Traveling Monastic Paths: Mobility and Religion in Medieval Ireland at Five Early and Late Medieval Irish Monasteries

by

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ABSTRACT

Mobility is an important aspect of the lives of religious individuals described by medieval texts in early and late medieval Ireland, and biogeochemical methods can be used to detect mobility in archaeological populations. Stories are recorded of monks and nuns traveling and founding monasteries across Ireland, Scotland, England, Wales, and other areas of Europe. However, these texts rarely address the quotidian lives of average monks and nuns who lived in monastic communities. This dissertation seeks to understand if travel was a typical part of the experiences of religious and lay people in early and late medieval Ireland. It also aims to increase understanding of how monastic communities related to the local lay communities, including addressing if the monastery was populated by those who grew up in the local area. Another methodological aim of this dissertation is to advance the field of archaeological biogeochemistry by (1) adding to the bioavailable strontium baseline in Ireland and (2) quantifying the contribution of ocean-derived strontium to coastal environments. These topics are explored through the biogeochemical analysis of 88 individuals buried at 5 early and late medieval monasteries in Ireland and the analysis of a total of 85 plant samples from four counties in Ireland. The three papers in this dissertation present: (1) a summary of the mobility of religious and lay people buried at the monasteries (Chapter 2), (2) a case study presenting evidence for fosterage of a local child at the early medieval monastery of Illaunloughan, Co. Kerry (Chapter 3), and (3) a study designed to quantify the impact of sea spray on bioavailable strontium in coastal environments (Chapter 4). The majority of lay and religious individuals studied were estimated to be local, indicating that medieval Irish Christianity was strongly rooted in the local community. The study of ocean-derived strontium in a coastal environment

indicates that sea spray has a non-uniform impact on bioavailable strontium in coastal regions. These findings shed new light on medieval monastic and lay life in Ireland through the application of biogeochemical methods, contributing to the growth of the field of archaeological chemistry in Ireland.

DEDICATION

To my parents, Sam and Judy, and my husband Dualtagh. Thank you for your constant love and support.

ACKNOWLEDGMENTS

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CHAPTER 1

INTRODUCTION

1. Introduction

Biogeochemical methods can be used to detect mobility of people who lived in the past, and mobility is a key theme in medieval Irish texts written about religious individuals including saints, monks, and nuns (Charles-Edwards, 2000; Flechner and Meeder, 2016; Hughes, 1966; Johnston, 2016; Loveluck and O'Sullivan, 2016). These texts suggest that religious people traveled around Ireland and Europe, often bringing faithful followers with them (Campbell, 1968; Edwards, 2002; Sharpe, 1995; Sharpe, 1991). However, the texts rarely address the lives of average members of a religious community, and it is unclear whether these members grew up in the local area or traveled long distances to join monasteries. This dissertation addresses these issues by analyzing the remains of 88 individuals buried at five medieval Irish monasteries (Chapter 2). One monastery in particular, Illaunloughan, is highlighted in a case study concerning the practice of fosterage at monasteries (Chapter 3). This dissertation also aims to expand the field of archaeological chemistry in Ireland through the creation of a baseline of bioavailable strontium for four counties (Co. Kerry, Co. Louth, Co. Tipperary, and Co. Wexford) based on 67 plant samples (Chapter 2). A third paper adds to the field of archaeological chemistry by measuring the effect of sea spray on the bioavailable strontium in coastal terrestrial settings, which has been cited as a factor that increases uncertainty when drawing conclusions about mobility based on biogeochemical data

(Chapter 4). This dissertation seeks to advance both applications of archaeological chemistry and understandings of religious and lay life in medieval Ireland.

2. Archaeology and isotopes in Ireland

Archaeological chemistry is a growing field in Ireland, and several studies investigating mobility in archaeological populations have been done by members of the Irish Isotopes Research Group. Goals of this group include building the baseline of bioavailable radiogenic strontium isotope ratios for all of the geological settings on the island of Ireland and increasing the amount of biogeochemical data in published sources (Daly et al., 2016). The result of these studies has been both an increased awareness of potential applications of archaeological science in Ireland and a better understanding of mobility in Ireland's past. Mobility has been examined in the context of the Neolithic and Bronze Age (Snoeck et al., 2016), the Iron Age (Cahill Wilson and Standish, 2016), the Viking Age (Knudson et al., 2012; Montgomery et al., 2014), and the early medieval period (Daly, 2015). In general, these studies have found a low percentage of individuals who were non-local to the site where they were buried (e.g., Knudson et al, 2012; Cahill Wilson and Standish, 2016), and even fewer individuals who originated outside of Ireland (e.g., Montgomery et al., 2014). However, studies that analyzed mobility at different ages by testing multiple skeletal and dental elements per individual found that a higher percentage of individuals had different radiogenic strontium ratios throughout their lifetimes, perhaps signifying some level of mobility within Ireland (e.g., Daly, 2015). This indicates that mobility within Ireland may have been practiced in the prehistoric and early historic periods, although the studies discussed above focus mostly on non-locals who originated from outside of Ireland.

3. Mobility and monasticism in medieval Ireland

Many texts suggest that mobility was a vital part of the process of founding and maintaining monastic communities in early and late medieval Ireland (Charles-Edwards, 2000; Flechner and Meeder, 2016; Hughes, 1966; Johnston, 2016; Loveluck and O'Sullivan, 2016). During the early medieval period (5th-12th centuries AD), Ireland was transitioning from a pagan to mostly Christian society, and texts suggest that religious individuals traveled across Ireland founding monastic communities, as demonstrated by proliferation of church sites during that period (d'Arcy, 1974; Hughes, 1966). During the late medieval period (12^{th}-16^{th} centuries AD), monastic orders that were centered elsewhere in Europe, including the Cistercians and Dominicans, began to found abbeys in Ireland (O'Keeffe, 2003; Stalley, 1987). Mobility has been cited as a mechanism that expands social networks and introduces new social and religious practices (Anthony, 1990; Baker and Tsuda, 2015; Burmeister, 2000; Stark, 1996; Tilly, 1978). Mobility likely played a vital role in spreading different forms of Christian practice in Ireland.

Archaeologists use biogeochemical methods, involving the radiogenic strontium and stable isotopic systems, to better understand the movements that individuals took during their lifetimes (e.g., Bentley, 2006; Ericson, 1985; Ericson, 1989; Knudson et al*.*, 2012). In this dissertation, radiogenic strontium isotope ratios and oxygen isotope values are used to estimate the mobility of eighty-eight religious and lay people buried at five medieval Irish monastic sites. Contextual archaeological data are used to assess the likelihood that an individual is lay or monastic, and a comparative baseline of radiogenic strontium isotope ratios of bioavailable strontium was constructed from sixty-seven plant samples from four counties (Co. Kerry, Co. Louth, Co. Tipperary, and Co. Wexford). The data are utilized to calculate the percentage of mobile religious and lay people at each site in order to compare religious and lay mobility during the early and late medieval periods. The results of this study provide a unique line of evidence for evaluating the role of mobility in religious and lay life in medieval Ireland.

4. Mobility and fosterage at Illaunloughan, Co. Kerry

Illaunloughan is an early medieval monastic site set on a small island between the Iveragh Peninsula and Valencia Island, Co. Kerry. The site contains the remains of a stone oratory, small beehive huts, and a reliquary or shrine (Marshall and Walsh, 2005; Ó Carragáin, 2009). It is a notable site because the monastic graveyard is one of only two early medieval monastic burial contexts that has been excavated in Ireland to hold an exclusively male and juvenile burial population, in addition to Skellig Michael, Co. Kerry (Marshall and Rourke, 2000; Marshall and Walsh, 2005; Scally, 2014). The presence of juveniles at these sites offers evidence for fosterage, in which the child was educated and cared for by people who were not members of the child's biological family in either lay or monastic contexts (Kelly, 1988; Ní Chonaill, 1997; Parkes, 2006; Parkes, 2004; Preston-Matto, 2011). This study seeks to understand how fosterage was practiced in the case of this individual buried on Illaunloughan and if the juvenile was from the local community before undergoing fosterage on the island.

Also, Illaunloughan was set within the early medieval region of Corcu Duibne, which was composed of three distinct areas that were controlled by kin groups called the Áes Irruis Deiscirt, Áes Conchinn, and Áes Irruis Tuascirt on the Dingle and Iveragh Peninsulas (MacCotter, 2008; MacCotter and Sheehan, 2009: 148). The cultural context of Illaunloughan provides the possibility to better understand the role that a small island monastery may have played in the overarching structure of the Church in early medieval Ireland. Scholars of medieval Ireland have argued that monastic communities took on different roles that range from isolationist, ascetic monasteries to those that ministered to lay people (Charles-Edwards, 2000). Some monasteries were likely more important to secular politics than others, and some monasteries probably had influence in only the local area (Mytum, 1992). The nearby island monastery of Skellig Michael was recorded in historical texts as an important site, whereas no records exist concerning Illaunloughan (Marshall et al., 2005; Ó Carragáin, 2003b; Scally, 1999).

