University of Alberta

Frankish Invader or Acculturated Greek? Investigating Birthplace and Cultural Integration at a 13th Century Cemetery in Corinth Using Strontium Isotope Analysis

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A thesis submitted to the Faculty of Graduate Studies and Research in partial fulfillment of the requirement for the degree of *Master of Arts*

in

Department of Anthropology

Edmonton, Alberta
Fall 2006

Your file Votre référence
ISBN: 978-0-494-22167-9
Our file Notre référence
ISBN: 978-0-494-22167-9

Abstract

Strontium isotope analysis is used to understand issues of movement in past cultural populations. This paper reports the preliminary results of a strontium isotope study on mobility and cultural assimilation during the occupation of Greece by western invaders in the 13th century. The exact nature of cultural integration between the Frankish rulers and their Greek subjects is not well understood. The historical evidence indicates that the two cultures did not influence each other in any significant way. Archaeological research on the subject suggests that some degree of influence may have occurred. The $^{87}Sr/^{86}Sr$ ratio was determined from the enamel of ten individuals interred in a Frankish cemetery in Corinth. Eight of the ten individuals display local values, indicating a childhood spent in the region. The burial of these local individuals, possibly Greek, in a cemetery used by the Frankish ruling class provides strong evidence that cultural integration was more meaningful than some previous scholarship has indicated.

ACKNOWLEDGMENTS

My thesis research encountered the odd bump along the way, and many thanks are due to the people who supported me throughout the process. First, my supervisor, Sandra Garvie-Lok, deserves thanks for allowing me access to her collections and for providing helpful comments and feedback on the various drafts of this thesis. Dr. Rob Creaser and Dr. Antonio Simonetti ran the samples and were always available to answer my questions about strontium isotope analysis.

Thank you to Dr. A.C. Aufderheide, who generously supplied unpublished research and materials on a previous incarnation of this thesis. Dr. John Kitchen kindly emailed me from sabbatical and provided much needed direction on religious burial rites. I would also like to thank Dr. Caroline Haverkort, who gave me advice on everything from sample preparation to ICP-MS specifications, and Dr. Michele Buzon, who reviewed a chapter for me, and was also available for any and all strontium queries that I might send her way. Thanks to Pam Mayne-Correia for access to her library. Thanks also to Darren Shaw and Steve Garcin, for their technical help and advice in the MACI lab.

I would also like to thank my former professors from the University of Winnipeg. Dr. Chris Meiklejohn, Dr. Michael McKinnon, and Dr. Deb Merrett demonstrated the kind of passion and curiosity that should drive any scholar, and were kind enough to help me become a better student.

I am also indebted to all the friends and family who have supported me (often via email and phone) though the last two years of my life. Thank you to Isaak, for reminding me to that school is not everything. And to Jon, who was always supporting me, even when tensions ran high. And to my Oma, thank you for only ever wanting your grandchildren to be happy.

I lift a bucket to my traveling companions – Aimee, Dennis, Kris, and Ian – who, though they may not know it, were the reason I was able to come back and finish this degree. Thanks (and a big hug) are due to Keely, who gave me something to look forward to on Sunday night. I have to thank Aimee again, this time for her all of her phone calls that made me feel like I was at home. And numerous thanks to the two friends who were there for me in the day-to-day. Julija – thank you for your friendship, office visits, and ever-ready supply of advice about anything and everything that I could ever think to ask. Mindy – thank you for your honesty, cooking, nightly calls, and basically being up for wasting time with me whenever I needed it.

To Matt - thank you for showing me the beauty of modern Greece, for listening to me talk every night about topics such as land appropriation in 19th C. Greece, and for giving me a new place to call home.

But mostly, my thanks are directed to my mom, who has been there for me in every way possible. I am grateful for so many things, too many to list in full, but mostly for the constant encouragement, the editing of six years of school papers, and the little bit of wanderlust she gave to each of her children.

Dedication

For my mom

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CHAPTER 1 - INTRODUCTION

> *"There are no stories without meaning. Afterwards, the story becomes the book of the living, like a blaring trumpet that raises from the tomb those who have been dust for centuries.... Still it takes time, you have to consider the events, arrange them in order, find the connections, even the least visible ones."*
>
> Niketas Choniates in *Baudolino* (Eco, 2000:12)

On 12 April, 1204 CE the Byzantine capital of Constantinople fell to invading Western Europeans during the 4th Crusade. Following the dramatic downfall of this once powerful Christian city, the crusaders spread out over Byzantium and established Frankish states. Though many of these Frankish-ruled areas would soon be lost, the settlements established in the Morea (modern-day Peloponnese) remained under relatively stable Frankish control until the arrival of the Ottoman Empire in the 15th C. Using archaeological and skeletal material from Corinth, located in the north-eastern Morea, this study will focus on the nearly 250-year period of co-habitation of the Franks and the Greeks. Using strontium isotope analysis, this research seeks to answer questions concerning the relationships and interactions between western invaders and Greek locals, focusing primarily on the latter half of the 13th century. Byzantium and Crusading are both extremely well documented topics of scholarship (see: Setton, 1969; Mayer, 1972; Kazhdan and Epstein, 1985; Angold, 1997; Treadgold, 1997; Riley-Smith, 2005). However, it is hoped that this study will add to the limited knowledge regarding the everyday sociocultural interaction between the Franks and Greeks, a topic which has not been studied extensively.

Before the arrival of the Western Europeans, commonly known as Franks, the Byzantine Empire was a large and successful empire that had once stretched from Syria to Italy, and from Austria to Crete. Due to its far-reaching territories, Byzantium was composed of a mixture of peoples, including individuals of Greek, Albanian, Bulgarian, Slavic, and Egyptian descent, among others (Ostrogorsky, 1971; Nicol, 1972a; Geanakoplos, 1979; Treadgold, 1997). The common language, Greek, was the unifying factor amongst these people. Byzantium had once been part of the Roman Empire, but over the centuries political, linguistic, and ecclesiastical differences led to a split between the two regions. This split was further solidified in 1054 CE by a permanent schism between the Western Catholic and the Eastern Orthodox Churches.

Due in part to the advent of crusades, many Western Europeans made the journey east to Byzantium. Begun in the 11^{th} C. CE, crusades were holy wars designed to reclaim Jerusalem and surrounding areas from Muslim rule. Although the Roman and Byzantine empires did diverge in religious teachings, Byzantium was a Christian nation, and should not have been the target of any of these crusades. However, for a number of reasons, primarily financial, the Franks did invade and capture Constantinople in the early 13^{th} C. The subsequent division and subjugation of Byzantine lands took decades; Corinth itself was subjected to a five-year siege before falling to the Franks in 1210.

After the fall of Constantinople, the process of settlement and integration in the Morea began between the two cultures. The initial crusaders, who came primarily from France, Italy, and Venice (Jacoby, 1973; Lock, 1995), sent for their wives and fellow countrymen to come to the Morea to seek land and riches (Dennis, 1968) and to help in the establishment of Frankish communities. The historical and archaeological sources differ in opinion regarding the exact nature and degree of interaction and integration that occurred between these two cultural groups. Many historical sources state that meaningful integration (*e.g.,* conversion of faith, intermarriage) was rare and that both the

Franks and the Greeks harbored distrust and distaste for each other (Geanakoplos, 1966; Nicol, 1972b; Jacoby, 1973). However, archaeological sources, including analyses of faunal remains and burial grounds, have shown that cultural integration was likely practiced to some degree (Ivison, 1996b; Lev-Tov, 1999). This study was designed to help clarify the extent of integration by examining skeletal remains recovered during excavations at Frankish Corinth.

Extensive excavations were carried out on Frankish occupation levels at Corinth between 1989 and 1997 (Williams and Zervos, 1990, 1991, 1992, 1993, 1994, 1995, 1996; Williams *et al.*, 1997, 1998). The excavations revealed an interesting portrait of the Frankish neighborhood. Although the Franks conquered Corinth in 1210, it was not until the 1260s or 1270s that a major building campaign began. Included in this building project was the construction of a multi-roomed structure (Unit 1) with a North European influence seen in the plain design of the arches, doorframes, and windowsills (Williams *et al.*, 1997). Based on archaeological and architectural evidence, Unit 1 is believed to have been a hospice that would have served pilgrims and the poor who arrived in Corinth (Williams and Zervos, 1995). Just north of the hospice is Unit 2, which was converted from a Byzantine monastery into a burial ground during the mid-13th C. Over 200 individuals, the majority of whom were found in the open-air cemetery in Room 4, have since been recovered from Unit 2 (Williams *et al.*, 1998). Osteological analysis of the skeletons recovered from Room 4 indicates both a transient and a local population. Barnes (2003; Williams *et al*, 1998) has noted that the skeletal population displays specific genetic markers indicating familial association and suggests that long-term Frankish residents of Corinth may have used part of the cemetery. Other skeletons indicate a wider degree of variation, pointing towards possible immigration into the area. The small skeletal collection also displays a relatively large number of rare diseases, such as multifocal eosinophalic granuloma. Based on the relatively high incidence rate of disease in the skeletal population, it is believed that the cemetery was associated with the nearby hospice (Williams *et al.,* 1997; Barnes, 2003).

Who were the individuals interred in the cemetery, and where did they come from? Following Barnes' (2003) conclusions based on osteological analysis, the individuals should be of both non-local (transient) and local (Corinthian) origin. The non-local individuals may have come from a variety of backgrounds. Lock (1995) includes a long list of immigrants who came to Frankish Greece, including merchants, settlers, crusaders, and mercenaries. As well, the establishment of a hospice in Corinth indicates that pilgrims, who were likely to fall ill during their travels (Cigaar, 1996), were also coming through the region. Those who died while under care at the hospice would have needed some kind of burial ground, much like the one found in Corinth in Unit 2. Meanwhile, individuals from the cemetery who are identified as local would have grown up in Corinth. The burial of local individuals in a Frankish cemetery raises interesting questions regarding cultural integration. If many of the historical sources are correct, the Franks and the Greek lived separate lives with the Franks always maintaining their sense of superiority over the Greeks (Nicol, 1972a). However, the intermingling of Greeks and Franks in death indicates that some meaningful integration may have occurred during life. The next step in this research is to determine whether these individuals were of local or non-local origin.

The determination of locals and non-locals will be carried out using strontium isotope ($^{87}Sr/^{86}Sr$) analysis. $^{87}Sr/^{86}Sr$ analysis involves aspects of several of the earth sciences, including geology and ecology, to answer a variety of questions regarding ethnicity, migration, and mobility. Strontium is a naturally occurring element found in most rock formations, often in combination with rubidium. Although strontium is a stable element, one of the isotopes of rubidium (^{87}Rb) is radioactive and will gradually decay into an isotope of strontium (^{87}Sr). This process of rubidium to strontium decay takes place over a long period of time (the half-life of rubidium is 4.7×10^{10} years) and leads to $^{87}Sr/^{86}Sr$ signatures in rock formations that are based on age and composition (Faure and Powell, 1972; Faure, 1986). Older rocks that began with high Rb/Sr ratios, such as granites and shales, typically have $^{87}Sr/^{86}Sr$ values between 0.710 and 0.740. Younger rocks that originally had low Rb/Sr ratios will have $^{87}Sr/^{86}Sr$ values between 0.703 and 0.704.

As rocks weather, strontium is introduced into the food chain. Based on the small mass differences between the isotopes of strontium, the strontium isotopic composition remains relatively unchanged as it moves up the food chain from soil to humans (Blum *et al.,* 2001). What this means is that soil will have the same $^{87}Sr/^{86}Sr$ value as the bedrock it lays on, herbivores will have the same $^{87}Sr/^{86}Sr$ value as the plants they consume, and carnivores will have the same $^{87}Sr/^{86}Sr$ value as the plants and herbivores they consume (Beard and Johnson, 2000). The variation in $^{87}Sr/^{86}Sr$ values between different parent rock formations is enough to differentiate between local environments from which individuals may have originated (Ericson, 1985; Price *et al.,* 1994b; Grupe *et al.*, 1997).

Once strontium enters the body, it is stored in the skeleton (Schroder *et al.,* 1972), retaining an $^{87}Sr/^{86}Sr$ ratio typical of the surrounding environment (Lenihan *et al.,* 1967). Researchers examine different skeletal tissues to gain information on different periods of an individual's development. The enamel portion of teeth is formed during early childhood and does not remodel or incorporate new elements later in life (Carlson, 1990; Hillson, 1996; Budd *et al.,* 2000). Bone, however, is remodeled continuously, and reflects the elemental intake of approximately the last ten years of life (Parfitt, 1983). The comparison of bone and enamel values in the same individual can reflect movement between geochemical zones during life (Price *et al.,* 1994a; Bentley *et al.,* 2002). It is also possible to compare enamel $^{87}Sr/^{86}Sr$ ratios, which reflect the geological signal acquired during childhood, with local $^{87}Sr/^{86}Sr$ values provided by faunal bone, soil, or water (Hodell *et al.,* 2004; Knudson *et al.,* 2004) as a means to identify possible immigrants to the region. Based on difficulties encountered in obtaining a biological signal of $^{87}Sr/^{86}Sr$ from bone, the comparison of enamel $^{87}Sr/^{86}Sr$ ratios to environmental and ecological $^{87}Sr/^{86}Sr$ ratios in a region is often the preferred method of interpretation (Price *et al.,* 2002).

Ericson (1985, 1988) was the first to suggest using $^{87}Sr/^{86}Sr$ analysis of human and faunal remains to understand patterns of residence and migration. It is now used as a means to determine an individual's geographic background and movement patterns directly, as opposed to relying on indirect indicators such as cultural or artifactual associations (Montgomery *et al.,* 2003). Researchers have used $^{87}Sr/^{86}Sr$ analysis to understand the first spread of settlers in Neolithic England (Budd *et al.,* 2001), the process of shifting migration at Grasshopper Pueblo, Arizona (Price *et al.,* 1994b), and the extent of influence of the Tiwanaku state in Bolivia and Peru (Knudson *et al.,* 2004, 2005). The studies mentioned above are all part of long-term research projects into a particular region. As such, they now have $^{87}Sr/^{86}Sr$ values for large numbers of human, faunal, and other ecological specimens (*e.g.*, Hodell *et al.*, 2004; Bentley and Knipper, 2005). This allows for broad comparisons across the regions, as well as the possibility of pinpointing precise locations where individuals may have spent their childhoods (Ezzo and Price, 2002; Budd *et al.*, 2004; Knudson *et al.,* 2005).

No previous $^{87}Sr/^{86}Sr$ analysis of human or faunal remains has been conducted on remains from the Mediterranean. For that reason, this research should be seen as a pilot study into the utility of using $^{87}Sr/^{86}Sr$ isotope analysis to examine cultural questions about this geographic region. It is hoped that the results of this research will inspire more $^{87}Sr/^{86}Sr$ studies in this region in the future. This would allow for an $^{87}Sr/^{86}Sr$ database to be established in the Mediterranean similar to those available for Mesoamerica or Central Europe.

The various cultural, archaeological, and technical issues in this thesis will be discussed as follows. Chapter Two acquaints the reader with the historical context of the events that led to the Fourth Crusade, the Frankish conquest of Byzantium, and the establishment of foreign rule in the Morea. Chapter Three provides a review of the archaeological excavations at Corinth, focusing specifically on the Frankish levels uncovered between 1989 and 1997. The theoretical background of strontium isotopes as a migratory tracer, and the method's potential to isolate place of birth, is outlined in Chapter Four. This chapter also includes a review of previously published literature regarding strontium isotope analyses to identify migration and mobility in the archaeological record. The skeletal material analyzed in this study is described in Chapter Five, along with sample processing procedures and specifications. Chapter Six deals with the results of the strontium isotope analysis and the possible interpretations of these findings. Previous oxygen, carbon, and nitrogen isotope analyses performed on the same individuals are taken into account. Also included in Chapter Six are problems encountered in distinguishing between locals and non-locals at the site, as well as the limitations of using strontium isotope analysis at Corinth. Finally, Chapter Seven outlines suggestions for future research that may provide further insight into the questions raised by the findings of this study.

CHAPTER 2 – CULTURAL BACKGROUND

> *"You took the Cross upon your shoulders, and on that Cross and on the Holy Gospels you swore that you would pass over Christian lands without violence, turning neither to right nor to left. You assured us that your only enemy was the Saracen [Arab], and this his blood only would be shed...*
> *Far from carrying the cross, you profane it and trample it underfoot. You claim to be in quest of a pearl beyond price, but in truth you fling that most precious of all pearls, which is the body of our Saviour, into the mud. The Saracens themselves show less impiety."*
>
> \- Niketas Choniates, *Annals*, V. 575/6

2.1 INTRODUCTION

The Byzantine Empire was one of the most successful and longest-lived empires of the Middle Ages.[1] Its capital, founded by Constantine in 330 CE on the straits of the Bosporus, was Constantinople. Although a schism had occurred in 1054 CE between the churches of Western Roman Catholicism and Eastern Orthodoxy, the inhabitants and the city of Constantinople were considered Christian. Its religious leanings, therefore, excluded it from the focus of earlier Crusades – holy wars aimed at recapturing perceived Christian lands and ensuring safe passage for pilgrims to holy sites. However, in 1204 CE Constantinople fell to western European invaders and the Byzantine Empire was subsequently divided up among the conquerors.

The Byzantines recaptured Constantinople in 1261, but several areas of the empire, most notably the Peloponnese, remained under western European control until the 15th century. This period of cohabitation between local Greek subjects and foreign Frankish rulers in the Peloponnese is the area of interest for this study. Lock (1995) comments that the emergence of a possible hybrid Franco-Greek culture during this time period is an intriguing and understudied topic. This chapter will review the history of the

[1] The Middle Ages is considered here to comprise the period from the end of the Roman Period (5th century CE) until the beginning of modern times (the beginning of the 16th century CE). The term Middle Ages is often interchanged with the term Medieval; this paper will use Middle Ages.

Byzantine Empire as it relates to the Fourth Crusade, the parceling out of land, and the conquest of the Peloponnese. It is crucial to learn why the western Europeans came to the eastern Mediterranean, as this will allow one to understand why relations were so strained between the two peoples, and why it was unlikely that real integration would occur during this period of interaction. As well, throughout the chapter the ethnic composition of each population will be discussed, as this pertains to the research question regarding the identity of the study population. Finally, the chapter will conclude by detailing the historical sources of information employed here regarding Frankish and Greek interaction, and how this may affect the interpretations of the strontium study.

2.1.1 Terminology

The inhabitants of the Byzantine Empire did not call themselves Byzantines, or their homeland Byzantium. The name Byzantium was given to the region by French scholars in the 17^{th} century (Lock, 1995). It was chosen because the region was ruled from Constantinople, which was formerly known by the Greek name of Byzantion; today the city is called Istanbul. In actuality, the people referred to themselves as *Rhomaioi*, which means 'true' Romans. They considered themselves part of the Roman Empire, and emphasized their descent from a Greco-Roman tradition (Kazhdan and Constable, 1982).

The country that is today known as Greece did not exist during the Middle Ages. The region was simply part of the Byzantine Empire; the official language of the empire, however, was Greek. For the purposes of this paper, the locals who inhabited Byzantium prior to the arrival of the westerners will be called Greeks. As well, the term Frankish, from the Greek *Frangoi*, is in this paper meant to comprise all of the westerners who came to the Eastern Mediterranean during the crusades. The invaders called themselves Latins, and while some sources prefer this term (Brand, 1968; Jacoby, 1973), most recent sources use the term Franks (*e.g.* Ilieva, 1991; Lock, 1995). The terminology from recent sources will be adopted for this paper. Although in earlier times the diversity of the westerners was recognized, by the 12th century CE 'Frank' was an ethnonym used by locals from the Eastern Mediterranean and the Middle East to describe these incoming invaders, regardless of their country of origin. Since this term was all-encompassing, it is argued that the Greeks saw all westerners as having the same set of cultural, linguistic, and religious beliefs; the locals viewed the invaders as a much more homogenous population than they likely were (Lock, 1995; Kazhdan, 2001).

2.1.2 Primary sources

The majority of information regarding Frankish rule in Greece, principally focusing on the Morea (*i.e.,* the Peloponnese), originates from two primary sources: *The Chronicle of Morea* and the *Assizes of Romania*. *The Chronicle of Morea* (dated to the mid-14th century) is a narrative work discussing life in Frankish Greece that exists in four different versions, each of which is written in a different language (Aragonese, French, Greek and Italian). It is unclear to scholars which of the four versions was the original, although the Greek and French versions are the most likely (Lurier, 1964, Topping, 1977d). All four differ slightly from each other. *The Chronicle of Morea* is not simply a dry recitation of past events, but rather combines "elements of history and legends, and seeks to inspire its readers or listeners by recalling to them the *gestes* [gestures] of the brave warriors of the conquest, and those who came after them" (Topping, 1977b:10).

The Chronicle is a valuable source as it discusses local and feudal customs and politics, folk stories, and information detailing the legal processes of the Morea (Lurier, 1964; Topping, 1977d), even if it has a tendency to romanticize the Frankish settlers (Lock, 1995).

The Assizes of Romania on the other hand is a set of more formalized codes and customs from the Frankish Aegean. They have come down to us in the form of 219 articles, likely from the 14^{th} century. Although quite short, *The Assizes of Romania* remains an important source on the feudal institutions of Frankish Greece (Topping, 1977b, 1977c).

This chapter focuses on the use of secondary sources for two primary reasons. First, the author does not speak any of the languages in which *The Chronicle of Morea* or the *Assizes of Romania* exist. Translations are available primarily for the French and Greek versions, and as it is beyond the scope of this research to examine and compare the different versions for inconsistencies, the author has chosen instead to rely on the decades of scholarship that has been devoted to interpreting the Chronicles. Second, although these are the primary sources, there exist several smaller historical sources, mostly in French, German, and Greek (see Lock, 1995:25). Thus, it was the decision of the author to rely upon secondary sources, which draw on all of this material.

2.2 THE BYZANTINE EMPIRE

2.2.1 Origins

The status of the region which became modern-day Greece has changed dramatically over the last 2000 years. During the height of the Roman imperial age, Greece was regarded as a remote outpost, with little political or economic strength (Gregory, 1984). Over time, as the Western Roman Empire fell under attack from invaders such as the Anglo-Saxons, Visigoths, and Vandals (Tierney and Painter, 1992), the Eastern Empire began to flourish. The Roman Emperor Constantine re-named the capital from Byzantion to Constantinople and made it his capital in 330 CE; the region became known as the Eastern Roman Empire.

During the next several hundred years differences developed between the Western and Eastern Roman Empires, and by the 7th century CE there had been a split in name between both halves. Although the Byzantine Empire began as the eastern portion of the Roman Empire it quickly evolved into an independent entity. Soon, religious, cultural, political, and linguistic differences had eroded the connection linking the two empires. In 1054 CE an official schism between the Western Catholic Church and the Eastern Orthodox Church was declared, a split which continues to exist today. The schism was in part due to debate over papal authority; opinions differed as to whether the pope should have supreme authority, or whether the pentarchies of the five patriarchs (Antioch, Alexandria, Constantinople, Jerusalem, and Rome) should rule (Efthimiou, 1987; Chadwick, 2003). As outlined below, this schism was used in part as justification by the Western crusaders to invade Constantinople.

The height of the Byzantine Empire occurred during the 10th and 11th centuries CE, a time when the empire's occupied territories were largest, and when it made the greatest advances in art, literature, and science (Ostrogorsky, 1969; Treadgold, 1988; 1997; Norwich, 1991). By 1000 CE Constantinople is said to have been one of the richest and most cultured regions in Western Europe, earning it the sobriquet 'Queen of

Cities'. Robert de Clari, a Frankish crusader wrote that, "For no man on earth, however long he might have lived in the city, could number them [the marvels of Constantinople] or recount them to you" (McNeal, 1996:112). The distinctiveness of Byzantine culture was based on a blend of Hellenic and Oriental traditions, which is evident in its economic policy, religion, art, and literature (Runciman, 1975; Tierney and Painter, 1992; Vryonis, 1992). In particular, the differences between Byzantine architecture and Frankish architecture are of importance to this study, and will be discussed in the following chapter.

2.2.2 Geographical boundaries

The geographical borders of the Byzantine Empire changed dramatically over the course of its more than 1000 years of history. It was constantly under attack from eastern invaders such as the Huns, Avars, Persians, Arabs, Bulgars, and Mongols (Geanakoplos, 1979). During the height of the empire's supremacy in the 10^{th}-11^{th} century CE, it stretched from modern-day Syria to Italy and from Austria to Crete. In the period immediately preceding the Fourth Crusade, Byzantium had been weakened by incessant warfare with neighboring Normans, Russians, and Seljuk Turks and had lost much of its original territory. Moreover, even though some of this land had been reclaimed by the Byzantines during the 11^{th} century (Figure 2.1), two massive losses in 1071 CE, to the Turks at Manzikert and the Normans at Bari, led to a general decline in the power of the Byzantine Empire (Geanakoplos, 1979).

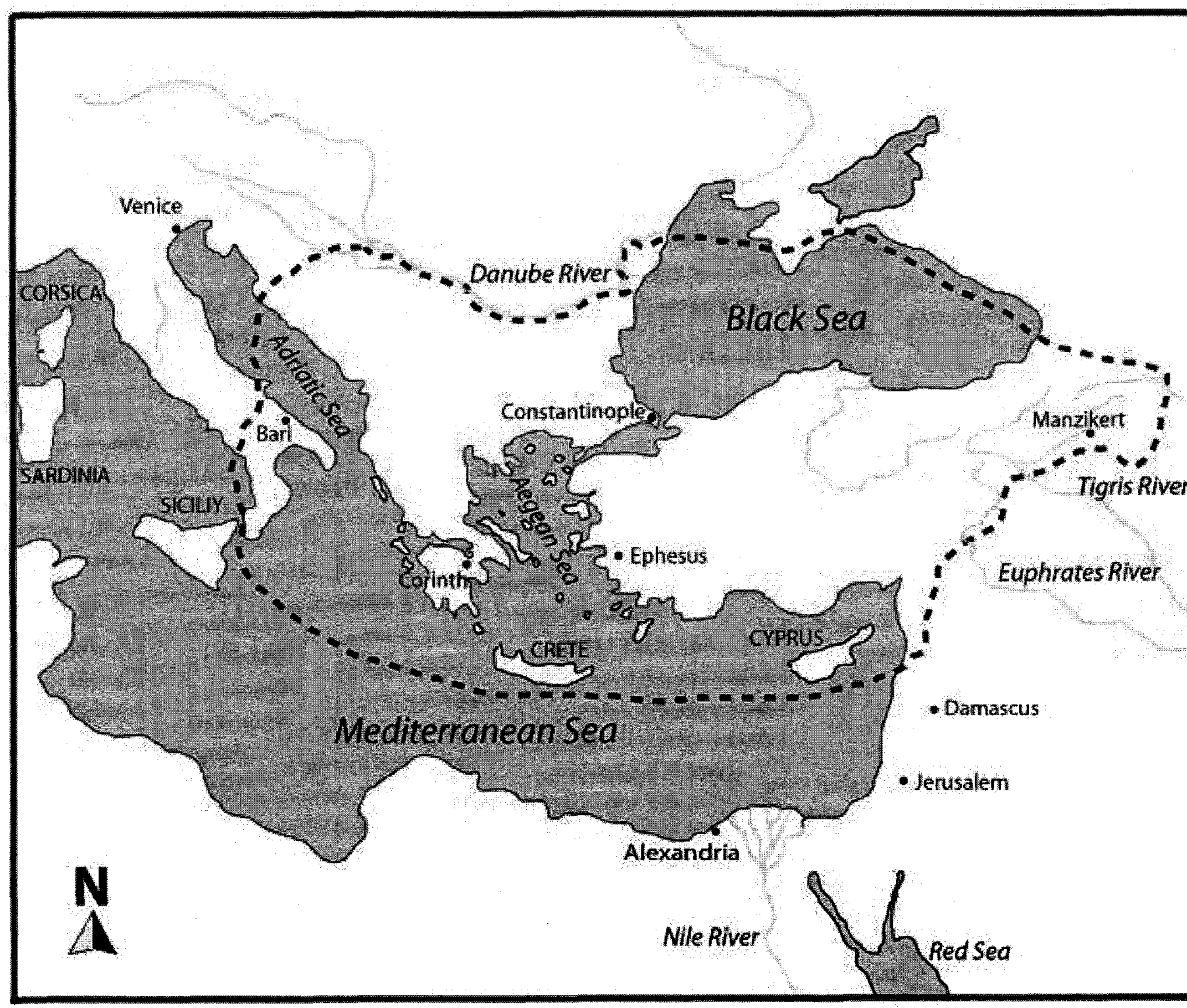

Figure 2.1: The Byzantine Empire in the 11th century CE (adapted from Geanakoplos, 1979:143)

2.2.3 Ethnicity of the Byzantines

The Byzantine Empire was a far-stretching region and its inhabitants were not as ethnically homogenous as one might think, based on typical Byzantine distaste of all non-Greek speaking individuals (Kazhdan and Epstein, 1985). One author compares the ethnic mixture of the Byzantines to that of the modern-day United States (Nicol, 1972a). To be considered Byzantine it was essential to adopt the cultural habits of the locals, belong to the Orthodox faith, and speak the common language of Greek (Treadgold, 1997).

