user that could be either inside or outside of the government. A contract agreement would have defined voyage specifics, such as time of delivery, destination port, amphora contents, shipment quantities, and the price of the goods. The ships were usually owned by a merchant who did not actually sail in them, although a captain could own the ship. By custom and eventually law, the owner accepted that the captain shipped a small cargo of his own items to sell, as long as this did not interfere with the main shipment. For example, Arnaud (2011:73) suggests that merchants under contract to the government loaded Cretan wine into *annona* ships from various origination points for transport to Rome. The wrecksite Plage d'Arles 4 contains commodities that could have been picked up along the way for private sale by the owner or captain (Arnaud 2011:72-73). By the 4th century, the imperial government placed specific time regulations on direct contract shipments to ensure their completion within a two-year span. This decree prevented the delay of shipments for the *annona* by captains making port calls to sell their own wares (Arnaud 2011:69-75).

Cabotage

Cabotage, also sometimes known as tramping, is when a merchant plies his commodities at any port he can sell them for the highest profit. This practice involves no contract or designated cargo. The captain would select what cargo he thought would maximize profits and then sail to other ports, harbors, or villages where he thought that he could sell his cargo for maximum profit, while buying new trade items if required. Arnaud (2011:76) further states, “The more the value of a determined item is subject to variation through space and time, the more it leads to tramping, in search of higher selling prices.” Tramp traders generally travelled along the coast, calling at ports determined by a captain experienced in local needs. The vessels may have been smaller in size than a direct contract merchant vessel, as the captain may have entered rivers, estuaries, and deltas to conduct his trading, along with the established deeper water ports. A larger tramp vessel could also have towed its own smaller boat to deploy into shallower waters or contracted locally with a small boat owner to move his goods ashore. Unlike the long distance shipping for the Empire, cabotage was a local and regional model, in which vessels would know and be prepared for the political conditions and possibly the wartime conditions of their trading area. Arnaud (2011:72) explains that “the less a market is certain the more tramping appears to be the solution.”

Discussion

The various models discussed above were not the only trade mechanisms at the time, but many scholars highlight them as the best representation of methods of trade (Renfrew 1972, Peacock and Williams 1995, Reynolds 2010, Royal 2012). They may all have occurred simultaneously, but that is not necessarily the case. The 4th-century Roman Empire was still a somewhat stable environment that could have supported all of the models, but archaeological studies suggest that the *annona* remained the largest contractor of goods in the Mediterranean (Royal 2012:49). Local tramping could have been a profitable enterprise at the time, although on a much smaller scale. After the collapse of North Africa and Egypt as suppliers of goods, during the 5th and 7th centuries, respectively, cabotage would have expanded as a system of trade due to its reliance on short-term, short distance trade. A captain would be less likely to risk a one- or two-year contract shipment because the destination port may have fallen to an enemy before his arrival. Tramp traders moving short distances away from their homes would exist within a trading society, but this trading along regional coastlines would increase during times of uncertainty. The possible routes that the vessel sailed also lend credence to the vessel being on some type of contract.

Ship's Route

As previously discussed, the wreck's main pile was comprised of approximately 90% North African amphoras. Taking this evidence into account, the ship likely embarked from a North African port. The petrology analysis (Appendix A) positively identifies 5 out of 13 samples as being of North African origin; all 5 samples came from Roman Africae, the modern nation of Tunisia. Samples 6, 11, and 13 (Appendix A) came from the ancient port of Sullecthum, along the Tunisian central coast, while samples 7 and 8 originated in northern Tunisia (Figure 34).

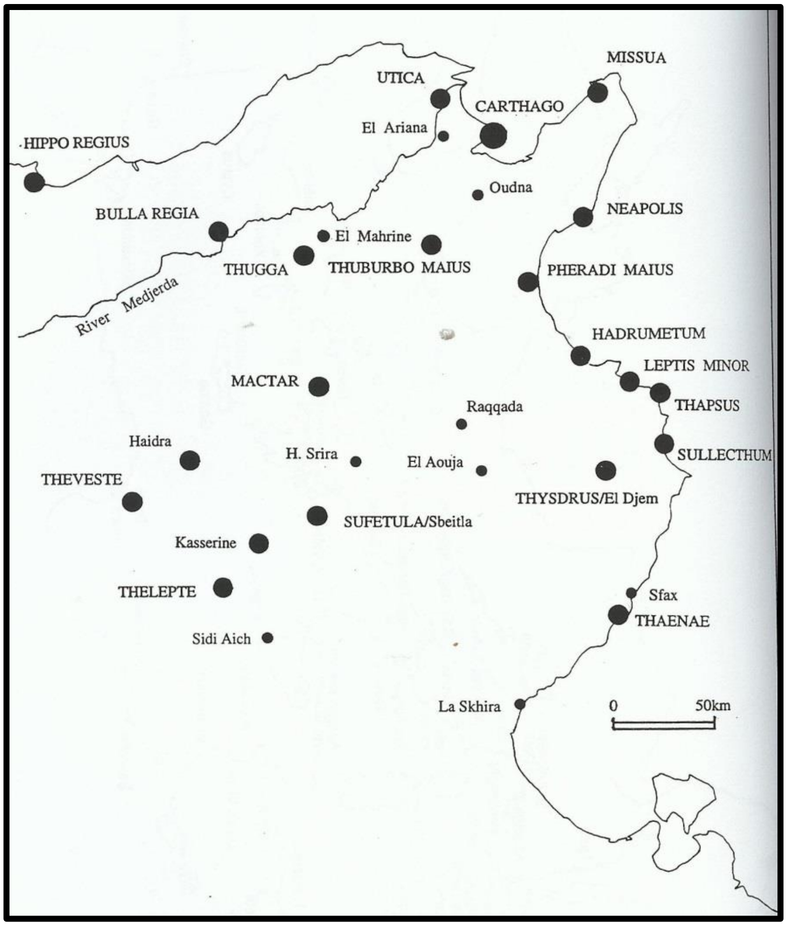

FIGURE 34. North African Manufacturing Centers (Reynolds 1995: appendix fig.2).

The analysis in the amphora chapter shows that both garum and olive oil were likely cargo contents, manufactured in or near a North African port or ports. The most likely ports were Sullecthum, a source of garum, or Neapolis and Carthage, ports of departure for olive oil (Keay 1984:414-417; Reynolds 1995:50). Based on the departure point, the types of amphoras, and the residue of pitch (needed to ship garum) found inside several of the amphoras, the ship likely carried both types of cargo. After clearing port, the ship probably sailed toward the southern coast of Sicily and then to Syracuse, as Syracuse was the closest large port on the sailing route to the Adriatic.

The ship's exact route cannot be definitively determined from the evidence presently available, but one could interpret the evidence in several ways. For example, the cargo includes a smaller number of amphoras with an Aegean origin and others that are possibly Cretan. The Aegean and Cretan amphoras are predominantly located in the spill pile, randomly mixed with all three African amphora types, which indicates that they were most likely loaded later in the voyage and on top of the African amphoras (See Site Interpretation Section).