This study seeks to better understand the role that Illaunloughan played within the broader structure of the Church, and the origins of three individuals in total are analyzed to better understand if the monastery had ties outside of the local area. Scholars have proposed that Illaunloughan was a proprietary monastery built and run by a family group (Marshall and Walsh, 2005; Mytum, 1992; Ó Carragáin, 2003b), and the practice of fosterage may have provided an avenue to connections with other areas outside of the Iveragh peninsula or it may have occurred within a local kin group. Such a kin group may have been particularly connected to the Church and known as *manach*-tenants who supplied both goods and personnel to the Church (Etchingham 1991: 118). The results reported here add to existing knowledge about life at early medieval island monasteries by addressing how the local lay community was connected to the monastic community.

5. Quantifying the impact of sea spray on bioavailable strontium in coastal regions

Archaeologists use radiogenic strontium isotope ratios to estimate whether people are local to the sites at which they are buried (Bentley, 2006; Ericson, 1989; Ericson, 1985; Knudson et al., 2012). Radiogenic strontium isotope ratios vary spatially based largely on the age of the underlying bedrock, and the ratios are preserved between the ecosystem's trophic levels (Blum et al., 2000; Dasch, 1969; O'Connor, 1988; Wallace et al., 1994). Because of this, strontium found in human bone and teeth is typically expected to reflect the underlying bedrock of the plants or animals that compose the human diet, although some processes such as soil formation and erosion can make certain sources of strontium more bioavailable to plants and animals (Bentley and Knipper, 2005; Knudson et al., 2014).

Another factor complicating the radiogenic strontium isotope system is the Sea Spray Effect, which refers to the possibility that ocean-derived strontium could overwhelm the sources of strontium found in terrestrial ecosystems (Montgomery et al., 2007). This is due to ocean water exhibiting a nearly uniform constant ratio ($^{87}Sr/^{86}Sr=0.7092$) worldwide (McArthur et al., 2001; Veizer, 1989). Whipkey et al. (2000) estimated that sea spray contributes 50-80% of bioavailable strontium in soil situated 50 m from the coastline of Hawaii, but the impact of sea spray has not been examined at other distances from the coast. Further, the implications of the Sea Spray Effect on studies of paleomobility have not been fully examined. This is especially relevant to the study of mobility at Irish monastic sites, such as Illaunloughan and Tintern Abbey (see Chapters 2 and 3) because many of them are located in coastal areas or on small islands.

In order to study the impact of the Sea Spray Effect at several distances from the coast, fifteen experimental samples and three control samples of plants growing near the western edge of the island of Inishark, Co. Galway, Ireland were collected. Based on the radiogenic strontium isotope ratio of seawater and that of the control samples, a mixing equation was used to estimate the percentage of strontium in the experimental samples that can be attributed to sea spray. Based on these findings, the implications for archaeological studies of mobility are presented and suggestions for baseline sampling practices are discussed. Future research, involving the measurement of soil depths, are recommended to better understand the Sea Spray Effect.

6. Contents

This dissertation contains three unpublished manuscripts addressing the topics described above.

Paper 1:

Title: Traveling Monastic Paths: Mobility and Religion in Medieval Ireland at Five Early and Late Medieval Irish Monasteries

Author List: Elise Alonzi, Kelly Knudson, other authors pending

Paper 2:

Title: Illaunloughan: A Case Study of Local Monastic Fosterage of a Juvenile in the Early Medieval Corcu Duibne Region

Author List: Elise Alonzi, Kelly Knudson, other authors pending

Paper 3:

Title: The Sea Spray Effect and Its Impact on Bioavailable Radiogenic Strontium Ratios in Coastal Environments

Author List: Elise Alonzi, Sofía Pacheco-Forés, Gwyneth Gordon, Ian Kuijt, Kelly J. Knudson

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CHAPTER 2

TRAVELING MONASTIC PATHS: MOBILITY AND RELIGION IN MEDIEVAL IRELAND AT FIVE EARLY AND LATE MEDIEVAL IRISH MONASTERIES

Elise Alonzi, Kelly Knudson, other authors pending

Author Contributions:

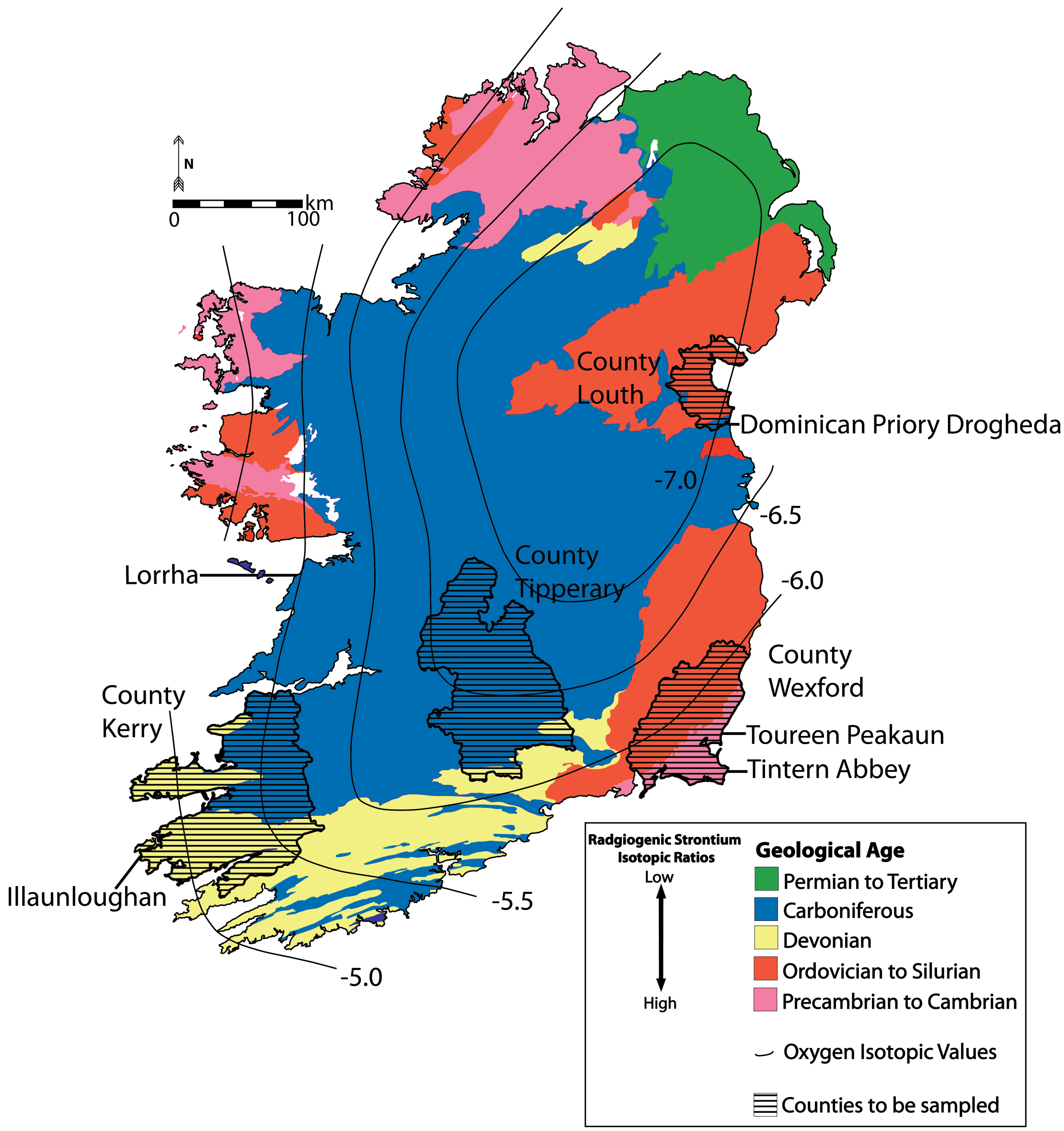
EA and KK conceived of the project, EA collected samples, performed the chemical analyses, and wrote the document

1. Introduction

Travel is recorded as a notable event in the lives of many high-status Irish monks and nuns, and according to medieval Irish texts, they traveled extensively in continental Europe, Ireland, Scotland, Wales, and England to lead and found monastic communities (Charles-Edwards, 2000; Flechner and Meeder, 2016; Hughes, 1966; Johnston, 2016; Loveluck and O'Sullivan, 2016). In the early medieval period (5^{th}-12^{th} centuries AD), mobility is cited as part of the mechanism for spreading and popularizing Christian practice in a previously pagan society (d'Arcy, 1974; Hughes, 1966). In the late medieval period (12^{th}-16^{th} centuries AD), monastic orders from elsewhere in Europe, such as France and England, founded abbeys in Ireland (O'Keeffe, 2003; Stalley, 1987). Mobility is a mechanism that can introduce new cultural practices (Anthony, 1990; Baker and Tsuda, 2015; Burmeister, 2000; Tilly, 1978), and religious institutions are formed and changed by the cultural practices of the members who participated in the religion (Stark, 1996). However, medieval texts do not indicate how common it was for medieval Irish people to be mobile if they were not one of the venerated saints or part of the elite class, and it is unclear what role mobility truly played in the spread and practice of Christianity. Did people who lived monastic lives in medieval Ireland experience mobility differently than those in lay communities?