Alongside the typical Greeks, who were descendants of the Roman Greek population, there was also a mixture of Albanians, Armenians, Bulgars, Georgians, Slavics, Syrians, Egyptians, Vlachs, and Jews, among others (Ostrogorsky, 1971; Nicol, 1972a; Geanakoplos, 1979; Treadgold, 1997). All of these groups, excepting the Jews who were often shunted to enclaves (Adler, 1907), would have had strong emotional ties to both the Orthodox Church and the Byzantine Empire. To be a *Rhomaios* it was not necessary to belong to any one country or region, but rather to acknowledge that you belonged to the culture and faith that formed the one true belief system (Nicol, 1972a).

2.3 THE FOURTH CRUSADE

2.3.1 The sack of Constantinople

The Fourth Crusade was the brainchild of Lothorio dei Conti di Segni, who took the name Innocent III when he became pope on 8 January 1198 CE. He was a pope who strove to use and increase the full power of the papacy (Tierney and Painter, 1992); he used this power to begin a crusade to regain Jerusalem from the Muslims. The crusades were usually conducted under holy pretenses, such as the attempt to regain the Holy Land, but they must also be thought of as a means for the Roman Empire to expand its geographical and commercial territory (Topping, 1977b). The Fourth Crusade was to prove a perfect example of this.

In August 1198 CE, Innocent III promulgated *Post miserabile*, an encyclical which was his first call-to-arms. Due to a number of underlying political reasons, such as the stand-off between King Richard I of England and King Philip II of France, it was difficult to raise an army and to acquire funds to support the crusade. During the planning stages it also became apparent that a slight diversion would be required; a truce for five years and eight months had been signed between the kingdom of Jerusalem and al'Adil, the leader of the Turkish army (Riley-Smith, 2005), making it difficult for the western crusaders to enter and fight in Palestine. In a secret clause of the Treaty of Venice it was decreed that the crusade would instead focus on Egypt, under the belief that Jerusalem could more easily be taken via Egypt (Queller and Madden, 1997). This diversion was not relayed to the crusaders however, as difficulties were feared if the crusaders realized that they were not to be attempting a direct re-claiming of the Holy Land.

It was necessary for the Frankish leaders to arrange sea transport for the crusaders, a task the Venetians undertook for a sizeable fee in order to ferry an estimated thirty thousand men. However, many of the crusaders instead chose a land route, meaning that only one-third of the expected number of men actually arrived in Venice (McNeal and Wolff, 1969). Although the number of men to be transported was severely diminished, the Venetians demanded full payment, which the crusaders were unable to meet. In order to relieve their debt, the crusaders agreed to attack the rich Christian port-city of Zara, a city that Venice had lost to Hungary and wanted to regain control over (McNeal and Wolff, 1969). The subsequent capture of the city led Pope Innocent III to excommunicate all those who were involved in its sacking.[2] Soon after, a claimant to the Byzantine throne, Prince Alexius IV Angelus, appealed for help from the crusaders to take the throne from the current ruler, Alexius III. In return for their help, he offered them rewards from the treasury of Byzantium (Payne, 1984), as well as a chance to heal the rift between both churches (Mayer, 1972). The additional allure of valuable reliquaries housed in Constantinople was enough to convince the poverty-stricken crusaders to alter their attack plan.

The crusaders' first encounter against Constantinople in July 1203 put Alexius IV on the throne. However, Alexius IV failed to fulfill his obligations to the crusaders and was despised by his own people for his subservience to the Franks (Runciman, 1955). Consequently, he was killed in January 1204 CE and the anti-Frankish ruler Alexius V came to the throne. Thus, in March 1204 CE the leaders of the Fourth Crusade, encamped outside the city walls, decided to conduct a second attack with the hope of conquering Constantinople and the Byzantine Empire. A treaty was drawn up by the crusaders before the battle that divided Byzantine-ruled land among the different factions of the crusade. This planned attack was met with some hesitation by the crusaders and it became necessary for the clergy traveling with the army to preach of the sins of the Byzantine Empire (sins which were rooted heavily in schismatic differences) in order to relieve the consciences of the soldiers (Riley-Smith, 2005). The confrontation began on

[2] Upon later realizing that the crusaders had no real choice in the matter, the Pope later recanted the excommunication for the majority of the crusaders; however, the Venetians remained excommunicated due to their leading role in the attack.

12 April 1204 CE, and was over by the following day. The subsequent three day sack of Constantinople is infamous, with the crusaders committing numerous acts of atrocity: murder, rape, looting, burning, and general destruction. Nicol (1979a:12) notes that the horrified Byzantines could scarcely believed that these pillagers were Christian men. The historian Niketas Choniates, who was present, called them "forerunners of Antichrist, the agents and harbingers of his anticipated ungodly deeds" (Magoulias, 1984:315).

2.3.2 Formation of the Frankish states of Greece

The conquering French and Venetian crusaders then began the task of dividing up their empire, an area they called Romania (Dennis, 1968). The main crusader states established were the Latin Empire of Constantinople, the Kingdom of Thessalonika, the Lordship (later Duchy) of Athens, the Duchy of the Archipelago and the triarchies of the islands of Euboea (which the Venetians controlled), and the Principality of Achaia (occupying most of the Peloponnese) (Figure 2.2) (Lock, 1995). In addition, three Byzantine successor states (Trebizond, the Despotate of Epiros, and the Empire of Nicaea) also came into existence; the latter two would prove to be the most consequential to the newly formed Frankish states (Geanakoplos, 1959).

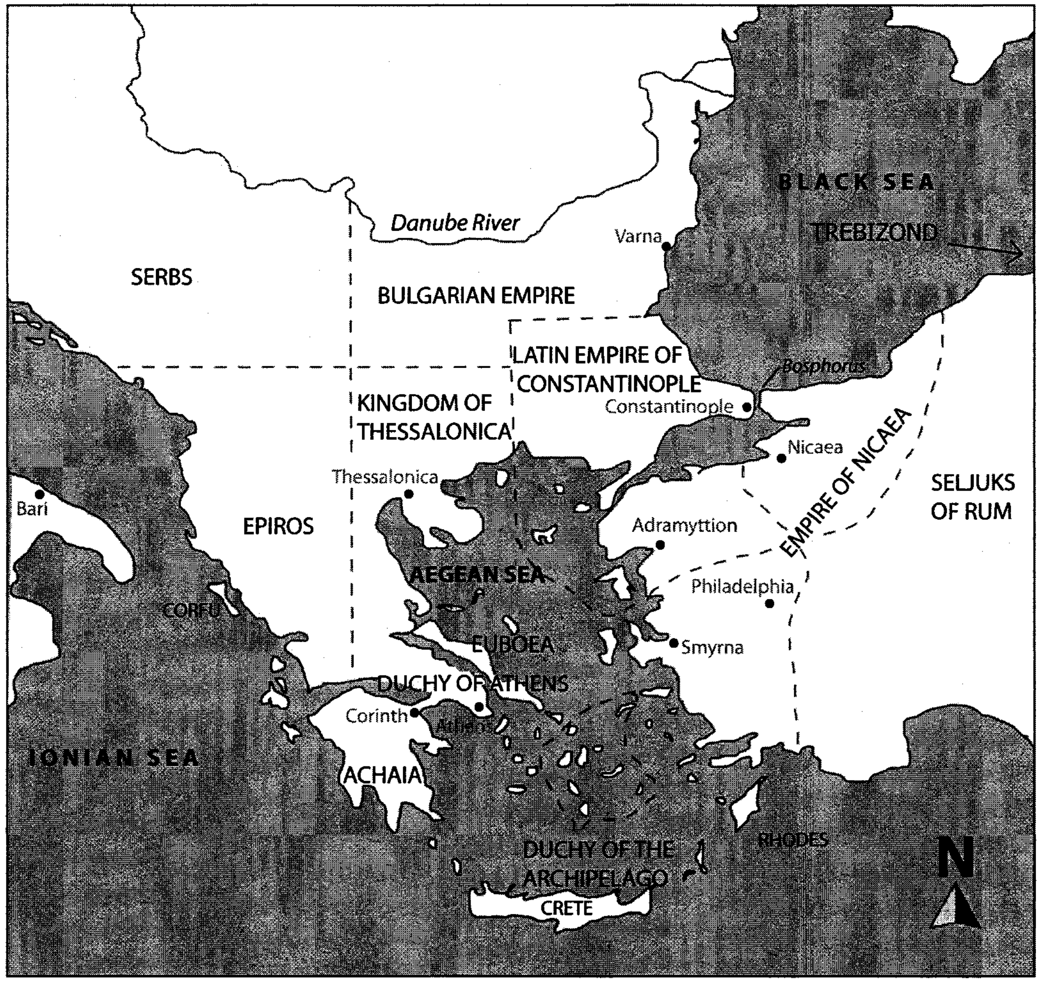

Figure 2.2: Frankish States of Greece (adapted from Lock, 1995:380)

Following the Western feudal system, fiefs became the norm in the division of lands within the larger Frankish states. This was not a wholly unknown system to the Greeks; their *pronoia* were similar in many respects (Ostrogorsky, 1971). Meaning 'provision', pronoia were land grants given to aristocrats, and to soldiers in lieu of regular pay. They allowed the owner of the grant to collect taxes from the tenants of the land (Treadgold, 1997). However, pronoia and fiefs differed in several key ways, including means of inheritance and level of authority (Wolff, 1969; Jacoby, 1973). The 600 or so fiefdoms (Mayer, 1972) established an extremely ranked social system, with Frankish barons and princes at the top, knights and sergeants in the middle, and local Greek proprietors, or *archontes,* near to the bottom. At the very bottom of the social hierarchy were the Greek peasants; unlike the *archontes*, the Greek peasantry would likely have had little day-to-day contact with the Frankish lords, and were not required to make concessions to their new rulers. Dennis (1968) believes that the *archontes* also lived a life under the Franks that was not that different from as it had been under the Byzantines. *The Chronicle of Morea* describes the system wherein in order for the *archontes* to retain any of the privileges they had under Byzantine rule, they were required to pay homage to their new Frankish lord and provide military service; in return, the Franks swore in writing to respect the laws and cultures of their Greek vassals (Lurier, 1964: verses 2093-2095). However, the implementation of a social system that had worked quite well in the Western Roman Empire did not mean success in the new Romania and as a result, the Empire would lose the majority of its lands over the next several decades.

This new Eastern Frankish Empire, though claiming rule over all of the former Byzantium, was only able to exercise rule in an 80 km or so radius outside of

Constantinople (Brand, 1968; Nicol, 1972b). In 1224 CE the kingdom of Thessalonika was lost, which meant that much of the region, including the Duchy of Athens, and consequently Thebes, Euboea, and Achaia, were effectively cut off from any contact or control by the Frankish-ruled Constantinople (Lock, 1995).

In brief, the rule of the Latin Empire of Constantinople was largely conducted by feeble and inept leaders, with land constantly being won and lost. Norwich (1996:212) puts it much more bluntly when he states that it "achieved nothing, contributed nothing, [and] enjoyed not a single moment of distinction or glory." The land was highly fragmented, lacked any real focal point for rule (Lock, 1995), and was constantly searching for more financial and military resources (Jacoby, 1995). Another extremely important problem was the inability of the Frankish rulers to gain the support of the native peoples (Jacoby, 1995). Although the conquerors were met with some favour initially, in a short time this had been lost. In part this was due to changing policy concerning the position of Greek churches, as well as the status of the Orthodox Church; the more lenient Frankish rulers allowed the Orthodox Church some freedom, which the subsequent more close-minded leaders soon disallowed. This led the natives to seek help from the Byzantine successor states, such as Nicaea and Epiros.

Wolff (1969) argues that the Eastern Frankish Empire was destined to fail, since funds and man-power were always in short supply and the locals were hostile and had charismatic leaders ensconced in Byzantine successor states to look to for leadership. The majority of the Eastern Frankish Empire was therefore lost by 1225 CE, and by 1254 CE Innocent IV recognized that the loss of Constantinople was inevitable (Brand, 1968). Constantinople was re-taken by the Byzantine leader of Nicaea, Michael Palaeologus, after a sympathetic Constantinople native opened the gates on 24/25 July 1261 CE (Phillips, 2004). This is especially interesting since the Byzantines had not even planned an attack, but were in actuality merely passing by on their way to battle with the Bulgarians when they learned the Franks would be unable to defend themselves (Mayer, 1972). After Constantinople was retaken by the Byzantines, the matter of the Frankish inhabitants of the city required some attention. Michael Palaeologus realized that he would still need to rely on Frankish traders to support the city; however, sympathetic Franks inside the city walls could help the westerners try to re-enter (Geanakoplos, 1959). The new emperor decided on a policy that sought to prevent a union between the different factions of the westerners (primarily Genoese, Pisans and Venetians) in rising up against the Byzantines. Michael Palaeologus laid out three provisions for the westerners: the Franks would be able to live in a defined area of the city, the Frankish areas would be governed by their own laws, and the merchants would not pay duties. Michael Palaeologus did forbid a massive influx of Venetians, who were amongst the most disliked of all the westerners. In keeping the westerners in their own city regions and by maintaining vigilant control, the emperor hoped to profit from the trade brought in by the westerners, while still maintaining his command of the throne (Geanakoplos, 1959). Once again made clear is the delicate balance required to negotiate relations between both cultures.

The history of the conquest and the loss of Constantinople is important to this study as it illustrates key events that fueled the antagonism between east and west. Runciman (1955:130) writes of the Fourth Crusade as an "act of gigantic political folly" that resulted in a region that became less safe for westerners and pilgrims and contributed to a memory of barbarity that the East had trouble forgiving or forgetting. If the Franks had altered their strategies somewhat, and had devoted more time to strengthening relations with the local population (Nicol, 1972b), it is possible they may have prevented the early demise of many of the Frankish states in Greece.

2.3.3 Ethnicity of the crusaders

The lofty (and often false) goal of a crusade was to fight against the foes of Christianity, recover Christian property, and defend Christian peoples. This made the crusades appeal to Christian regions across Western Europe. Riley-Smith (2005) notes that because of its wide appeal, a crusading army was considered to be international, even if many of its members were from one region. In the case of the Fourth Crusade, the majority of the army came from France (Burgundy, Champagne, Flanders and Provence primarily), Italy, and Venice[3] (Jacoby, 1973; Lock, 1995). However, over time a much more varied group of people came from the west. Heatherington (1991:8) relates that following the conquest of Constantinople, in the rest of Greece "a ceaseless cavalcade of Burgundians, Normans, Angevins, Provencales, Flemings, Florentines, Lombards, Venetians, Genoese, Neopolitans, Sicilians, Catalans, Navarrese, Aroganese, and Hospitallers flows to and fro."

2.4 Principality of Achaia

Constantinople was lost to Frankish rule in 1261 CE and was beset by in-fighting, petty intrigues, and ill-management. In contrast, the Principality of Achaia, which

[3] During the Middle Ages, Venetians were one of several independent states in what is now modern-day Italy. This sea-faring power astutely used the Fourth Crusade to further its own agenda – the expansion of its trading empire (Phillips, 2004).

comprised the peninsula of the Peloponnese and was also known as the Morea during the Middle Ages (Figure 2.3), was highly successful, and is the focus area of this study.

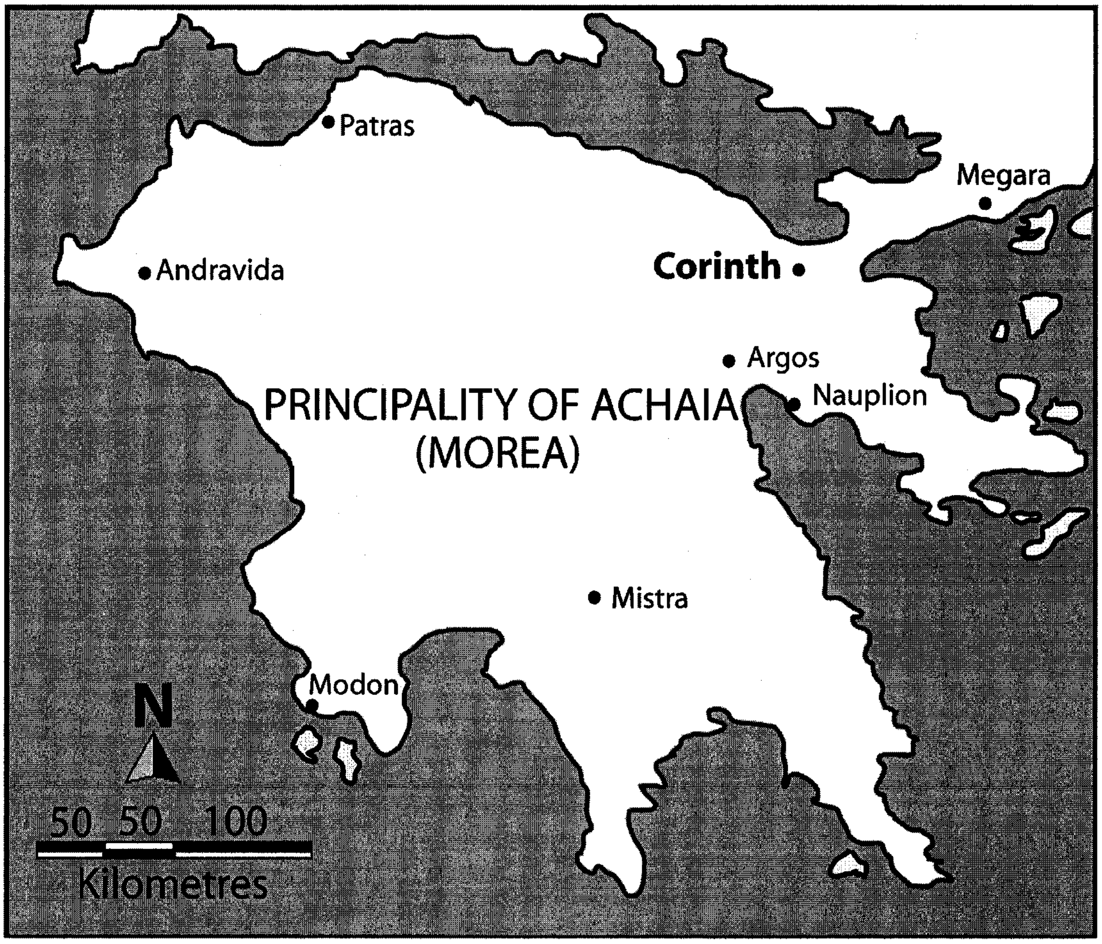

Figure 2.3: Principality of Achaia (adapted from Lock 1995:381)

During the Middle Ages, at a time during which travel could be slow and dangerous, the Peloponnese would have been seen by many as a remote region (Heatherington, 1991; Lock, 1995). This isolation meant that the inhabitants of the region had long been prone to invasions and acts of piracy. The locals were accustomed to defending their territory themselves, and did not rely on the Byzantine leaders in Constantinople for either help or protection (Lock, 1995). Its remoteness and remove from centers of influence also became an asset under Frankish rule. It was bordered to the east by the Duchy of Athens and Thebes, which was under Frankish control, making it less likely a target to Byzantine armies. As well, its extensive coastline meant that sea trade was relatively easy to conduct.

Lock (1995:7) characterizes the Morea as the "best documented, the richest and the most secure" of the Frankish states in Greece. In the treaty of March 1204 CE, Achaia had been given to the leader of the Fourth Crusade, Boniface of Montferrat. For strategic and familial reasons, Boniface instead requested the kingdom of Thessalonika, which he was granted. This left the rule of the Morea open to whoever should conquer it from the locals. This task fell to two men, William of Champlitte and Geoffrey de Villehardouin, who were both successful. By 19 November 1205 CE William of Champlitte was recognized by Innocent III as the 'Prince of Achaia', ruler of the Morea. He soon began dividing and distributing the land to his friends and soldiers. However, the complete capture of the Morea was a process that took many years; Acrocorinth for example, held out until 1210 CE, and the bulk of the region was captured by 1212 CE (Topping, 1977d). The capture of the entire Peloponnese did not occur until 1248 CE.[4] Areas of the Morea were to remain under Frankish control until the mid 15^{th} century CE and the coming of the Turks.

By 1209 CE William was dead and Geoffrey de Villehardouin had taken control. He, along with another Frankish noble, Othon de la Roche, sent for their wives, children, and more men from the region of Champagne and Burgundy to rule some of the fiefs (Longnon, 1962; Ilieva, 1991). Women came as well, who then married into the local

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[4] After 1248 CE the only area of Morea that was not in the control of the Villehardouins was the southern region of Messenia, which remained under Venetian rule (Jacoby, 1995).

Frankish community. Families were soon started and the basis of a Frankish community in the Morea began.

The rule of the Villehardouin family was a long and prosperous one, allowing ample time for cultural synthesis to occur between the invading Franks and the local Greeks. The Villehardouin court encouraged their former French countrymen to come to Greece to seek fame, fortune, and land. A number of young nobles from France came to the Morea to learn knighthood; it is in fact said that the Geoffrey de Villehardouin II had an entourage of eighty knights with golden spurs at his castle in Andravida (Dennis, 1968).

Although the Villehardouins had conquered the Morea with little resistance, the Franks soon began construction on fortified castles at strategic coastal locations. One such castle, located in the Arcadian region, was called Matagrifon, which means 'Kill (or Stop) Greek' (Miller, 1964). It seems the Franks were less concerned with fighting off foreign invading armies than they were in holding back the local Greeks. It has also been argued that the Franks were able to avoid many aspects of day to day life involving the Greeks by secluding themselves in their castles and fortresses (Jacoby, 1973; Ilieva, 1991).

Although Cheetham (1981) notes that the Franks involved the locals, mostly higher-ranking landowners, in some aspects of social and political life such as the distribution of fiefs and army campaigning, little information beside this exists regarding everyday life under Frankish rule. It is argued in this paper that these two concessions, the distribution of fiefs and participation in campaigns, are allowances that sought to serve only the Franks, and not to foster better relations between the two groups. The fiefs being 'distributed' by the Franks had in fact previously belonged to Greeks *archontes*. In allowing the Greeks to be involved in the re-distribution of the fiefs, it is made to seem as if the Franks were kind and just rulers interested in establishing better relations with the local Greeks. However, what appears to have happened is that the Franks took Greek land which had been under the rule of the local *archontes*, gave their own countrymen first opportunity at the most desirable land, and then made the appearance of giving the Greeks back good land. In reality they were just giving the Greeks back that portion of what had previously been theirs, which the Franks did not need or want. It is important to note that the Greek peasantry likely would not have been affected too greatly by this transition. The peasants were 'attached' to the land, and went with whoever the owner was.

Allowing Greeks to participate in army campaigns was a more obvious plan designed to benefit the Franks. The crusaders and conquerors were notoriously short on men and funds, so by 'allowing' their vassals to fight alongside them, the Franks were able to easily overcome both of these shortcomings. Furthermore, although Ilieva (1991) argues that these types of concessions, especially the involvement of the *archontes* in politics, is seen nowhere else in the Frankish colonies, it is important to realize that the Franks were but a small minority amongst a large majority of Greeks (Topping, 1977b). It would have been a smart political move by the Frankish rulers to involve the Greeks in some degree of policy-making. This does not necessarily mean, however, that there was any real form of cultural integration occurring.

2.4.1 Ethnic populations

Although the background of the crusaders has been discussed above, it is important to note that there may have been differences regarding immigration to the Morea. We hear of William of Champlitte and Geoffrey de Villehardouin requesting young men to come to the Morea from France[5], with the promise of riches and land (Dennis, 1968). The foreign population of the Morea increased once word got out about the success of Villehardouin; men also flocked in from Palestine, Syria and the Latin Empire of Constantinople (Cheetham, 1981). It is reasonable to assume, however, that the majority of the Frankish inhabitants of the Morea came from Western Europe.

2.5 SOCIAL AND CULTURAL INTEGRATION

As shown above, the background information on the Byzantines and Franks is necessary in order to understand the changing attitudes that the two cultures felt towards one another, and to see the "gradual transformation of their societies from amicable rivalry to overt hostility" (Geanakoplos, 1976:3). The arrival of the Franks in 1204 CE was not the first time that western Europeans were present in areas of the Byzantine Empire. Crusaders had passed through Constantinople on their way to the Holy Land during previous crusades (Nicol, 1972a), and there had been a long history of commercial trade and artistic exchange between the west and east (Bryer, 1973; Leyser, 1973; Kazhdan and Epstein, 1985; Lock, 1995). Angold (1997) describes the relationship between the two cultures as mutually respectful; the Byzantines respected the prowess of Frankish knights, while the Franks admired Byzantium's financial success and artistic sensibilities. However, this mutual respect and attitude of tolerance was disrupted by a

[5] By 1225 CE, 450 Frankish knights were said to be dispersed throughout Morea (Jacoby, 1995)

wave of an anti-Frankish mood that swept through Constantinople in 1182 CE (Dvronik, 1966) and resulted in the murder of all Franks in Constantinople.

Even before the physical acts of violence against Franks in 1182 CE, the westerners, while perhaps tolerated, had never really lost their 'alien' status. A Frank had three choices upon arrival in Byzantium:

1. Attempt to integrate completely into Greek society. If this route was chosen the Frankish individual needed to accomplish three requirements: (a) adopt the Greek language, (b) convert to the Orthodox faith, and (c) marry a Greek woman, with the children adopting a western name (Nicol, 1979a). Apparently this was rarely accomplished. Even if a foreigner was to complete the first two tasks, it was illegal in many areas, and was still seen as improper among the ruling Byzantine class, to marry a foreigner (Kazhdan and Epstein, 1985; Nicol, 1994).
2. Attempt to live as if Byzantium were a French province. This was an approach in which Frankish culture and architecture were transplanted unaltered into a new colony, with no influence by the local culture. The Italians did this in Caffa, in the Crimea, where an essentially north-Italian town was built onto the coasts of the northern Black Sea. This was not a successful means to survive in a foreign culture, and not entirely realistic (Bryer, 1973).
3. Establish a third hybrid cultural group, amalgamating aspects of Frankish and Greek culture. This option proved to be the most successful, but was practiced primarily only by the Venetian merchants (Bryer, 1973).

Once the Franks became the ruling class, the adoption of culture began to work in the opposite direction. Jacoby (1973:873) aptly describes the changing nature of interaction once the Franks conquered the area:

> "Conquest, whether gradual or abrupt, created a problem of a completely different nature: the relationship between elite of conquerors, their descendants, and the Latins [Franks] who joined them, on the one hand, and the indigenous population on the other, had to be defined and a pattern of permanent co-existence between the two groups devised."

It is likely that at first, language would have been a large factor preventing integration and interaction. Dating back to before the schism of 1054 CE, language barriers already existed: the Western Roman Empire spoke Latin, while the Byzantine Empire was predominantly Greek speaking. The time had long passed where even the highly-educated were bilingual (Geanakoplos, 1979; Ciggaar, 1996). The sources provide conflicting arguments regarding the adoption of language. Some argue that the Franks, though ardently believing in the superiority of French language[6] and culture, did learn Greek and adopted some Greek cultural conventions in an attempt at improving relations (Dennis, 1968; Topping, 1977a; Geanakoplos, 1976). Others contend that the Franks knew very little Greek, and vice versa (Ilieva, 1991).

Although the perception of Frankish and Greek integration has changed over the years, sources continue to agree that the dominant factor that continued to differentiate the two cultures was always religion (Vryonis, 1967; Jacoby, 1973; Topping, 1977b; Cheetham, 1991; Ilieva, 1991; Efthimou, 1987; Lock, 1995; Phillips, 2004). Whether one was Catholic or Orthodox served as a permanent distinction that was difficult for the other group to overcome in their everyday dealings. In Constantinople, where the

[6] It is said that the French spoken in Morea was as beautiful as the French spoken in Paris (Goodenough, 1967:261).

Frankish presence was initially the most dominant, the majority of Greek clerics would not recognize the authority of the Roman Church (Gill, 1973), and in the countryside most of the religious leaders continued to speak only in Greek (Brand, 1968). The Franks dealt with this insubordination by replacing many of the Greek bishops with Franks (Dennis, 1968); the Greeks retaliated by 're-baptizing' their children and cleansing the altars after Frankish services (Geanakoplos, 1979).

However, the Franks did appear to realize the extreme importance of the Orthodox faith to the Greeks and did not prevent all Greek clerics and churches from operating. They seemed to have recognized that complete restrictions would have caused an uproar that their scanty resources would have been unable to deal with. In the Morea, where the two Orthodox archbishops were replaced by Catholics, Cheetham (1991) relates how the Catholic clergy often had few people to administer, and little to do, as there was little need for a Catholic priest in an overwhelmingly Greek community. Religious conversions were rare but did occur, although the conversion was almost always from Orthodox to Catholic (Brand, 1968).

The historical sources present slightly different versions regarding the exact nature of Frankish and Greek secular dealings. As stated earlier, the brutality of and justification behind the Fourth Crusade were unlikely to have made easy interaction possible (Geanakoplos, 1976). Even with a lack of fusion, however, it was still necessary for both cultures to live along side each other. In the Morea in particular, where Greeks and Franks lived together for a long period, the rule of the Villehardouins ensured that there was some toleration and co-operation between the two (Topping, 1977b; Ilieva, 1991; Angold, 2003). The Frankish elite would only have had contact with the upper echelons of Greek society however, meaning that for the majority of the population, the *paroikoi* (peasants), the Franks would always remain foreigners (Dennis, 1968; Topping, 1977a).