Two potential paths offer reasonable interpretations of the route, given the Joni wreck's final resting place. Both routes would have left North Africa and most likely stopped at Syracuse on the eastern shores of Sicily, a distance of approximately 310 nautical miles, although it could have been considerably more as a ship in ancient times rarely sailed in a direct or straight path. Instead, they generally sailed where the wind and currents could take them which could double or triple the distance traveled, while at times not even sailing at all if the wind was directly against the direction they needed to sail. The average sailing speed for a merchant vessel at this time was approximately 2-5 nautical miles per hour, with approximately 10-12 sailing hours per day, as vessels typically did not sail in darkness. This translates to 20-60 nautical miles that could be travelled in a typical day, a very wide range (Jurisic 2000:52). Sailing for Sicily and onto Syracuse would have minimized open water sailing, provided numerous small coves for overnight protection, and given the vessel a chance to resupply the crew's needs, while acquiring any news updates on conditions along the Illyrian coast. There are many possible routes that could be discussed, but this thesis will only discuss the two most likely from a standpoint of sailing conditions and time, two prominent factors for a trader. From Syracuse, the captain likely chose one of the two routes discussed hereafter.

Possible Route One

One possible route led north from Syracuse to the Italian peninsula at Locri or Crotona. The ship could have resupplied or picked up trade amphoras here, and then sailed 160-180 nautical miles east across open water to Nicopolis or Butrint, on the Macedonian mainland. (Figure 35).

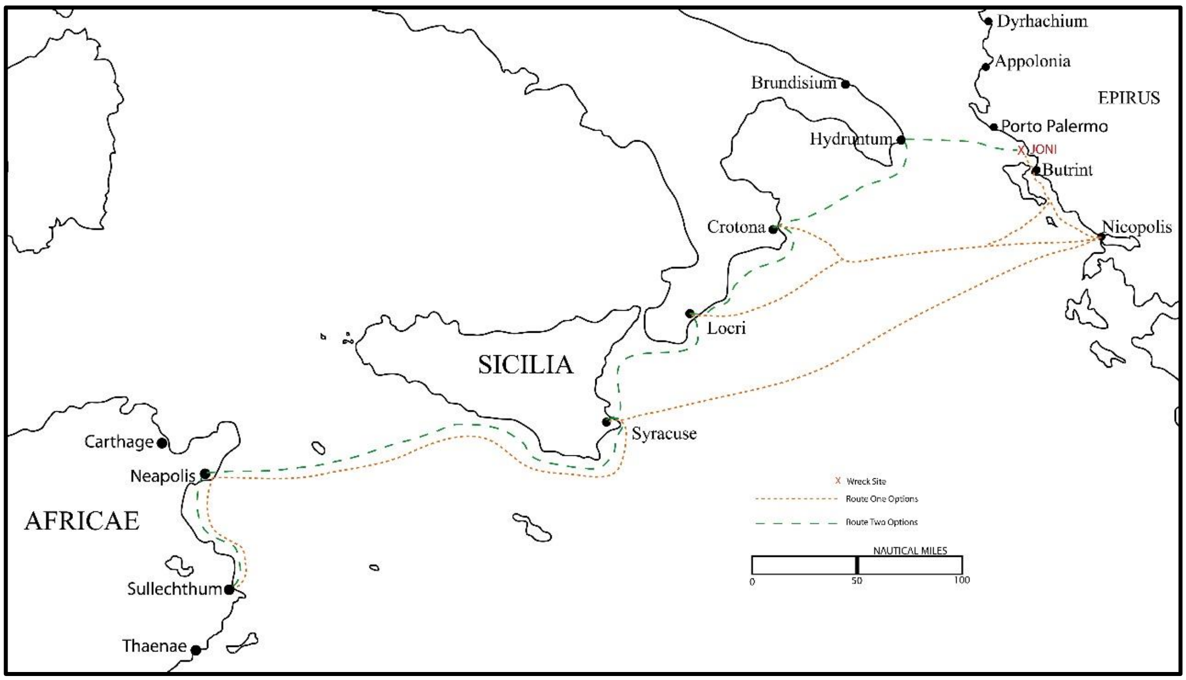

FIGURE 35**.** Ship's possible routes. **(A**uthor 2013).

The vessel could also have sailed directly to Nicopolis from Syracuse, but the approximately 300 nautical-mile open water trip would likely preclude this. From Nicopolis, the ship could easily have sailed up the western coast of Macedonia, through the Corfu straits, and into Butrint, whose Roman presence would have made a natural stopping point on a northerly sail. This distance, 65 nautical miles, could have taken only two days given an average speed of 3 knots, or up to two or three weeks if wind conditions were against them. The captain could have picked up supplies or possibly traded part of his olive oil cargo for the Aegean LRA 2 wine amphoras at Butrint before proceeding north. From Butrint, the wreck site lies approximately 20 nautical miles north, so if the ship had taken this route, one can reasonably assume that the disaster occurred shortly after leaving Butrint.

Possible evidence for this route comes from the typology of the amphoras themselves. One of the amphora types, located along the outer perimeter of the main pile and throughout the spill pile, has been identified as a Late Roman 2. The manufacturing centers for this type lay in the Aegean, with possible kiln sites at Kounoupi in the Argolid, Knidos, and the island of Chios (Opait 2004:295-296). These amphoras are commonly associated with both olive oil and wine transport. Loaded with a North African cargo of predominantly olive oil, fish sauce, or both, the captain might have wanted to diversify his cargo and pick up wine carriers. Cretan wine was common at Butrint in the 4th century, while Aegean wine was described as a beverage par excellence (Reynolds 2010:49-50). A merchant would have wanted to maximize his potential profits; therefore, he was unlikely to have left Tunisia with less than full cargo. Instead, he probably traded a portion of the African olive oil cargo for wine while traveling. Butrint is one city where such a transaction could have occurred.

Possible Route Two

A second possible route would have had the ship leave from Sicily and sail northeast along the southern boot of Italy, with possible stops in Locri, Crotona, and Hydruntum (Figure 2). The Cretan amphoras could have been acquired at one, or all, of these ports. Gallimore (2012:10,11) states that Cretan amphoras, dating through the 3rd century and possibly into the 4th, have been found in many sites along the entire southern boot of Italy. Brundisium, an original Roman colony, and Crotona or Hydruntum, both originally Greek colonies, would likely have maintained trading ties with Crete and the Aegean. Brundisium or Hydruntum are strong possible candidates as the last port of call for the Joni vessel. Both lie at the boot heel of Italy, both appear as ports in ancient sailing route texts, and both could have served as the last stopping point for a ship before sailing east across the shortest point of the Adriatic Sea. The route from Hydruntum (west side) to Apollonia (east side) is also represented on a map of well-travelled ancient Adriatic ship routes, making that route very likely (Figure 36).