In this study, mobility in medieval Ireland is examined through the biogeochemical analysis of eighty-eight individuals who were buried at five early and late medieval (8^{th}-16^{th} centuries AD) Irish ecclesiastical and monastic sites to elucidate to what extent mobility was practiced by medieval Irish people (see Figure 1). These sites include: Illaunloughan, Co. Kerry; Toureen Peakaun, Co. Tipperary; Lorrha, Co. Tipperary; Tintern Abbey, Co. Wexford; and Dominican Priory, Drogheda, Co. Louth. This paper addresses the following questions: (1) How did the patterns of mobility for lay and religious people compare between the early and late medieval period? and (2) How frequently did ecclesiastical people move away from their natal communities to live at a monastery? Archaeological context is used to estimate which individuals were likely members of the religious and lay communities, and rates of mobility in these groups are compared to add to the narrative of the development and practice of Christianity in medieval Ireland. This study will supply a better understanding of the lived experience of medieval Irish monasticism and will further develop the contextualization of monasticism within everyday life in medieval Ireland.

Figure 1. Map of $^{87}Sr/^{86}Sr$ and $\delta^{18}O_{D\text{-}SMOW}$ distributions, site locations, and counties sampled for the bioavailable radiogenic strontium isotope baseline (Darling 2003; Geological Society of Ireland 2017).



2. Early and late medieval monasticism in Ireland

2.1. Early and late medieval Ireland: An introduction

Early (5^{th}-12^{th} centuries AD) and late (12^{th}-16^{th} centuries AD) medieval Ireland are distinct time periods during which Irish culture changed politically, socially, and religiously. Ireland was divided into over one hundred chiefdoms of kingdoms, or *tuatha,* during the early medieval period (Jaski, 2000; Kelly, 1988; Wailes, 1995). Christianity was introduced by missionaries from the continent and Britain in the fifth century, and the elite invested in ecclesiastical buildings and monastic communities in part to bolster their political influence (d'Arcy, 1974; Manning, 1995; Ó Carragáin et al., 2011). Scholarship flourished as law tracts, religious texts, and poetry were written in monasteries, ecclesiastical sites, and royal sites (Duncan, 2016; Kelly, 1988). Around the ninth century, Vikings began raiding Irish monasteries and starting colonies in Ireland such as Dublin (Barrett, 2003; Etchingham, 2001; Etchingham, 1996; Knudson et al., 2012). During the early medieval period, institutionalized power in the form of kingdoms and the Church became more prevalent in Ireland than it had been in the preceding Iron Age (Kelly, 1988).

The Anglo-Normans arrived in Ireland in AD 1169, beginning the late medieval period (Barry, 1987; Otway-Ruthven, 1968). Smaller kingdoms were consolidated into larger territories and provinces, and continental monastic orders, such as the Dominicans and Cistercians, founded monastic houses in Ireland (Barry, 1987; O'Keeffe, 2003; Otway-Ruthven, 1968; Potterton, 2005). During this period, Ireland became more politically connected to England, and families who claimed origins outside of Ireland owned significant areas of land (Otway-Ruthven, 1968). Late medieval Ireland differs from early medieval Ireland in the increase of formalized political, social, and religious ties to groups outside of the island of Ireland.

Life in medieval Ireland can be examined through archaeological data, and much information about medieval Ireland is recorded in contemporary texts. These include annals which were typically written at ecclesiastical sites (Hennessy, 1871; Mac Airt and Mac Niocaill, 1983; Manning, 2000; McCarthy, 2008; O'Donovan, 1851; Warner, 1990), narratives of saints' lives called hagiographies (Campbell, 1968; Edwards, 2002; Sharpe, 1995; Sharpe, 1991), and law texts (Kelly, 1997; Kelly, 1988). These texts are useful sources, but they often portray the idealized lives of the elite rather than the daily experiences of average people living in medieval Ireland. Also, these texts were influenced by the political and religious contexts of the authors, who were members of monasteries that held elite places in society that relied on the economic and political support of secular patrons (Johnston, 2013:95). For instance, the text of the Life of St. Brigit was used by Cogitosus to assert the dominance of the church in Kildare by suggesting that the Kildare church was part of a *paruchia* that spread throughout Ireland (Stout, 2017:73).

3. Christianity in early and late medieval Ireland

Beginning in the early medieval period, Christianity rose to prominence in Ireland. In AD 431, Palladius was sent from Rome as a missionary, beginning the conversion of Ireland that was continued by St. Patrick and others (Charles-Edwards 2000; d'Arcy, 1974; Manning, 1995). A distinctly Irish version of Christianity began to develop, which over time caused differences in the practices undertaken by medieval Irish people and the doctrines promoted by the Church in Rome (d'Arcy, 1974; Edwards, 1990; Manning, 1995:5; Ó Carragáin, 2011). These differences included issues such as the date of Easter and differences in monastic practices (Campbell, 1968; Ó Cróinín, 1982; O'Hagan, 2012).

Early medieval Irish monasteries often followed ascetic doctrines, which emphasized withdrawing from society to follow austere ways of life. Some of these communities were influenced by the practices of St. Anthony, who founded a community of ascetic monks in the Egyptian desert (Bitel, 1994; Follett, 2006; Rousseau, 1978). Often these solitude-seeking communities or individual hermits sought out harsh and isolated locals such as island in the Atlantic and sparsely inhabited areas (Ó Carragáin, 2013). Other monasteries, known as *civitas*, were founded in populous areas and ministered to the community of lay people (Bolger and Moloney, 2012, 2014; Charles-Edwards, 2001:119; Valante, 1998). Saints' lives suggest that some powerful saints founded several monasteries across Ireland and Scotland that were allied as *paruchiae* or federations of monasteries (Charles-Edwards, 2001; Hughes, 1966:63; Ó Carragáin, 2011:9). For instance, the influential St. Columba is reported to have founded monasteries in modern day Scotland, Northern Ireland, and the Republic of Ireland (Sharpe, 1995; Valante, 1998:6). However, the monastic *paruchiae* may not have had as important a role in religious practice as it was suggested in these texts (Etchingham, 1993). These texts form a valuable starting place for inquiries about everyday life at a monastery, but they do not shed light on how the average monk or nun might have experienced mobility.

The Church in Ireland underwent significant changes in the eleventh and twelfth centuries. At the Synod of Ráth Breasil in AD 1111, regional dioceses were formed that changed the previously close relationship between the Church and the regional secular leaders (Hughes, 1966:258). This reorganization opened up the opportunity for monastic orders from the Continent and England to found Irish monasteries, which were much larger and more formalized than the early medieval monasteries (Stalley, 1987). By the beginning of the twelfth century, Cistercian, Augustinian, Dominican, Benedictine, and other orders had founded monasteries in Ireland (Burton, 1994; Flynn, 1993; Hughes, 1966). These were often located in resource-rich areas on land granted by wealthy families or in the center of large towns. Politically powerful donors, some of whom were Anglo-Norman, socially and monetarily supported these monasteries (Potterton, 2005; Stalley, 1987). Non-wealthy people may have been excluded from some areas of religious practice, as the late medieval monastic communities were arranged hierarchically from lay brothers who were essentially agricultural workers, to the academically trained choir monks, to the powerful abbot (Hughes, 1966; Stalley, 1987). The system of Continental monastic orders and regional dioceses was in place until Henry VIII dissolved the monasteries in the sixteenth century (Ellis, 1990; Stalley, 1987). At this point the monastic buildings were sold to wealthy families and converted to domestic residences or demolished to be used as quarries (Lynch, 2010; Potterton, 2005; Stout and Stout, 2016).

4. Archaeological studies employing isotope methods in Ireland

Biogeochemical methods have been used to understand mobility in several medieval Irish contexts. Knudson et al. (2012) analyzed individuals buried in Viking Dublin (10^{th}-13^{th} centuries AD). The data indicate that the majority of the study population likely originated from near the burial site, although some may have moved to the area later in life (Knudson et al., 2012:317). Based on oxygen isotopic values ($\delta^{18}O$), Cahill Wilson and Standish (2016) suggest that several of the twenty-seven individuals dating from the fourth to seventh centuries AD who were buried at sites in eastern Ireland were of non-local origin. Daly (2015) found that nine of the eleven individuals buried at the Corbally 1 and 2 sites in County Kildare were mobile during their lifetimes. Two individuals buried at the early medieval monastery on High Island, Co. Galway were analyzed, and at least one appears to be non-local based on its $\delta^{18}O$ (Cahill-Willson et al., 2014). However, large scale biogeochemical analyses of individuals buried at early and late medieval monastic sites in Ireland have not been completed until this project.

5. Sites included in this study

Illaunloughan, Co, Kerry (4 individuals, see Figure 1 and Tables 1 and 2): Illaunloughan is an island that lies between Valencia Island and the Iveragh Peninsula in County Kerry. The architectural remains on the island include a drystone oratory, several beehive huts known as *clóchans,* and a reliquary shrine (Marshall and Walsh, 2005). A monastic community was founded on this small island in the mid-seventh century, and it was likely a proprietary site that was run by and passed down within a family (Alonzi et al., In Preparation-b; Marshall and Walsh, 2005; Mytum, 1992; Ó Carragáin, 2003b). Of the seventeen individuals who were buried on Illaunloughan during the early medieval monastic phase, three were juveniles, twelve were adult males, sex could be identified for two individuals (Buckley 2005: 3). This has been interpreted as evidence for fosterage at the monastery (Alonzi et al., In Preparation-a; Buckley, 2005; Marshall and Walsh, 2005). The burials analyzed in this study were excavated from the area around the drystone oratory on the eastern end of the island (Marshall and Walsh, 2005). The island was used for burial after the monastic community had dissolved in the late ninth century, and one burial tested here is from the later phase (Marshall and Walsh, 2005).