Indeed, it is argued in several sources that the Frankish invaders and Greek locals lived lives that were entirely distinct from one another, with no significant fusion ever occurring (Geanakoplos, 1959, 1966; Nicol, 1972a). Bryer (1973) attributes this to a lack of curiosity in both the Franks and the Greeks toward the other culture. The Franks always maintained their sense of superiority over the 'lower-class' Greeks (Nicol, 1972a). In the case of Greek and Frankish interaction, it seems that more time spent together did not result in better relations. If a fellow Greek began to display any favorable regard towards the Franks, thought of as inferior by the bulk of the Greek population, the 'Latinized' individual was said to be betraying both the Orthodox Church and the Byzantine state (Geanakoplos, 1976).

The Frankish rulers were said to vary in their treatment of their Greek subjects, sometimes resorting to a form of toleration and moderation, and at other times using force and persecution (Efthimou, 1987). However, there is evidence that both Frankish and Greek individuals participated in government (Dennis, 1968; Cheetham, 1991). Although the Frankish intentions of this have been discussed above, it does mean that Franks and the upper-class Greeks would have had some meaningful communication (although the language of this communication is still under debate).

Although the Frankish invaders were able to make the choice as to whether they wanted to adopt Greek practices, the local Greeks were not able to make that decision. After the Morea was parceled off, the previous Greek landowners were required by necessity to pay at least some form of allegiance to the Franks in the hopes of being able to retain their land. As mentioned above, the Greek elite were forced to pay homage and act as vassals in return for some semblance of peace and stability in the region (Dennis, 1968; Lock, 1995). As well, the Franks soon took control over the main economic interests of the Morea: agriculture, cattle breeding, wine-making, and silk-worm breeding, all of which were valuable resources to the Franks (Ilieva, 1991). Meanwhile, the Venetians continued to dominate commercial trade in the Aegean (Vryonis, 1967). Both of these economic factors meant that the local Greeks would have had to make some kind of concession to their Frankish ruler. They were, in every sense, required to make the best of the situation.

Intermarriage is one of the most telling signs of true cultural assimilation. Again, the sources differ in opinion regarding intermarriage. Some Frankish rulers, such as the Catalans and Venetians, forbade intermarriage by law, while in the Morea it was strongly discouraged (Jacoby, 1973). Jacoby (1973, 1995) states that a Frankish sense of superiority among the knights led to marriages primarily with women from their homeland, or other Frankish women who had come to the Morea. Intermarriage was supposedly extremely rare. It is argued by Jacoby (1973) that a strong disapproval of intermarriage was a means by which the French attempted to hold onto their identity amongst a much larger Greek population.

However, it has also been argued that among the upper class, marriage between the two cultures may have occurred as a means of strengthening political ties (Dennis, 1982; Nicol, 1994), although it was usually only Greek daughters who were married off to foreigners (Nicol, 1972c). Indeed, intermarriage must have occurred with at least some regularity, since the offspring of unions between lower-class Greeks and Franks, *gasmouloi*[7], were a well-known cultural sub-group (Longnon, 1962; Dennis, 1968). The gasmouloi were usually raised Orthodox (Nicol, 1972c) and were said by Byzantine scholar George Pachymeres to have "had the discretion and cautious spirit of the Greeks, the ardor and pride of the Franks" (in Geanakoplos 1959:127). The gasmouloi were looked down upon by all members of society, even after they played a large role in helping the Byzantines re-claim Constantinople (Longnon, 1962). The existence and attitudes toward the gasmouloi are extremely informative as they provide a definitive sign of interaction and intermarriage between the two cultural groups and show attitudes towards the intermingling of Frankish and Greek culture. Archaeological evidence for integration is also supported by Ivison's (1996b) examination of burial grounds; he argues for intermarriage based on supposed Greek and Frankish intermingling in cemeteries. Lock (1995) notes that western women were extremely scarce in the Morea, which may have prompted some lower-class Franks to intermarry.

Further non-literary sources regarding integration include an examination of faunal remains from Frankish monasteries in 13th century CE Corinth (Lev-Tov, 1999). These analyses indicate that the monks were consuming a unique diet that combined local Greek foods with Frankish practices such as hunting. Lev-Tov argues that the monks, who would have been considered high-ranking individuals, largely consumed a diet of Greek foods as opposed to adhering to western dietary practices. Although the monks could have forced the Greek population to produce foods they were accustomed to

[7] Although the gasmouloi were the offspring of any relationship between a Westerner and Greek, it is argued by Jacoby (1995) that the majority were the result of Venetian and Greek intermarriages. As such, it is less likely that the gasmouloi would have been present in Corinth, which was not controlled by the Venetians during the time period the study individuals were interred.

(barring any crop differences resulting from differing climates), the fact that the monks did not do this reveals that the Franks were practicing some adaptive measures. It should be noted however, that the upper-class pursuit of hunting still allowed the monks to maintain their separation from the locals.

2.6 SUMMARY

In summary, it seems as if both cultural groups, the Franks and the Greeks, were forced over time to interact with each other on at least some level. The degree of cultural assimilation seems to differ depending on the source of information examined. Many of the historical sources support the belief that interaction or cultural fusion was minimal at best. However, the archaeological evidence points towards probable cultural integration between the Franks and the Greeks. It is possible that the type of cultural association occurring may have depended to some degree on what social class one belonged to. The upper-class Greeks, who were accustomed to a certain kind of lifestyle, would have had to make larger concessions to the Frankish rulers in order to hold on to their land and level of power. The Greek peasants, on the other hand, would have had minimal contact with the Frankish rulers, who tended to stay in large fortified castles.

Thus, it is argued here and elsewhere that the life of a Greek peasant was not altered much by the arrival of the Franks. In the countryside and in much of the Morea, the Orthodox Church continued on as before. Conversions to the Catholic faith were certainly not the norm. The Frankish rulers do not seem to have adopted much of the Greek culture as their own. In the Morea, the Franks are said to have been staunchly proud of their own background and language and felt it unnecessary to absorb any aspects of Greek life. The situation is perhaps best described by Venetian diarist Marino Sanudo (~14th C. CE) who writes, "Although these places are subjected to the rule of the Franks and obedient to the Roman Church, nevertheless almost all of the population is Greek and is inclined toward this sect [the Orthodox Church], and their hearts are turned toward Greek matters, and when they can show this freely, they do so" (see Jacoby, 1995:542).

It is hoped that this study will provide another source of non-literary evidence to help clarify the exact nature of interaction between the Franks and the Greeks. The presence of locally-born and raised individuals who were then buried in a Frankish cemetery can be construed to indicate two different situations, or a combination of both: (1) that Greek acculturation was occurring to a large extent in Corinth during the 13th century, and (2) that locally-born Franks were being buried in the cemetery as well. If the entire skeletal population presents a non-local signal it becomes more likely that only western European-born individuals were interred in this Frankish cemetery.

CHAPTER 3 – ARCHAEOLOGICAL SITE BACKGROUND

3.1 INTRODUCTION

The site of Corinth has a long and fascinating occupation history which dates back as far as the Neolithic. Due to the extensive occupation of the area and the historical prominence of the city, Corinth was one of the earliest Greek city-states subjected to extensive archaeological study. Excavations at Corinth began in 1896, and while research initially dealt with Classical and Roman remains the accidental discovery of Frankish levels in the 1980s prompted a shift in focus. This chapter serves to give a very brief review of the history of Corinth. Following that, the excavations of the Frankish levels will be discussed. Finally, the two building complexes of interest to this study, Unit 1 and Unit 2, will be considered in an attempt to expand our understanding of where the individuals under examination may have come from and what kind of interaction and integration may have been occurring in Frankish Corinth.

3.2 HISTORY OF CORINTH

The ancient city of Corinth lies in the northeastern corner of the Peloponnese situated near the Isthmus of Corinth, a narrow piece of land which provides the only overland route between mainland Greece and the Peloponnese (Figure 2.3).[8] The original site was chosen due to its strategic location on a hill, which had easy water access and fertile land. The hill also provided protection in the form of three natural stone walls, which limited access to the settlement from all directions except from the west. This

[8] This brief history of Corinth is taken from the following sources and the reader is directed to them for more detailed information: Finley (1932), Robinson (1965), Wiseman (1978), Salmon (1984), Engels (1990), Gregory (1991; 1993) and Williams and Bookidis (2003).

stone-walled area would eventually be turned into the Acrocorinth, a dominating and massive citadel which served as both the ancient and medieval acropolis. The Acrocorinth's undefended western entrance was easily protected by building up fortifications over time. Corinth's proximity to two natural harbours, Lechaion to the north and Kenchreai in the east, as well as its proximity to the Isthmus, has likely been taken advantage of since the founding of the settlement at Corinth in the Neolithic, sometime around 6000 - 5000 BCE. Corinth was also occupied during the Mycenaean period, but reached its full glory in the Archaic period; this prosperous era lasted until the end of the Hellenistic period. Thus, from around the 8^{th} C. BCE until the sack of the city by the Romans in 146 BCE, Corinth figured as a major city-state of Greece. During this period, the wealth and importance of Corinth rivaled that of Thebes and Athens, due in part to a domination of maritime trade and heavy commercial traffic and trade in the Isthmus, as well as the fact that Corinth hosted the Isthmian Games every two years. After being destroyed by Rome in 146 CE, Corinth was gradually rebuilt. Julius Caesar re-founded Corinth as a colony in 44 BCE, and it was visited by the apostle Paul in 51/52 CE.

During the early Byzantine Period, Corinth retained a semblance of importance, serving as the head of Hellas (a theme which today would represent much of modern Greece). Widespread destruction caused by earthquakes in 365 and 375 CE necessitated several rebuilding periods. Between the 6^{th} and 9^{th} C. Corinth fluctuated in terms of importance, eventually acquiring more power through the silk trade network. A thousand years after the Roman destruction, Corinth was once again ransacked in 1147 CE, this time by Roger of Sicily. Over the next 50 years or so, Corinth was again rebuilt. In

1205, Corinth came under siege by the invading Franks, and eventually succumbed to them in 1210. From 1210 until 1458 Corinth remained under Frankish rule. Corinth was eventually captured by the Ottoman Empire in 1458, which held the city until 1833.

It is important to note that the region surrounding Corinth is subject to numerous earthquakes, two of which destroyed the city in 375 and 551 CE. A massive earthquake in 1858 was so devastating that it forced the movement of the settlement to a location about 3 km northeast of the ancient city. Unless otherwise noted, all references to Corinth in this paper are to the ancient site of Corinth, and not the post-1858 settlement.

3.3 EXCAVATIONS AT FRANKISH CORINTH

As noted above, excavations have been carried out in Corinth since 1896 under the auspices of the American School of Classical Studies at Athens and early work focused on Classical Era remains, such as the Temple of Apollo, the Agora, the Pirene, and the South Stoa (Richardson, 1896, 1897, 1898, 1900). Scranton (1957) notes that the earliest excavators, hindered by a lack of modern excavation techniques, and in their desire to reach Classical levels, kept little to no record of the Frankish-era levels. It was not until the 1920s and 1930s that better excavation records began to be kept by the archaeologists on site. Essentially, three phases of excavations in Corinth have focused on the Frankish levels. Each is discussed below.

3.3.1 1950s

In his volume *Medieval Architecture in the Central Area of Corinth* (1957), Scranton describes changing architectural patterns in Corinth throughout the Middle

Ages. He characterizes the Frankish Period as being a time of continuity, not upheaval, arguing that there is no evidence of any 12th C. building being completely replaced by later (*i.e.*, Frankish) structures. Scranton states that the Frankish period is not characterized by remodeling, but by an increased accumulation of earth (~1m) in many homes and squares. He argues that this merely represents the debris of day-to-day living, as well as the possible demolishing and construction of new walls. More modern research, however, has begun to question many of Scranton's conclusions. As will be shown below, Williams (2003) argues for an abrupt shift in land use and cultural artifacts between 1200 and 1250 CE. Ivison (1996a) also cautions against relying on some of the previous work done on Frankish Corinth, stating that recent work supersedes Scranton's 1957 findings.

3.3.2 1960s

Excavations done in the early 1960s provide a more detailed perspective of Corinth during the Middle Ages (Robinson and Weinberg, 1960; Robinson 1962). Work focused on the area southwest of the Agora and south of the West Shops. Excavations recovered four two-room 11th-13th C. apartments which show some industrial use (*e.g.*, moulds for casting, remnants of scoriae), a complex of residential structures which show extensive modifications and rebuilding, and a very large and narrow 12th C. Byzantine structure. Excavators are unclear as to the exact purpose of the building, but have suggested a possible association with the important silkworm industry which flourished in Corinth during this time period. Frankish-era building fragments dated to the late 13th-14th C. have also been found, often in such poor condition that reconstructing their overall plan proves impossible. In many cases the Frankish walls overlay pre-existing Byzantine structures (see Robinson, 1962:106).

Williams (2003) notes that investigators have interpreted the artifacts and architecture from the 1960s excavations in two ways: 1) that the sacking of the city by Roger of Sicily in 1147 CE caused serious damage to the economy and population size, leaving it especially vulnerable to attack from the Franks 50 years later, or 2) that Corinth recovered from the attack in 1147 CE, but with a somewhat decreased population and slightly lower standards of living conditions; it is also construed that the five year siege by the Franks on Corinth caused more damage to the city and its population than the attack 50 years prior.

3.3.3 1980s and 1990s

During the late 1980s excavators were searching for Roman remains and accidentally uncovered Frankish-era levels. Following their discovery, study of Frankish remains began in 1989 and continued until 1997 under the direction of Charles K. Williams II. This work, focused on a 50m x 80m area west of Robinson's 1960s work and south-east of Temple E (Figure 3.1), was able to expose portions of the Frankish city. Detailed excavations reports can be found in Williams and Zervos (1990, 1991, 1992, 1993, 1994, 1995, 1996) and Williams *et al.* (1997, 1998). In brief, excavations uncovered a wide graveled street, a 12th C. monastery which was converted to Frankish use in the 13th C. (Unit 2), a large structure containing a hostel, pharmacy, and infirmary (Unit 1), and several other buildings with various uses (Williams, 2003).

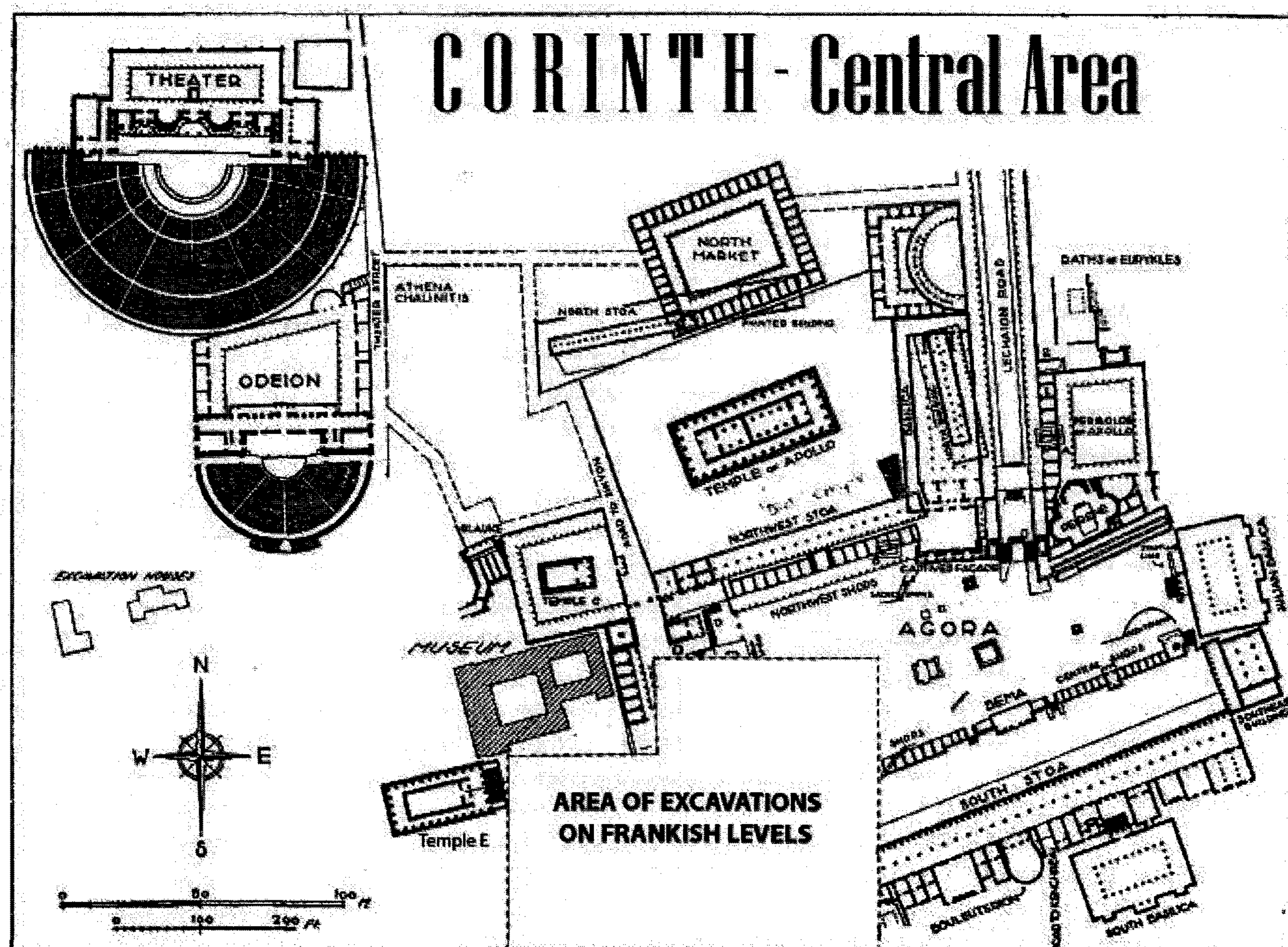

Figure 3.1: Ancient Corinth with Frankish excavations shown (adapted from Robinson and Weinberg (1960:226)

3.4 LAYOUT AND CHRONOLOGY OF THE FRANKISH NEIGHBORHOOD

The 1989-1997 excavations present a fairly complete picture of Frankish Corinth during the 13th and 14th centuries.[9] The Frankish settlement directly overlaps, or in some cases, simply reuses, preexisting Byzantine structures. The stone from Byzantine structures was appropriated for new Frankish buildings, and Frankish waste was deposited in newly constructed garbage pits (Williams and Zervos, 1990). The Frankish neighborhood was centered around a large public market street running toward the Acrocorinth in the south. The large street was bound on both sides by small shops and buildings which provided some overhanging protection from the sun and weather for people on the street. It has been suggested by excavators that the street may have served as an appropriate location for mercantile fairs which occurred often throughout the Middle Ages. The large market street was accessible through a number of smaller side streets (Figure 3.2). Surrounding the market street were several large structures designated as units by the excavators. The two units of importance, Unit 1 and Unit 2, are discussed below. Briefly, Unit 1 lies to the west of the market street and is believed to have been a hospice as it includes such auxiliary rooms as an infirmary and kitchen. The market street terminates to the north at Unit 2, which is comprised of over a dozen small rooms; the focus of the building is a church narthex and accompanying rooms built in the 12th century and remodeled by the Franks into a cemetery in the 13th century.

[9] The following information about Frankish Corinth is largely taken from Williams *et al.* (1997, 1998) unless otherwise noted. For more in-depth description of the units recovered in Frankish Corinth and their architectural outlines the reader is directed to these sources.

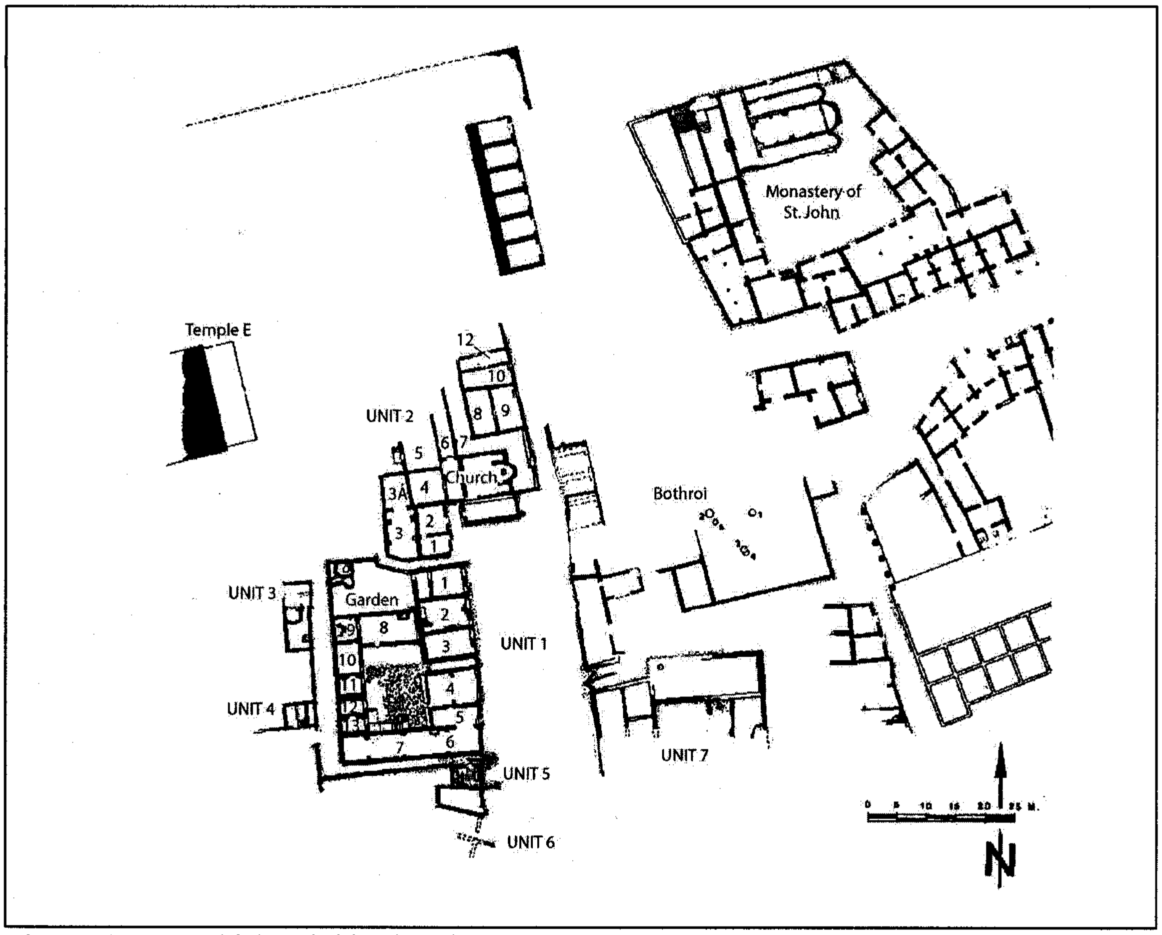

Figure 3.2: Frankish neighborhood of Corinth (adapted from Williams, 2003:27)

Overall, excavations at Corinth are believed to show that one massive building effort took place in the late 1260s and 1270s, evidenced best by the large market street which ran towards the Acrocorinth, the redesign of Unit 2, and the construction of Unit 1. Williams and colleagues (1998) believe that this type of building effort obviously required time and money, but also concentrated planning on the part of the Frankish rulers. Several explanations behind the need for such a building program have been suggested, including an increase in the number of Frankish immigrants after the fall of Constantinople in 1261 CE, new trading opportunities as a result of ties forged between William de Villehardouin and Naples, and a change in focus away from crusading efforts towards further establishment of already conquered regions. The archaeological evidence also displays a strong foreign presence as witnessed by an increase in Roman and Venetian pottery, glass drinking cups, lamps, and Tuscan jetons (calculation instruments or tokens used by bankers in the Middle Ages (Williams and Zervos, 1992)). It has been suggested that there may have been a foreign enclave in the western area of Frankish Corinth (Williams and Zervos, 1992).

During the five year siege of Corinth by the Franks a large number of Greeks fled for Monemvasia. During the mid-13th C. the city regained its footing and stature, and Williams (2003) notes that a high standard of living is seen at Corinth between about 1250 and the first several years of the 14th C. However, the rest of the 14th century proved to be disastrous for Corinth. Evidence of destruction and rebuilding is seen throughout Units 1, 5, and 6 and is hypothesized to be the result of earthquakes which rocked the city in 1300 and sometime after 1312 CE. The city was also severely damaged by a raiding mercenary army, the Catalan Grand Company, in 1312. The violence sustained by the inhabitants of Corinth at this time is evidenced in human remains recovered from a well. Signs of trauma are evident on the bones, and some of the bodies may even have been thrown into the well by the Catalans (Williams *et al.*, 1997). Although rebuilding efforts did occur, they were often done half-heartedly (Williams *et al.*, 1998).

3.4.1 Unit 1

Situated in the eastern area of Frankish Corinth, Unit 1 was a large multi-roomed structure built in two separate phases sometime in the last third of the 13th C., and was likely one of the first entirely Frankish buildings erected (Figure 3.3). Architectural elements such as minimally decorated door jambs, arches and window sills all indicate a Northern European influence (Williams *et al.,* 1997). The first section of Unit 1 constructed included the thick outer-walled Rooms 1, 2, and 3 located in the northeastern corner. The second building phase included the remaining rooms, which were built in a more haphazard fashion than the more ordered rooms of the first phase (Williams and Zervos, 1992). Rooms 6 and 7 are believed to have been two-storied rooms. Overall, Unit 1 seems to have been originally designed as a rectangular complex centered around a small paved courtyard (Williams and Zervos, 1996).

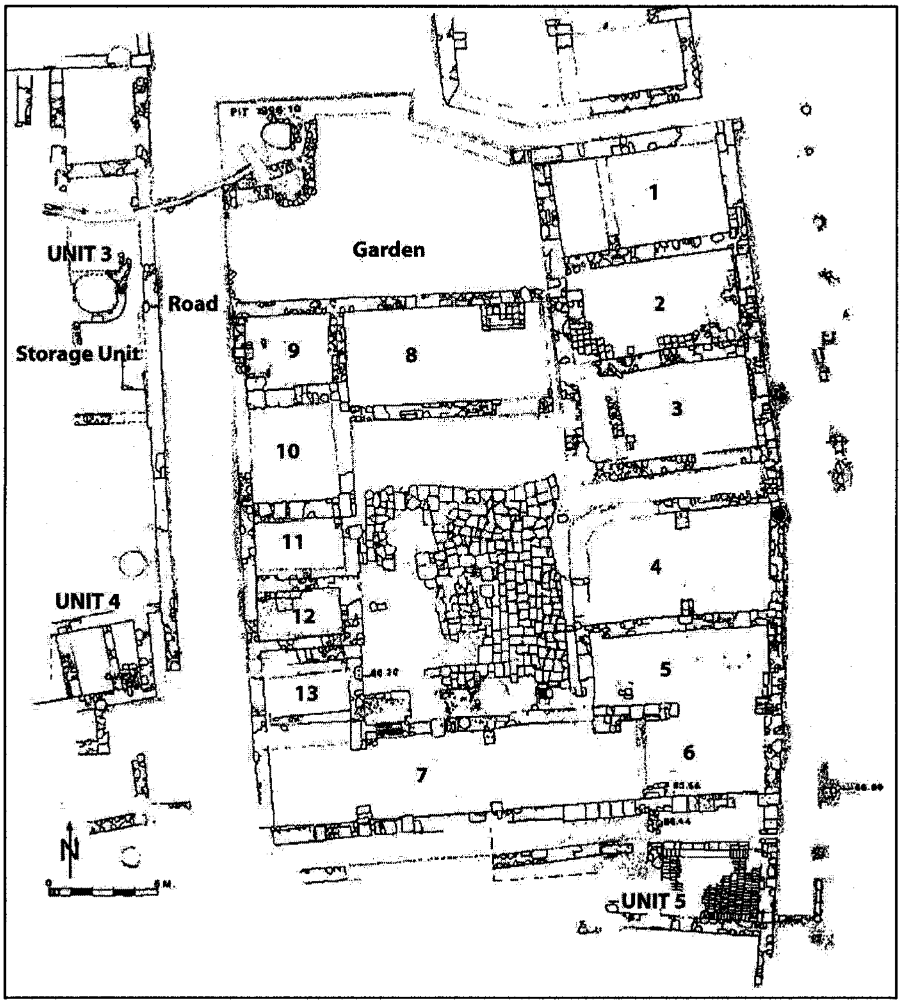

Figure 3.3: Unit 1 (adapted from Williams *et al.*, 1997:10)

The functions of several of the rooms have been suggested by the excavators. Room 2 was likely a kitchen due to the presence of a large hearth filled with ash and small bones, as well as signs that large amounts of water were used (Williams and Zervos, 1993, 1994). A large number of international coins and tokens were found in Room 4, suggesting it was used as a banking facility (Williams and Zervos, 1995). Room 5 contained a large number of pots and jars (including alberelli, drug jars used by healers during the Middle Ages) and thus has been identified as a pharmacy (Williams and Zervos, 1995). Room 6 may have been a dormitory or infirmary, Room 7 served as an entrance room or hall, Room 8 was a secondary kitchen, Room 11 was a storeroom, and Room 12 was a type of cellar or storage room for items that required a cool environment.