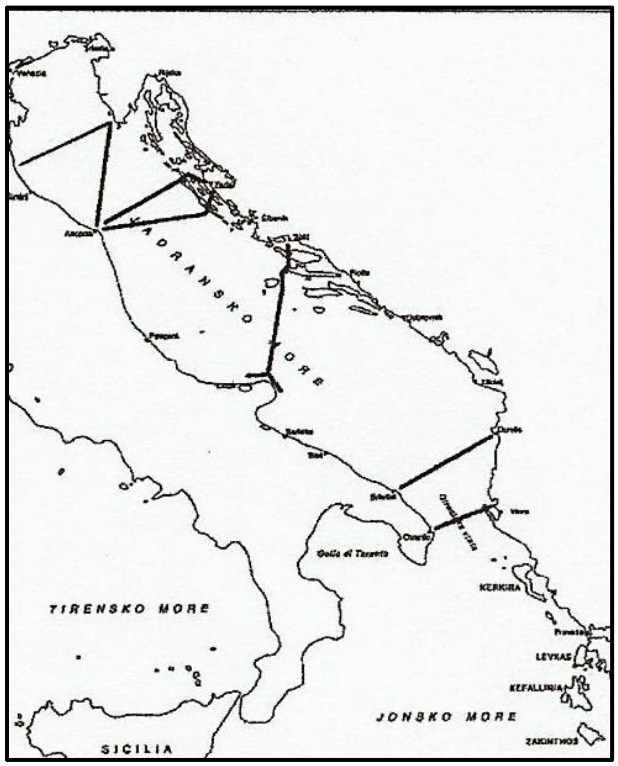

FIGURE 36. Ancient sailing routes in the Adriatic Sea (Kozličič, Bratanič 2006:111).

The distance from Hydruntum to the wreck site spans only 61 nautical miles. Hydruntum also makes sense as a departure point, as a ship's captain would also have wanted to take advantage of the northerly currents in the eastern Adriatic. These run in a northerly direction along the eastern coastline and in a southerly direction along the western coastline (Orlić et al. 1992:109,112). Vessels of the time were very broad for their length, had only a single square sail, and were not very good sailors. Therefore currents predominately, and wind a slightly lesser factor, would have particularly affected a heavily laden vessel such as the *Joni*. (Whitewright 2010:7-8).

Illyrian Destination Port

The actual Illyrian destination of the vessel is difficult to determine. No Roman trading ports lay in the immediate area of the Joni wreck, and the nearest sheltered bay lies 6 nautical miles north at Porto Polermo. The next potential large trading port north was Appolonia, 68 nautical miles north of the wreck site. The vessel could have been sailing to Appolonia, but the captain would have wanted to sail the shortest route across the Adriatic before turning north. For a fully loaded vessel, 60 nautical miles would have been a long day's sail. With nighttime approaching or twilight already there, a captain could have sought a cove or small bay, such as where the vessel sank, for night protection before sailing north the next day.

Final Interpretation

The second of the two routes is the most likely. As discussed, an ancient text indicates that this route was preferred. Many centuries later, Abbot Nikolas still mentioned this as the preferred route (Wachsmann 2009:296-297). The route up the boot of Italy would also have provided easier access to supplies and more opportunities to trade.

With a fully loaded vessel, the captain would have wanted to cross the Adriatic with the least amount of time being spent in the open sea, and sailing from Hydruntum to the coastline of Illyricum would have provided the best option. Additionally, this distance could be made in one long day's sailing time, allowing the ship to arrive before darkness fell completely. By choosing the longer southern route to stop first in Greece or even Crete, the vessel would have been subject to open ocean hazards for a much longer period.

Finally, the political situation in Illyria, and down into Macedonia, might have added an element of instability. If the vessel sank later into the 4th century, the captain might have heard news of unrest and possible Gothic incursions into the northern Balkans and down into Illyria. The captain might have been informed of such news while in Syracuse and/or in the cities of southern Italy. Any type of instability on the east side of the Adriatic might have made him want to keep to the Italian mainland as long as possible.

As scholars gather more evidence at the Joni site or from now undiscovered Adriatic wrecks, they will likely ascertain a more definite answer about the ship's route. I do not believe that we will ever be able to identify the final destination, although a full excavation of the site might make that possible. What we can determine, though, is how the analysis of the Joni cargo fits into the methods and mechanisms of ancient trade. As there is very little scholarship about this time period in the Adriatic, much of the thinking we have right now on trade can change as more evidence is published.

Adriatic trade

Evidence collected from known underwater sites suggests that, by the 4th century, Roman commerce and trade continued to decrease in both the Mediterranean and the Adriatic, but had not completely disappeared (Figure 37).

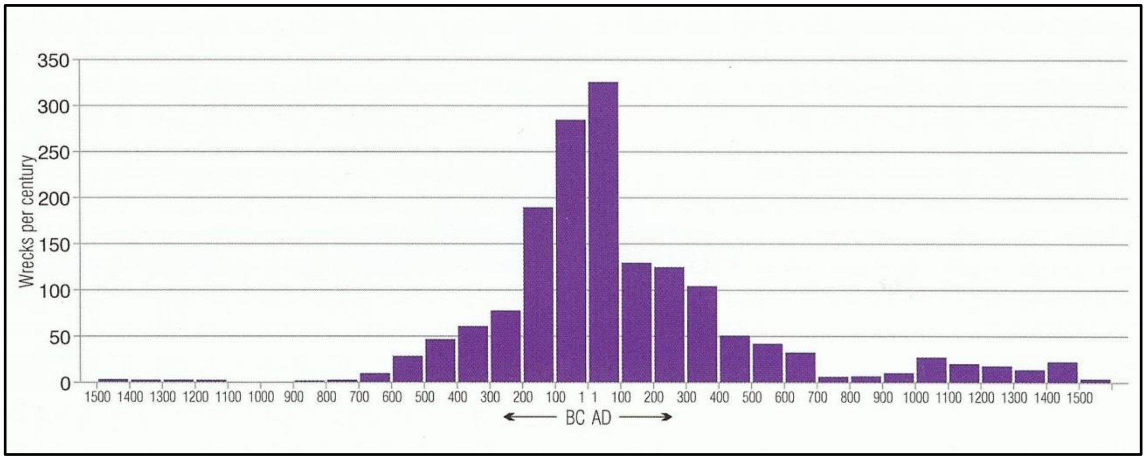

FIGURE 37. Shipwrecks found by century. (Wilson 2011:35).

As the Goths put pressure on the northeast border of the Empire, and the new Eastern administrative center at Constantinople began to grow, seaborne trade appears to have decreased from previous levels. This could have occurred for two reasons: The aforementioned problems of the Empire likely led to a decrease in shipping because of the potential instability at the destination end of the route, or this apparent decrease in Adriatic trade may be skewed by a dearth of evidence, that is, due to the lack of a systematic survey of the eastern Adriatic before 2009. Through the auspices of ICEP, researchers should collect a much wider range of data in the coming years; this may show that there was much more trade in the region than what is thought right now.

Archaeological sites at Poville, Duboka Cove, and Cavtat, Croatia, show that the majority of the goods being brought through the Adriatic came from North Africa, but were augmented by smaller amounts of goods staged at transshipping points, such as in southern Italy or Greece (Jurišić 2006:189). Research by Parker (1992), Jurišić (2000), and Kozličič (2006) shows that the prevalent sailing route taken by most traders was that of the eastern Adriatic sailing north. This corresponds with the prevalent currents in the Adriatic that run north on the eastern side and south along the coast of Italy. Here, I believe, will be found more evidence of broader trade patterns (Figure 38).