Toureen Peakaun, Co. Tipperary (8 individuals, see Figure 1 and Tables 1 and 2): This monastic site was founded in the Glen of Aherlow in County Tipperary by St. Abban in the mid seventh century, and it is named after St. Béccán, who is recorded as the monastery's first abbot by the *Annals of Ulster* and the *Annals of Inishfallen* (Charles-Edwards, 2002; Mac Airt and Mac Niocaill, 1983; Ó Carragáin, 2016). A twelfth century church is extant on the site, but excavations have revealed that this may have been preceded by an earlier church building (Ó Carragáin, 2016). Also, excavations have revealed a possible hermitage area adjacent to the monastic site that appears to be built in the middle of a stream or small waterway (Ó Carragáin, 2016). The site is notable for housing a large engraved high cross and around thirty early medieval inscribed stones, many that appear to be grave markers inscribed with names. The individuals buried at this monastery compose two early medieval burial phases, and some may have Anglo-

Saxon ties (Ó Donnabháin and Mhurchadha, 2010). One stone appears to be “signed” by an artisan with an Anglo-Saxon name (Charles-Edwards, 2002:118), and St. Béccán was one of those addressed in a letter from St. Cummian, an Anglo-Saxon saint who was supported the Roman Church’s date for Easter over the Celtic Church’s date of Easter in the famous Easter Controversy (Ó Cróinín, 1982; O'Hagan, 2012).

St. Ruadhán’s Church, Lorrha, Co. Tipperary (10 individuals, see Figure 1 and Tables 1 and 2): The monastic site at Lorrha was likely founded in the sixth century AD, based on annalistic evidence for St. Ruadhán and archaeological excavations of the ecclesiastical enclosure (Bolger and Moloney, 2014; Bolger et al., 2012; Linnane, 2002). In the early medieval period, the *Annals of Inishfallen* and the *Annals of Ulster* record both bishops and abbots at Lorrha, which suggests that it had both ecclesiastical and monastic functions (Bolger et al., 2012: 113). Lorrha had links with the ascetic and fundamentalist Céli Dé movement, and the associated text known as the Stowe Missal was held at Lorrha from about the eleventh to fourteenth centuries AD (Bolger et al., 2012; Follett, 2006). After the reorganization in the twelfth century at the Synod of Ráth Breasil, Lorrha lost its status as an episcopal center and was part of the Killaloe diocese (Bolger et al., 2012: 115). Around this time, Augustinian monastic rule was adopted at the site, and a larger Augustinian priory was built within the original ecclesiastical enclosure (Bolger et al., 2012:113). The individuals included in this study were buried to the west of the western wall of the eleventh century stone church, and their dates of burial span the early and late medieval periods (Bolger et al., 2012; Ó Carragáin, 2011). Other architectural remains at the site include two carved high crosses (8^{th}-9^{th} century AD) and the fifteenth century priory (Bolger et al., 2012).

Tintern Abbey, Co. Wexford (24 individuals, see Figure 1 and Tables 1 and 2): This abbey was founded around AD 1200, when William Marshall, the Earl of Pembroke, survived a shipwreck on the southern coast of Ireland and vowed to found a monastery in thanks (Lynch, 2010: 3). Monks from Tintern Abbey in Wales traveled to the newly founded monastery to populate it, and both monasteries were in the Cistercian order, which originated in France (Lynch, 2010: 4). The monastic house remains largely intact today, as it was given to the Colclough family after its dissolution in 1536, who lived there until 1959 (Lynch, 2010: 9). The burials in this study were excavated from within the monastic church, including the nave, chancel, transept, ambulatory, and chapel the churchyard (Lynch 2010:39).

Dominican Priory Drogheda, Co. Louth (42 individuals, see Figure 1 and Tables 1 and 2): This priory was likely founded in AD 1224 (Bradley, 1978; Halpin and Buckley, 1995). It was a high-status monastic house, as two Archbishops of Armagh were buried at the site during the twelfth century, but it had largely fallen into ruin before the monastery was dissolved by King Henry VIII in AD 1540 (Bradley, 1978; Halpin and Buckley, 1995). There are few standing remains of the monastery, consisting only of a bell tower. The individuals in this study were buried in the churchyard during the late medieval period (12^{th}-14^{th} century AD) based on radiocarbon dating and artifactual evidence (Halpin and Buckley, 1995:193). One area of the site housed mainly male burials, perhaps belonging to members of the Dominican religious community, while another part of the site has a sex distribution indicative of the lay community (Halpin and Buckley, 1995:193).

Table 1. Contextual Information and Isotope Data for Human Samples.

Laboratory Number	Specimen Number	Site	Age	Sex	Time Period and Date	Ecclesiastical or Lay (E or L)	Skeletal Element	$^{87}Sr/^{86}Sr$	$\delta^{18}O_{VPDB}$	$\delta^{18}O_{dw[V\text{-}SMOW]}$
ACL-8597	IRE-TP-0519	Toureen Peakaun	Younger adult	Probably male	EM	L	M1	0.71067	-4.3	-6.7
ACL-8598	IRE-TP-0519						M3	0.71063	-3.8	-6.1
ACL-8599	IRE-TP-0596	Toureen Peakaun	Younger or middle age adult	NA	EM	E	M1	0.71002	-3.6	-5.8
ACL-8600	IRE-TP-0596						M3	0.71014	-4.3	-6.8
ACL-8601	IRE-TP-0596						Femur	0.71091	-4.2	-6.6
ACL-8602	IRE-TP-0417	Toureen Peakaun	Young adult	Female	LM	L	M1	0.70934	-4.3	-6.7
ACL-8603	IRE-TP-0417						M3	0.71095	-3.6	-5.8
ACL-8604	IRE-TP-0417						Femur	0.71065	-6.9	-10.1
ACL-8605	IRE-TP-0494	Toureen Peakaun	Middle adult	Male	LM	L	M1	0.70874	-2.5	-4.4
ACL-8606	IRE-TP-0494						M3	0.70892	-5.5	-8.3
ACL-8607	IRE-TP-0494						Ribs	0.71011	-5.4	-8.2
ACL-8608	IRE-TP-0421	Toureen Peakaun	Middle or older adult	Male	EM	L	M1	0.71070	-4.7	-7.3
ACL-8609	IRE-TP-0421						Humerus	0.71035	-8.1	-11.6
ACL-8610	IRE-TP-0384	Toureen Peakaun	Young adult	Female	LM	L	M1	0.71003	-5.0	-7.6
ACL-8611	IRE-TP-0384						Ribs	0.70998	-5.0	-7.6

ACL-8612	IRE-TP-0368	Toureen Peakaun	Adult	Male	LM	L	Femur	0.71055	-6.7	-9.8
ACL-8613	IRE-TP-0490	Toureen Peakaun	14-16 yrs	Male	LM	L	M1	0.71029	-6.3	-9.3
ACL-8614	IRE-TP-0490						M3	0.71016	-6.0	-9.0
ACL-8615	IRE-TP-0490						Ribs	0.71091	-5.6	-8.4
ACL-8616	IRE-TA-53	Tintern Abbey	Adult	Male or probable male	LM	E	M1	0.70979	-4.7	-7.2
ACL-8617	IRE-TA-53						M3	0.70976	-5.5	-8.3
ACL-8618	IRE-TA-53						Rib	0.70963	-4.9	-7.5
ACL-8619	IRE-TA-54	Tintern Abbey	Adult	Female	LM	E	M1	0.71107	-4.9	-7.5
ACL-8620	IRE-TA-54						M3	0.71126	-3.6	-5.8
ACL-8621	IRE-TA-54						Rib	0.70953	-5.0	-7.6
ACL-8622	IRE-TA-58	Tintern Abbey	Adult	Male or probable male	LM	E	Rib	0.70972	-5.2	-7.9
ACL-8623	IRE-TA-59	Tintern Abbey	Adult	Male or probable male	LM	E	M1	0.71019	-3.0	-5.1
ACL-8624	IRE-TA-59						M3	0.71008	-5.8	-8.7
ACL-8625	IRE-TA-59						Rib	0.70961	-5.9	-8.9
ACL-8626	IRE-TA-60	Tintern Abbey	Adult	Male or probable male	LM	E	M1	0.71161	-6.1	-9.1
ACL-8627	IRE-TA-60						Rib	0.70969	-6.0	-9.0
ACL-8628	IRE-TA-62	Tintern Abbey	Adult	Male or probable male	LM	E	Rib	0.70966	-5.5	-8.2