Damage occurred to many parts of Unit 1 in the early 14th C., and though some attempts were made to rebuild, these were mostly simple repairs such as the clearing out of debris, putting down new floors, and the construction of new doorways (Williams and Zervos, 1991, 1992). It is believed that the structural damage seen in Unit 1 likely resulted from an earthquake which occurred around 1300, as no trace of fire damage was found (Williams and Zervos, 1992). By 1305 the city has recovered sufficiently to be able to host over 1000 knights in a jousting contest held in Corinth (Gerstel, 2001). However, as mentioned above, a later Catalan raid and another earthquake around 1312 may have led to more permanent architectural and economic damage to the city.

Overall, Unit 1 has been identified as a hospice by the excavators, designed to deal with the numerous number of foreign individuals, such as pilgrims and traders, who came through Corinth (Williams and Zervos, 1994, 1995). A short review of the history and nature of hospices in the Middle Ages is required in order to fully understand the types of people who may have used the hospice, and may have ultimately ended up in the nearby cemetery in Room 4, Unit 2.

3.4.1.a Ancient hospices

Hospices, in various forms and names, have been around for thousands of years. The ruins of a suspected hospice have been found as far back as 14^{th}-16^{th} BCE, at the Minoan palace of Knossos (Hellenic Ministry of Culture, n.d.). The word hospice, along with hospital, hotel, hostel, host and hostess, all have their root in the Latin word *hospes*, meaning both host and guest. All of these words also have, as their base, the idea of extending hospitality, in the form of protection, nourishment, and companionship (Stoddard, 1992). The precursor of the modern-day hospice has been traced back to several different origins and it is believed that the expanding world of Christianity was an important catalyst. First, in the early 4^{th} century CE, the emperor Constantine decreed that *nosocomeia* (infirmaries) should be built in all Roman cities. This was due partly to his Christian religious leanings, but more likely was a result of a need to heal the many Roman soldiers injured in warfare – a way of keeping the Empire strong. However, this endorsement of helping fellow Christians soon led to a notable increase in the care of the sick and the dying in the Mediterranean (Phipps, 1988). Second, as put forth by Gask and Todd (1953), the ever-increasing correspondence that took place between bishops, scattered throughout the vast Christian world, called for some kind of resting-place for the messengers transporting the letters. Eventually, this evolved into resting-places for not only messengers, but also pilgrims who had become ill, and eventually, a place for any that needed help. These places became known as *xenodochia*, which literally means 'house for strangers'.

Hospices first began their move into the western world late in the 4th century CE, in part due to the works of St. Fabiola, a wealthy Roman who had suffered extreme grief at the death of her husband and vowed to ensure that others would be more comfortable when they were dying (Wright, 1933). Inspired by the *xenodochia* she had seen in the east, she returned home and founded hospices in Ostia, the port of Rome, and Porto, Italy. Both of these hospices were for pilgrims (many pilgrims were only able made the trek as far as Rome), and were the first of their kind in Western Europe (Phipps, 1988).

By the time of the Crusades, hospices were well established and abundant, especially along the pilgrim route in Byzantium (Ciggaar, 1996). The goal of a hospice is said to have focused on six compassionate acts found in the 'Parable of Sheep and Goats' (Matthew 25:35-36): "For I was hungry and you gave me food, I was thirsty and you gave me something to drink, I was a stranger and you welcomed me, I was naked and you gave me clothing, I was sick and you took care of me, I was in prison and you visited me." Because early Christians believed that seven was the holy number, a seventh act of mercy, burying the dead, was included (Phipps, 1988). Ciggaar notes (1996) that though many of these hospices were religious organizations, some were privately owned and run for profit.

It is also important to note here that there was a difference between hospitals and hospices. Hospitals flourished in the Middle Ages, but tended to focus on curing and healing wounds and illnesses. Many hospitals had hospices attached to them as separate places in which to care for pilgrims, the poor, and occasionally, lepers. A large number of the pilgrims are said to have died on their pilgrimages and would have required burial, preferably on consecrated ground (Ciggaar, 1996). It is in the nearby Unit 2 that we find a suitable resting spot for these pilgrims.

3.4.2 Unit 2

Located to the north of the market street, Unit 2 has a longer settlement history than Unit 1. The complex was built in the first third of the 12th C., and was domestic in nature. Built over in the 13th C. by the Greeks (Williams and Zervos, 1991), the second phase of Unit 2 was as a Byzantine monastic complex, which included a church and monastery. The focus of the structure was the small church built in the southeast corner of the complex which had rooms extending west from the narthex of the church (Figure 3.4). By the mid-13th C., several decades after the Franks took Corinth, the invaders began extensive modifications to Unit 2. Chief among these changes was the conversion of a Byzantine room with tiled floors east of the narthex into a open-air cemetery. This modification was done by placing a thick layer of earth on the floor and totally removing the roof (Williams *et al.,* 1998). The bulk of the human remains recovered in Unit 2 were found in the burial ground located in Room 4; the graves and remains unearthed are discussed below. After the early 14th C. it appears that more burials began to take place within the church and narthex; although burials had occurred in the church previously they were less numerous and more restricted in location than the 14th C. burials (Williams and Zervos, 1992; Williams *et al.,* 1998).

3.4.2.a Room 4 graves

Excavation of the cemetery took place between 1996 and 1997 under the supervision of Dr. Ethne Barnes and Dr. Art Rohn. The cemetery in Room 4 yielded nearly 100 individuals, many of which were articulated skeletons (Figure 3.5). The other remains were disarticulated and often placed haphazardly at the foot of another burial. Williams *et al.* (1998) note that reburial was common and that the disturbance of past burials was nearly impossible to avoid, and indeed, was likely expected. Most of the Room 4 individuals were buried in a Christian manner with their bodies laid out flat on their backs facing east (except for SCO-50, which was facing north) with their hands and arms crossed over their stomachs (Williams *et al.,* 1997). The actual graves were fairly simple holes or pits with stones lining part or all of the shaft. Rooftiles were commonly placed on top of the head or upper-body (or under the chin to prevent the jaw from falling open), and were all of similar shape and design (Williams *et al.*, 1998). Grave goods were rare, but included some jewelry and fragmentary pottery. Much of the archaeological material recovered, such as pieces of plates and pitchers, is believed to have been part of the burial fill (Barnes, 2003).

Osteological analysis has been performed on the individuals recovered from Room 4, the results of which are discussed in Chapter Five and Six. Briefly however, the analysis does show that life in Corinth during the Middle Ages was difficult, with high infant mortality and chronic diseases such as anemia (including the congenital thalassemia), brucellosis, and rheumatoid arthritis. Barnes (2003) and Williams *et al.* (1998) argue that the high incidence rate of relatively rare and incapacitating diseases seen in the remains indicates that the cemetery in Room 4 was likely associated with the nearby hospice in Unit 1.

The use of the burial ground in Room 4 was originally thought to have ended with the Catalan sack of 1312. However, excavators now believe that the final layer of fill in Room 2 is associated with the earthquake of 1300 (Williams *et al.*, 1998:245). This places the dates of burial for the individuals studied in this research between approximately 1250 and 1300 CE.

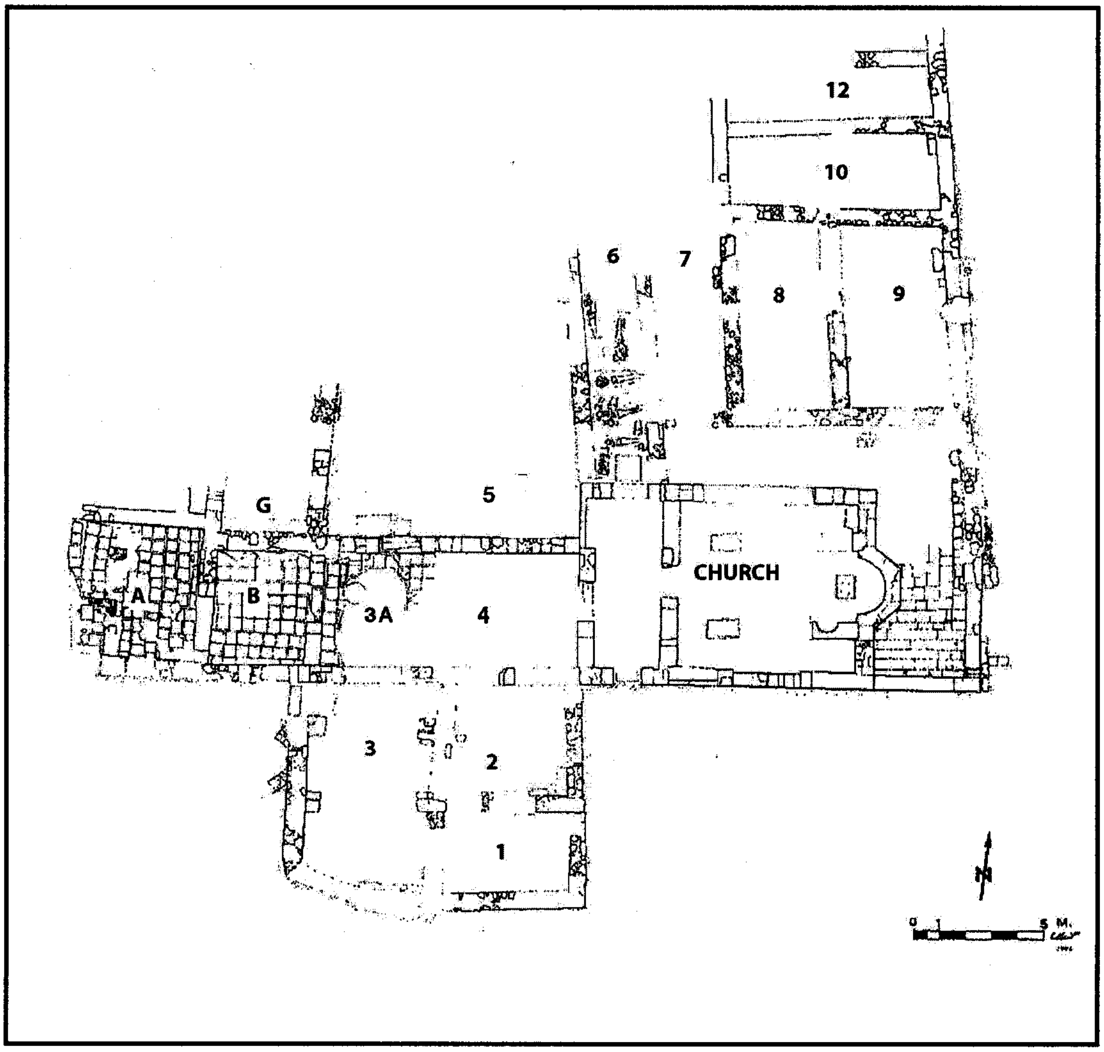

Figure 3.4: Unit 2 (adapted from Williams *et al.*, 1997:20)

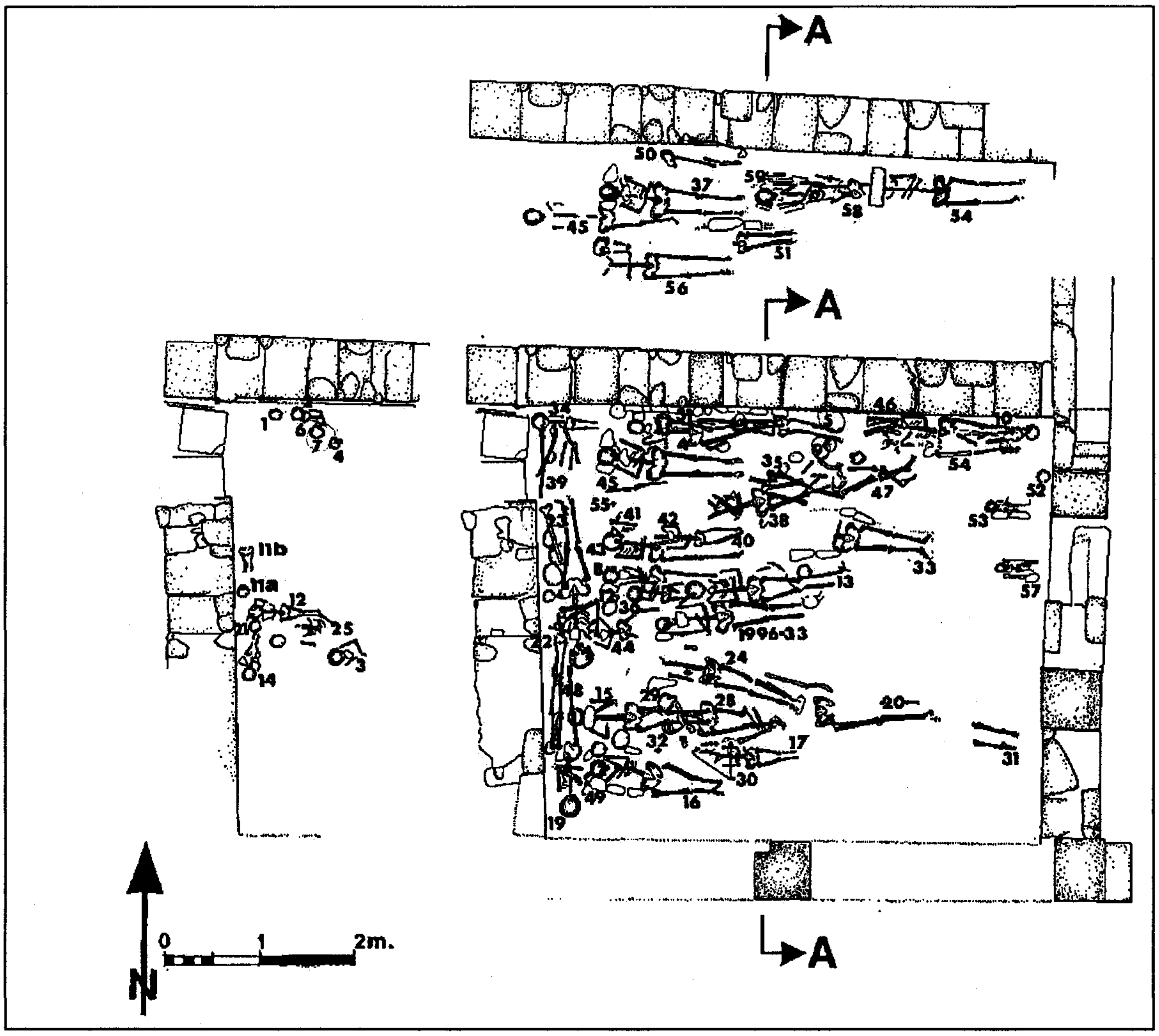

Figure 3.5: Room 4 graves in Unit 2 (adapted from Williams *et al.*, 1998:238)

3.5 SUMMARY

Areas of Frankish Corinth were successfully excavated during the 1980s and 1990s and provide insight into life during the late 13th century. The architectural remains indicate that a focal area of the neighborhood was a large, colonnaded market street which ran on a north-south axis. Directly west of this street is Unit 1, a multi-roomed structure centered around a paved courtyard. The identification of kitchens, a pharmacy, an infirmary, and a banking facility, suggest that Unit 1 served as a hospice during the late 13th C. for sick and poor individuals and pilgrims who passed through Corinth

(Williams and Zervos, 1995). The market street terminated to the north at Unit 2, a Byzantine monastery which had been converted into a Frankish burial ground in the 1260s or 1270s. Remains have been recovered from several parts of Unit 2 but only the graves from the earliest levels of Room 4 have been analyzed for this research. Osteological analysis has shown a large number of individuals with relatively rare and chronic diseases; this has led excavators to conclude that an association existed between the hospice in Unit 1 and the burial grounds of Unit 2 (Williams *et al.,* 1998; Barnes, 2003).

Chapter 4 – Theoretical Background

4.1 INTRODUCTION

This research uses stable strontium isotope analysis to examine the issue of ethnicity and migration in Frankish-ruled Greece during the 13th century CE. Strontium isotope analysis has been used successfully on skeletal material at archaeological sites all over the world from a wide array of time periods to study issues of residence patterns, mobility, and ethnicity. Ericson (1985, 1988) first suggested the utility of strontium isotopes to archaeological studies. Since then, researchers using strontium isotope analysis have reported the $^{87}Sr/^{86}Sr$ value range at Grasshopper Pueblo, a 14th century CE complex in east-central Arizona, and were able to gain insight into the process of migration that led to the settlement of the site (Price *et al.*, 1994a; Ezzo *et al.,* 1997; Ezzo and Price, 2002). Strontium isotope analysis has also been used extensively in Central and Western Europe, where it has primarily focused on the settling of Neolithic Europe, which is likely associated with the spread of the Bell Beaker and Linearbandkeramik cultures (Price *et al.*, 1994a, Grupe *et al.*, 1997; Bentley *et al.*, 2002). A range of studies have also been applied to various other archaeological sites and regions including Mesoamerica, Africa, and Asia. One of the main advantages of extensive study in a single geographic region is the ability to establish baseline $^{87}Sr/^{86}Sr$ values with which to compare $^{87}Sr/^{86}Sr$ values of skeletal samples (*c.f.,* Hodell *et al.*, 2004; Knudson *et al.*, 2004). Data from such studies allow for more precise tracing of movement in individuals. As of yet, ecosystem strontium isotope analyses have not been reported from Greece. This research is therefore a preliminary step in the creation of a database of

$^{87}Sr/^{86}Sr$ values for the eastern Mediterranean similar to those developed for Central Europe, England, South America, and the United States. This chapter will provide a general overview of stable isotope analysis before discussing in greater detail the use and theoretical background of strontium isotope analysis. A review of previous archaeological work using strontium isotopes will follow. Finally, the potential problems inherent in strontium isotope analysis will be considered, with attention being paid to diagenesis, sample selection, present-day contamination, and determining a 'local' signal.

4.2 STABLE ISOTOPE ANALYSIS

4.2.1 Stable isotopes

The field of archaeological stable isotope analysis blends together theoretical aspects culled from geology, chemistry, ecology, and physics. Stable isotope ratios are able to provide insight into past behavior, including aspects of diet, health, residence, migration, and mobility; they also serve as a means to reconstruct paleoenvironmental conditions (see Schoeninger, 1995; Katzenberg and Harrison, 1997). The atomic number of a chemical element is the number of protons (positive charges) in the nucleus of its atoms. This number is the defining number characteristic of a given element, invariant for all atoms of that element. Although the number of protons does not change for an element, the number of neutrons can vary. The addition of neutrons will not change the chemical properties of an element but will add mass. Atoms of the same atomic number but different atomic weights are called isotopes. Isotopes of an element have slightly different masses, which can be measured using isotope ratio mass spectrometry (IRMS).

An element may have unstable (*i.e.,* radioactive) and stable isotopes. Radioactive isotopes decay over time, and their constant rate of decrease in abundance can be used for radiometric dating. Stable isotopes do not decay, and hence are not useful in radiometric dating analyses. However, the study of stable isotopes is able to provide information on climatic, geographical, and dietary issues. Most elements have two or more stable isotopes, with one isotope usually present in much greater abundance than the other isotopes (Ehleringer and Rundel, 1989).

Most anthropological stable isotope studies have utilized one or more of four different isotopes: carbon ($^{13}C/^{12}C$), nitrogen ($^{15}N/^{14}N$), oxygen ($^{18}O/^{16}O$) and strontium ($^{87}Sr/^{86}Sr$) (Katzenberg 2000). A few published applications have used sulfur ($^{34}S/^{32}S$) (Richards *et al.* 2003). Oxygen, carbon, and nitrogen isotopes will be discussed in Chapter 6 in relation to previous work completed on the study area.

4.2.2 Instrumentation

Stable isotope ratios are determined on an isotope ratio mass spectrometer, a device able to separate charged ions based on their differences in mass. Mass differences in isotopes are very small, so it is necessary for the measurement instrumentation to be extremely sensitive. As described by Ehleringer and Rundel (1989), a mass spectrometer consists of three different components: (1) a source of molecule ionization, (2) a magnetic field which deflects the particles based on mass and collects the now-charged particles as they travel down a flight tube and (3) collectors which trap the ions at the other end of the flight tube (Figure 4.1).

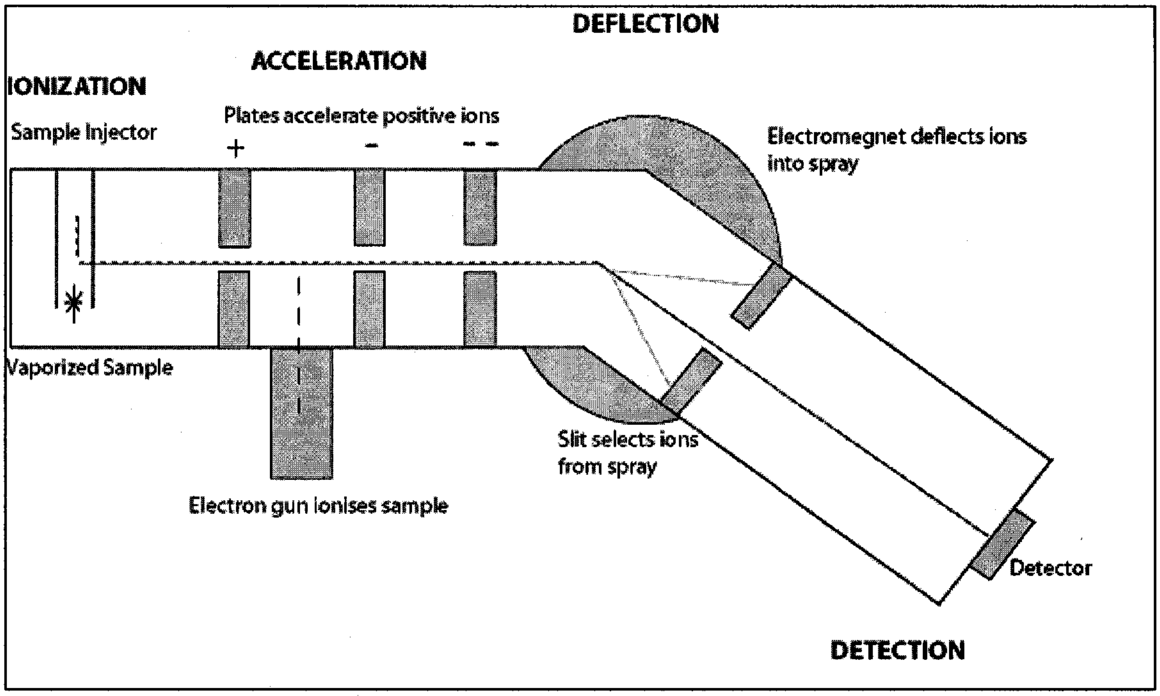

Figure 4.1: A mass spectrometer

4.2.3 Measurement

While it is possible to measure the abundance of isotopes in a sample absolutely, the variation in abundance is usually very small and subject to error through sample preparation, sample heterogeneity, and fluctuations within the mass spectrometer on a daily basis (Hayes, 1982 in Lajtha and Michener, 1994). As a result, isotope ratios of a sample are compared against an industry standard so that any fluctuations are equally shown in both the sample and the standard (Lajtha and Michener, 1994). This allows for extremely small differences between the sample and the standard to be accurately assessed (Ehleringer and Rundel, 1989). The ratio measurement of one isotope to another isotope (*e.g.*, ^{87}Sr to ^{86}Sr) indicates the isotope composition of a sample.

4.2.4 Notation

Once strontium isotope levels in the sample have been measured and compared to the standard, the sample's strontium isotope composition is typically expressed as a ratio of $^{87}Sr/^{86}Sr$. $^{87}Sr/^{86}Sr$ ratios are usually recorded to the fifth or sixth decimal place. Although differences at the fifth or sixth decimal place may seem insignificant, they are in fact quite large. The measurement error of strontium isotope ratios using modern mass spectrometers is between ±0.00001 and ±0.00003. As Grupe and colleagues (1997) note, depending on the precision of the mass spectrometer used, a difference of 0.001 is equal to between 33.3 and 100 measurement units.

4.3 STRONTIUM GEOCHEMISTRY

4.3.1 Rubidium and strontium

The majority of igneous, metamorphic, and sedimentary rocks contain some proportion of two trace elements: rubidium (Rb) and strontium (Sr). Both are present in minute quantities; the characteristics of each will be discussed briefly.[10]

Rubidium – Rb (atomic number 37) is an alkali metal with two naturally occurring isotopes: ^{85}Rb and ^{87}Rb. It is present in crustal rocks in a concentration of 90 ppm. The radius of a Rb ion (r=1.48 Å) allows it to substitute for potassium (K) (r=1.33 Å) in rock-forming minerals.

Strontium – Discovered in 1808 by Sir Humphrey Davy, strontium (atomic number 38) is named for the Scottish town of Strontion. It is an alkaline earth metal that occurs in the earth's crust at an average concentration of 400 ppm. Sr plays no discernable

[10] Unless mentioned otherwise, the following section is taken from two principal sources on isotope geology used by anthropologists and archaeologists, Faure and Powell (1972) and Faure (1986).

physiological or biological role in the body and has very few practical uses.[11] It has four naturally occurring isotopes: ^{88}Sr, ^{87}Sr, ^{86}Sr, and ^{84}Sr.[12] Their abundances in nature are ~88.25%, ~7%, ~9.87%, and ~0.56%, respectively. The radius of a Sr ion (1.13 Å) is very similar to that of calcium (Ca) (0.99 Å), which allows Sr to replace Ca in minerals such as apatite and calcium carbonate.

4.3.2 Rubidium to strontium decay

Rubidium and strontium are important to earth sciences since one of the isotopes of rubidium (^{87}Rb) is radioactive and will eventually decay into a stable isotope of strontium (^{87}Sr). This means that over time, the amount of ^{87}Sr in any given rock will increase, as conversely, the amount of ^{87}Rb decreases. ^{87}Rb decays so slowly (it has a half-life of 4.7 X 10^{10} years) that even $^{87}Sr/^{86}Sr$ values obtained from prehistoric periods are considered to be constant. The decay of ^{87}Rb to ^{87}Sr has been used extensively by geochronologists to obtain dates for the time of crystallization of rubidium-bearing rocks and minerals (*e.g.,* Faul and Jäger, 1963; Evans, 1991; Henjes-Kunst and Kreuzer, 1982; Faure, 2000). Rocks or minerals that initially began with high Rb/Sr ratios and that are extremely old (more than 100 million years (mya)) will have higher $^{87}Sr/^{86}Sr$ ratios (Tricca *et al.*, 1999). This includes most granites, sandstones, and shales, which have values between 0.710 and 0.740. Rocks or minerals that are younger (less than 100 mya) and that originally had low Rb/Sr ratios, such as basalts, limestone, and marble, will have

[11] Modern day uses of strontium are limited to tasks such as removing gas from vacuum tubes, and as a source of colour in bullets, signal rockets, flares and fireworks (Schroder *et al.*, 1972). As strontium was not known or used during the Middle Ages, all strontium absorbed by the skeleton would have been of natural origin.

[12] Strontium also has 14 unstable isotopes which can be produced in a laboratory. One of these, ^{90}Sr, is well known since it is a product of the nuclear fusion of uranium. As with the other isotopes of strontium, ^{90}Sr becomes principally concentrated in the human skeleton. Unlike the stable isotopes of strontium, it is dangerous since it emits radiation which can destroy soft and hard tissue.

lower $^{87}Sr/^{86}Sr$ ratios, typically around 0.703 and 0.704 (*e.g.*, Rogers and Hawkesworth, 1989). The $^{87}Sr/^{86}Sr$ value of 0.7092 for seawater is a mixture of $^{87}Sr/^{86}Sr$ ratios of young volcanics (0.703), marine carbonates (0.708), and continental crust (0.726) (Faure, 1986); it is considered to be constant and unchanged based on geographical location (De Paulo and Ingram, 1985). Bedrock formations all over the world vary widely in their bulk composition and age, both of which influence their $^{87}Sr/^{86}Sr$ ratio (Grupe *et al.*, 1997). This leads to variation in $^{87}Sr/^{86}Sr$ values, which typically range between 0.700 and 0.760.

4.3.3 Introduction of strontium into the food chain

As rocks and deposits weather, strontium is introduced into the food chain. It enters groundwater before moving to soil, plants, and animals (Faure and Powell, 1972; Sillen and Kavanagh, 1982). As strontium moves up the food chain it is discriminated against in favour of calcium (biopurification). Essentially, this means that the higher an organism is in the food chain, the lower its strontium concentration will be. Palaeodietary studies have long used this variation as a means to better understand the relative proportion of dietary constituents (*e.g.*, proportion of meat consumed in relation to plants) (see Elias *et al.*, 1982; Aufderheide, 1989; Ezzo, 1994; Sanford and Weaver, 2000).

Although strontium concentrations will change according to trophic position, the isotopic composition ($^{87}Sr/^{86}Sr$) is not altered (fractionated) (Price *et al.*, 1994b). Thus, fractionation is not a serious concern in strontium isotope composition studies of ecosystems. Strontium isotopes are not fractionated because the relative mass differences of the four strontium isotopes are extremely small (Faure and Powell, 1972; Blum *et al.*, 2000). Even if some degree of fractionation did occur, this would be corrected for during measurement in the mass spectrometer through normalization of the non-radiogenic isotopes to the known value (*i.e.*, the standard, NIST SRM 987) (Capo *et al.*, 1998; Faure, 1986; Dickin, 2005). Thus, the strontium isotope composition of an organism will reflect the local geology of the region from which it acquired its food sources (Dasch, 1969; Hurst and Davis, 1981; Graustein, 1989). Basically, soil will have the same $^{87}Sr/^{86}Sr$ value as the bedrock it sits on; plants will have the same $^{87}Sr/^{86}Sr$ value as the soil they grow in; herbivores will have the same $^{87}Sr/^{86}Sr$ value as the plants they eat, and carnivores will have the same $^{87}Sr/^{86}Sr$ value as the herbivores and plants they consume (Beard and Johnson, 2000). There is enough natural variation in $^{87}Sr/^{86}Sr$ values of parent rocks and minerals to differentiate between, and possible identify, the local environments from which an individual originated (Ericson, 1985; Price *et al.*, 1994b; Grupe *et al.*, 1997). This is why the study of isotope compositions, in contrast to elemental concentrations which are used to examine dietary constituents, is used as a 'tracer' technique.