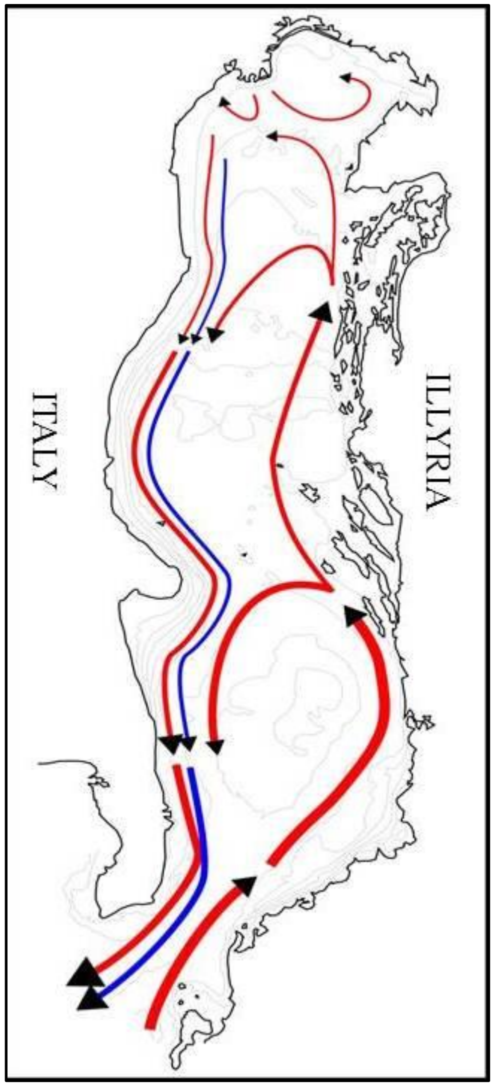

FIGURE 38. Adriatic Sea currents
(http://commons.wikimedia.org/wiki/File:Adriatic_Sea_Currents_2.svg)

The prevailing winds are very diverse, and are more determined by time of year. They are defined by the northeasterly Bora, southeasterly Scirocco, northwesterly Etesians as well as the normal land and sea breezes. The Bora and Scirocco are frequent during the colder months, while the others are more dominant during the warmer months, with the Scirocco coming across the Mediterranean from North Africa (Pandžić and Likso 2005:81-83).

Imports into the Adriatic

Trade cargoes in the 4th century consisted of a mixed variety of goods, usually of North African origin, but also a mix of eastern Mediterranean products. This mix of items suggests that vessels stopped at transshipment points along the way and added to their original cargoes. Shipwrecks, such as the Joni and Cavtat, show that the imports were olive oil, fish sauce, olives, and wine. Based on the types of amphoras found on wrecks, these tended to be from North Africa, while imports from Spain and Gaul were virtually nonexistent (Jurišić 2000:57). Building materials such as tiles and stone, common cargoes in the 2nd and 3rd centuries disappeared from the underwater archaeological record during the 4th century. This decline seems counterintuitive, as the terrestrial record shows defensive fortifications being built up around Dyrrhachium and Butrint both during the 4th and 5th centuries (Royal 2012: 110-116). The fortification materials may have been sourced in local areas, which might explain why fewer cargoes have been found of building supplies. The materials, such as clay and stone, do not deteriorate, and so would likely survive in the archaeological record if present.

Transshipment centers may have shifted locations at this time. Up until the 3rd century, Crete acted as a transshipment point for goods travelling east to west across the Mediterranean, and north to south along the Aegean-Tripolitan corridor. Evidence shows that this began to decline by the 3rd century, and that the ports of southern Italy and Sicily became staging points into the Adriatic for Cretan wine (Gallimore 2013: elec. comm.). This pattern correlates directly with the shift in economic administration of the diocese of Macedonia and its corresponding merchant routes, which shifted to the eastern Mediterranean, during the 4th century.

As of 2012, only 9 possible wreck sites from this time period have been surveyed and published, so these interpretations are open to change. One of these, the Cavtat site, is particularly interesting, as it is the only published wreck with the same typologies, Keay 25 and LRA2, as the Joni, although the initial interpretation of the amphora typologies looks to have been mislabeled as African 2.

The site is much farther north than the Joni wreck, which could suggest a northern destination point for the Joni, as the Joni could have been transporting the same needed commodities closer to the Roman troops in the Danubian region. As more sites are surveyed and excavated, the contents and commodities being traded might very well change, but right now the evidence shows that the staples of olive oil, wine, and fish sauce were the predominant trade goods shipped into the Adriatic region.

Adriatic Exports

Physical evidence is very hard to find for Illyrian exports. This is probably due to the fact that most of them were perishable goods, such as meats, grains, cheese, and mead, along with small valuable cargoes, such as precious metals and stones (Jurisic 2000:56,57). In the 4th century, Illyria did not produce many exports that would have required amphoras, mostly small amounts of wine, and because of their lasting durability underwater, amphora piles are how we are most likely to find shipwrecks. In addition, the fact that the army was consuming much of the locally produced goods for its troops in the northern regions of Illyria makes it likely that few agricultural products were actually being exported.

The Place of the Joni Wreck in 4th Century Adriatic Trade

Although the final destination and exact purpose of cargo on the Joni wreck may never be known, hypotheses for both can be investigated. The intact nature of the wreck site helps tremendously in making hypotheses. The main cargo pile remained intact, and even the spill pile exhibits a fair degree of cohesion. The amphoras that make up the bulk of the cargo allow for the formation of hypotheses regarding trade because the majority comes from North Africa, a region investigated heavily over the years. The other two types also lead us to a discussion that is becoming more amenable to study as more data is placed into scholarly hands, the use and evolution of transshipment points. Reynolds (2010), Gallimore (2013) and Jurišić (2010) all make cases for shifting transshipment centers, although only Jurišić has studied the Adriatic in depth. This lack of data makes it difficult to prove the intended use of the Joni vessel, although data collected to date, along with the material culture, suggest a possibility: the *annona, civica or militaris*.

By the late-4th century, the *annona* accounted for much of the long-term, long distance merchant trading in the Mediterranean (Royal 2012:49). The basic staples for the Roman army at this time were grain, meat, wine, and olive oil (Johnston as quoted in Adams 1995:122,123). The first two would have come from local sources as part of the *annona* tax, while olive oil and wine would have been mostly imported in transport amphoras. During this era, the army in Illyria required more supplies than normal. Due to incursions and outright invasions from the northeast by Gothic peoples, the Illyrians would have been constantly in the field. Local taxation, and in some cases confiscation, would have provided grain and wheat supplies, but olive oil and wine would have to come from somewhere else. There is an old saying that “an army travels on its stomach," and the Roman officials would have wanted to keep the army well supplied, as the troops served as the bulwark against Gothic incursions.

The evidence from the Joni site suggests that the bulk of the cargo would have been olive oil, with small quantities of fish sauce and wine, not perishables. The fish sauce and wine could have been meant for the army on contract, but, more likely, they would have been the merchant's personal cargo; he likely would have sold these more valuable items for a greater profit. No open areas exist within the main amphora pile. This continuity of an intact cargo suggests that perishable goods, such as grains, were not present before the wrecking event, to then deteriorate in the site formation processes and leave a gap, as we see on the Levanzo I wreck (Royal 2012:47). That the Joni had only olive oil and wine, and possibly fish sauce, and the lack of any other trade cargo, such as building materials, perishable goods, statuary, or other such items, implies that the vessel probably served the *annona*. We know the vessel was not heading to Rome; therefore, the most likely end user was someone in Illyria who needed large quantities of olive oil. The army is a likely candidate.