ACL-8629	IRE-TA-48	Tintern Abbey	Younger adult	Male	LM	L	M1	0.71048	-4.6	-7.1
ACL-8630	IRE-TA-48						Rib	0.70974	-4.8	-7.4
ACL-8631	IRE-TA-26	Tintern Abbey		Female	LM	L	M1	0.71013	-6.2	-9.2
ACL-8632	IRE-TA-26						M3	0.70979	-6.6	-9.7
ACL-8633	IRE-TA-26						Rib	0.70974	-5.0	-7.7
ACL-8634	IRE-TA-4	Tintern Abbey	Adult	Female	LM	L	Rib	0.70986	-5.4	-8.2
ACL-8635	IRE-TA-36	Tintern Abbey	Younger or middle adult	Female	LM	L	Rib	0.70951	-5.0	-7.7
ACL-8636	IRE-TA-85	Tintern Abbey	Adult	Male	LM	E	Long bone	0.70970	-5.3	-8.0
ACL-8637	IRE-TA-89	Tintern Abbey	Adult	Male	LM	E	Rib	0.71000	-5.5	-8.3
ACL-8638	IRE-TA-42	Tintern Abbey	Middle adult	Male	LM	L	M1	0.71003	-5.1	-7.7
ACL-8639	IRE-TA-42						M3	0.70998	-3.4	-5.6
ACL-8640	IRE-TA-42						Long bone	0.70945	-4.9	-7.5
ACL-8641	IRE-TA-90	Tintern Abbey	Older adult	Male	LM	E	Rib	0.70966	-5.6	-8.4
ACL-8642	IRE-TA-41	Tintern Abbey	Younger adult	Female	LM	L	M1	0.71026	-5.0	-7.7
ACL-8643	IRE-TA-41						M3	0.71043	-4.5	-7.0
ACL-8644	IRE-TA-41						Rib	0.70986	-5.7	-8.6
ACL-8645	IRE-TA-12	Tintern Abbey	Middle adult	Female	LM	L	M1	0.70984	-4.0	-6.4
ACL-8646	IRE-TA-12						M3	0.70984	-4.6	-7.1

ACL-8647	IRE-TA-12						Rib	0.70994	0.7	-0.2
ACL-8648	IRE-TA-5	Tintern Abbey	Adult	Male	LM	L	Rib	0.70958	-5.2	-7.9
ACL-8649	IRE-TA-76	Tintern Abbey	Adult	Male	LM	L	M1	0.70970	-5.6	-8.4
ACL-8650	IRE-TA-76						M3	0.71012	-4.7	-7.2
ACL-8651	IRE-TA-76						Rib	0.70977	-6.0	-8.9
ACL-8652	IRE-TA-93	Tintern Abbey	Adult	Male	LM	L	M3	0.71059	-5.1	-7.8
ACL-8653	IRE-TA-93						Long bone	0.70985	-4.7	-7.2
ACL-8654	IRE-TA-13	Tintern Abbey	Adult	Male	LM	L	M3	0.71029	-5.9	-8.8
ACL-8655	IRE-TA-13						Rib	0.70990	-6.9	-10.2
ACL-8656	IRE-TA-40	Tintern Abbey	Younger adult	Male	LM	L	Long bone	0.70959	-6.5	-9.6
ACL-8657	IRE-TA-87	Tintern Abbey	Younger adult	NA	LM	L	M1	0.71047	-4.3	-6.8
ACL-8658	IRE-TA-87						M3	0.71031	-4.0	-6.4
ACL-8659	IRE-TA-87						Rib	0.70934	-5.6	-8.5
ACL-8660	IRE-TA-47a	Tintern Abbey	NA	NA	LM	L	M1	0.71091	-6.8	-10.0
ACL-8661	IRE-TA-47a						M3	0.71053	-5.1	-7.7
ACL-8662	IRE-TA-47a						Long bone	0.70980	-6.3	-9.3
ACL-8663	IRE-TA-F61	Tintern Abbey	NA	NA	LM	L	M3	0.70998	-6.2	-9.1
ACL-8664	IRE-TA-F61						Rib	0.70975	-7.2	-10.5
ACL-8665	IRE-IL-180	Illaunloughan	Adult?	Male	EM	E	Rib	0.70930	-6.6	-9.8

ACL-8666	IRE-IL-106	Illaunloughan	Young adult	Female	LM	L	M1	0.70972	-6.0	-8.9
ACL-8667	IRE-IL-106						M3	0.70944	-5.7	-8.6
ACL-8668	IRE-IL-120	Illaunloughan	Older adult	Male	EM	E	Rib	0.70927	-5.6	-8.4
ACL-8669	IRE-IL-172	Illaunloughan	Juvenile 5-7 years	NA	EM	E	M1	0.70933	-6.3	-9.3
ACL-8670	IRE-IL-172						M1 Deciduous	0.70933		
ACL-8671	IRE-LR-7	Lorrha	25-35	Female	LM	L	M1	0.70857	-5.3	-8.0
ACL-8672	IRE-LR-7						Rib	0.70824	-4.3	-6.8
ACL-8673	IRE-LR-48	Lorrha	40-45	Male or probable male	LM	L	Rib	0.70826	-9.0	-12.8
ACL-8674	IRE-LR-37	Lorrha	60+	Female		L	M1	0.70827	-6.0	-9.0
ACL-8675	IRE-LR-37						Rib	0.70827	-7.3	-10.6
ACL-8676	IRE-LR-26	Lorrha	Preadult, 7-8	NA	LM	L	M1	0.70873	-5.4	-8.2
ACL-8677	IRE-LR-26						Rib	0.70828	-6.5	-9.6
ACL-8678	IRE-LR-3	Lorrha	16-20	NA	LM	L	M1	0.70841	-7.2	-10.4
ACL-8679	IRE-LR-3						M3	0.70843	-8.3	-12.0
ACL-8680	IRE-LR-3						Rib	0.70823	-7.1	-10.3
ACL-8681	IRE-LR-34	Lorrha	Preadult, 5-6	NA	LM	L	long bone	0.70819	-5.7	-8.6
ACL-8682	IRE-LR-25	Lorrha	Preadult, 9-10	NA	LM	L	Rib	0.70823	NA	-8.3
ACL-8683	IRE-LR-22	Lorrha	35-45	Female	LM	L	M1	0.70908	-5.5	-10.1
ACL-8684	IRE-LR-22						M3	0.70905	-6.9	-9.4
ACL-8685	IRE-LR-22						Rib	0.70821	-6.4	-8.5

ACL-8686	IRE-LR-29	Lorrha	25-35	Male	LM	L	M1	0.71249	-5.6	-9.1
ACL-8687	IRE-LR-29						M3	0.71251	-6.2	-8.6
ACL-8688	IRE-LR-29						Rib	0.70827	-5.8	-8.8
ACL-8689	IRE-LR-44	Lorrha	35-45	Male	LM	L	Long bone	0.70967	-5.9	-6.9
ACL-8690	IRE-DPD-50	Dominican Priory Drogheda	Older Adult	Male	LM	E	M1	0.70972	-4.4	-8.7
ACL-8691	IRE-DPD-50						Rib	0.70973	-5.8	-6.9
ACL-8692	IRE-DPD-42	Dominican Priory Drogheda	Older Adult	Male	LM	L	M1	0.70990	-4.4	-7.6
ACL-8693	IRE-DPD-42						M3	0.70984	-5.0	-8.4
ACL-8694	IRE-DPD-40B	Dominican Priory Drogheda	Adult	Male	LM	L	Long bone	0.71104	-5.6	-8.0
ACL-8695	IRE-DPD-2005	Dominican Priory Drogheda	NA	NA	LM	L	M1	0.71010	-5.3	-9.2
ACL-8696	IRE-DPD-2005						M3	0.70992	-6.2	-7.7
ACL-8697	IRE-DPD-2005						Long bone	0.70959	-5.1	-8.7
ACL-8698	IRE-DPD-39	Dominican Priory Drogheda	Juvenile, 2-4 years	NA	LM	L	Rib	0.70964	-5.9	-9.0
ACL-8699	IRE-DPD-18	Dominican Priory Drogheda	Adult?	Male?	LM	L	Long bone	0.70918	-6.1	-9.0
ACL-8700	IRE-DPD-60	Dominican Priory Drogheda	Adult	Female	LM	L	Long bone	0.71009	-6.0	-8.6
ACL-8701	IRE-DPD-41	Dominican Priory Drogheda	Adult	Female	LM	L	Long bone	0.70999	-5.8	-8.3