4.3.4 Uptake of strontium into the skeleton

Due to their similar atomic radii and chemical behavior, calcium and strontium have a strong association that exists throughout the food chain. Thus, the strontium in a person's diet is directly linked to the consumption of foods containing calcium. High calcium foods such as leafy vegetables, beans, and dairy products will contribute calcium and strontium to the skeletal system (Burton, 1996; Burton and Wright, 1995). It has also been suggested that another direct source of bedrock strontium may have been provided by the processing of grains with milling stones during the Middle Ages. Åberg (1998) argues that during the process of grinding grain some of the grinding stone would have been worn away and mixed in with the grain products, then eaten, unbeknownst to the consumer.

Strontium, along with calcium, beryllium, magnesium, barium, and radium, is known as a 'bone-seeker'. Calcium is essential for bone structure. As strontium is introduced into an organism, it will follow, and often replace, calcium in the crystalline lattice of hydroxyapatite in the skeletal system (Likins *et al.*, 1960; Posner, 1969; Nelson *et al.*, 1986). Although a large proportion of ingested strontium will be excreted (Spencer *et al.*, 1973), over 99% of all strontium incorporated into the body will be stored in the skeleton (Schroder *et al.*, 1972). The absorption, incorporation, storage, and excretion of strontium in the skeletal system differ between tissues (*i.e.*, bone, dentine, and enamel). These differences allow the $^{87}Sr/^{86}Sr$ ratios obtained from analysis of the bone and teeth of single individuals to inform on geological areas in which these individuals may have spent time during different developmental stages of their lives. The following section will discuss the composition, characteristics, and development of enamel, dentine, and bone.

4.3.4.a Composition of teeth and bone

The examination of $^{87}Sr/^{86}Sr$ ratios in past populations is limited by tissue choice, usually restricted to either bone or teeth. Teeth are composed of dentine, a relatively hard inner core and enamel, an even harder, brittle carapace (Figure 4.2). Tooth enamel is often deemed the more useful tissue as an indicator of human exposure to strontium for two primary reasons. First, due to its low porosity and organic content, enamel is the best-preserved tissue of the body and is frequently found in the archaeological record.

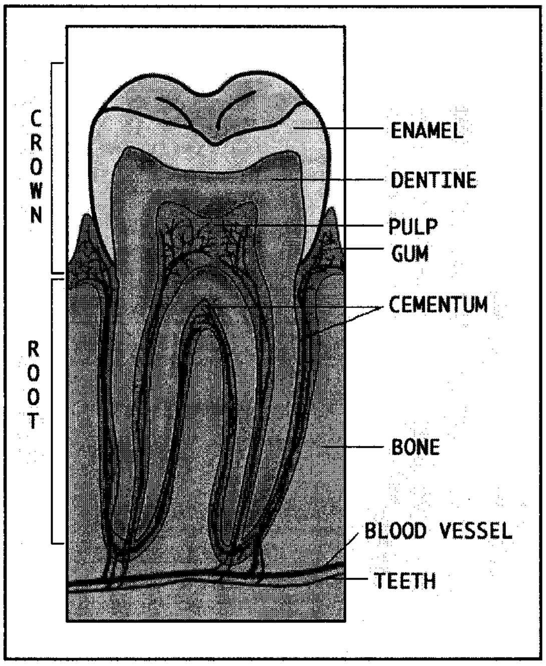

Figure 4.2: Parts of a tooth (adapted from Fentress, 2005)

Second, overall it is more resistant than bone and dentine to chemical alteration during life and in the post-mortem burial environment (Carlson, 1990; Dreissens and Verbeeck, 1990; Hillson, 1986, 1996; Kohn *et al.*, 1999; Shellis and Dibdin, 2000; Trickett *et al.*, 2003).

Dental and skeletal tissues are composed of both an inorganic (mineral) and organic fraction; the relative contributions of the inorganic and organic fractions differ between tissues.

Inorganic – The mineral component of teeth and bone consists primarily of hydroxyapatite $(Ca_{10}(PO_4)_6(OH)_2$, a crystalline lattice made up of calcium and phosphate ions (Posner, 1969). However, during life there are numerous ionic exchanges between the surrounding environment and the forming hydroxyapatite. Calcium is often replaced with strontium or sodium, while phosphate can be replaced by carbonate or bicarbonate.

Organic – The organic fraction of teeth and bone differs between tissues. In enamel, the organic component is extremely small (< 1%) and is made up of soluble and insoluble proteins, peptides, and citric acid (Stack, 1967). In dentine, cementum, and bone, the organic portion consists of collagen, which provides tensile strength to the teeth and bone. Collagen is a fibrillar protein with a helical structure (Otanni *et al.*, 2002). When teeth or bone are being mineralized, the apatite crystals are laid down in and around the collagen fibrils (Otanni *et al.,* 2002). Collagen deteriorates more quickly in the archaeological record, which is one reason why dentine and bone (both of which have a higher organic component than enamel) are not as well-preserved in the archaeological record.

The organic fraction of teeth (specifically dentine) also contains a small percentage (<5%) of material besides collagen referred to as ground substance. This water-soluble material, which has proven difficult to isolate, is believed to contain various lipids, peptides, glycoproteins and glycosaminoglycans (Williams and Elliott, 1989:364). Ground substance also deteriorates relatively quickly in the archaeological record, so is unlikely to provide much useful information (Hillson, 1986)

4.3.4.b Characteristics of enamel, dentine and bone

Enamel – Enamel is often used to study past populations, as it has long been known that a "growing tooth is a biologic recorder of both health and disease" (Sarnat and Schour, 1941:1990). Research has shown that even in cases where the dentine of a tooth has been contaminated post-mortem and is isotopically similar to the surrounding soil and groundwater, enamel still retains its biogenic signal (Budd *et al.*, 2000). Enamel can be used to study a wide range of topics, including nutritional, metabolic, and pollution issues (*e.g.,* Corruccini *et al.*, 1982; Fergusson and Purchase, 1987; Goodman and Rose, 1990; Reitznerová *et al.*, 2000, FitzGerald *et al.*, 2006).

Enamel is the hardest and most calcified human tissue, comprised of approximately 97% inorganic material, 1% organic material, and 2% water (Scott and Symons, 1967:172). The inorganic (mineral) portion consists mainly of apatite crystallites. Enamel crystallites are different from the crystallites found in either bone or dentine, tending to be much longer (Hillson 1986). As well, the crystallites are packed closely together, with the very minimal organic and water component interspersed in between. Fully-formed mature enamel can vary in both thickness and density depending on its location on the tooth. Enamel tends to be thickest and most dense at the incisive edges and cusps, while it is thinnest near the cervical margin. The growth layers of mature enamel are similar to those of an onion as the layers formed first are those nearest to either the occlusal surface or to the dentine. Subsequently, layers will grow down the sides of the crown, essentially covering the initial layers. The depositional rate in which the layers are formed is well known (Hillson, 1996), meaning that the layers record events in the tooth's formation along a known time axis.

After formation, tooth enamel is no longer metabolically active, and unlike bone and parts of dentine, is not turned over or replaced. However, it is possible that ion exchange can still take place between the outer (surface) layer of enamel and saliva in the oral cavity (Carlson, 1990) (see 4.3.4.c for a detailed discussion). Since enamel formation ends in childhood, chemical analysis of enamel has become increasingly popular in order to understand physiological, biological, and dietary changes occurring during childhood. However, it is important to note that conversely, chemical analysis of enamel does not inform on any point during an individual's life that occurred after enamel formation.

Dentine – The bulk of a tooth is composed of dentine, which provides the basic shape of each tooth. Dentine is a softer dental tissue (though is it still harder than bone) that is surrounded on all sides by either enamel or cementum. Like bone and enamel, dentine is composed of both a mineral and organic fraction. Dentine is approximately 75% inorganic, 20% organic, and 5% water (Williams and Elliot, 1989). The inorganic component consists of hydroxyapatite, while collagen makes up the bulk of the organic fraction. An important characteristic of dentine is dentinal tubules. These tubules pass perpendicularly through the collagen fibrils (which are placed one on top of another to form 'mats' of collagen) (Hillson, 1996). Contained within these tubules are the dentine-forming cells, odontoblasts. The presence of the odontoblasts, which are active throughout life, indicate that dentine is a living tissue and continues to be remodeled throughout life. While dentine is thus a source of information on different stages in an individual's life, its propensity towards diagenesis often precludes the stable isotope analysis of its mineral fraction. As well, since dentine is not as highly mineralized as enamel, it does not preserve as well in the archaeological record. As the organic portion (collagen and ground substance) is lost over time, the overall structure of dentine becomes weakened. It is possible to find teeth in the record that appear fully preserved; upon opening however, it is revealed that there are numerous fissures or cracks running through the dentine (Hillson, 1996).

Bone – Bone is made up approximately 70% organic material (primarily collagen) and 30% inorganic material (including apatite carbonates) (Sillen, 1989). Most stable isotope research using bone has analyzed the $\delta^{13}C$ and $\delta^{15}N$ values of its collagen fraction as it reflects the dietary protein portion of the diet (see Harrison and Katzenberg 2003 for review), can be recovered unaltered in samples that are thousands of years old (van der Merwe, 1989; Bocherens *et al.,* 1991), and was initially thought to be more dependable than apatite (Katzenberg, 1992). For this research, the fact that no strontium is found in the collagen portion of bone means that the apatite fraction must instead be analyzed. Apatite carbonates last much longer in the record, and reflect on total dietary intake. However, there are diagenetic concerns with the analysis of apatite carbonate. The carbonate portion of bone is much more likely to participate in chemical interchange with the burial environment (Schoeninger and DeNiro, 1982). However, it is believed that with proper purification techniques it is possible to isolate the biogenic signal (Sullivan and Krueger, 1981; Lee-Thorp and van der Merwe, 1991; Lee-Thorp, 2002).

4.3.4.c Development of teeth and bone

Teeth - Teeth develop under a fairly regulated schedule, the chronology of which is well documented (Figure 4.3), providing researchers with a idea of age at exposure when they are studying stable isotope values and elemental levels in a particular tooth (Budd *et al.*, 1998). The formation of deciduous teeth begins *in utero* from about ten to four weeks before birth (Hillson, 1996). Permanent tooth enamel formation begins around birth, and continues forming until adolescence (Shafer *et al.*, 1984:880). Enamel formation begins and ceases at well-known times for each tooth in the mouth (e.g. Gleiser and Hunt, 1955; Anderson *et al.*, 1975; Dean and Beynon, 1991; Hillson, 1996; Liversidge, 2000). This study examines only the third and fourth premolars. Crown formation for permanent third premolars begins between 1 and 2 years of age and ends between 5 and 6 years, while fourth premolar formation begins around 2 years of age and continues until between 6 and 7 years (Hillson, 1996; Ash and Nelson, 2003).

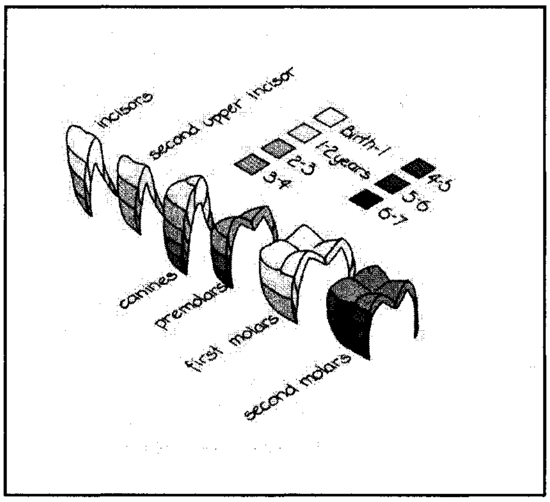

Figure 4.3: Time of formation for permanent tooth crowns in humans (from Hillson, 1986:135)

Once enamel is formed, it is not remodeled and thus does not actively participate in any more chemical substitution (Carlson, 1990; Driessens and Verbeeck, 1990; Hillson, 1986; 1996; Kohn *et al.*, 1999; Shellis and Dibdin, 2000; Trickett *et al.*, 2003). However, it has been argued that enamel composition can change *in vivo* in the oral cavity through the exchange of dental strontium with saliva (Horn *et al.,* 1997 in Horn and Müller-Sohnius, 1999). If this were true, it would mean that enamel analysis would not be solely informing on the foods consumed and the geological region lived in during childhood, but would in actuality be an average of all the strontium absorbed throughout life, from all regions an individual lived and ate in. This viewpoint has been challenged by Grupe and colleagues (1999), who argue that the mechanical and chemical cleaning performed on enamel samples before analysis will remove a minimum of 0.2 mm of the outer enamel surface, thereby removing any 'altered' material. Montgomery and colleagues (1999) performed laser-ablation inductively-coupled-plasma mass-spectrometry (LA-ICP-MS) on both the tooth surface and the enamel-dentine junction (EDJ) on modern and archaeological specimens and found no evidence of strontium enrichment from the oral cavity. As will be described in the Chapter 5, proper cleaning procedures were carried out in order to ensure the removal of the outer layer of potential contamination. This is the method preferred by most authors (Grupe *et al.*, 1997; Ezzo and Price, 2000; Bentley *et al.*, 2002; Price *et al.*, 2002; Knudson, 2004).

Strontium is usually present in concentrations between 50-400 ppm in enamel (Hillson, 1996). Since enamel does not incorporate any elements after formation, its strontium concentration and isotopic composition are established during childhood. This means that strontium isotope ratios obtained for the Corinth burials reflect the geological region from which food was consumed during early childhood

Bone – While enamel ceases formation early in childhood, bone continues to regenerate and incorporate new elements until death. Although this research does not analyze human bone it does use faunal bone. Remodeling rates of bone may vary between animals and humans but for the purposes of this research, the difference in turnover rates is not relevant. As will be discussed below, the faunal specimens are being used to determine a 'local' $^{87}Sr/^{86}Sr$ value for the Corinth area. The animals will have lived in Corinth all their lives, and will have picked up an average $^{87}Sr/^{86}Sr$ value for the region in their bone. This value will not have changed substantially over time as the animal grew older.

In summary, enamel of individuals from the Corinth cemetery will reflect the $^{87}Sr/^{86}Sr$ ratio of the geological area in which they grew up. The $^{87}Sr/^{86}Sr$ ratio of the faunal bone will display a local signal for the Corinth area. This will allow for comparison to be drawn between the two sets of values.

4.3.5 Summary

Strontium isotope analysis is based on the principle that $^{87}Sr/^{86}Sr$ values pass unchanged up the food chain from bedrock to consumer. Based on analyses of enamel and/or bone values, which reflect different periods in an individual's lifetime, it should thus be possible to identify individuals who moved between different geographical and geological zones during life. It is also possible to compare enamel samples, which reflect the geological signal acquired during childhood, with local $^{87}Sr/^{86}Sr$ values to determine if an individual was 'local' or 'non-local'. Local values may be determined through a number of means (discussed below). The comparison of enamel $^{87}Sr/^{86}Sr$ ratios to environmental and ecological $^{87}Sr/^{86}Sr$ ratios in a region is often the preferred method of interpretation, based on difficulties encountered in obtaining a biological signal of $^{87}Sr/^{86}Sr$ from bone; the issue of diagenesis and modern-day pollution will be discussed in detail below.

4.4 STRONTIUM ISOTOPE ANALYSIS IN ARCHAEOLOGY

The usefulness of exploiting $^{87}Sr/^{86}Sr$ ratios for geochronological purposes has long been recognized (Faure and Powell, 1972; Faure 1986). However, the use of strontium isotope analysis in biological systems as a possible tracer for residence was first suggested by Ericson (1985, 1988). Over the last twenty years, strontium isotope ratios have been used extensively all over the world to better understand issues of migration, mobility, residence patterns, and geographic origin of individuals, artifacts, animals, plants and foods.

$^{87}Sr/^{86}Sr$ ratios are used extensively in animal tracer studies, often as a means to thwart poachers and aid conservation. Species studied include salmon (Koch *et al.*, 1992; Åberg, 1995; Kennedy *et al.*, 1997), deer (Beard and Johnson, 2000), rhinoceros (Hall-Martin *et al.*, 1993), reindeer (Åberg, 1995) and elephants (van der Merwe *et al.*, 1990; Vogel *et al.*, 1990; Koch *et al.*, 1995). The movement of mammoths and mastodons in the southern United States has also been examined (Hoppe *et al.*, 1999). $^{87}Sr/^{86}Sr$ ratios have also been looked at in plant systems to monitor increasing calcium enrichment in trees (Åberg *et al.*, 1990), to track the uptake of strontium from soil to vine (Horn *et al.*, 1993), and to understand variation in the $^{87}Sr/^{86}Sr$ ratio of plants based on soil depth (Dambrine *et al.*, 1997). Recently, the origins of wine and cheese were determined using strontium isotopes (Barbaste *et al.*, 2002; Fortunato *et al.*, 2004).

Strontium isotope analyses of artifacts from archaeological investigations have focused primarily on determining the provenance of various objects, including stone (Gale *et al.*, 1988), ancient glass (Henderson *et al.*, 2005; Degryse *et al.*, 2006), marble (Brilli *et al.*, 2005), wood (Reynolds *et al.*, 2005), ivory (Lafrenz, 2003) and shell beads (Vanhaeren *et al.*, 2004). However, the bulk of archaeological investigations have investigated skeletal remains.

Several geographic regions have been the focus of numerous studies focusing on $^{87}Sr/^{86}Sr$ values in the human skeleton. Studies at Grasshopper Pueblo in southeast Arizona were among the first to apply $^{87}Sr/^{86}Sr$ isotope analysis to human remains; they were able to successfully determine shifting patterns of migrations to the region over time, as well as gain additional insight into the social structure of the settlement based on movement to and from the region by outsiders and locals (Price *et al.*, 1994b; Ezzo *et al.*, 1997; Ezzo and Price, 2002). Mesoamerican remains have also been analyzed for their $^{87}Sr/^{86}Sr$ ratios, aided in part by a large database of environmental $^{87}Sr/^{86}Sr$ ratios with which to compare skeletal $^{87}Sr/^{86}Sr$ ratios (Hodell et al., 2004). Research at various sites under the rule of Tiwanaku, Bolivia show that influence and people likely flowed out from the capital into the colonies (Knudson, 2004; Knudson *et al.,* 2004, 2005). Individuals from Tikal, Guatemala are hypothesized to have had their $^{87}Sr/^{86}Sr$ ratios altered by the everyday consumption of lime (Wright, 2005). $^{87}Sr/^{86}Sr$ ratios of remains from foreign compounds in Teotihuacan, Mexico show a large number of non-locals whose exact origin remains unknown (Price *et al.*, 2000). And finally, individuals with mutilated teeth from Campeche, Mexico ($16^{th}/17^{th}$ C. CE) displaying extremely high $^{87}Sr/^{86}Sr$ ratios led researchers to suggest that these people may represent the earliest African Diaspora of slaves to the New World (Price *et al.,* 2006).

Work in Neolithic Central Europe has focused on the origin of two cultures: Bell Beaker and Linerbandkeramik. $^{87}Sr/^{86}Sr$ analysis of Bell Beaker remains indicate the people were highly mobile and likely traveled in small groups which included women and children, disputing the notion that Bell Beaker individuals were warriors or invaders (Price *et al.*, 1994a, 1998, 2004; Grupe *et al.*, 1997, 1999; Horn and Müller-Sohnius, 1999). Study of the $^{87}Sr/^{86}Sr$ ratios of the Linerbandkeramik, thought of as the first farmers in Central Europe, also suggests high mobility (especially among females), as well as differing social classes based on geographic origin (Price *et al.*, 2001; Bentley, 2001; Bentley *et al.*, 2002, 2003, 2004; Bentley and Knipper, 2005). $^{87}Sr/^{86}Sr$ analysis of Neolithic individuals from Britain indicates movement of ~100 km, primarily between chalky uplands to a more radiogenic strontium environment in the north-west (Budd *et* *al.*, 2001, 2003, 2004; Montgomery *et al.*, 2000). $^{87}Sr/^{86}Sr$ ratios obtained for remains dated to the Roman period in Britain are a little less informative, but may indicate that movement was not restricted strictly to males, as had been thought based on past assumptions about a strong military presence during this period (Budd *et al.*, 2004; Montgomery *et al.*, 1999; 2005; Evans *et al.*, 2006).

Other smaller-scale projects in Europe include a comparison of methods for obtaining $^{87}Sr/^{86}Sr$ ratios in material from Neolithic Austria (Latkoczy *et al.*, 1998; Prohaska *et al.*, 2002), the identification of non-locals suggesting a highly mixed population in Roman Bavaria (Schweissing and Grupe, 2003), the detection of two individuals of non-Norwegian origin among Vikings found in Scotland (Montgomery *et al.*, 2003), understanding foraging mobility and food procurement patterns in Siberia (Weber *et al.,* 2002), and identifying evidence of diagenesis in enamel-dentine pairs from Switzerland (Chiaradia *et al.*, 2003). Work in Asia is sparse, limited to two studies which demonstrate the possibility of matrilocal residence in prehistoric Thailand (Bentley, 2004; Bentley *et al.*, 2005). South Africa has had several separate $^{87}Sr/^{86}Sr$ projects conducted, including early work by Sealy *et al.* (1991, 1995) on the potential of $^{87}Sr/^{86}Sr$ as a paleodietary indicator and migration tracer, as well as associated diagenetic concerns, in samples from the southwestern Cape. Also in South Africa, Balasse *et al.* (2002) demonstrated seasonal mobility in sheep herders between the coast and hinterland. Recently, Tafuri and colleagues (2006) examined the connection between diet and mobility to socio-economic changes in Libya. Finally, although Budd *et al.* (1999) have made a strong case for using $^{87}Sr/^{86}Sr$ ratios to track migration between islands in French Polynesia, the work has not yet been conducted to the best of this author's knowledge.

$^{87}Sr/^{86}Sr$ analysis has been performed on possible human ancestors: in Swartkrans, South Africa, Sillen and colleagues (1995, 1998) encountered difficulty in reconstructing habitats of *Australopithecus robustus* and *Homo* sp. based on differences between biologically and geologically available strontium. In Germany meanwhile, a stag mandible found in the same stratum as a specimen of *Homo erectus heidelbergensis* was analyzed for its $^{87}Sr/^{86}Sr$ ratio as a pilot study aimed at eventually determining the home range of *H. erectus heidelbergensis* (Horn *et al.*, 1994).

Other interesting topics approached using strontium isotope analysis include determining the geographical background in which K'inian Yax K'uk'Mo, a Copan ruler in Mexico, grew up (Buikstra *et al.*, 2004); distinguishing evidence of early professional residential mobility during the Middle Ages at a mine in the Black Forest, Austria (Schutkowski, 2002); identifying origins of 19th century African slaves (Cox and Sealy, 1997); locating the homeland of the Iceman Otzi from Hauslabjoch (Hoogewerff *et al.*, 2001; Müller *et al.*, 2003), and separating commingled remains of American soldiers from the Viet Nam War (Beard and Johnson, 2000).

As can be seen from the above review of strontium isotope work in anthropology and other related fields, there has been no work reported from the Mediterranean. Although many of the strontium isotope studies above are conducted as part of large-scale and long-term investigations into the strontium isotope values of a particular region (*e.g.*, Mesoamerica, Neolithic Central Europe), the research being conducted here should be considered as analogous to the initial projects that came at the beginning of these larger projects (*e.g.*, Price *et al.*, 1994a; 1994b). It is hoped that this study will generate interest in strontium isotope work in the Mediterranean and will result in more analyses conducted on a range of materials and at various locations in Greece.

4.5 PROBLEMS IN STRONTIUM ISOTOPE ANALYSIS

Although strontium isotope analysis is now used regularly to better understand migration and mobility, the issue of contamination remains a concern. The main question is whether the recorded $^{87}Sr/^{86}Sr$ signal reflects the strontium absorbed during life, or whether it was acquired after death. The two types of contamination, modern-day and post-mortem, will now be discussed, along with suggestions for ways to ensure that only the biogenic $^{87}Sr/^{86}Sr$ signal is preserved.

4.5.1 Modern-day contamination

Although rarely discussed, modern-day contamination of local $^{87}Sr/^{86}Sr$ values of soil and water samples must be considered as a form of post-mortem contamination. There are two sources of modern-day contamination: agricultural fertilizers and atmospheric strontium. Atmospheric strontium will be discussed further below in relation to the use of geological maps. However, the modern-day use of agricultural fertilizers has the potential to pose a problem in strontium isotope analyses by obscuring the biological $^{87}Sr/^{86}Sr$ signal. Fertilizers can affect the $^{87}Sr/^{86}Sr$ signal of skeletal material by altering both groundwater and soil stable strontium isotope composition. Bentley (2001) describes several areas where fertilizers are likely to have contaminated the soil and groundwater at sites in Maryland, U.S.A. and the Upper Rhine Valley, Germany (see Böhkle and Horan, 2000; Tricca *et al.*, 1999). Nonetheless, modern fertilizers are not considered to be a problem for this research. Chemical fertilizers were first developed in Europe in the late 1800s but it was not until the 1920s that their use and popularity became widespread (Beaton, n.d.). Early work began at ancient Corinth[13] in 1896 and excavators soon found the remnants of major architectural features, such as the Temple of Apollo, the Agora, the South Stoa, and the Pirene (Richardson, 1896, 1897, 1898, 1900). Field notes describe the process in which land was acquired; once excavators had found features of significance, the Greek government was notified and land was either purchased or appropriated from the landowners (Richardson, 1897). As both the South Stoa and portions of the Agora were located in close proximity to where the Frankish excavations took place in the 1990s, the relevant land would likely have been purchased in either the late 1800s or early 1900s for future excavations. After purchase or appropriation the land would have ceased to be farmed, and modern fertilizers would thus not have been used. Natural fertilizers such as manure (which may have been used before the land was acquired by the government) would simply reflect the $^{87}Sr/^{86}Sr$ values of the animals they came from – and so would not alter the 'local' isotopic composition.

4.5.2 Post-mortem contamination

One of the primary concerns raised by critics opposed to using strontium isotope analysis to understand mobility relates to what exactly the $^{87}Sr/^{86}Sr$ value of archaeological tissues is informing on. At issue is whether the $^{87}Sr/^{86}Sr$ signal of an individual obtained through isotope analysis is the $^{87}Sr/^{86}Sr$ signal acquired during life or

[13] The modern-day settlement of Corinth is located about 3 km from ancient Corinth. The location was first moved in 1858 after a disastrous earthquake destroyed much the city.

whether that signal has been contaminated post-burial. The contamination of skeletal remains by chemical alteration or exchange post-mortem is known as diagenesis. Diagenesis is a concern for all anthropologists who study the chemical composition of bones and teeth. Due to its complex nature and relevance to a range of studies, diagenesis is extremely well-studied in the literature (*e.g.,* Pate and Brown, 1985; Nelson *et al.*, 1986; Ezzo, 1992; Price *et al.*, 1992; Sillen and Sealy, 1995; Grupe *et al.*, 1999; Horn and Müller-Sohnius, 1999; Budd *et al.*, 2000; Hoppe *et al.*, 2003).

Although contamination and exchange of elements can occur *in vivo* in the oral environment (see 4.3.4.a), diagenesis is of primary concern once an individual is deceased and in the ground. Contamination takes place through chemical exchange or addition that occurs between the skeleton and the burial environment, *i.e.,* groundwater and soil. The two primary means of contamination are: (1) the addition of secondary minerals, such as calcite, into the pore spaces of bone (Sanford, 1993); and (2) the often permanent chemical alteration of biological apatite through post-mortem substitution of trace elements for calcium, which are then incorporated into hydroxyapatite during recrystallization (Bentley, 2001, Knudson, 2004). The most common and effective way to deal with these two forms of diagenesis is through the choice and pretreatment of the human tissue under analysis.

4.5.2.a Past work on diagenesis

The choice of human tissue to be analyzed will impact a study in several ways. Enamel informs on conditions incurred during childhood while bone reflects on adulthood. Although bone is more prone to diagenetic change, its value for informing on events later in life has meant that many studies still analyze bone for its $^{87}Sr/^{86}Sr$ ratio. If bones and enamel are to be studied, what precautions must be made to prevent a diagenetic $^{87}Sr/^{86}Sr$ signal?

Enamel – As discussed above (see 4.3.4.a), after formation enamel is not remodeled and is not involved in chemical substitution with the burial environment (Carlson, 1990; Driessens and Verbeeck, 1990; Hillson, 1986, 1996; Kohn *et al.*, 1999; Budd *et al.*, 2000; Shellis and Dibdin, 2000; Trickett *et al.,* 2003). An argument has been made that the outer layer of enamel may participate in chemical exchange with the oral environment *in vivo* (Horn *et al.,* 1997 in Horn and Müller-Sohnius, 1999). Although this has been contested (Grupe *et al.*, 1999) it has become customary to mechanically remove a minimum of 2 mm from the outer surface of the enamel before analysis (Ezzo and Price, 2002; Bentley *et al.*, 2002; Price *et al.*, 2002; Knudson 2004).