The uses of olive oil for an army are many: food, medicine, personal hygiene, warmth, lamp oil, and lubricants for machines, such as catapults and ballistae. All of these would have been needed in bulk to supply an army. Supplies would have been at a premium for army field commanders in the late-4th century, when there was as much fighting between Romans as with non-Romans. Roman wars during the late-4th and early-5th centuries included civil wars between the descendants of Constantine and Julian, the Gothic invasions that killed Valens (A.D. 378) and led directly to the final split of the Empire in A.D. 395, with the Theodosian dynasty in the East's starting to emerge, and, finally, the sacking of Rome in A.D. 410 and 455 that led to the Western empire's falling in A.D. 476. Given the number of conflicts, military supplies could be sold at a premium in the established operational date range of the Joni wreck, A.D. 350-425.

As noted earlier in this thesis, Aquileia was a supply hub to the northern troops, Salona was a transshipment point to anywhere in the eastern empire, and Dyrrhachium was a major port with roads leading directly to Constantinople. Any of these could have served as a likely destination port for the Joni vessel. From any of these ports, the supplies could have been offloaded and transported to the army inland. When using the typologies on the Joni wreck in terrestrial studies, determining whether the North African amphoras had a particular consumer at their destination site is difficult. North African amphoras are found in the coastal ports, but as transport amphoras, not much on inland sites. In Bezeczky's (1987) study of the amber route in upper Pannonia, he only observed one North African amphora, and he did not identify the typology. Karagiorgou (2003) provides a detailed usage of Late Roman 2 vessels along the Danube, with many of the sites in her study being army camps. This is far north and east of the Adriatic, although it cannot be discounted that LR 2 amphorae on the Joni or Cavtat sites could have been for military usage there.

While the evidence is insufficient to conclude that the cargo was military supplies, the idea cannot be discounted. The Joni and Cavtat wrecks were both sailing north; they had supplies used in bulk by the military, and the Danubian border region was on fire from Gothic incursions, while merchants would have been leery of sending their cargoes into an unclear geopolitical situation. All of these factors could be interpreted as pointing to a military cargo.

CHAPTER 6: FUTURE RESEARCH and CONCLUSIONS

Programs such as ICEP will continue to provide additional data concerning Late Roman trade, but one program can only be so effective when there is so much area in need of exploration. The study of transport amphoras needs to continue so we can determine the role *annona* played in the late 4th century Adriatic trade system. Data collected to date show that it was the major contributor to Mediterranean trade, but as more data are analyzed, we may find that contractual trade outside of the *annona* or even more localized trading was just as important.

The premise that the Joni wreck could have been part of the *annona militaris* should be further explored as more studies are conducted throughout the western Balkans. Ceramic evidence in Roman military campsites has been investigated along the Danubian regions to the north of Illyria, but more archaeological investigations are needed farther south in the Dacia and Epirus regions. These added data could help determine if the transport amphoras found in ports such as Dyrrhachium, Salona, and Aquileia were directed to the military on contract.

Joni Wreck Future Research

The first area to investigate is that of the possible Cretan amphora. The amphorae on site need to be thoroughly recorded to determine their exact origins. The determination of the transshipment ideas, along with that of the Cretan wine, also needs to be finalized. Next, the broken amphorae must be investigated to determine which types were lined with pitch. This information may add a great deal to the data set if African A, B, or C carried wine or garum, or if LRA 2 carried olive oil as well as wine.

The algae growth currently on the wreck must be investigated to determine if it is a natural occurrence or the result of our physical presence, for example, caused by the tags left behind on each amphora. It would appear from the timing of the physical evidence, that our presence was the mitigating factor in the algae growth. The spill site also requires further investigation. The amphorae present should be counted and measured by type. The majority of the LR2 and Cretan amphorae were found at this site, and further clues about their loading order may be found.

The above can be completed with limited disturbance to the site. Unfortunately, there are no conservation facilities in Albania at the moment; therefore, the site cannot be truly excavated. The amphorae could suffer irreparable harm if removed from the salt water for an extended period of time. This limitation, along with the amphorae being concreted together and forming one large cohesive pile, would likely prohibit further work. The goal of any future study at the wreck site should be data collection. The intact nature of the site warrants as much attention as possible.

Conclusion

Adding to the archaeological data set is one of the most important contributions we can make. Every new piece of evidence helps make our interpretation more accurate, now and for future studies. As seen throughout this thesis, there is an important need for sources in the Adriatic Sea, as it set the boundary between the Eastern and Western empires, while being administered by both. The Adriatic Sea is a very important gateway between the two empires, as the West continued to its conclusion in the 5^{th} century, while the East thrived for another 300 years, and after that, gradually losing territory until the final sacking of Constantinople in 1453.

The initial fieldwork conducted by RPM Nautical Foundation, as part of the coastal exploration program, demonstrates how much modern scholarship can be changed. The newfound underwater sites have added much to the paltry data sets that currently exist in the Adriatic. The site is a time capsule for ancient cargo. However, the modern research approach also highlights the difficulties involved in conducting a field study without proper facilities. For example, the main pile of amphoras was completely concreted together, making it difficult to measure. We were unable to keep the amphoras out of the water for any length of time for study or address the fibrous grass under the site hindering our dredging. The small tolerance set into the software of site recorder came to prominence when the toe end of the amphorae could not be measured. Without the ability to measure the end of an axis from center of mouth to toe, the measurements of the handles and mouth became vitally critical in precisely recreating the site in Rhino. A greater tolerance could have led to great error in the measured points' placement in Rhino, making the site plan unusable.

The amphoras were an interesting study. Many studies have been conducted on amphoras. These studies have measured their volume, determined the materials from which they were made, and identified their likely contents. The Joni site has contributed to the known data and provided physical evidence of pitch-lined amphorae, allowing for firmer interpretations of wine and garum as cargo. There is also the possibility of discovering a previously unknown type of amphora. By studying the types of amphoras and their locations on the wreck site, we can determine which amphora were loaded first, and possibly the order of the ports from which they came. The amphoras at the Joni site can lead to new or altered hypotheses on lading, sailing patterns, and the type of cargo contained in each amphora.

Yet, the preponderance of the amphoras were shown to derive from North Africa, making it the vessel's probable starting point. The small number of LRA2 and possible Cretan amphoras most likely means that they were picked up in route at a transshipping point or port, not in Crete or Greece. The long sailing time to these countries, along with their small numbers, offers more evidence that the amphoras were being picked up in route. And while several routes may have been taken, I believe the route from North Africa, through Sicily, onto the Italian peninsula at Crotona or Hydruntum, and then to the wreck site to be the most probable. The vessel was likely sailing north using the scirocco winds and northern currents along the eastern Adriatic when it sank after striking the geological formation known as the Razor. This theory could also be supported by the fact that the only other known vessel with this same type cargo was found much farther north at the Cavtat site.

The ship was likely delivering cargo as part of the *annona*, very possibly the *annona militaris*. This can be surmised by the type of cargo (mainly olive oil and wine), its likely northern destination, and an active military in need of these types of supplies. Indeed, without further investigation, these hypotheses will remain unproven, and, even if the site was fully excavated, the possibility remains that no firm proof of the vessel’s destination or its original purpose may be found.

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APPENDIX A: PETROLOGY REPORT

The amphorae of the Joni Wreck- Illyrian coast. A fabric and petrological study.