ACL-8702	IRE-DPD-53	Dominican Priory Drogheda	NA	NA	LM	E	Rib	0.71008	-5.5	-8.3
ACL-8703	IRE-DPD-47	Dominican Priory Drogheda	Juvenile, 6-8 years	NA	LM	L	Long bone	0.70973	-5.5	-6.8
ACL-8704	IRE-DPD-24	Dominican Priory Drogheda	NA	NA	LM	L	M1	0.70944	-4.3	-8.0
ACL-8705	IRE-DPD-24						M3	0.70944	-5.3	-8.3
ACL-8706	IRE-DPD-19	Dominican Priory Drogheda	Juvenile, 11-13 years	NA	LM	L	M3	0.71095	-5.5	-9.2
ACL-8707	IRE-DPD-19						Long bone	0.70979	-6.2	-8.5
ACL-8708	IRE-DPD-25	Dominican Priory Drogheda	Adult	Probably Female	LM	L	M1	0.71048	-5.7	-9.0
ACL-8709	IRE-DPD-25						M3	0.71007	-6.0	-8.0
ACL-8710	IRE-DPD-27	Dominican Priory Drogheda	Adult	Male	LM	L	M1	0.70985	-5.3	-9.8
ACL-8711	IRE-DPD-27						M3	0.71007	-6.7	-9.1
ACL-8712	IRE-DPD-27						Rib	0.70968	-6.1	-9.5
ACL-8713	IRE-DPD-38	Dominican Priory Drogheda	Adult	Female	LM	L	Rib	0.70985	-6.4	-8.4
ACL-8714	IRE-DPD-40A	Dominican Priory Drogheda	Middle-aged Adult	Female	LM	L	M1	0.70899	-5.6	-10.1
ACL-8715	IRE-DPD-40A						M3	0.70896	-6.9	-8.8
ACL-8716	IRE-DPD-40A						Rib	0.70961	-5.9	-9.2

ACL-8717	IRE-DPD-61	Dominican Priory Drogheda	Middle-aged adult	Male	LM	L	Rib	0.70990	-6.2	-9.0
ACL-8718	IRE-DPD-10s	Dominican Priory Drogheda	NA	NA	LM	L	M1	0.71037	-6.0	-9.0
ACL-8719	IRE-DPD-10	Dominican Priory Drogheda	Adult	Male	LM	L	Rib	0.70958	-6.1	-9.2
ACL-8720	IRE-DPD-46	Dominican Priory Drogheda	Older Adult	Female	LM	L	Rib	0.70995	-6.2	-6.8
ACL-8721	IRE-DPD-23	Dominican Priory Drogheda	Young Adult	Male	LM	L	M1	0.70891	-4.3	-8.6
ACL-8722	IRE-DPD-23						M3	0.70871	-5.7	-9.7
ACL-8723	IRE-DPD-23						Rib	0.70964	-6.6	-7.3
ACL-8724	IRE-DPD-57	Dominican Priory Drogheda	Adult?	Female	LM	L	M1	0.70995	-4.8	-8.9
ACL-8725	IRE-DPD-57						M3	0.71007	-6.0	-9.9
ACL-8726	IRE-DPD-57						Rib	0.70990	-6.8	-8.2
ACL-8727	IRE-DPD-52A	Dominican Priory Drogheda	NA	NA	LM	L	Long bone	0.70993	-5.5	-9.6
ACL-8728	IRE-DPD-15	Dominican Priory Drogheda	Adult?	Male	LM	E	Long bone	0.70996	-6.5	-9.3
ACL-8729	IRE-DPD-15*	Dominican Priory Drogheda	NA	NA		L	Long bone	0.70959	-6.3	-9.3
ACL-8730	IRE-DPD-36	Dominican Priory Drogheda	Juvenile, 16-19	NA	LM	L	M1	0.71113	-6.3	-8.5
ACL-8731	IRE-DPD-36						Rib	0.71025	-5.7	-9.3

ACL-8732	IRE-DPD-36						Long bone	0.71027	-6.3	-7.6
ACL-8733	IRE-DPD-F1B1	Dominican Priory Drogheda	NA	NA	LM	L	M1	0.71001	-5.0	-9.1
ACL-8734	IRE-DPD-F1B1						M3	0.71035	-6.1	-9.6
ACL-8735	IRE-DPD-F1B1						Rib	0.71017	-6.5	-9.6
ACL-8737	IRE-DPD-B51	Dominican Priory Drogheda	Juvenile, 16-18 years	NA	LM	L	M1	0.70990	-5.6	-8.4
ACL-8738	IRE-DPD-B51						M3	0.70987	-6.4	-9.4
ACL-8739	IRE-DPD-28	Dominican Priory Drogheda	Adult?	Male	LM	L	M1	0.71139	-5.6	-8.5
ACL-8740	IRE-DPD-28						M3	0.71245	-6.9	-10.0
ACL-8741	IRE-DPD-28						Long bone	0.71016	-5.8	-8.7
ACL-8742	IRE-DPD-58	Dominican Priory Drogheda	Adult	NA	LM	L	Rib	0.70967	-5.8	-8.7
ACL-8743	IRE-DPD-52B	Dominican Priory Drogheda	Adult	Male	LM	L	M3	0.71084	-5.9	-8.8
ACL-8744	IRE-DPD-52B						Rib	0.70993	-5.9	-8.7
ACL-8745	IRE-DPD-34	Dominican Priory Drogheda	Adult	Female	LM	L	M1	0.70977	-5.4	-8.2
ACL-8746	IRE-DPD-34						M3	0.70968	-6.0	-9.0
ACL-8747	IRE-DPD-34						Long bone	0.70979	-6.5	-9.5
ACL-8748	IRE-DPD-30	Dominican Priory Drogheda	Middle-aged adult	Male	LM	E	M1	0.71008	-5.7	-8.5

ACL-8749	IRE-DPD-30						M3	0.71015	-5.4	-8.2
ACL-8750	IRE-DPD-30						Rib	0.71013	-5.4	-8.2
ACL-8751	IRE-DPD-56	Dominican Priory Drogheda	Middle-Aged Adult	Female	LM	L	M1	0.70930	-6.9	-10.1
ACL-8752	IRE-DPD-56						M3	0.70921	-6.2	-9.2
ACL-8753	IRE-DPD-56						Long bone	0.70981	-5.0	-7.7
ACL-8754	IRE-DPD-45	Dominican Priory Drogheda	Middle-Aged Adult	Male	LM	L	M1	0.70920	-7.9	-11.5
ACL-8755	IRE-DPD-45						M3	0.70892	-6.3	-9.3
ACL-8756	IRE-DPD-45						Rib	0.70973	-6.3	-9.3
ACL-8757	IRE-DPD-3	Dominican Priory Drogheda	Adult	Male	LM	E	Long Bone	0.71001	-6.3	-9.3
ACL-8758	IRE-DPD-14	Dominican Priory Drogheda	Adult	Probably Male	LM	L	Long Bone	0.71000	-7.1	-10.3
ACL-8759	IRE-DPD-4	Dominican Priory Drogheda	Adult	Female	LM	L	M1	0.71035	-5.2	-7.8
ACL-8760	IRE-DPD-4						M3	0.71001	-4.2	-6.7
ACL-8761	IRE-DPD-4						Rib	0.70991	-5.1	-7.8
ACL-8762	IRE-DPD-59	Dominican Priory Drogheda	Adult	Male	LM	L	M1	0.71128	0.0	-1.1
ACL-8763	IRE-DPD-59						M3	0.71082	-6.1	-9.1
ACL-8764	IRE-DPD-59						Rib	0.71001	-6.4	-9.5

ACL-8765	IRE-DPD-7	Dominican Priory Drogheda	Old Adult	Male	LM	L	M1	0.71073	-4.2	-6.6
ACL-8766	IRE-DPD-7						M3	0.71065	-6.5	-9.6
ACL-8767	IRE-DPD-7						Rib	0.70970	-8.8	-12.6
ACL-8768	IRE-DPD-21	Dominican Priory Drogheda	Adult	Male	LM	L	M1	0.71138	-4.6	-7.1
ACL-8769	IRE-DPD-21						M3	0.71128	-7.0	-10.2
ACL-8770	IRE-DPD-21						Rib	0.71001	-5.8	-8.7
ACL-8771	IRE-DPD-5	Dominican Priory Drogheda	Older Adult	Male	LM	L	M1	0.70959	-3.0	-5.0
ACL-8772	IRE-DPD-5						M3	0.70944	-5.6	-8.5
ACL-8773	IRE-DPD-5						Rib	0.70961	-8.8	-12.6
ACL-8774	IRE-DPD-6	Dominican Priory Drogheda	Middle-aged adult	Male	LM	L	M1	0.70973	-4.7	-7.3
ACL-8775	IRE-DPD-6						M3	0.70954	-6.7	-9.9
ACL-8776	IRE-DPD-6						Rib	0.70977	-5.9	-8.8

Table 2. Skeletal Population and Sample by Site. Information gathered from skeletal reports (Bolger and Moloney, 2012; Buckley, 2005; Halpin and Buckley, 1995; Ó Donnabháin and Mhurchadha, 2010; O'Donnabhain, 2010).