Bone – Post-mortem contamination of bone is mainly concentrated on the surfaces of bone directly exposed to the burial environment (*i.e.*, the outer surface and the inner medullary cavity) (*e.g.*, Lambert *et al.*, 1982; Waldron, 1981; 1983). As with enamel, mechanical abrasion of the outer surface and inner medullary cavity should remove much of the contamination (Price *et al.*, 1992). It has also been shown that subjecting bone (as well as enamel) to a weak acetic acid wash will serve to separate biogenic and diagenetic mineral based on solubility differences (Sealy *et al.*, 1991). To monitor diagenetic change in bone many researchers study a number of different elemental concentrations and ratios; variances from normal and known levels are purported to signal contamination (Sillen, 1989; Price *et al.*, 1994b; Grupe *et al.*, 1997). These include calcium, phosphorus, iron, aluminium and manganese. Price and colleagues (1994b) note that bone recovering a biogenic signal should have a Ca/P ratio of 2.1-2.2. If the ratio is higher from this it is a sign that calcium carbonate, the primary source of contamination to the biogenic $^{87}Sr/^{86}Sr$ ratio in bone, is present. A complete list of tests for diagenesis on the bone material used in this study is listed in Chapter 5.

4.5.3. Determining 'local' versus 'non-local'

4.5.3.a Introduction

One of the most important issues in strontium isotope analysis is the differentiation between local and non-local strontium values. The task of distinguishing a foreigner from a local using only skeletal $^{87}Sr/^{86}Sr$ values has led to the suggestion of a number of methods discussed below. First however, it is important to note that individuals who display a local value may have moved between isotopically similar geological zones during life and that this movement may not be discernable using $^{87}Sr/^{86}Sr$ analysis. Some studies (*e.g.*, Bentley *et al.*, 2003, 2005) note that individuals may be identified as non-local by their $^{87}Sr/^{86}Sr$ value when in fact they were locally based, but ate a diet foraged from a wide catchment area. This interpretation is much more pertinent in studies involving the early spread of agriculture or prehistoric cultures. Medieval Greece was not a foraging and nomadic society, but rather relied upon agriculture and animal husbandry.[14]

It is also important to note the distinction between biologically available strontium and geologically available (geological substrate) strontium. Biologically

[14] It is important to note that during the Middle Ages in Greece, herding ranges could have been spread out over a large area, with the mountain and hills used during the summer, while the lowlands were likely used in the winter (Halstead, 1998). However, a large herding range would only increase the area considered to be 'local'.

available strontium consists of the strontium present in the natural environment, which is available for consumption and/or absorption (Price *et al.*, 2002). Geologically available strontium is discussed in depth below; it is the strontium present in the underlying rock formations, which then travels up the food chain.

4.5.3.b Geological maps

The long history of using strontium isotopes in geological studies has resulted in the study and establishment of $^{87}Sr/^{86}Sr$ values for bedrock locations all over the world (*e.g.*, Faure, 1986). While it would be much easier for anthropologists and biologists simply to use these bedrock values to compare to the $^{87}Sr/^{86}Sr$ values obtained for archaeological samples, it is now clear that $^{87}Sr/^{86}Sr$ values of foods consumed do not actually constitute an exact direct reflection of the bedrock $^{87}Sr/^{86}Sr$ (Price *et al.*, 2002). Blum and colleagues (2000) note that in smaller areas with uniform geological formations, the $^{87}Sr/^{86}Sr$ value will move up the food chain nearly unchanged. However, areas with a more diverse geological foundation result in more variation in the $^{87}Sr/^{86}Sr$ values of overlying soil (Sillen *et al.*, 1998). Moreover, even the same geologic structure can have variable $^{87}Sr/^{86}Sr$ ratios as areas of the same rock can contain different proportions of minerals, which will weather at different rates (Fullager *et al.*, 1971). Price and colleagues (2002) suggest that atmospheric sources of strontium, such as precipitation, may result in differences between geologically and biologically available strontium. Corinth is particularly at risk for the inclusion of atmospheric strontium into the soil as coastal regions can be affected by marine aerosols (Sealy *et al.,* 1991). While Price and colleagues (2002) note that the differential weathering rates and atmospherics sources of strontium are likely to have a very minimal effect on $^{87}Sr/^{86}Sr$ values, it has still been concluded that underlying bedrock formations are poor sources for determining the local $^{87}Sr/^{86}Sr$ for a region (Price *et al.*, 2002; Budd *et al.*, 2004; Hodell *et al.*, 2004).

4.5.3.c Soil analysis

Price and colleagues (2002) describe several situations in which $^{87}Sr/^{86}Sr$ soil values will not accurately predict the local biologically available $^{87}Sr/^{86}Sr$ value. First, alluvial soils will usually acquire an $^{87}Sr/^{86}Sr$ value that has been averaged from a number of geological sources. Second, any plants that have grown near water will have $^{87}Sr/^{86}Sr$ values similar to the water value. Third, it is possible for deeper and older water to become incorporated into groundwater, thus affecting the soil value (Jørgensen *et al.*, 1999). Finally, work carried out in South Africa (Sillen and Sealy, 1995; Sillen *et al.*, 1998) has revealed that soil values can be extremely variable in a relatively small region and often quite different from bedrock values; this research has also demonstrated that surface water $^{87}Sr/^{86}Sr$ values can be lower than that of nearby plants and soil. Essentially, while strontium is not fractionated as it moves from source to source, there is not an exact one to one relationship between bedrock or soil values and those of plants, water, and animals that are further along in the food chain.

4.5.3.d Bone averages

As neither bedrock nor soil can act as accurate measurements of the local $^{87}Sr/^{86}Sr$ value, many researchers instead use an average of all human bone $^{87}Sr/^{86}Sr$ values (± 2 s.d.) (*e.g.*, Price *et al.*, 1994a; 1994b; Grupe *et al.*, 1997; Bentley *et al.*, 2002). The bone average, assumed to reflect local values, should present an estimate to aid in the identification of individuals who have lived in the region for a significant length of time. This value can be compared against each individual tooth in order to identify migrants. The bone average method is believed by some to be a very conservative estimate for distinguishing between locals and non-locals (Grupe *et al.*, 1999). However, the primary obstacle in using bone averages is the diagenetic alteration of bone post-mortem. Bone is much more prone to diagenesis than enamel (Nelson *et al.*, 1986; Hoppe *et al.*, 2003; Lee-Thorp, 2002) and it has been argued that a diagenetic change in bone may lead an overestimation of non-locals (Bentley *et al.*, 2004). This is because contamination of the bones with local soil and water strontium of a uniform $^{87}Sr/^{86}Sr$ value will result in bone values with an insufficient range of variation. The deviations will thus also be minimal and most of the individuals will likely fall outside of the local range.

Although this research does not include the analysis of archaeological human bone, it is important to discuss the implications associated with the use of bone in strontium isotope work. Many studies (*e.g.*, Price *et al.*, 1994b; Ezzo and Price, 2002; Grupe *et al.*, 1997) analyze human bone and teeth and compare the values seen in the two tissues. As diet is reflected in $^{87}Sr/^{86}Sr$ values, a difference would indicate migration from one geochemical zone to another in between the end of childhood (after the end of enamel formation) and death. The differences in value that can be seen between enamel and bone, as well as what kind of cultural situations could have led to these values, are listed in Table 4.1.

4.5.3.e Local animals

Since it is not possible to use geological maps as direct indicators of the local $^{87}Sr/^{86}Sr$ value and there are diagenetic considerations when using human bone, it becomes necessary to determine the local value in some other way. It has become commonplace in the literature to use local faunal material to determine the average local signal (Price *et al.*, 2000, 2002; Knudson *et al.*, 2004, 2005; Bentley *et al.*, 2004, 2005). The analysis of animal tissue allows for an average $^{87}Sr/^{86}Sr$ ratio of the region to be obtained; herbivores are known to acquire a consistent average $^{87}Sr/^{86}Sr$ ratio over the course of a lifetime (Blum *et al.*, 2001; Price *et al.*, 2002). Animals are thus a good source of information on the strontium that was biologically available during the time period in question. There are some decisions to be made with regards to the choice of animal sample as described below.

Table 4.1: Possible results of strontium isotope analysis comparing $^{87}Sr/^{86}Sr$ values in bone and teeth

	Local Bone Signal	**Non-Local Bone Signal**
Local Enamel Signal	(1) The individual was a resident of the same region for his or her entire life; (2) The individual migrated between two or more geochemically similar regions during life.	(1) The individual lived in the region during childhood (when enamel formed), then spent the last years of life outside the region before returning shortly before death; (2) The individual lived in an area geochemically similar to the local region during childhood but spent time in a geochemically different area prior to coming to the local region shortly before death.
Non-Local Enamel Signal	The individual immigrated into the region after the enamel of the adult teeth was fully formed (~12 years).	The individual did not spend his or her childhood in the region and either (1) moved into the area so recently before death that bone did not have time to remodel to reflect local values; (2) was brought to the region after death; (3) did not consume local foods (unlikely during

		the 13th century CE); or (4) was extremely mobile, so that the bone signal reflects an average value for all areas where food was consumed.

First, is it better to use modern or archaeological samples? Modern animal samples are much more likely to have been exposed to some degree of pollutants and fertilizers within their diet catchment areas (*e.g.*, Probst *et al.*, 2000). This can alter the 'local' $^{87}Sr/^{86}Sr$ value they present. As well, modern domesticated animals are more likely to be fed food that has been grown or harvested outside of the region. Knudson and co-workers (2004, 2005) avoid this issue by ensuring that their modern faunal samples were only fed natural foods which were grown within the study region. Archaeological faunal samples do not have these problems, but are as prone to diagenesis as human remains. This suggests objections similar to those raised above for the use of human bone. However, when studying faunal remains it is assumed that these will provide an estimate of the local $^{87}Sr/^{86}Sr$ value. Thus, the prospect of chemical exchange with the burial environment is less problematic. If contaminated, the faunal bone will merely acquire the local $^{87}Sr/^{86}Sr$ ratio (Grupe *et al.*, 1997; Price *et al.*, 2000). This would be a problem when studying human samples, where a false 'local' bone $^{87}Sr/^{86}Sr$ value could be taken as indicative of recent local residence. However, as the local faunal samples are assumed to provide a local $^{87}Sr/^{86}Sr$ value, their alteration toward the local $^{87}Sr/^{86}Sr$ value is not as serious an issue.

The second matter to consider when choosing a faunal sample is which species or type of animal to use. Many studies (*e.g.*, Knudson 2004; Knudson *et al.*, 2004, 2005; Wright, 2005) use small modern rodents, as they are easy to collect and transport. Pigs are also relatively commonly used (Bentley *et al.*, 2004, 2005). Price and colleagues (2002) note that while larger animals inhabit a larger region, and therefore incorporate strontium from more available sources, they are often difficult to obtain. This study used archaeological material, of which only specimens of larger animals were available.

4.6 SUMMARY

The use of strontium isotopes to clarify issues of residence, migration and mobility has provided information on a diverse array of topics, such as the provenance of ivory from the Uluburun shipwreck (Lafrenz, 2003); the possible matrilocal movement of men from Ban Chiang, Thailand (Bentley *et al.*, 2005) and the foraging ranges of inhabitants of the Ol'khon, Sibera (Weber *et al.*, 2002). This study attempts to understand issues of migration and acculturation in 13th century Corinth. Strontium isotope analysis is perfectly suited to address these topics as it informs on geological (and hence, geographical) place of origin. Strontium isotopes are also ideal for study since they are not fractionated up the food chain, and the analysis of enamel should provide a biogenic $^{87}Sr/^{86}Sr$ signal for the individuals' place of birth.

CHAPTER 5 – MATERIALS AND METHODS

5.1 INTRODUCTION

The materials used in this study were recovered from excavations at Frankish Corinth in the late 1980s and early 1990s. Samples analyzed for $^{87}Sr/^{86}Sr$ ratios include human enamel, faunal bone, and soil. This chapter will present sample material information, laboratory processing methods, and mass spectrometer specifications. Also included will be a brief discussion of previous diagenetic tests performed by Garvie-Lok (2002) on bone samples from Frankish Corinth.

5.2 MATERIALS

5.2.1 Room 4, Unit 2 burials

The human remains used in this study (n=10) were recovered from the Room 4, Unit 2 cemetery in Corinth. Age and sex information is provided in Table 5.1. Osteological analysis was carried out by Dr. E. Barnes, who reported two main findings (Barnes, 2003). First, some of the individuals from Room 4 represent a transient population likely making use of the nearby hospice in Unit 1. This assessment is based on a high prevalence of severe health problems, as well as non-metric trait analysis (Williams *et al.,* 1997; Barnes, 2003). The second finding is that non-metric markers concentrated in certain areas of the cemetery point towards long-term familial use of some grave plots (Williams *et al.*, 1998). Unfortunately, these two findings are not able to elucidate further on where these individuals were originally from, although they have much to offer with regard to the overall health of the population.

Table 5.1: Human enamel samples (Room 4, Unit 2) from the 13th Century

Sample	Grave	Demographic Information	Tooth Sampled
SCO-44	1991-5	Male, 16-17 years	RP_4
SCO-46	1995-7b	Female, 30-35 years	LP_4
SCO-47	1995-9c	Female, ca. 18 years	RP_4
SCO-50	1996-12	Male, 40-45 years	LP_4
SCO-54	1996-18	Male, 25-35 years	RP^4
SCO-55	1996-20	Female, over 40 years	RP_3
SCO-57	1996-23	Male, 25-35 years	RP_3
SCO-59	1996-32	Male, 30-35 years	RP_4
SCO-60	1996-35	Female, 22-24 years	RP_3
SCO-61	1996-36	Female, 22-24 years	LP_4

5.2.1.a Past work on diagenesis

Although only enamel from the ten individuals was examined for this study, previous research used the accompanying bone samples for analysis. Carbon and nitrogen isotope analyses were performed on these individuals (Garvie-Lok, 2002); the results of these investigations in relation to the strontium isotope analysis will be discussed in Chapter 6. Because this research examined bone, which is much more prone to diagenesis than enamel, multiple tests looking for diagenetic changes were performed. Tests examining the potential of using both bone collagen and bone carbonate are briefly discussed below. For a complete list of diagenetic tests, as well as a much more detailed examination of the tests, the reader is directed to Garvie-Lok (2002).

a) Carbonate content – Chemical analyses of bone typically examine either collagen (organic fraction) or carbonate (mineral fraction). Carbonate analyses are somewhat limited due to the post-burial build up of diagenetic calcium carbonate. It is now assumed that an abundance of calcium carbonate beyond the normal lifetime accumulation could be an indicator of diagenetic alteration (Schoeninger and DeNiro 1982). Carbonate content is measured through Fourier transform infrared spectroscopy (FTIR). FTIR allows for the identification of contaminants by comparing the spectra produced by uncontaminated and unaltered bone to the spectra of the archaeological bone under analysis (*e.g.*, Weiner *et al.*, 1993; Sillen and Sealy, 1995; Hoppe *et al.*, 2003).

b) Apatite Crystallinity – Increased crystallinity in bone is also used as a possible indicator of diagenesis (*e.g.,* Hedges, 2002; Reiche *et al.,* 2003). This occurs through the dissolution and conversion of smaller crystallites into larger and more stable crystals of apatite. Crystallinity is also measured using FTIR.

c) Collagen Content – The analysis of collagen for isotope studies requires the removal of the collagen protein from the apatite structure. If only small amounts of collagen are retrievable from a sample, it is likely that the collagen recovered is of poor quality, and has possibly been contaminated (Ambrose, 1990; van Klinken, 1999).

d) Bone Collagen C/N Ratio – As collagen breaks down over time it is argued that carbon or nitrogen may be lost, which causes a change in the C/N ratio (Ambrose, 1990). It is also possible for materials high in carbon, such as lipids, to attach to the collagen. Any changes in the C/N ratio may be indicators of post-mortem contamination.

Using these diagenetic tests, Garvie-Lok (2002) concluded that the bones were displaying biogenic $\delta^{13}C$ and $\delta^{15}N$ signals and could inform on dietary and cultural activities. As noted by Garvie-Lok (n.d.), because diagenetic analyses have shown the bone samples of this population to be well-preserved, it is assumed that enamel, which is much less prone to contamination (Budd *et al.*, 2000; Price *et al.*, 2002; Wright, 2005), will also retain its biogenic stable isotope signals.

5.2.2 Archaeological faunal materials

This study analyzed archaeological faunal material of five specimens of *Ovis/Capra* [sheep/goat][15] dating to 12th or 13th century CE. These were recovered in 1997 during excavation of a medieval roadway in the area of the southwest corner of the forum. None of the samples were complete although all were easily identifiable as right humeri. It is believed the faunal samples represent domestic debris. See Table 5.2 for sample information. Sheep and goats were the primary domesticated animals in Byzantium, supplying meat, cheese, and wool to their owners. At Corinth in the Middle Ages, sheep and goat would have been the dominant animals (Kazhdan, 1991; Kazhdan and Nesbitt, 1991), which is supported by the zooarchaeological evidence (Lev-Tov, 1999).

Table 5.2: Archaeological faunal bone samples

Sample	**Species**	**Element**	**Location**	**Date (CE)**
SCO-F01	*Ovis/Capra*	Right humerus	SW Forum	12/13th Century
SCO-F02	*Ovis/Capra*	Right humerus	SW Forum	12/13th Century
SCO-F03	*Ovis/Capra*	Right humerus	SW Forum	12/13th Century
SCO-F04	*Ovis/Capra*	Right humerus	SW Forum	12/13th Century
SCO-F05	*Ovis/Capra*	Right humerus	SW Forum	12/13th Century

[15] In the archaeological record, it is difficult to distinguish between specimens of *Ovis* sp. (sheep) and *Capra* sp. (goat), and often specimens are placed into a joint category. The *Ovis/Capra* identification was made by Dr. Sandra Garvie-Lok upon initial inspection of the specimens.

5.2.3 Soil Material

One soil sample was collected from within the medullary cavity of SCO-FO1 and was removed using a cleaned dental pick.

5.3 METHODS

5.3.1 Enamel

Initial sample preparation was completed by the author in facilities of the University of Alberta Department of Anthropology, Edmonton. The first stage of preparation occurred in the fall of 2004. All tooth samples had been photographed with details catalogued by Julija Kelecevic prior to dissection. Each tooth was visually examined for any noticeable cracks or fissures before being mechanically abraded using an aluminum oxide grinding stone (Dremel #952, 3/8") attached to a Dremel tool (Dremel MultiPro 395). Samples were abraded to remove any visible contamination, sediment, or calculus on the exterior of the tooth. Following cleaning, the enamel was dissected from the tooth using a diamond cutting disc (NTI Diamond disc, Interflex-double sided, 8 mm diameter, thickness 0.15 mm) attached to a Dremel tool. As the specimens were fragile and partially broken in many instances, consistency was not possible in terms of which side or portion of the enamel was sampled. Upon enamel dissection, all traces of adhering dentine were removed from the samples using the flat edge of the diamond cutting disc. The samples were viewed under a 7-fold hand-magnification lens to ensure that all dentine had been removed. Dentine was identified by a change in colour from white (enamel) to off-white/yellow (dentine). All cutting and sanding tools were ultrasonically cleaned in between each sample to avoid cross-contamination.

The second stage of sample preparation was completed in January 2006. Enamel samples were re-cleaned through mechanical abrasion with the same sander attached to a Dremel tool. Samples were examined at 50x magnification under a Wild M5 dissecting scope to ensure no dentine remained on the samples. Once all dentine had been removed from the enamel, the samples were weighed on a micro-balance (all samples measured between 10-40 mg) and sent to the Radiogenic Isotope Facility, University of Alberta, for ICP-MS analysis.

In a Class 100 cleanroom facility, the enamel samples were pre-treated for isotope analysis by laboratory technician Jaime Donneley, who processed the samples according to the following guidelines. Each individual sample was placed into a 1.5 ml centrifuge vial before being sonicated, first for 15 minutes with Millipore (MQ) water and then for 15 minutes with acetic acid. The samples were left to sit out overnight. The acid was then washed out with MQ water and transferred to microwave tubes. A rubidium-strontium spike was added,[16] along with 4 ml of 16N HNO_3 and 1 ml 9.75N HCl. The samples were digested and transferred to another set of clean Teflon vials and left to dry overnight on a hotplate set at 80° Celsius. 3 ml of 0.75N HCl was then added to the digested sample, which was left to sit for approximately 30 minutes before being centrifuged at 5000 rpm for 10 minutes. The samples were next loaded onto unspiked strontium columns with a pipette. 3x1 ml 0.75N HCl was added and allowed to completely drain each time. The same procedure was followed with 3x1 ml 2.5N HCl.

[16] A 'spike' solution contains a known concentration of an element (*e.g.*, rubidium, strontium), which has had one of its isotopes artificially enriched. This allows its isotopic composition to be used to measure the sample isotopic concentration accurately.

17 ml 2.5N HCl was added with a graduated cylinder and also allowed to drain. Using a graduated cylinder, the Sr and 5 ml of 2.5N HCl was collected, and one drop of HPO_4 was added before the sample was dried out overnight on an 80° Celsius hotplate. Finally, the columns were filled halfway with 6N HCl, capped and submitted for analysis on the mass spectrometer.

5.3.2 Bone

Initial faunal bone preparation was completed by the author in facilities of the University of Alberta Department of Anthropology, Edmonton. Because the bones were heavily coated in soil from the site, the samples were washed using MQ water and a soft toothbrush before being left to dry overnight. After all visible traces of mud had been removed, small sections of bone were dissected from the larger sample using a diamond disc (Abrasive Technology Thin-Flex Diamond Disc X929.7, 22.2 mm diameter, 0.22 mm thickness) attached to a Dremel tool. All cancellous bone and any visible contamination (sediment, roots) on the inside of the medullary cavity was removed using an aluminum oxide grinding stone (Dremel # 952, 3/8") attached to a Dremel tool. As bone is prone to post-mortem contamination, the faunal samples were mechanically abraded further to remove the bone surfaces (*i.e.*, the exterior surface, the interior (medullary cavity) surface and all cut edges) that had come in contact with the burial environment. Abrasion continued until the bone had achieved a uniform pale yellow/white colour. Samples were then weighed on a microbalance (all samples measured between 400-1400 mg) and sent to the Radiogenic Isotope Facility for ICP-MS analysis. At the isotope facility the bone samples were pretreated by a lab technician in the same manner as listed above for enamel.

5.3.3 Soil

Soil samples were removed from the interior of the medullary cavity of SCO-F01 using a cleaned dental pick. The soil was placed into a Fisher Scientific 20 ml scintillation vial before being sent to the Radiogenic Isotope Facility. Once there the soil sample was processed by the laboratory technicians. The soil sample was first placed into a Teflon container along with enough MQ water (~10 ml) to completely submerge the sample. The sample was then capped and placed on a hotplate overnight at 80° Celsius. Next, the sample was centrifuged to separate the soil from the water. The water, now containing the leachable strontium, was transferred to another Teflon container before the spike was weighed and added. The sample was once again placed on overnight on a hotplate at 80° Celsius. Finally, the sample was re-suspended in the loading solution and the same column procedure as used for the bone and enamel samples was followed. Briefly, 3x1 ml 0.75N HCl, then 3x1 ml 2.5N HCL, and then 17 ml of 2.5 HCl were added with a pipette and allowed to completely drain each time. The Sr and 5 ml of 2.5N HCl was collected, and one drop of HPO_4 added before being dried out overnight on an 80° Celsius hotplate. Finally, the columns were filled halfway with 6 N HCl, capped, and submitted for analysis on the mass spectrometer.

5.4 ICP-MS ANALYSIS

Strontium isotope ratios were obtained from the Radiogenic Isotope Facility, Department of Earth and Atmospheric Science, University of Alberta, under the direction of Dr. Robert Creaser and Dr. Antonio Simonetti. The samples were submitted for analysis using NuPlasma solution mode multi-collector inductively coupled plasma mass spectrometry (MC-ICP-MS), coupled with a desolvation nebulizer system (DSN-100 from Nu Systems Inc.).[17] The samples were diluted in 2% HNO_3 in order to avoid overloading the detection limit of the machine. Once the proper concentration was achieved through dilution, the sample was aspirated into the ICP Torch through the desolvating nebulizing system. The strontium isotope data were obtained in static, multi-collection mode using 6 Faraday collectors[18] for a total of 400 seconds, made up of 40 scans in 10 second intervals. The ICP system was 'washed-out' for 5 minutes following the analysis of each sample in order to avoid any cross-contamination between samples. The repeated analysis of a 100 ppb solution of the strontium isotope standard (NIST SRM 987) produced an average value of 0.710242 ±0.000041, which is similar enough to the accepted value of 0.710245 for the purposes of this research. The internal precision (standard error) typically varies between 0.00001 to 0.00003 (2σ level).

5.5 SUMMARY

All material used for this study underwent proper cleaning and processing techniques before submission for analysis using ICP-MS. The procedures followed in

[17] The coupling of the MC-ICP-MS to the desolvating nebulizing system allows for improved levels of sensitivity in low abundance samples.
[18] Faraday collectors (or cups) measure the current in a beam of charged particles. A metallic collector intercepts a particle beam and then sends this current to a measuring instrument.

this study followed commonly used techniques in the literature. Results of the $^{87}Sr/^{86}Sr$ analysis will be presented in Chapter 6 along with a discussion of the possible interpretation of the findings.

CHAPTER 6 – RESULTS AND DISCUSSION

6.1 INTRODUCTION

The results of the enamel and bone $^{87}Sr/^{86}Sr$ analysis are outlined below. Following that, a section on previous research on oxygen, nitrogen, and carbon isotopes will be presented in terms of what the analyses can add to our understanding of the background of the Corinth individuals. Difficulties encountered in making the distinction between locals and non-locals will be discussed, along with suggestions for ways in which this problem can be approached. Finally, once the Corinth individuals have been assigned to either local or non-local status, the possible backgrounds and ethnic origins of these people will be considered.

6.2 RESULTS

6.2.1 Human enamel samples

Strontium isotope ratios obtained for the ten archaeological enamel samples are listed in Table 6.1. The strontium concentration and isotope ratio of each sample are displayed graphically in Figure 6.1. The $^{87}Sr/^{86}Sr$ results show a grouping of five individuals around 0.708 (SCO-44 at 0.708432, SCO-47 at 0.708444, SCO-57 at 0.708285, SCO-59 at 0.708309 and SCO-61 at 0.708485), three individuals grouping together in the 0.709 range (SCO-46 at 0.709591, SCO-50 at 0.709069 and SCO-60 at 0.709138), and two individuals who fall slightly higher around 0.710 (SCO-54 at 0.710920 and SCO-55 at 0.710041). Strontium concentrations for the individuals are much more uniform. Seven individuals have strontium concentrations within a range of only 20 ppm (SCO-46 at 81.04, SCO-50 at 82.96, SCO-54 at 97.1, SCO-55 at 94.56, SCO-57 at 92.3, SCO-59 at 94.06 and SCO-60 at 83.52). The remaining three individuals display more variable strontium concentration results between 144 and 209 ppm (SCO-44 at 208.8, SCO-47 at 206.1 and SCO-61 at 144.9).

6.2.2 Faunal bone samples

Five samples of archaeological faunal bone were analyzed using ICP-MS. The results are listed in Table 6.1. The faunal bone $^{87}Sr/^{86}Sr$ isotopic values and concentrations are displayed in Figure 6.1. All five faunal $^{87}Sr/^{86}Sr$ values cluster between 0.7085 and 0.7087. The strontium concentrations display slightly more variation, ranging between 138 to 283 ppm.

6.2.3 Soil sample

The soil sample from Corinth returned a $^{87}Sr/^{86}Sr$ ratio of 0.708844 ±0.000014. The soil sample had previously been treated to remove the leachable strontium and thus was not analyzed for strontium concentration.