1 Introduction

This report illustrates the results of the analysis of fabric for a number of amphorae from the Joni Wreck, located on the Illyrian coast. The amphorae analyzed include ovoid-globular shaped vessels with swollen necks (samples 1, 2, 3, 4, 9, 12), one amphora here identified as Zeest 72-73 (sample 5) and Tunisian Keay 25 amphorae (samples 6, 7, 8, 11 and 13). The main aim of the analysis was to study the fabric of the ovoid-globular vessels, which morphologically resemble the Late Roman 1 and Late Roman 2, and to establish if these could be sourced to one area of production and if shared similar fabrics to the Late Roman 1 and Late Roman 2 amphorae as known in the literature.
The analysis of the fabric includes a description of the visual characterization first and then the petrology. The description of the textural analysis of the fabrics: density chart, degree of sorting and size of the inclusions follow the guidelines contained in the PCRG 1997. Microphotographs of the amphorae illustrated here were taken with a field of view of 3mm (these were taken at the Oceanography Centre, University of Southampton at the courtesy of Dr Rex Taylor).
Thin sections were taken of the following amphora samples: 1, 2, 3, 4, 5, 12 and 6; for samples 9, 7, 8, 11 and 13 the visual characterization is provided. A discussion on the results of the fabric analysis carried out is then provided.

2 Fabric analysis

Amphora sample 1
Globular vessel with swollen neck.
<u>Visual Characterization:</u>
Light-red in colour (Munsell 2.5YR 6/8) with darker exterior and interior edges (2.5YR 4/8 red), smooth fracture. A very-fine grained fabric, where inclusions, white in colour, are seen with difficulty. At x10 magnification, the quartz is silt-sized, extremely fine white calcareous inclusions are present in sparse amount (7% of the density chart). Very fine dark inclusions, and occasional clay pellets are also present.
<u>Petrology:</u>
Thin sectioning shows a calcareous clay matrix made up by abundant, very fine calcite and limestone inclusions which confer a yellowish colour to an optically isotropic groundmass. Inclusions of siltstone and very-fine sandstone (Plates I to IV) are present in sparse amount (5% of the density chart). Also present are cherts, sparse in amount (5%), calcitic foraminifera; rare (1%) plagioclase feldspar, and lumps of clay. The background quartz is very fine, <0.125mm in size, very common to abundant in amount (30 to 40%) and moderately sorted. The larger quartz grains are rectangular in shape and >0.25mm in size. The siltstone ranges from 0.5mm to 1.2mm in size, and contains very fine material, some of which is rectangular shaped, brownish-red in colour, bright; other is orangey, bright, and less regular shaped. Under plane polirized light (Plate IV), this material is characterized by high relief, bright red and orangey in colour, no pleochroic; possibly iron minerals. This same type of very fine minerals occurs in the clay matrix.

Amphora sample 2 Visual characterization:
Light-red in colour (2.5YR 6/8) with darker (2.5YR 4/8 red) very-fine interior and exterior edges, and reddish-brown surfaces (2.5YR 4/6 red). A very fine-grained fabric, compact, no inclusions are readily visible. At x10 magnification, the quartz is silt-sized; extremely fine white limestone and dark inclusions are present.

Petrology:
Thin sectioning shows a calcareous-calcitic clay matrix, optically anisotropic. It contains siltstone inclusions, sparse in amount (3 to 5%) ranging in size from 0.25mm to 1mm; rare cherts (1 to 2%) and calcitic foraminifera, small plagioclase feldspar, 0.2mm in size and rare in amount; lumps of clay are also present (Plate V). The siltstone contains very fine, bright reddish-brown, orangey in colour material, possibly iron minerals. These very fine minerals very commonly occur in the clay matrix, and are better visible under plane polarized light (Plate VI). Indentified brown heavy minerals are present in the fabric characterized by high relief, colour: orangey, no pleochroic, cracks can be seen inside; under crossed polarized light these are dark. The quartz is very common (30%), moderately sorted, less than 0.125mm in size, while coarser grains are rectangular in shape and up to 0.25mm.

Amphora sample 3
Ovoid vessel with swollen neck. Same typology as amphora sample 2.
Visual characterization:
Light-red in colour (Munsell 2.5YR 6/8). A very fine-grained fabric, no inclusions are readily visible. At x10 magnification, very fine dark and white inclusions can be seen, also one calcite inclusion, up to 2mm in size and few clay pellets 1mm in size.

Petrology:
Thin sectioning shows an optically anisotropic groundmass containing abundant calcite and limestone. Siltstone inclusions are present in a sparse amount (3 to 5% of the density chart) ranging from 0.2mm to 0.7mm in size. The siltstone contains very fine possibly iron minerals. Similar minerals very commonly occur in the clay matrix. Cherts (2% in amount), calcitic foraminifera, occasional plagioclase feldspar, and lumps of clay are also present. The quartz is abundant, very fine, <0.125mm in size and well-sorted, larger quartz grains are 0.25mm in size (Plates VII-VIII).

Amphora sample 4
Outward rim and a slightly bulbous neck.
Visual characterization:
Reddish-brown in colour (Munsell 2.5YR 5/8 red) with darker surfaces (2.5YR 4/8 red). Very fine-grained fabric, compact, rare white inclusions can be seen. At x10 magnification, rare white calcareous inclusions are present and very fine dark inclusions.

Petrology:
Thin sectioning shows a calcareous-calcitic clay matrix, optically anisotropic. It contains sandstone and siltstone inclusions in sparse in amount (5%); also cherts (3%), rare (1 to 2%) very small plagioclase feldspar, lumps of clay, while very fine flakes of mica can be seen. The siltstone shows similar properties as in previous fabrics. The largest sandstone in the fabric and visible in the microphotograph is <1mm in size (Plate IX). Moreover, very fine, rectangular, reddish and orangey in colour inclusions; possibly iron minerals, occur very commonly in the clay matrix, these are better visible under plane polirized light (Plate X).

Amphora sample 5
Amphora Zeest 72-73 (see Bertoldi 2012: 157).
Visual characterization:
Creamish-beige to the naked eye (Munsell 10YR 7/4 very pale brown) with irregular fracture. Very fine-grained fabric, no inclusions are readily visible. At x10 magnification, the quartz is silt-sized, while there is a sparse to moderate amount (7 to 10% of the density chart) of very fine black and red inclusions.
Petrology:
Thin sectioning shows an optically isotropic groundmass full of calcite. Calcite inclusions are very commonly scattered in the clay matrix; calcitic foraminifera and shells are present. The fabric contains also rare plagioclase feldspar, and one fine sandstone inclusion, 1.5mm in size containing a calcitic clay matrix. The quartz is abundant, very fine, >0.125mm, moderately sorted, angular and sub-angular in shape. Larger quartz is up to 0.7mm in size (Plate XI).

Amphora sample 12
Ovoid vessel with swollen neck.
Visual characterization:
Light-red in colour (2.5YR 6/8) with a very fine darker external edge (2/5YR 4/8 red). Very fine-grained fabric, compact, smooth fracture, no inclusions are readily visible. At x10 magnification, no inclusions are visible with the exception of some red iron ore, and lumps of clay.
Petrology:
Thin sectioning shows a calcareous-calcitic clay matrix, optically anisotropic. Siltstone inclusions are present in sparse amount, ranging from 0.3mm to 0.7mm in size. These show similar properties to those previously analyzed. Cherts (2%), lumps of clay (5%), rare plagioclase feldspar are present. Also, very fine, rectangular shaped minerals occur commonly in the clay matrix; these are bright red-orangey and no pleochroic in plane polirized light, possibly iron minerals (Plates XII-XIII).