Site Name	**Location**	**Date of Burials**	**Number of Individuals Excavated**	**Age Distribution**	**Sex Distribution**	**Number of Individuals Sampled for This Study**
Illaunloughan	Co. Kerry	7^{th}-9^{th} centuries, Late Medieval	17	14 adults, 3 juveniles	12 males, 2 unknown	4
Toureen Peakaun	Co. Tipperary	7^{th}-12^{th} centuries	30 (14 are late phase *cillin* burials)	12 adults, 2 juveniles, 15 infants, 1 unknown	1 possible male, 6 males, 2 females, 6 unknown	8
Lorrha	Co. Tipperary	13^{th}-15^{th} centuries	72	49 adults, 38 juveniles, 4 infants	7 Male, 9 female, 25 unknown	10
Tintern Abbey	Co. Wexford	13^{th}-15^{th} centuries	106	33 non-adults, 73 adults	42 males, 23 females, 8 unknown	24
Dominican Priory Drogheda	Co. Louth	13^{th}-16^{th} centuries	61, more fragmentary	50 adults, 11 juveniles	32 males, 14 females, 4 unknown	42

6. Identifying Monastic and Lay Individuals

The level of likelihood that each individual participated in monasticism as a monk, priest, or other religious person was estimated based on five categories of archaeological and historical factors (see Table 3). These factors are based on the burial surroundings and context, and they are derived from historical records about burial and early Christian practices (Fry, 1999; O'Brien, 2009; O’Brien, 1992; Scott, 2011; Stalley, 1987). Factors 1-3 are meant to distinguish monastic and lay individuals within a monastic cemetery, and Factors 4-5 are meant to ensure that individuals were buried at a monastic site during it active use by a monastic community. Both sets of factors are necessary because the Church began to require burial at church sites in the eighth century, meaning that burials on monastic sites could represent lay or religious individuals (O’Brien, 2009; O’Brien, 1992). The specific date or time period of each burial was considered in this process, and therefore individuals buried at a monastic site after the monastic occupation had ended were not considered to fulfill Factor 5-Historical information about the site (30 of 88 individuals, 34.1%). Also, only early medieval individuals at Illaunloughan were considered to fulfill Factor 4-Geographical setting of the site (3 of 88 individuals, 3.5%). A score of zero represents the lowest likelihood that an individual was a religious person, and a score of five represents the highest likelihood. For this study, a score of three or more was considered a religious individual. There is little variation in medieval Irish Christian burials, and therefore the difference between two and three factors fulfilled was considered sufficient to distinguish between religious and lay individuals (O’Brien, 2009; O’Brien, 1992; Scott, 2011).

Factor 1- Location of burial in the cemetery (66 of 88 individuals, 75%)- Burial outside of the eastern end of the church was the most likely area for burial of important ecclesiastical people in the early medieval period (Horn et al., 1990; Marshall and Rourke, 2000; Marshall and Walsh, 2005), and burial inside the church became favored for ecclesiastical and high-ranking people in the late medieval period (Fry, 1999:170). Within the church the areas nearest the altar, such as the chancel, are considered holy and were likely reserved for ecclesiastical burials (O'Donnabhain, 2010). Certain areas of the burial ground outside of the church could be segregated for use by the ecclesiastical community, as recorded in the *Annals of the Four Masters* (Fry, 1999; Mays, 2006; O'Donovan, 1851). A high percentage of individuals in this study qualified for this factor because sites that had a possibility of yielding monastic individuals were favored during site selection.

Factor 2- Burial group has mostly male or juvenile burials (55 of 88 individuals=62.5)- This causes the cemetery to not have the 1:1 sex ratio expected of a typical population, can indicate the presence of ecclesiastical burials (Halpin and Buckley, 1995; Marshall and Walsh, 2005). This is only true in the case of monastic sites that were not nunneries, which held communities of religious women (Bitel, 1986; Collins, 2015).

Factor 3- Grave style or grave goods (7 of 88 individuals, 8.0%)- Indicative grave goods or grave style that may indicate a religious person include high-status burial preparations such as stone-lined graves and inscribed stones. Stick pins are one such type of indicative grave good because religious personnel were often buried in a habit rather than the traditional cloth burial shroud (Fry, 1999).

Factor 4- Geographical setting of site (3 of 88 individuals, 3.5%)- The setting of the monastery can be taken into account. For instance, some early medieval monasteries lack the facilities to minister to a lay population or are set in isolated areas with a natural physical boundary, such as a body of water. Archaeologists have suggested that males buried at early medieval monasteries that are not set near a lay population are religious individuals (Delaney, 1975; Fanning, 1981; Henry, 1945; Marshall and Rourke, 2000; Marshall and Walsh, 2005; O'Donnabhain, 2014). Illaunloughan was the only site classed as a monastic site based on this factor.

Factor 5- Historical information about site (30 of 88 individuals, 34.1%) - All sites in this study except Illaunloughan have written evidence that the sites were monastic in nature. These written sources include annals that mention abbots at the sites (Toureen Peakaun, Lorrha) and histories of the Cistercian and Dominican orders (Tintern Abbey and Dominican Priory Drogheda) (Bolger and Moloney, 2012; Halpin and Buckley, 1995; Lynch, 2010; O'Hagan, 2012). This factor was only considered fulfilled if the individual was buried at the site during the time period covered by the historical information.

Table 3. Criteria Used to Estimate if an Individual was Ecclesiastical.

Criteria	Factors indicating ecclesiastical individual
1. Location of burial in the cemetery	Burial near east end of the church or inside the church
2. Burial group has mostly male or juvenile burials, or female if a nunnery site	Sex distribution is not indicative of a typical population
3. Grave style or grave goods	Grave goods indicating ecclesiastical burials may include a habit pin indicating burial in habit or grave markers like inscribed stones
4. Geographical setting of site	Monastic site lacks a known adjacent lay settlement nearby, such as a small island, especially for early medieval sites
5. Historical information about site	Historical texts exist indicating the presence of an abbot or monastic population

7. Estimating mobility through biogeochemistry

7.1. Radiogenic strontium isotope ratios

Individual's mobility during their lifetimes can be estimated by comparing radiogenic strontium isotope ratios from human bone and teeth to the ratios found in the bedrock, soil, and ecosystem in the area of the burial site (Bentley, 2006; Ericson, 1989; Ericson, 1985; Knudson et al., 2012). These ratios increase with the age of the underlying bedrock because the amount of ^{87}Sr increases through radioactive decay of ^{87}Rb while the amount of ^{86}Sr is stable (Dasch, 1969; O'Connor, 1988; Wallace et al., 1994). In the environment, the isotopes of ^{87}Sr and ^{86}Sr do not experience substantial biopurification or fractionation as they travel through ecosystems' trophic levels (Blum et al., 2000), so human $^{87}Sr/^{86}Sr$ values can be directly compared to those in the ecosystem to deduce mobility. Strontium is substituted for calcium in bone hydroxyapatite (Turekian and Kulp, 1956), and certain sources of strontium are more likely to be incorporated into the human body based on weathering of rock and soil formation (Bentley and Knipper, 2005; Knudson et al., 2014). Oceans have a worldwide contestant radiogenic strontium ratio ($^{87}Sr/^{86}Sr$=0.7092), and sea spray contributes this ratio to terrestrial ecosystems in coastal environments (Veizer, 1989; Whipkey et al., 2000). Sea spray does not necessarily overwhelm the ratios of bioavailable available strontium isotopes in coastal contexts, but it can contribute a high percentage of strontium to plants growing near the ocean (Alonzi et al., In Preparation-b). Mobility should only be inferred when the radiogenic strontium ratios for the humans and local area differ in the third or fourth decimal place, due to variations that occur in bones and teeth throughout the body (Knudson et al., 2016).

7.2 Sources of strontium in medieval Irish diets

Strontium acts like calcium in chemical reactions and replaces calcium in the mineral fraction of bone and tooth enamel because they have very similar ionic radiuses (Sr-1.32 Å; Ca- 1.18 Å), and strontium found in the human body is introduced by calcium-rich food sources (Bentley, 2006:137; Ezzo, 1994; Turekian and Kulp, 1956). Geological formations can have heterogeneous mineral compositions, thus causing the soil to have different isotopic ratios of strontium available to organisms than the underlying bedrock based on weathering and soil formation processes (Bentley and Knipper, 2005; Knudson et al., 2014; Price et al., 2002). Because of these factors, it is necessary to assess the sources of strontium in the diets of the individuals being studied.

In medieval Ireland, calcium-rich sources of food were derived from terrestrial, aquatic, and marine sources. Such dietary sources that are known from historical and archaeological evidence include dairy products and the bones of fish and animals (Kelly, 1997; McCormick et al., 2011; Montgomery et al., 2007; Montgomery et al., 2003; O'Sullivan et al., 2013). Salmon and trout, which are anadromous fish that inhabit both aquatic and marine waters, are specifically mentioned in medieval Irish Law Texts (Kelly, 1997). These types of fish could carry the typical marine radiogenic strontium isotope ration ($^{87}Sr/^{86}Sr$= 0.07092) into inland environments. Evidence for fishing includes bones found on archaeological sites as well as medieval fishing weirs found in the Shannon and Fergus Estuaries (O'Sullivan et al., 2013; Stout and Stout, 2016). Also, seaweed was likely an important source of marine-derived strontium in medieval diets. First, seaweed may have been mixed with soils to improve the quality of the fields for agricultural purposes in medieval Ireland and Scotland (Kelly, 1997; Montgomery et al., 2007). Finally, sea salt was likely used to preserve foods, as pickling vegetables was very common in medieval Ireland (Kelly, 1997). Because of the multitude of food sources connected to the ocean in medieval Ireland, it is likely that most individuals had some exposure to marine-derived strontium in their lifetimes.