Table 6.1: Enamel and bone $^{87}Sr/^{86}Sr$ ratios and strontium concentration

Sample	Sample Information	Strontium Concentration (ppm)	$^{87}Sr/^{86}Sr$	2s Error
SCO-44	Male, 16-17 years	208.8	0.708432	0.000016
SCO-46	Female, 30-35 years	81.04	0.709591	0.000025
SCO-47	Female, ~18 years	206.1	0.708444	0.000014
SCO-50	Male, 40-45 years	82.96	0.709069	0.000016
SCO-54	Male, 25-35 years	97.1	0.710920	0.000016
SCO-55	Female, +40 years	95.46	0.710041	0.000026
SCO-57	Male, 25-35 years	92.3	0.708285	0.000018
SCO-59	Male, 30-35 years	94.06	0.708309	0.000018

SCO-60	Female, 22-24 years	83.52	0.709138	0.000022
SCO-61	Female, 22-24 years	144.9	0.708485	0.000027
SCO-F01	*Ovis/Capra*	138.59	0.708683	0.000017
SCO-F02	*Ovis/Capra*	222.46	0.708628	0.000057
SCO-F03	*Ovis/Capra*	323.16	0.708740	0.000023
SCO-F04	*Ovis/Capra*	144.63	0.708522	0.000024
SCO-F05	*Ovis/Capra*	282.04	0.708597	0.000025
SCO-SOIL	Soil Sample	NA	0.708844	0.000014

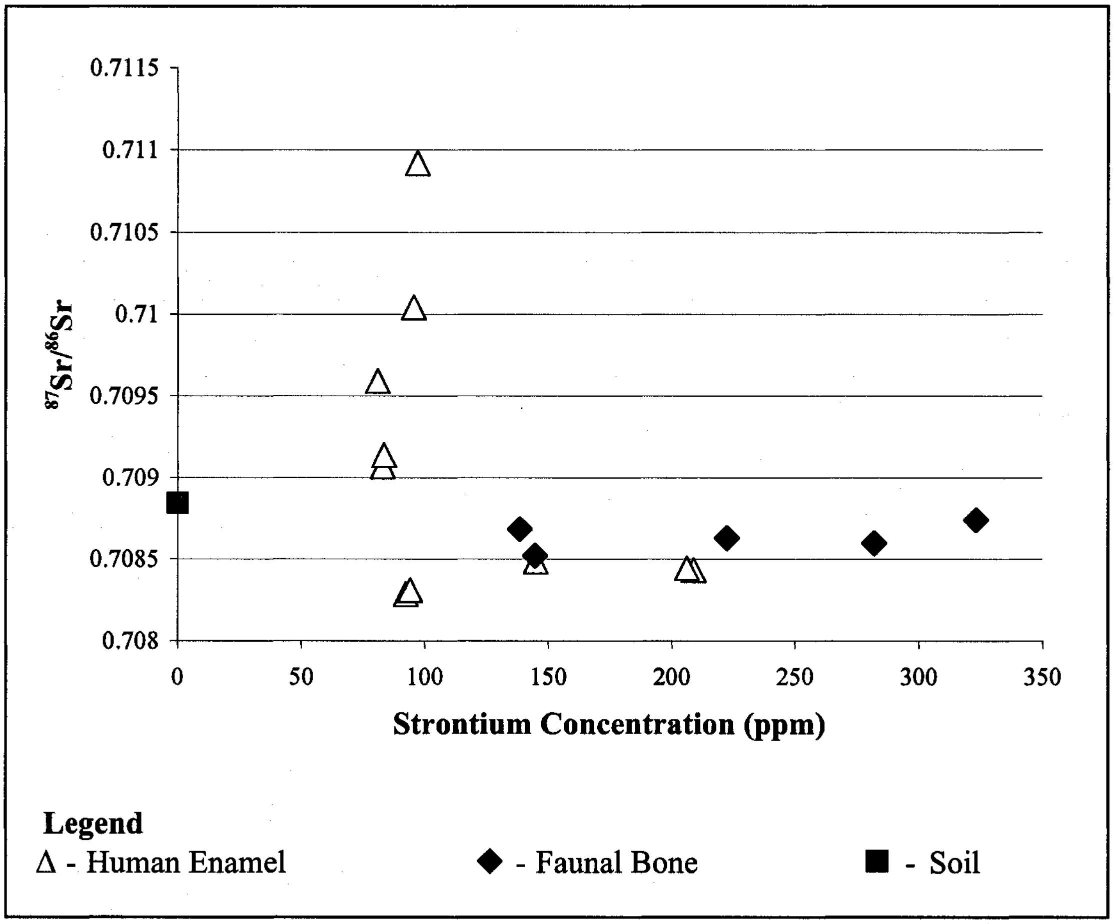

Figure 6.1: Strontium isotope ratios versus strontium concentration in human enamel, faunal bone, and soil samples from Corinth

6.3 PRIOR STABLE ISOTOPE WORK

The enamel of ten individuals from 13th C. Frankish Corinth, as well as a later 14/15th C. Frankish Corinth population and a Turkish Corinth population, were previously analyzed for oxygen isotope ($^{18}O/^{16}O$) values (Garvie-Lok, n.d.). Paleodietary studies using $\delta^{13}C$ and $\delta^{15}N$ values were also undertaken with the same three Corinth populations (Garvie-Lok, 2002),[19] although only the 13th C. Frankish results will be discussed here. These two previous isotopic studies have implications for this $^{87}Sr/^{86}Sr$ analysis as oxygen isotopes can provide complementary information on migratory issues and carbon and nitrogen isotopes can help determine if individuals were consuming radically different diets, which may be linked to cultural and ethnic background.

6.3.1 Oxygen

Briefly, the source of ingested water will affect its oxygen isotope composition (commonly expressed as $\delta^{18}O$), which is then reflected in bone and enamel mineral $\delta^{18}O$ (Longinelli, 1984; Luz *et al.*, 1984). The $\delta^{18}O$ of local drinking water varies according to distance from the sea, elevation, and temperature (Schwarz *et al.*, 1991). Determining migration patterns using oxygen isotopes is based on much the same reasoning as strontium isotope analysis, and movement is determined through one of two means: 1) differences in the $\delta^{18}O$ values between an individual's enamel and bone may indicate movement between climatic zones or, 2) hard tissues can be compared to published modern sources which provide oxygen ratios for specific regions (*e.g.*, Evans *et al.*, 2006)

The oxygen isotope study (Garvie-Lok, n.d.) attempted to better understand population mobility in Corinth throughout the Middle Ages. The results from the Turkish population were able to best demonstrate the usefulness of oxygen isotope analysis; two individuals were clearly identifiable as immigrants based on differences in oxygen values

[19] Although Garvie-Lok (2002) performed a thorough analysis on dietary issues in this population it is not possible to directly apply all aspects of those findings to this research. Garvie-Lok (2002) analyzed bone, which informs on approximately the last 10 years of life, while this study looks at enamel, which records dietary information during childhood.

which indicated a childhood spent in a climate dissimilar to Corinth. Unfortunately, the oxygen results from the ten individuals from 13th C. Corinth were somewhat inconclusive with regard to migration. This is in part due to the fact that $\delta^{18}O$ values are dependant on climatic zone and large geographical areas can have similar climates. Although the $\delta^{18}O$ values for enamel all had a limited range, indicating the ten individuals grew up in Corinth or in a region with a similar climate, as noted by Garvie-Lok (n.d.) this could include a number of different places within the Mediterranean basin. The $\delta^{18}O$ results are able to rule out a number of more northern regions, such as northern France and England, as possible childhood locations of any non-local individuals, based on climate differences.

6.3.2 Carbon and nitrogen

Stable carbon and nitrogen isotope ratios are extremely well studied complex topics; the reader is directed to Katzenberg (2000) for more detailed information. Carbon isotope analysis, at its most basic level, is based on the fact that different varieties of plants follow different photosynthetic pathways, which are then reflected in their $\delta^{13}C$ values (Smith and Epstein, 1971). Most plants (~95%), including trees, shrubs, barley, rice, wheat, and oats, among others, follow the C3 (Calvin-Benson) photosynthetic pathway. The next most prevalent pathway is followed by C4 (Hatch-Slack) plants, which include grains such as corn (maize), millet, and sorghum. There are also plants that follow the Crassulacean acid metabolism (CAM) pathway; these include most succulents (*e.g.*, cacti) (Ambrose, 1993; Katzenberg, 1992). All plants obtain their carbon from the atmosphere, and because of fractionation effects, have depleted values when compared to atmospheric CO_2 (-7.7‰). C3 plants have the most negative $\delta^{13}C$ values (-20‰ to -35‰), CAM plants are intermediate and C4 plants have the least negative values (-9‰ to -14‰) (Ambrose, 1993). It is thus possible for researchers to determine what kinds of plants were being eaten by an individual, as well as the relative contribution of C3 and C4 plants to the diet. However, the consumption of marine resources can result in human tissues that present $\delta^{13}C$ values which fall between C4 and C3 plant values, often making it difficult to distinguish between marine and plant components of the diet (Schoeninger, 1995). Thus it is common for researchers to analyze nitrogen and carbon isotopes together, as nitrogen isotopes can determine between marine and terrestrial diets, but are similar for C3, C4 and CAM plants (Katzenberg, 1992).

Stable nitrogen isotope analysis examines the ratio of ^{15}N to ^{14}N, expressed as $\delta^{15}N$, and can inform on both plant and animal protein consumption in marine and terrestrial environments. Nitrogen is acquired by plants either through the soil or the atmosphere. Plants that obtain nitrogen from the atmosphere (*e.g.*, legumes) have lower $\delta^{15}N$ values than plants that get their nitrogen from the soil (Katzenberg, 1992). As well, the $\delta^{15}N$ levels will increase as an organism moves up the food chain; carnivores, for example, will have the highest $\delta^{15}N$ values (DeNiro and Epstein, 1981).

$\delta^{13}C$ values for the 13th C. Frankish population indicate that the majority of plants consumed were C3 grains (likely wheat), as well as some C4 grains (likely millet). $\delta^{13}C$ and $\delta^{15}N$ patterning also indicate that certain animal protein sources, such as dairy products, eggs and meat were eaten (Garvie-Lok, 2002); this corresponds with what archaeological excavations have recovered in the debris (Williams *et al.*, 1997; Williams *et al.,* 1998). Some consumption of marine resources is also suggested by $\delta^{15}N$ and zooarchaeological remains (Garvie-Lok, 2002). If vast differences had been seen in the $\delta^{13}C$ and $\delta^{15}N$ values, it may have suggested that some of the individuals had consumed different diets (indicating possible non-local origin and/or migration) at some point in their lives. However, the range of values for $\delta^{13}C$ and $\delta^{15}N$ in the Corinth individuals are both very narrow, which leads Garvie-Lok (2002, n.d.) to state that the ten individuals could have come from a single community.

6.4 DETERMINING A 'LOCAL' SIGNAL

The process of determining which individuals were local and which were non-local can be a difficult task. As Bentley (2001:183) aptly notes, "Since there is no absolute rule for identifying an immigrant from an isotopic signature, this step takes some justification." The following section will attempt to do just that. It is first necessary, however, to determine if post-depositional contamination has occurred in the samples, as this will affect the isotopic differences between locals and non-locals.

6.4.1 Strontium concentration

6.4.1.a Human

Strontium concentration is not often discussed in the $^{87}Sr/^{86}Sr$ literature (*e.g.,* Price *et al.,* 2002; Budd *et al.,* 2004; Knudson *et al.,* 2005), but is of relevance to this study due to the connection between concentration, diagenesis, and determining a local signal. The amount of strontium in an individual's tissue is determined by diet and metabolic processes (see Chapter 3). Examination of strontium concentration in the enamel samples reveals that seven out of the ten individuals group together in the 80-95 ppm range, while the remaining three have more variable values, ranging between 104-210 ppm. There are two possible explanations for the very similar concentrations found in seven of the samples: 1) that the majority of the enamel samples have been diagenetically contaminated by the local soil, and this has resulted in concentration equilibration between the samples and the soil, or 2) that the seven individuals with comparable concentrations grew up in a similar region and consumed similar diets during childhood (*i.e.,* relatively equal proportions of various Ca-rich resources).

The diagenetic explanation is unlikely for a number of reasons. First, numerous studies have shown that enamel is inert after formation, and is not prone to post-mortem contamination (Carlson, 1990; Driessens and Verbeeck, 1990; Hillson, 1986, 1996; Kohn *et al.*, 1999; Budd *et al.*, 2000; Shellis and Dibdin, 2000; Trickett *et al.,* 2003). Second, the enamel strontium concentrations are well within the normal range for humans (Underwood, 1977), which fall between 50-300 pm, but can go as high as 600 ppm (Brudevold and Söremark, 1967). The majority of researchers who include strontium concentrations in their analysis and interpretation (*e.g.*, Budd *et al.*, 2001; Montgomery *et al.*, 2000, 2003; Chiaradia *et al.*, 2003; Evans *et al.*, 2006) are satisfied with merely ascertaining that their concentration results are within the normal range. It should also be noted that even in studies that analyze bone, which is much more prone to contamination (Budd *et al.*, 2000), diagenesis is not considered a factor even when values reach as high as 1160 ppm (*e.g.*, Price *et al.*, 1994b).

The alternative, that the seven individuals lived in a similar region and/or consumed similar diets, is a much more likely explanation. Strontium concentrations can vary according to both geographic location and trophic position (Brudevold and Söremark, 1967). Herbivores have higher strontium concentrations in their tissue because plants are higher in strontium than animal tissues (Tuross *et al.*, 1989). This is because the amount of strontium ingested decreases the higher an organism is on the food chain. This process, known as biopurification, means that plants have the highest strontium concentration, while herbivores which eat these plants have slightly depleted levels, and carnivores which eat the herbivores have even more depleted levels (Sanford, 1993). Price and colleagues (1994a) point out that low strontium concentrations in enamel could be a result of the consumption of milk, which has a low strontium concentration, during childhood. In a study on Mediaeval (10^{th}-16^{th} C. CE) individuals from England, Mays (2003) found that none of the infants studied displayed low strontium concentrations[20] expected of consuming a diet consisting wholly of breast milk. Mays puts forth the suggestion that infant diets in this region may have been regularly supplemented from birth with small amounts of food with relatively high Sr/Ca ratios.

Montgomery *et al.* (2003) make the argument that two non-local ('exotic') individuals found in their research, though having similar $^{87}Sr/^{86}Sr$ values, could not have come from the same place due to their dissimilar strontium concentrations (169 ppm versus 58.2 ppm). Interpretation of strontium concentration and isotopic composition is not quite as clear cut in this research. Two of the seven individuals who have strontium

[20] Mays (2003) interprets strontium concentration in relation to the concentration of calcium (Sr/Ca ratio); this is the way strontium is expressed and understood in the literature focusing on strontium as a palaeodietary indicator. This study did not measure calcium concentration as the original research design of this work followed the approach taken in the $^{87}Sr/^{86}Sr$ literature, which only takes into account strontium concentration (expressed as ppm) and does not measure calcium concentration (*e.g.*, Price *et al.*, 1994a; Budd *et al.*, 2001; Montgomery *et al.*, 2003; Evans *et al.*, 2006). Burton and colleagues (2003) have recently suggested the use of Sr/Ca as another means to investigate human movement in the past, but this method is not common in the literature.

concentrations in the 80-95 ppm range display $^{87}Sr/^{86}Sr$ values that likely indicate a childhood spent outside of Corinth. As well, the three individuals with strontium concentrations in the 104-210 ppm range display $^{87}Sr/^{86}Sr$ values that point to a locally-based childhood. It is therefore not possible to simply say that variant strontium concentrations indicate different origins. Instead, it is argued here that the five individuals (SCO-46, SCO-50, SCO-57, SCO-59, and SCO-60) who display relatively comparable strontium concentrations and isotopic compositions could have spent their childhood in the same geographic zone (*i.e.*, Corinth) and consumed similar foods, or similar proportions of foods, during childhood. This corresponds with the carbon, nitrogen, and oxygen analyses (Garvie-Lok, 2002, n.d.). The three individuals (SCO-44, SCO-47, and SCO-61) who have higher concentrations but have isotopic compositions in the local range (the determination of a local range is discussed in detail below) likely spent their childhood in Corinth, but may have consumed different foods (*i.e.*, more plants than dairy products). A range of over 60 ppm is possible in a single population from the same region, as evidenced by Evans et al. (2006). Finally, all that can truly be said is that the two individuals (SCO-54 and SCO-55) who display comparable concentrations but have $^{87}Sr/^{86}Sr$ values outside the local range spent their childhood outside of Corinth, but could have been consuming a range of diets as evidenced by the range in concentration within the 'local' Corinth region.[21]

[21] It is important to note that strontium concentration is not being offered here as evidence for the diet of these individuals. Rather, diet is merely offered as a possible explanation for the variation seen in the strontium concentration values of this population.

6.4.1.b Faunal

Although it has been shown that post-mortem contamination of strontium concentration is not a concern for the human enamel values the same cannot be said for the faunal bone values. Bone is much more prone to diagenetic change and although all five faunal samples display concentration values which would fall within the normal range, the $^{87}Sr/^{86}Sr$ values fall within a very limited range, indicating possible diagenesis. Although diagenetic changes to strontium concentration in the faunal bone are not of relevance to the arguments made in this study, the possible implications for diagenetic change in the isotopic composition of the faunal bone will be discussed below.

<u>6.4.2 Locals versus non-locals</u>

Since it has been shown that the enamel samples are unlikely to have been contaminated after burial it is now possible to begin to make the distinction between locals and non-locals. Although the various means used by researchers to distinguish between local and non-local individuals were previously discussed in Chapter 4 (4.5.3), a brief description of each is provided:

1) Values for a range of geological and/or biological samples in a region are obtained, which will provide a local signal that can be compared against enamel samples. Commonly analyzed samples include bedrock, water, leachable soils, and plants (*e.g.*, Hodell *et al.,* 2004).
2) Bone $^{87}Sr/^{86}Sr$ values can be compared to enamel $^{87}Sr/^{86}Sr$ value in a single individual. A 0.001 difference in $^{87}Sr/^{86}Sr$ ratio between the two tissues is

construed to indicate migration between geochemical zones after childhood and before death (*e.g.*, Grupe *et al.,* 1997).

3) The human bone values (± 2 s.d.) for all individuals can be averaged. This is argued to provide a local signal (Price *et al.*, 2001), and will provide an $^{87}Sr/^{86}Sr$ range (*e.g.*, 0.70914 – 0.71004 in Bentley *et al.*, 2002). Any individuals whose enamel values fall within the range are considered to have spent their childhood locally. Any individuals whose enamel values lie outside the range spent their childhood in a different geochemical zone, before moving to the 'local' region sometime before death.
4) Modern faunal bone or enamel is analyzed to obtain an $^{87}Sr/^{86}Sr$ ratio of the biologically available strontium (*e.g.*, Knudson *et al.,* 2004, 2005). This will also provide a range in local $^{87}Sr/^{86}Sr$ values which can be compared against enamel $^{87}Sr/^{86}Sr$ values in the same way as #3.
5) Archaeological faunal bone or enamel can also be examined to obtain an $^{87}Sr/^{86}Sr$ ratio of the biologically available strontium (*e.g.*, Bentley, 2004; Bentley *et al.*, 2005), which can then be compared against enamel $^{87}Sr/^{86}Sr$ values in the same way as #3.

This study did not analyze human bone due to diagenetic concerns (see 4.5.2). It has also been concluded that bedrock values do not present an exact one-to-one relationship with biologically available strontium (Price *et al.*, 2002). As well, since this research is as a pilot study into strontium isotope analysis in the Mediterranean, no large-scale strontium analysis of local plants, soils, and water has yet been conducted in Greece, as has been done for Mesoamerica (Hodell *et al.,* 2004). Since modern faunal bone is more likely to have been affected by pollution and fertilizers (Price *et al.*, 2002) and due to sample availability, archaeological faunal material was analyzed; this leaves only Option #5 as a means in which to distinguish between local and non-local individuals.

However, there were slight complications in the attempt to obtain an average of the archeological faunal material (± 2 s.d.) to provide a local range of $^{87}Sr/^{86}Sr$ values. All previous studies that analyzed archeological faunal material used enamel (Bentley 2004; Bentley *et al.,* 2004, 2005; Bentley and Knipper, 2005). As enamel is less prone to diagenesis than bone, the samples had a much wider range in values. As noted by Bentley *et al.* (2004), any contamination of the local bone values will narrow the local range produced by the standard deviation of the values (Horn and Müller-Sohnius, 1999), resulting in the over-estimation of non-local individuals in the study population. At this point it is not entirely clear if diagenesis has occurred. The strontium concentrations in the faunal bone are quite variable, and fall within normal ranges. Nelson and colleagues (1986) found a similar pattern in their analysis of archaeological seal bones; while the strontium concentrations appeared unaltered, the $^{87}Sr/^{86}Sr$ isotopic data strongly indicated diagenesis. However, all of the Corinth faunal samples had previously undergone diagenetic tests and were found to have retained their biogenic signals for carbon and nitrogen (Garvie-Lok, 2002). In addition, the samples underwent an acid pre-treatment to remove secondary carbonate in the laboratory.

What is clear is that the $^{87}Sr/^{86}Sr$ ratios of the faunal bone fall within a limited range (0.70852 – 0.70868). Even if contamination was occurring, the strontium isotopic composition displays a local value. While this local value is still informative, the narrow range (± 2 s.d.) presents some difficulties in distinguishing between local and non-local individuals. The result of using only the average $^{87}Sr/^{86}Sr$ ratio (± 2 s.d) of the faunal bone is shown in Figure 6.2.

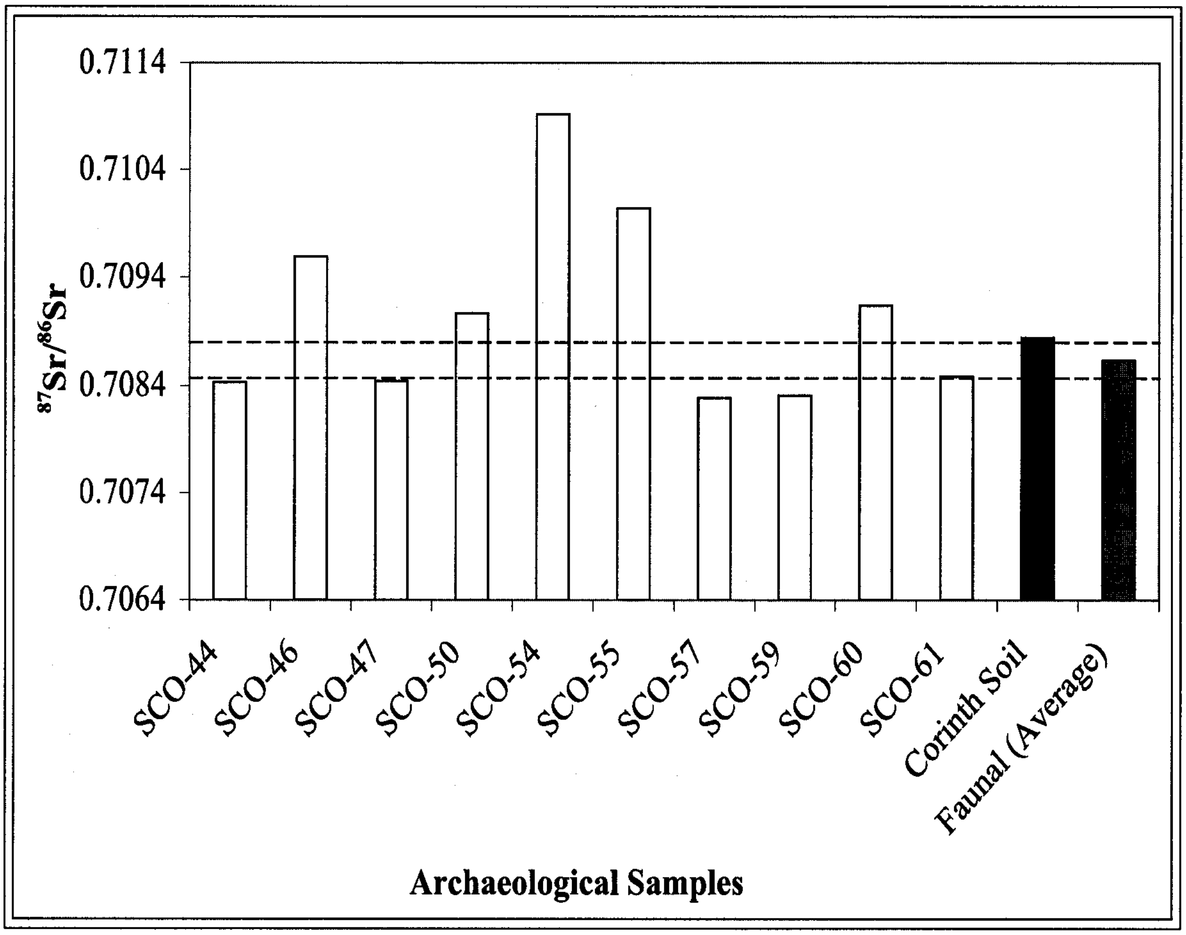

Figure 6.2: Determining a local range using an average bone value (±2 s.d.)

Although it could be argued that the faunal samples are all simply displaying a biogenic local signal, a review of the literature using modern faunal bone indicates that this is unlikely. Knudson and colleagues (2004) used modern guinea pigs fed a diet of locally-grown foods; $^{87}Sr/^{86}Sr$ values for the animals displayed a range of 0.7059 to

0.7067. Even though the guinea pigs were fed essentially the same foods grown in the same area, their $^{87}Sr/^{86}Sr$ ratios did display a reasonable range of variation.

Moreover, if the range acquired for the Corinth samples is used to separate locals from non-locals, only one individual (SCO-60, at 0.709138) would be considered local. As well, four of the individuals (SCO-44, SCO-47, SCO-57, and SCO-59) classified as non-locals all display remarkably similar $^{87}Sr/^{86}Sr$ ratios (0.708432, 0.708444, 0.708285, and 0.708309, respectively). Although it is possible that these four individuals grew up in the same region, all came to Corinth before death, and were all buried in the same cemetery, it seems probable that the 'local' range acquired using an average of the faunal bone $^{87}Sr/^{86}Sr$ values is too narrow. It is interesting to note that even the local soil $^{87}Sr/^{86}Sr$ ratio does not fall within the local range as defined by the faunal bone.

It thus becomes necessary to establish an alternate means to determine which individuals grew up in Corinth and which did not. After a review of the literature it was concluded that no previous research had reported this particular problem. The author decided, therefore, to use a combination of previously published methods in an attempt to gain a biologically-based distinction between locals and non-locals. Previous research (*e.g.*, Price *et al.*, 1994b; Ezzo *et al.*, 1997; Bentley *et al.*, 2002) has used averages of the $^{87}Sr/^{86}Sr$ ratio in archaeological human bone (±2 s.d.) to acquire a local signal. As pointed out by Ezzo and colleagues (1997) the use of bone averages includes the possible risk of including non-locals, who have not spent enough time in the region for their bone to reflect local $^{87}Sr/^{86}Sr$ ratios,[22] in the determination of the local values. Since the Corinth research does not run the risk of analyzing possible non-local animals, this is not

[22] As stated previously, bone turnover rates vary in an individual. Price and colleagues (1994a) estimate a period of between 7-10 years before an individual's bone will have completely acquired a local signal.

a concern for this study. Using an average of the $^{87}Sr/^{86}Sr$ ratio of faunal bone it is thus possible to acquire a 'local' $^{87}Sr/^{86}Sr$ value.

However, the application of 2 s.d. to widen the local range does not work with the faunal bone due to possible diagenetic concerns. It is here that we must turn to other research to better understand 'non-local' $^{87}Sr/^{86}Sr$ signatures. Strontium isotope studies have also analyzed bone and enamel $^{87}Sr/^{86}Sr$ ratios for a single individual, with a difference of 0.001 or greater between the two tissues deemed to show movement between different geochemical zones (Price *et al.,* 1994a; Price *et al.,* 2000). Since it is not possible to compare bone and enamel pairs in the Corinth population, the faunal $^{87}Sr/^{86}Sr$ average will be used as the local bone signal. The Corinth enamel $^{87}Sr/^{86}Sr$ ratios will then individually be compared to the faunal average, with a difference of 0.001 designated to distinguish between locals and non-locals.

In an important study on the Bell Beaker period in Bavaria, Grupe and colleagues (1997) interpreted their data using both of the aforementioned methods. Averaging bone $^{87}Sr/^{86}Sr$ results (±2 s.d.) suggested 25% of the study population to be non-locals; using a cut-off value of 0.001 between an individual's enamel and bone $^{87}Sr/^{86}Sr$ values indicated that 17.5% of the population were non-locals.

In summary, this research will use an average of the faunal bone $^{87}Sr/^{86}Sr$ values, and then apply a 0.001 cut-off range on either side of the faunal bone average. Any individuals with enamel $^{87}Sr/^{86}Sr$ values inside of the range are deemed to have spent their childhood locally in Corinth, while any individuals with enamel $^{87}Sr/^{86}Sr$ values outside of the range are of non-local origin. The determination of locals versus non-locals using this method is displayed in Figure 6.3.