Amphora sample 6:
Amphora Keay 25.1 (Africana 3A)
Visual characterization:
Red and grey coloured fabric core containing numerous, small white inclusions of limestone, well-sorted, 0.2mm in size. Salakta production, central Tunisia.
Petrology:
Under thin section this is a quartz-limestone fabric. It contains a common amount (20%) of rounded limestone, generally between 0.25 and 0.5mm in size, and a common amount (20%) of sub-rounded quartz grains-generally 0.25 segments in size. Also, rare plagioclase feldspar and rare grains of pyroxenes are present (Plate XIV).

Amphora sample 7:
Amphora Keay 25
Visual description:
Red-brick in colour containing very fine quartz-sand and yellowish inclusions of limestone. These latter are moderately scattered in the clay matrix, the largest are 0.5mm in size. At x10, occasional quartz grains are <0.5mm in size.

Amphora sample 8:
Amphora Keay 25
Red in colour containing rare inclusions of limestone. At x10 magnification, limestone inclusions are 2mm in size. One sandstone inclusion is present, <0.5mm in size.

Amphora sample 9: vessel characterized by fabric similar to the ovoid-globular amphorae

<u>Visual characterization:</u>

Reddish-brown in colour (Munsell 2.5YR 5/8 red) with darker surfaces (2.5YR 4/8 red). Very fine-grained fabric, compact, rare to sparse (3 to 5% of the density chart) white calcareous inclusions can be seen.

Amphora sample 11: Keay 25.1 (Africana 3A)

<u>Visual characterization:</u>

Light peach in colour with creamy external edge. Numerous white limestone inclusions are readily visible. Tunisia production. At x10 magnification the quartz is very fine, the largest inclusions of limestone are 0.5mm in size. Tunisian production.

Amphora sample 13: Keay 25

<u>Visual characterization:</u>

A cylindrical container with evident tooling marks on the exterior surface.

Red in colour with numerous white inclusions of limestone, >0.5mm in size. This also could come from Salakta, central Tunisia.

3 Discussion

The main distinctive features of the fabrics of the ovoid-globular vessels (samples 1, 2, 3, 4, and 12) are their very-fine grained nature, where no inclusions are readily visible, with the exception of some white calcareous material, and their colour: light-red, reddish-brown with a quite smooth fracture. Same clay matrix: calcareous, and same type of inclusions including roundish siltstone-and very-fine sandstone containing a sort of iron minerals; also cherts, foraminifera, plagioclase feldspar and clay lumps, indicate that these were sourced from the same geological area of sedimentary deposits. Sedimentary deposits, however, by their nature are widespread.

Typologically the amphorae show similarity with the Late Roman 1 (samples 2 and 3) and the Late Roman 2 (sample 2, 4, and 12). However their fabrics are different from the standard Late Roman 1, produced in *Cilicia* and Cyprus, and from Late Roman 2. Studies of the Late Roman 1 show that this vessel contains volcanic material: dark grains of pyroxenes and red serpentine (amphora website Southampton; Williams 2005 who analyzes amphora samples from Seleucia Pieria) that are apparent under a binocular microscope. The fabric of the Late Roman 1 from kiln sites in Cyprus is also different from the Joni wreck vessels because of the presence of few small serpentine and dark volcanic minerals and, in thin section, strongly pleochroic hornblende (ibid.).

The ovoid-globular vessels are also different from the Late Roman 2 fabric as this latter does not contain siltstone inclusions (Peacock 1984; Southampton amphora website). An Aegean origin is suggested for the amphorae of the Joni wreck. Cherts, foraminifera and plagioclase occur in Aegean amphorae such as in the Late Roman 2 (description of the LR2 in Peacock 1984: 20, and Southampton amphora website). Moreover, amphorae described as Cretoise 1e in the literature, and produced on the isle of Crete (see Bertoldi 2012: 127) show an outward rim and swollen neck while its fabric is very fine-grained and light-red in colour (Bertoldi 2012: 158). The later variants of the Cretan amphorae are dated from the mid 3rd to the beginning 5th (ibid.: 127). Further investigation is needed regarding the origins of these vessels. On the basis of the geological inclusions, an area in the Aegean, Black Sea and East is not excluded.

The amphora sample 5 has been identified as Zeest 72-73. Bertoldi (ibid.) describes this type as an oval shaped vessel, ca. 100 and 110 cm in height, with the body marked by numerous ridges on its external surface. Gentle narrowly spaced ridges are present on the external surface of the sample of the Joni wreck. Also, the rim with flange angled downwards, conical neck, characteristic handles, and carinated shoulder characterize the Joni wreck amphora. The origins of the Zeest 72-73 have been assigned to the Black Sea area, while Asia-Minor is also suggested and is dated to the 2nd-3rd centuries AD (ibid.). In

Beirut it has been found in contexts dated to the mid 3rd century AD (Reynolds 2010 cited in Bertoldi 2012: 157).

With regard to the amphorae Keay 25 of the assemblage, Salakta production is represented within it (sample 6). The characteristic firing conditions: red and grey fabric core, the numerous white limestone inclusions and its occurrence on the Keay 25 amphora type, form the criteria for the identification of this workshop in the Joni wreck amphorae. Salakta, ancient *Sullecthum*, located in central Tunisia, produced large quantities of amphorae from the mid 2nd to the beginning of the 4th century AD (it was a very important commercial partner of Portus, the imperial port of Rome). The Keay 25 from Salakta are dated to the 4th century AD. Keay 25 amphora samples 11 and 13 containing a common amount of limestone inclusions could also be attributed to the central area of Tunisia, while samples 7 and 8, in a red fabric, to North Tunisia.

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APPENDIX B PETROLOGY SAMPLING REPORT

Ceramic Analysis Report: 2012 Field Season

Peter Campbell

RPM Nautical Foundation/University of Southampton

Introduction

This report outlines the sampling of archaeological ceramics under the auspices of Dr. Adrian Anastasi as part of the Albanian Coastal Survey. Thirteen samples were selected from Site AA09AA, also known as the “Joni Wreck.” Analysis methods include petrology, mass spectrometry, and DNA analysis. This report details the sampling and analysis methodologies, as well as contact information for the labs conducting the testing.

Sampling Methodology

Samples were chosen from thirteen amphoras spread over the wreck site. These were chosen from Keay 25 North African amphora and Late Roman 1 and 2 amphoras. Table 1 lists each sample by number, its artifact number, and general typology. Appendix A shows each amphora *in situ* and the sample retrieved from the amphora.

Sample 1	SPW-0026	Late Roman
Sample 2	SPE-0038	Late Roman
Sample 3	SPE-0012	Late Roman
Sample 4	SPW-0007	Late Roman
Sample 5	SPW-0034	Late Roman
Sample 6	1-0020	North African

Sample 7	Unlabeled	North African
Sample 8	Unlabeled	North African
Sample 9	SPW-0050	Late Roman
Sample 10	1-0005	North African
Sample 11	SPE-0017	North African
Sample 12	SPW-0001	Late Roman
Sample 13	Unlabeled	North African

Table 1. List of samples.