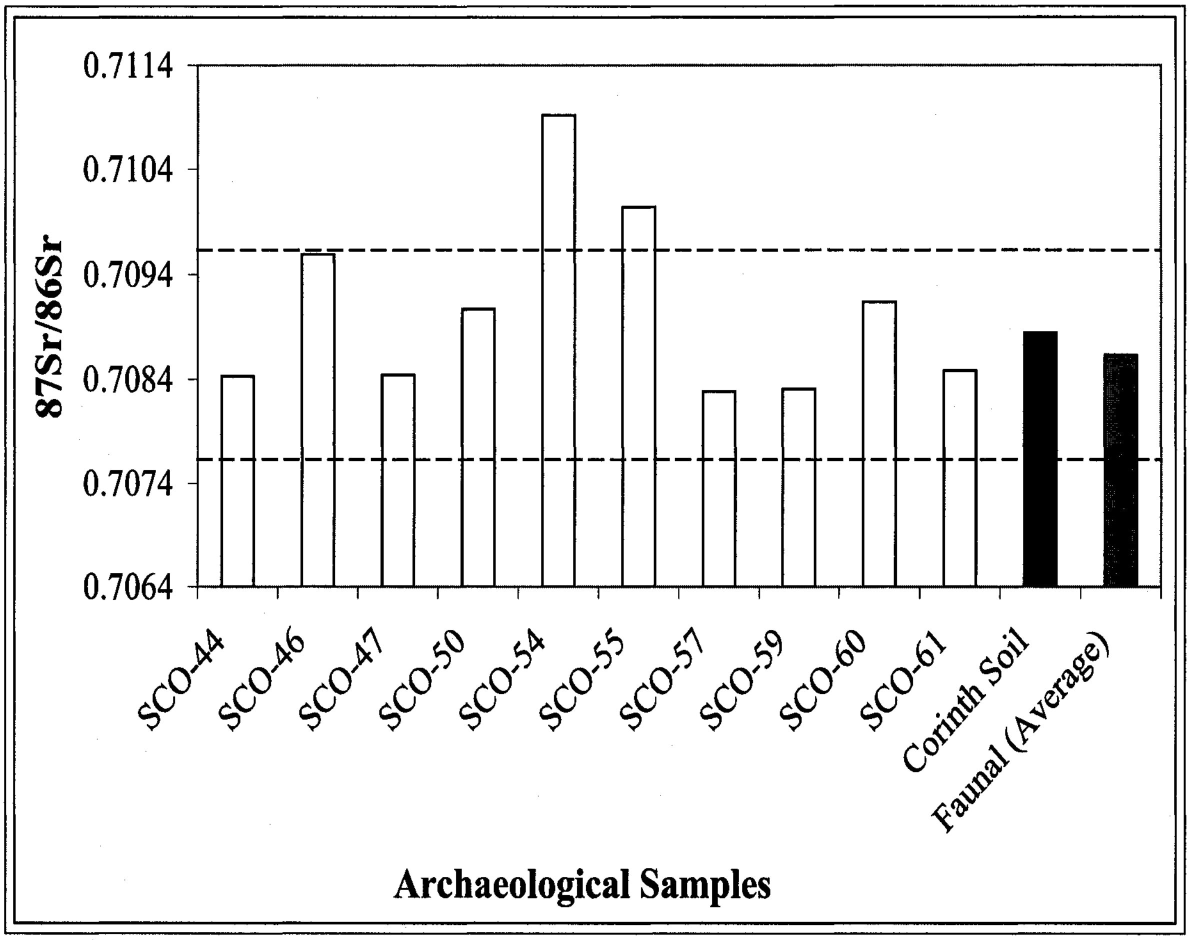

Figure 6.3: Determining a local range using an average bone value and a 0.001 cut-off between bone and enamel

6.4.3 Discussion

A suitable method has now been established for distinguishing locals from non-locals in 13th century Corinth. The results indicate that of the ten individuals analyzed, eight are of local origin, and two are of non-local origin. Although one sample (SCO-46) nearly falls outside of the range, this individual is still considered local. The two non-local individuals (SCO-54 and SCO-55) are a male (25-35 years) and a female (over 40 years). Although the sample size is too small to see any kind of pattern, the fact that both sexes are represented in the non-local category is evidence that migration to Corinth was not solely limited to either males or females.

Also of note is the fact that three of the individuals (SCO-46, SCO-50, and SCO-60) have $^{87}Sr/^{86}Sr$ ratios that group around 0.709. The accepted value for all seawater is 0.7092, and the consumption of marine resources can slightly raise an individual's $^{87}Sr/^{86}Sr$ signature towards this value (Knudson *et al.*, 2004). Although the consumption of some marine resources by the Corinth individuals is in agreement with zooarchaeological remains (Williams *et al.,* 1997,1998), the $\delta^{13}C$ and $\delta^{15}N$ analysis does not support marine protein sources as a major component of the diet (Garvie-Lok, 2002).

The eight local samples are in agreement with Garvie-Lok's research (2002, n.d.) that suggests the Frankish Corinth population was raised in Corinth, or an area with a similar climate, and that they consumed a comparable diet. Further discussion on possible origins of the two non-locals, as well as the interpretation as to the cultural background of the local individuals, will be considered below.

6.5 Migration and acculturation in 13th century Corinth

Strontium isotope analysis is a powerful tool in archaeological studies as it allows for the determination of movement and migration through direct means. This strontium study, when combined with previous research using oxygen, carbon, and nitrogen isotopes, is able to identify eight of the individuals under study as locals and two individuals as non-locals. However, what does this really mean in the context of Frankish-Greek relations in Corinth during the 13th century? The following section will deal with this issue by outlining who these individuals might have been, how they may have ended up being interred in a Frankish cemetery, and what information this research adds to previous scholarship on migration and acculturation during Frankish rule in Greece.

6.5.1 'Local' individuals

Eight of the ten individuals have been identified as local based on oxygen and strontium isotope analyses. Both isotope analyses examined enamel and these analyses indicate that the local individuals spent their childhood in Corinth. Final interment in a cemetery in Corinth means that these individuals also spent time before death in the near vicinity. Although it may seem at first glance that any local people buried in Corinth were of Greek descent, this is not the not necessarily the case. The two different backgrounds of the local individuals will now be discussed.

6.5.1.a Acculturated Greeks

Although many of the historical sources believe that meaningful cultural integration did not occur between the Franks and the Greeks (Geanakoplos, 1959, 1966; Nichol, 1972a; Bryer, 1973), the archaeological evidence (Ivison, 1996b; Lev-Tov, 1999) posits that some integration may have taken place. It has been argued that for many of the local Greeks, such as the peasants, life would not have been that different under Frankish control than it was under Byzantine rule (Topping, 1977a). However, upper-class Greeks, especially *archontes*, may have come into much more contact with the Frankish rulers for agricultural, economic, military, or political reasons (Dennis, 1968; Cheetham, 1981; Ilieva, 1991). As noted by Dennis (1968) and Lock (1995), many *archontes* were required to swear allegiance to and act as vassals for their Frankish rulers. There is thus the potential that some of the eight local individuals may have been upper-class Greeks who became acculturated enough in Frankish ways to be buried in a Frankish cemetery.

The possible burial of Orthodox Greeks in a Frankish cemetery raises interesting questions about burial rites within the Catholic Church. One reason for concern is the argument made by Moore (1987:88), who asserts that, "This was an age of classification, and it was in the eleventh century that cemeteries began to imitate the precise and sharp distinctions which were then rapidly and harshly being established among the living." This statement is in reference to Western Europe about 200 years earlier, but the principle of transferring the same social divisions that existed in life into the graveyard brings forth the possibility that Greek individuals may not have been allowed to be buried in a Catholic cemetery.

Roman Catholic Canon Law[23] decrees that Catholics should have either have their own cemetery or a portion of a public cemetery which has been properly blessed (Can. 1240). However, there are exceptions to the rule. Power (1967) lists three different burial scenarios involving Catholics: 1) if the Catholics are granted a separate section of the cemetery, this area is to be blessed by a priest; 2) if a separate section is not available and Catholics are placed indiscriminately then the whole cemetery must be blessed if the majority of the graves belong to Catholics, and 3) if a separate section is not available

[23] Catholic Canon law was not fully codified until 1582 CE, which was further revised in 1917 and 1963. Before 1582 Catholic law existed in separate supplements that were periodically issued by the Pope and canon councils. Although the Canon Law was not issued until two centuries after the Frankish period under study, some form of it did exist at the time. It has been argued that since Christian burials are both a religious act and an ecclesiastical rite, the rites involved in burial have come down through the ages relatively unchanged (McGuire, 1967).

and Catholics are placed indiscriminately but the majority of the graves are not Catholic then each individual Catholic grave must be blessed. Thurston (1913) notes that when a Catholic cemetery is the only appropriate burial ground in the vicinity it is possible for non-Catholics to be interred there. Moreover, Thurston (1913) also writes that when funerary rites are being performed, Catholic and Orthodox rituals share many similarities. That Canon law allows for the burial of Catholics and non-Catholics in the same vicinity, as well as the fact that Catholic and Orthodox funerary rites are so similar, increases the possibility of a Greek being buried in a Frankish cemetery. Further review of the literature indicates that difficulties only truly arose when attempts were made to bury non-baptized individuals in a Catholic area (Effros, 1997). In Frankish areas in the 6^{th}-8^{th} C. CE the Church lacked resources to prevent even Jews (whose differences from the Catholic Church are much greater than the differences between the Catholic and Orthodox Church) from being buried in Catholic or semi-Catholic cemeteries (Effros, 1997). In addition, it has been argued that the burial of 'controversial' individuals (*e.g.*, non-Catholics, suicides, heretics) may be expedited by having a less official or solemn funeral, arranging the burial at an inconvenient time, and through the general avoidance of publicity (McGuire, 1967).

The arrival of numerous western Europeans in Greece and surrounding areas throughout the Middle Ages necessitated some kind of system for dealing with the large number of deceased Franks in a foreign land. It was likely recognized during the Crusades that it was not always possible to follow every Catholic guideline or wish regarding death and burial. Although it was desirable to be buried in one's homeland this was not always feasible. Frankish leaders who perished in a crusade often had their bodies separated for burial; examples include Aymer de Valence (d. 1261) whose heart returned to Frankish soil for burial while the rest of his body was left in a foreign land (Boase, 1972), and St. Thomas Aquinas (d. 1274), whose bones were boiled down for ease of transportation from Priverno, Italy after he died while on a mission to unite the Catholic and Orthodox Churches (Binski, 1996). Crusaders who were not high-ranking or wealthy would not have had this option and would have had to be buried in a local cemetery.

Although the above examples come from a range of time periods during the Middle Ages they serve to illustrate the point that there were not strict restrictions on burials in Frankish cemeteries. It is argued here that the Frankish cemetery at Corinth would have allowed for the burial of non-Catholics. It has been shown that Catholics and non-Catholics can be buried in the same area as long as the correct blessing rituals are carried out. As the Greeks outnumbered the Franks it is not unlikely that a burial co-mingling between the two cultures took place. As will be discussed below in the Non-Local discussion, a number of pilgrims or travelers would have been passing through Corinth and if they fell ill and were treated at the hospice, burial in the nearby cemetery would have been the most logical step. In these cases it would not always have been possible to ensure that every individual who fell ill was Catholic.

In summary, the eight individuals who are deemed local could have been higher-class Greeks who through frequent dealings with the Franks became acculturated enough to wish to be buried in a Frankish cemetery. This corroborates analysis of Frankish and Byzantine tomb inscriptions which led Ivison (1996b) to note that intermingling between the two cultures in death very likely occurred. Although it can be argued that some of the individuals may have been Greeks who converted to the Catholic faith, conversions were not commonplace (Brand, 1968).

6.5.1.b Second (or more) generation Franks

The Franks ruled Corinth for over 250 years. The historical sources tell us that after conquering the region many men, including Geoffrey de Villehardouin and Othon de la Roche, sent to France for their wives to come join them (Longnon, 1962). At the behest of William of Champlitte and Geoffrey de Villehardouin, young men from regions across France were invited to the Morea to come seek land and fortune (Dennis, 1968). Men are also to have arrived from Palestine, Syria and the Latin Empire of Constantinople (Cheetham, 1981). Although none of these men would display a local $^{87}Sr/^{86}Sr$ signature, their offspring would. The Frankish men started families and communities in the Morea, whether it was with Frankish women from back home or with local Greek women. Any of the children born of these unions would have spent their childhood in the Morea (and Corinth) and would have local $^{87}Sr/^{86}Sr$ values. It is interesting to note that although the offspring of Frankish individuals would have been considered by the Greeks, and likely by themselves, as foreigners (or 'non-local') in life, they are treated as locals in death.

6.5.2 'Non-local' individuals

Strontium isotope analyses indicate that two of the individuals were of non-local origin. The two non-locals display relatively similar $^{87}Sr/^{86}Sr$ ratios (0.71092 and 0.710047) and concentrations (97.1 and 95.46). This similarity in their $^{87}Sr/^{86}Sr$ signature opens up the possibility that the two non-locals originated from the same region. As well, the $\delta^{18}O$ analysis performed on this population (Garvie-Lok, n.d.) is able to narrow the origin options. Based on the $\delta^{18}O$ results, the two non-local individuals grew up outside of Corinth, but in a region with a similar climate to that of Greece. When hypothesizing possible locations from which the two non-local individuals may have originated, the oxygen results allow for the elimination of a number of areas in northern and central Europe for which biologically available strontium values are available (*e.g.*, Germany, Austria, England) (Grupe *et al.*, 1997; Bentley *et al.*, 2004; Bentley and Knipper, 2005; Budd *et al.*, 2004) and where possible crusaders, merchants and pilgrims may have come from.

As has been mentioned above (see 4.5.3.b) it is not possible to use published geological (bedrock) $^{87}Sr/^{86}Sr$ values as an exact one-to-one indicator of biologically available strontium (Price *et al.*, 2002). In addition, as noted by Lafrenz (2003), the strontium values obtained by geologists are often associated with a very specific geographic area, as opposed to acquiring numerous $^{87}Sr/^{86}Sr$ ratios for large regions. A review of the geological literature concerning strontium values in other areas of Greece and within the Mediterranean Basin reveals a wide variation in strontium isotope values. Examples include the island of Tinos in the Cyclades, which has $^{87}Sr/^{86}Sr$ ratios that range from 0.70373 to 0.71850 in whole rock samples (Bröcker and Franz, 1998). On Santorini samples can vary greatly depending on the type of rock sampled: basalts cluster around 0.703 and 0.704, dacites 0.704, and pumice at 0.705 (Briqueue *et al.,* 1986). In a study of several sites included in the Hellenic Arc (an arc of islands in southern Greece), seven Aegina samples ranged from 0.7041 to 0.7068 and eight Methana samples from 0.7058 to 0.7061 (Pe, 1975). Areas outside of Greece also show a wide degree of variation. Vesuvian lava samples from Italy range between 0.7071 and 0.7102 (Hoffs and Wedepohl, 1968), the region of Hatay in southeast Turkey display values between 0.703353 to 0.705490, depending on the type of rock examined (*e.g.*, basalts or tholeittes) (Alici *et al.*, 2001), and extremely high strontium ratios were returned from Jumilla, Spain (0.7136 to 0.7158) (Powell and Bell, 1970).

It becomes clear that particular types of rocks within a larger bedrock formation may vary widely in their strontium values. Anthropologists are interested in the biologically available strontium and, for this reason, little information is gained by using geological strontium values. As will be discussed in Chapter 7 more biological strontium values are needed in Greece and the Mediterranean for strontium isotope analysis to become more helpful in understanding issues of migration and mobility. As this point while it is not possible to pinpoint the geographic origin of these two non-local individuals, potential suggestions for their cultural background can be discussed.

6.5.2.a Greeks

Although the term *non-local* carries with it the implication of a foreign background, in actuality the two non-local individuals could have come from a number of regions in the Morea and Greece. Non-local merely means that the individuals did not grow up in Corinth proper. At this point, $^{87}Sr/^{86}Sr$ work in Greece and the larger Mediterranean Basin does not allow for further identification as to childhood origin. It is assumed that if Greek individuals from the nearby countryside outside Corinth fell ill, they might have been taken to the hospice for treatment, and may have been buried in the cemetery. The number of Greek travelers or tourists who made the journey to Corinth is at this point unknown.

6.5.2.b Franks

Ciggaar (1996) notes the possible backgrounds for the large number of foreigners who would have traveled through the different regions of Frankish Greece. Included in this list are ambassadors, pilgrims, refugees, fugitives, mercenaries, merchants, artists, scholars, and finally, crusaders. Lock (1995) compiles a more detailed list which discusses the five separate groups of immigrants who entered Frankish Greece both immediately prior to, as well as after, Frankish occupation of the region. These include 1) merchants from Venice, Genoa, and other parts of Italy who had been trading throughout the Aegean in much of the 12^{th} century; 2) French settlers from areas such as Champagne, Flanders and Lombardy, who were there (possibly with state incentives) to increase the Frankish presence in Greece; 3) Frankish officials and soldiers stationed in Constantinople who left the city after it was retaken by the Byzantines in 1261 CE; 4) Catalans who arrived after 1302 and eventually overthrew many of the Frankish lords; and 5) Gascon and Navarrese mercenaries who arrived after 1370 CE. The two final categories of immigrants, the Catalans, and the Gascon and Navarrese mercenaries, may be disregarded, as use of the first phase of the burial ground ended after a earthquake in 1300 destroyed much of Corinth (Williams *et al.*, 1998). However, the first three groups could all have utilized the hospice and, ultimately, the cemetery. It appears that the main groups of immigrants to Corinth would have been pilgrims, crusaders, and merchants.

Pilgrims – Prior to the conquest of Byzantium by the Franks, pilgrims were a fairly common sight in Greece. Pilgrims would have come from a range of social classes and would have originated from a number of regions within Western Europe (Eisner, 1991; Ciggaar, 1996). The process of pilgrimage itself allowed for even the most destitute of individuals to make the journey to the holy land. Cheap food and lodging were provided along the route, pilgrims were exempt from taxes, and in many cases charitable donations were made by wealthier individuals to the poor pilgrim (Ciggaar, 1996). Corinth was not a stopping point on the major pilgrimage routes[24] though it still would have seen the arrival of some pilgrims, who would have stayed in local resting-stops or hotels. Even with the beneficial allowances made to pilgrims, the journey would still have been long and arduous and not all would have survived. Ciggaar (1996) writes that the life expectancy of a pilgrim on the road was short and that many individuals put their affairs into order before departing in case they did not return. The treatment of ill pilgrims would have occurred in the nearby hospice (Williams *et al.*, 1998).

After the 4th century CE, the establishment of hospices became common throughout much of Western Europe. Hospices were increasingly popular during the Crusades, as there were more and more pilgrims who were making the journey to the holy land. Many of these pilgrims became ill on the trip and needed a place to recuperate (Ciggaar, 1996). Hospices specialized in the treatment of the sick and poor and the burial of the dead (Phipps, 1988). Although not all of the pilgrims would have succumbed to their illnesses, it is safe to say that at least some proportion did not complete their

[24] Eisner (1991) describes the route taken by most pilgrims. Beginning in Venice, ships would sail through the Mediterranean stopping at Modon (southwestern Morea), Cythere, Crete, Rhodes, Cyprus and finally Joppa (Jaffa in modern-day Israel).

pilgrimage. These people would have needed some kind of burial ground, much like the one found in Corinth.

Crusaders – Although the majority of men fighting in the Fourth Crusade came from France, other areas also provided men. Venetians, Genoese, Sicilians, Catalans, Navarrese, and Aroganese flowed through Frankish Greece (Heatherington 1991; Lock, 1995), and are regions with somewhat similar climates to that of Greece. These foreign-born men could easily have died in battle or fallen sick while in Corinth. As well, all of the Frankish men and women who established families and communities in the Morea (see 6.4.1.a) immediately after the Fourth Crusade would have eventually required burial.

Traders – The Byzantine Empire was a centre for trading activity as it lay between Central Asia and Europe. The majority of trading occurred in Constantinople, and merchants from Western Europe, Egypt, Persia, Russia, and the Balkans are all said to have converged there (Laiou, 1992). The Venetians enjoyed special tax privileges, and were the most active merchants in the region (Lock, 1995). It is not certain how many of these merchants would have come to Corinth, but the likelihood is strong, considering Corinth's coastal position. Again, if these merchant individuals died in Corinth a proper burial would have been required.

6.5.3 Historical, archaeological, osteological, and isotopic evidence

The nature of Frankish and Greek relations from the 13th to the 15th century is an important topic that has been examined from a number of different viewpoints. The historical sources present somewhat contradictory evidence on topics such as language, religion, policy, and marriage. Most of the primary sources on life and events in

Byzantium and Frankish Greece during the Middle Ages were written by higher-class individuals such as politicians, princesses, and princes (*e.g.*, Niketas Choniates, Anna Comnena, and Geoffrey de Villehardouin). The potential bias of these writers is known, and can be dealt with. Other sources, such as *The Chronicles of Morea* and *The Assizes of Romania*, have writers who remain elusive. However, a completely unbiased historical account of society in Frankish Greece is difficult to obtain. The archaeological examination of 13th C. Corinth has shown a cemetery and hospice situated close to each other in a Frankish neighborhood. Excavators believe that the two existed in association, with the deceased individuals from the hospice being buried in the cemetery (Williams *et al.*, 1998). Osteological examination of human remains from the hospice suggests that the cemetery was used for burial of members of established families, as well as burial of more transient individuals (Williams *et al.*, 1997, 1998; Barnes, 2003).

$\delta^{13}C$ and $\delta^{15}N$ analysis of the ten individuals from 13th C. Corinth suggest that the sample population consumed a fairly uniform diet based on wheat and millet (Garvie-Lok, 2002). Oxygen isotope ratios display a small range of values, which indicate that the individuals grew up in Corinth or a climate similar to Corinth (Garvie-Lok, n.d.). This strontium isotope project was designed to help determine who these individuals were, in the hopes that this would inform on Frankish and Greek cultural integration. The positive identification of eight of the individuals as locally born supports Barnes' conclusion that the cemetery was used in part by families from Corinth (Williams *et al.*, 1998; Barnes, 2003). As this point, the strontium analysis is not able to say conclusively whether these local individuals were of Greek or Frankish descent. The two non-local individuals display very similar $^{87}Sr/^{86}Sr$ values, suggesting they grew up in the same geochemical region. The possibilities for determining this geochemical region present interesting opportunities for future work using $^{87}Sr/^{86}Sr$ analysis in Greece and the Mediterranean.

6.6 CONCLUSION

Results of the $^{87}Sr/^{86}Sr$ analysis indicate that eight of the individuals examined were of local origin, while two individuals display non-local $^{87}Sr/^{86}Sr$ values. Distinguishing between local and non-local individuals in this research was complicated by a narrow range in $^{87}Sr/^{86}Sr$ values for the faunal bone samples. It was necessary to use a combination of methods used in the literature to properly distinguish the locals from non-locals. It is important to remember that $^{87}Sr/^{86}Sr$ analysis can both under- and overestimate the amount of movement and migration occurring in any given population. Underestimation of movement occurs because strontium isotope analysis does not identify individuals who moved between geochemically similar regions (Grupe *et al.*, 1997). Conversely, $^{87}Sr/^{86}Sr$ analysis may overestimate movement by identifying individuals as non-local when in fact they are locals who were acquiring their food from a wider (and not geochemically similar) catchment area (Bentley *et al.*, 2003, 2005). As Greece in the Middle Ages was an agrarian society that did not practice wide range foraging, it is more likely that migration and movement are being underestimated at Corinth.

The eight local individuals are hypothesized to have come from one of two cultural backgrounds: Greek or Frankish. It is possible that representatives from both populations were interred in the cemetery and are now found to display local $^{87}Sr/^{86}Sr$

values. If they were Greek, they were likely high-status Greeks who had a heavy degree of contact with the ruling Franks, and become acculturated enough to be buried in the Frankish cemetery. If some or all of the individuals had a Frankish background they would have had to have been either second (or more) generation. The first Franks who arrived in Corinth would have retained their non-local $^{87}Sr/^{86}Sr$ signatures in their enamel. The subsequent offspring of the Franks however, would have acquired a local $^{87}Sr/^{86}Sr$ value during childhood. As the Franks ruled Corinth for over 250 years, a burial place would have been required for all the Franks who died there.

The two non-local individuals are much harder to pin down in terms of geographic origin, although $\delta^{18}O$ does suggest a childhood spent in a warm climate such as Corinth. Both sexes are represented in the non-local category. This means that both males and females were mobile in the Middle Ages in Greece. Possible suggestions for the background of these individuals include Frankish crusaders, traders, and pilgrims. They individuals may also have been of Greek descent, and merely spent their childhood in a geochemically dissimilar area somewhere outside of Corinth. At this stage, it is not possible to say definitively who these individuals were, or where they originally came from. It is obvious that further strontium isotope work is required in both Greece and the Mediterranean Basin. Suggestions for specific future research goals will be discussed in the following chapter.

CHAPTER SEVEN – FUTURE CONSIDERATIONS

7.1 INTRODUCTION

This research served as a preliminary inquiry into the utility of using strontium isotope analysis as a means to better understand interactions between two cultures during an intriguing and understudied period in Greece. In the end, while the results are somewhat inconclusive with regard to the actual cultural affinity of the individuals tested, they do provide some insight into cultural integration at Frankish Corinth. In addition, this research is able to provide several suggestions for future strontium isotope work in Corinth and the Mediterranean, and also highlights the limitations of the method.

Any anthropological study that utilizes the $^{87}Sr/^{86}Sr$ ratio in skeletal remains seeks to answer, at the most fundamental level, two main questions: who are these people, and where did they come from? As has been explained in the previous chapters, the origin and movement of individuals across the landscape can inform on a variety of cultural issues. In particular, this research was interested in examining evidence for cultural integration between ruling-class Franks and local Greeks. This study identified eight of the ten individuals as local, and two individuals as non-local. If some or all of the eight local individuals are of Greek descent, their burial in a Frankish cemetery would indicate that cultural integration at Corinth was occurring to a much larger extent than had previously been suggested by historical sources. However, the possibility also exists that some or all of the locals were second or more generation Franks. While this is not directly related to cultural integration *per se*, it would provide information about the formation of Frankish communities in Corinth, and would support Barnes' (2003) conclusion that long-term familial use of the cemetery was occurring. Even more possibilities exist for the origin of the two non-local individuals, though their very similar $^{87}Sr/^{86}Sr$ ratios present the likelihood that they originally came from the same region. The oxygen isotope results (Garvie-Lok, n.d.) narrow the possibilities substantially, as the individuals came from a warm climate similar to that of Corinth. This eliminates many regions in Western Europe, but still leaves any number of areas within the Mediterranean Basin as possible sites of origin.

This research is of considerable relevance since it was able to demonstrate that $^{87}Sr/^{86}Sr$ analysis is a feasible form of inquiry into the cultural habits of past populations in Greece. Furthermore, it is able to provide a number of suggestions for how the next round of $^{87}Sr/^{86}Sr$ analysis performed in Greece should be conducted. These suggestions are listed below.

7.2 FUTURE CONSIDERATIONS

As has been stated previously, this research was designed as a pilot study for $^{87}Sr/^{86}Sr$ analysis in Greece. More work is required to bring further clarity both to the findings of this study and to the results of any future strontium isotope research in the same region; listed below are suggestions for these future $^{87}Sr/^{86}Sr$ analyses. The first suggestion is fairly evident – more $^{87}Sr/^{86}Sr$ analysis needs to be done on human remains from a wide range of sites within Greece and surrounding regions. This will help develop a database and regional map of $^{87}Sr/^{86}Sr$ values with which to compare individual values, and will also inform on the amount of $^{87}Sr/^{86}Sr$ variation that can be seen across the Mediterranean. Specifically for this research, it would be helpful to have $^{87}Sr/^{86}Sr$ values from a number of sites surrounding Corinth. This could possibly give us clues as to whether the two non-local individuals found in this study were actually from areas quite close to, but outside of, Corinth.

While diagenetic issues were not a major concern for this study a better understanding of the post-depositional environment would be possible by determining the $^{87}Sr/^{86}Sr$ ratio of an individual's enamel and dentine. Dentine is much more prone to chemical contamination or alteration after death than enamel (Budd *et al.,* 2000) and would be able to present a clearer picture of the level of diagenesis occurring at the site. While this could also be achieved through the analysis of bone, at some sites it is not always possible to positively match an individual's skeletal and dental remains due to grave mixing or disturbances.

In addition, more $^{87}Sr/^{86}Sr$ analyses of faunal specimens from a wider catchment area in Greece are required. This would assist in the establishment of a database, and the analysis of faunal remains would provide much-needed local values. In a sense, large-scale $^{87}Sr/^{86}Sr$ analysis of human remains means nothing if there are no local values for comparison. It is also suggested that future faunal analysis use enamel tissue, as opposed to the bone tissue used in this study. This will help eliminate faunal bone $^{87}Sr/^{86}Sr$ values that fall within such a narrow range that it is difficult to establish a 'local' and 'non-local' range. It will also do much to eliminate any possibility that diagenetic processes have somehow altered the biogenic $^{87}Sr/^{86}Sr$ signal. If no faunal specimens of either teeth or bone are available for study, the analysis of ecological samples such as water, plants, and soils is advised.

Finally, while this study has used information from a number of isotopic analyses to determine the geographical origin of these individuals, it is possible that the inclusion of lead isotopes may provide further information. Though lead concentration has been used frequently to distinguish between socio-cultural groups (Aufderheide *et al.,* 1981, 1985, 1989; Handler *et al.,* 1986; Reinhard and Ghazi 1992; Ghazi *et al.,* 1994), lead isotopes have also proved successful at separating individuals based on their exposure to lead (Molleson *et al.,* 1986; Carlson, 1996). Lead isotopes are similar to strontium isotopes in many ways: lead is not fractionated as it travels from the ground into the skeleton, lead ore deposits present unique signatures based on date of formation, and there is enough variability to possibly allow for the provenance of human remains to be determined (Carlson, 1996). Essentially, humans are exposed to lead by natural or anthropogenic causes through inhalation, ingestion, or absorption; over 90% of lead ends up in the skeletal system (Barry, 1975; Gross *et al.,* 1975). If enough lead isotope signatures are known for deposits across Europe, the examination of lead isotopes in humans remains could help to further pinpoint geographic origins (Bower *et al.,* 2005). However, the lack of information at this time of lead isotope values for ore deposits limits prospects for the widespread use of this analysis.

Ultimately, the examination of different isotope systems will represent separate and independent indicators of where an individual originated (Bentley and Knipper, 2005). The use of several isotope analyses means that even if some of the isotope systems prove uninformative, there are likely to be some that can help to further inform on cultural processes in the past.

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