As each amphora was chosen for sampling, the author clipped pieces for analysis using a weighed rod. Samples average in size approximately 10 cm by 3 cm. This provides a large enough sample for petrology, mass spectrometry, and thermoluminescence dating, should there be unresolved questions about dating of the amphoras in the future. Each amphora was photographed *in situ* before sampling and its artifact number recorded for the database. Samples were placed into plastic artifact bags with labels, and then sent together to the University of Southampton following fieldwork.

DNA swabs were taken from Samples 10, 11, and 12. This consisted of using Copan Italian DNA tips to wipe the interior of the amphoras, a non-destructive process. Due to the small sample size (3 amphoras) it currently cost prohibitive to undertake analysis at this time, as a sample size of 40-50 would best suit the expenses associated with sequencing the DNA. For this reason, the samples are being curated at University of Southampton until a large enough sample size is generated through future fieldwork.

Analysis Methodology

The primary analysis method is petrology, examining the clay matrix of the samples. Samples will be examined using a microscope for diagnostic inclusion, then photographed using a high-resolution camera. This processes narrows down the geographical regions where the clay used for the amphora is found. Thin-sections of the amphoras will then made, allowing for use of a higher resolution microscope. Diagnostic inclusions previously identified will be examined in an attempt to identify precise workshops where the amphoras were created. The author expects highly accurate results for the North African samples, as workshops for these have a well-established database, and good accuracy on the Late Roman samples, which are well published.

Mass spectrometry will be used in an attempt to identify residues left from the organic cargos. Molecules of organic cargo can become lodged in the ceramic fabric. Dissolving a sample of ceramic and sending it through a mass spectrometer can identify these residues if a comparative molecular structure is known. The Joni samples will be tested for olive oil, wine, and fish residues. However, wine residues can be complicated by saltwater and to date only wine residue from terrestrial amphoras have been recovered.

Conclusion

Results are expected within a year of receipt by each laboratory. Petrology samples were accepted on January 28, 2013, and mass spectrometry samples will be sent to the lab in spring 2013. The final analysis report will be sent to Dr. Adrian Anastasi so that copies can be kept for records in Albania.

Contact Information

Coordinator

Peter Campbell, MA RPA

University of Southampton

pbc1g11@soton.ac.uk

Petrology

Dr. Pina Franco and Dr. Lucy Blue

University of Southampton

pf1w07@soton.ac.uk

Mass Spectrometry

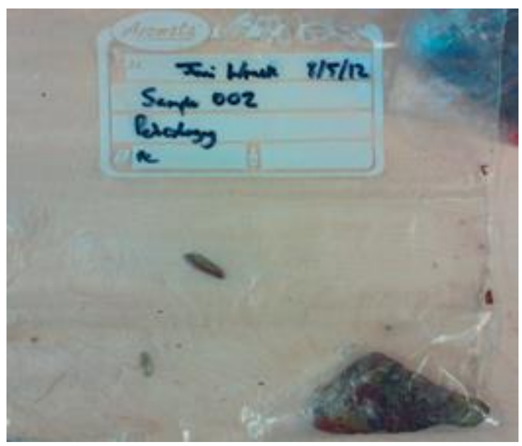
Dr.Timothy Ward

Millsaps College

wardtj@millsaps.edu

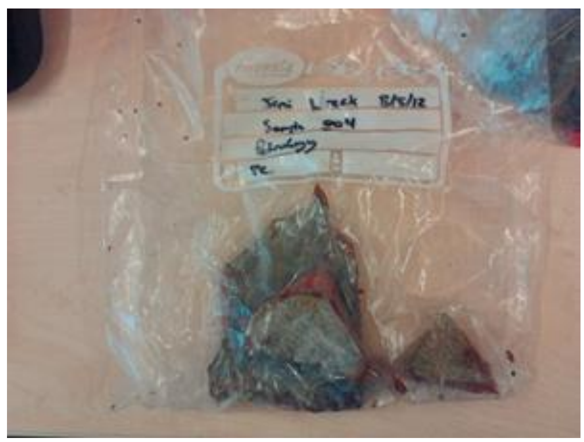
Sample 1. SPW-0026

Sample 2. SPE-0038



Sample 3. SPE-0012

Sample 4. SPW-007



Sample 5. SPW-0034

Sample 6. 1-0020

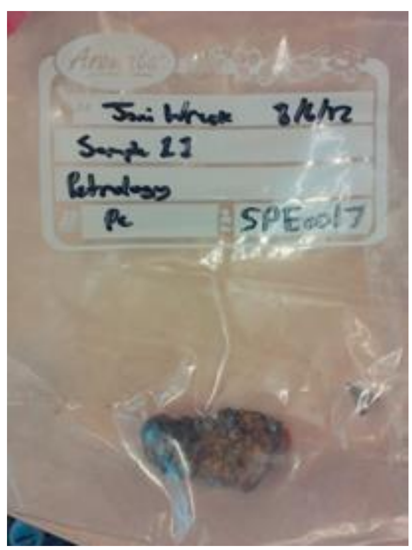

Sample 7. Unlabeled


Sample 8. Unlabeled

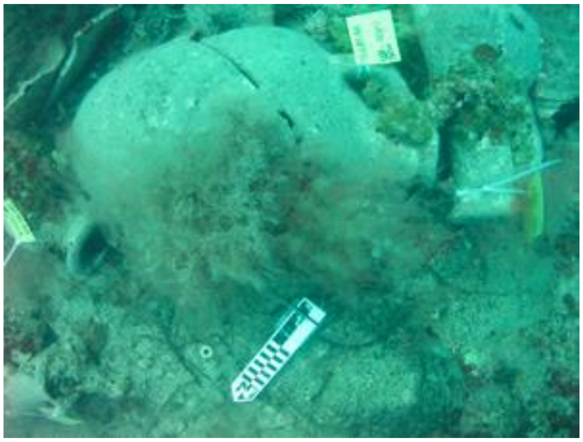

Sample 9. SPW-0050


SAMPLE 10 UNAVAILABLE FOR DESCRIPTION

Sample 11. SPE-0017

Sample 12. SPW-0001



Sample13Unlabeled

APPENDIX C: PROFORMA SAMPLE FROM THE FIELD

31JUL		JONI		31JUL		MOO
0082	A	3.202	3.288			
	J	8.122	7.912			
0044	J	7.484	7.740			AF C BURIED
	A	3.564	3.634			
1-0083	A	3.502	3.580			3A? BURIED
	J	8.176	8.082			
1-0078	A	3.373	3.360	3.364	HQ	AF 3C BURIED
	J	8.378	8.432	8.265		
1-0076	A	3.492	3.762	3.952		
	J	8.018	8.010	7.952		3A BURIED
1-0037	A	4.164		4.226		3C BURIED
	J	6.626		6.512		
1-0036	A	4.534		4.632		3A BURIED
	J	6.392		6.292		
1-0036	A	4.706	4.646	4.426		3B BURIED
	H	8.123	8.146	8.040		
1-0048	H	7.632	7.660	7.562		B BURIED
	A	5.474	5.450	5.442		
10047	H	7.873	7.934	7.768		B BURIED
	A	5.262	5.170	5.346		
1-0040	H	8.148	8.214	8.035		UNKNOWN
	A	4.874	4.802	4.956		
1-0062	H	7.474	7.488	7.442		3B BURIED
	A	5.792	5.182	5.752		