Dairying and consumption of animal bone were likely the most common calcium-rich terrestrial source of strontium in the medieval Irish diet (Kelly, 1997; McCormick et al., 2011). However, crops seem to have increased in importance as a component in diets between the Iron Age and early medieval period, as pollen evidence suggests that forests were cleared and agriculture increased by the fourth century (McCormick et al., 2011:5). In the late medieval period, cereal-drying kilns are evidence for the drying and storage of cereal crops (McCormick et al., 2011; Stout and Stout, 2016). Also, the increased presence of enclosures and fences indicate a need to keep animals out of lands used for cereal crops (McCormick et al., 2011:6).

The management of dairy herds is discussed in written evidence such as law texts and Saints' Lives, and cows were an important prestige item in medieval Irish society (Kelly, 1997; McCormick, 1995). The age at death profile for cows found at medieval Irish archaeological sites suggests that these herds were maintained for the purpose of dairying (McCormick et al., 2011:42). Also, historical records and law texts record the practice of booleying, which refers to moving cows to sometimes faraway pastures during different times of year (Boyle, 2004; Kelly, 1997). The movement of the cows associated with booleying might be a source of non-local strontium to medieval Irish people, although the records about booleying do not indicate that the dairy products were transported back to the home territory along with the cows. Most food, including dairy, consumed during the early and late medieval periods in Ireland was likely of local or relatively local origin, as little evidence for long-distance trade of food exists. Archaeological evidence suggests that there was trade of salt, wine, ceramics, and metal goods between Ireland and the Continent in the early medieval period, but evidence for non-Irish pottery declines in the seventh century (Loveluck and O' Sullivan, 2016).

7.3 Stable oxygen isotope values

Oxygen isotopes ($\delta^{18}O$) vary based on regional hydrology and are correlated with climate (Domínguez-Villar et al., 2008; Gat, 1996; Grootes et al., 1993; Négrel et al., 2003), and they can also be used to estimate whether an individual was local or non-local to the site by comparing the human-derived values to those found in precipitation and local waterways (Longinelli, 1984; Luz et al., 1984; Schwarcz and Schoeninger, 1991). Oxygen isotope values are impacted by practices such as breastfeeding, weaning, and consuming boiled liquids through the process of isotopic fractionation (Knudson, 2009; Wright and Schwarcz, 1998). They also vary seasonally and with climate change (Balasse, 2002; Domínguez-Villar et al., 2008; Gat, 1996; Grootes et al., 1993). The radiogenic strontium and oxygen isotopic systems pattern differently over Ireland, and using a combination of these data allows for a more accurate assessment of non-local individuals (Cahill Wilson and Standish, 2016; Darling et al., 2003; Knudson et al., 2012) (see Figure 1). Stable oxygen isotopic data are shown in terms of $\delta^{18}O$ and measured in parts per thousand, known as per mil (‰). The relationship between the concentrations of oxygen isotopes and this value is defined as follows: $\delta^{18}O= ((\delta^{18}O / \delta^{16}O_{sample)} / (\delta^{18}O / \delta^{16}O_{standard}))-1)\ 1000$ (Coplen, 1994).

8. Materials and methods

8.1. Archaeological site selection and sampling strategy

Sites were selected based on the availability of accessible cleaned and analyzed skeletal collections of individuals buried at medieval Irish monastic sites. Bone preservation is poor at many of the early medieval monastic sites that have been excavated in Ireland, so the available sites were severely limited. Each skeleton was inspected before inclusion in this study to ensure sufficient preservation, and badly preserved individuals were excluded from the experimental design. A first and third molar and piece of bone from a rib or long bone was collected from each individual in this study, if the dental or skeletal element was present. The collections analyzed in this study are housed at the University College Cork or the National Museum of Ireland (NMI), and they were sampled and exported under the Permits to Alter and Export #6166, issued by the NMI.

8.2. Plant baseline site selection and sampling strategy

Plants were sampled to establish the strontium isotope signatures found in the four counties containing the archaeological sites (Co. Kerry, Co. Louth, Co. Tipperary, and Co. Wexford). Plant sampling sites were selected based on practices that have been agreed upon by members of the Irish Isotopes Research Group (Daly et al., 2016; Snoeck et al., 2016). Non-woody plants were sampled from wooded or undisturbed areas in order to avoid the effects of non-local strontium introduced by fertilizer used on modern agricultural fields. These plants were dried and imported for analysis at Arizona State University (ASU) under USDA APHIS Permit no. PCIP-14-00573.

8.3. Sex and age estimations

Sex and age estimations had been carried out prior to this study, and the original terminology used by the osteologists are used here (Bolger and Moloney, 2012; Buckley, 2005; Halpin and Buckley, 1995; Ó Donnabháin and Mhurchadha, 2010; O'Donnabhain, 2010). As age at death is not central to the research question of this paper, no further refinement of the age categories was undertaken. Sex is used as part of the criteria for estimating that an individual is ecclesiastical, and the original sex estimations were sufficient for this purpose.

8.4. Sample preparation for elemental concentration and radiogenic strontium analyses

All samples in this study were prepared at Arizona State University (ASU) in the Archaeological Chemistry Laboratory (ACL) based on established methods (Knudson et al., 2016). The samples were first photographed and then cast in plaster to document the morphology of the teeth. The teeth and bone samples were then cleaned using a Dremel drill with a diamond-tipped bit. During this process, only cortical bone is retained for analysis, as the porous cancellous bone is more likely to be impacted by post-depositional contamination. The bone samples then undergo chemical cleaning, which consists of a thirty-minute bath in Millipore water within an ultrasonic cleaner followed by a thirty-minute bath in 0.8 mL of acetic acid (CH_3COOH) within an ultrasonic cleaner. The samples are then placed in another five-minute Millipore water bath before being dried in an oven set at 50°C for one hour. The bone samples are ashed in a furnace set to 800°C for 10 hours. The enamel powder is taken directly from the mechanically cleaned tooth using a clean diamond-tipped Dremel drill bit. Both the tooth enamel powder and the ashed bone are dissolved in 500 μL trace metal grade (15.5-16M) nitric acid (HNO_3) before undergoing strontium separation.

8.5. Analysis of elemental concentrations

In the W.M. Keck Foundation Laboratory for Environmental Biogeochemistry (KFLEB) at ASU, concentrations of elements including uranium, phosphorus, neodymium, and calcium were analyzed to estimate the level of contamination of the samples. Samples with inadequate concentrations or unexpected ratios of the elements listed above were excluded from further study. First, a stock solution was created by dissolving 0.0030 g of clean powdered bone ash or tooth enamel in 3.50 mL of Millipore water (18.2 MΩ) and 0.5mL VWR 16M HNO_3 (Trace Metal Grade). Then, 0.53 mL of this stock solution was diluted with 14.47 mL twice-distilled 0.32 M HNO_3. A Thermo-Finnigan X-series quadrupole inductively coupled plasma mass spectrometer (Q-ICP-MS) was used to analyze the samples and a calibration curve comprising internal standards and NIST 1400. The CUE-0001 samples had a mean Ba/Sr =0.48 ± 0.01 (1σ, n =19) and a mean Ca/P = 1.94 ± 0.05 (1σ, n =19). The NIST-1400 samples had a mean Ba/Sr =1.05 ± 0.03 (1σ, n =19) and a mean Ca/P = 1.88 ± 0.04 (1σ, n =19).

8.6. Separation of strontium isotopes and analysis of strontium isotopic ratios

In the KFLEB, SrSpec EiChrom resin was used to separate the strontium (Knudson et al., 2012). The resin was washed several times to mitigate contamination and loaded into a glass column. Enough stock solution to provide 100 µg of calcium was dried down and dissolved in 1 mL of 5 M HNO_3, and this was diluted with 1.4 mL of 18.2 MΩ Millipore water for plant samples. For human samples, the required amount of stock solution was dried down, dissolved in 0.23 mL of 5 M HNO_3 and then diluted in 3.37 mL of 18.2 MΩ Millipore water. A Neptune multi-collector inductively coupled plasma mass spectrometer (MC-ICP-MS) in the KFLEB was used to analyze the radiogenic strontium ratios (Knudson et al., 2012). SRM-987, a standard, was run at 25 ppb and the average was $^{87}Sr/^{86}Sr$= 0.710255± 0.000030 (2σ, *n* = 118). The expected average of this standard is $^{87}Sr/^{86}Sr$=0.710235±0.000020 (2σ, n = 76), which coincides with the values presented here (Hodell et al., 1989).

8.7. Sample preparation and analysis for carbon and oxygen isotope analysis

Samples were prepared in the Archaeological Chemistry Laboratory at Arizona State University and analyzed in the Colorado Plateau Stable Isotope Laboratory at Norther Arizona University, following methods in Koch et al. (1997) and Knudson et al. (2015). Fifteen milligrams of tooth enamel powder or 20 mg of bone powder is treated with 0.04 ml 2% bleach (NaOCl) per milligram of enamel or bone powder. The solution is agitated, left to sit for 24 hours, and decanted and rinsed with Millipore water to remove the NaOCl. The sample is then washed three times, which involves adding Millipore water, agitating, centrifuging, and decanting. The sample is then treated with 0.04 ml acetic acid (CH_3COOH) for each milligram of powder, agitated, centrifuged, left to sit for 24 hours, and dried. The samples are then analyzed on a Gasbench connected to a Delta V Advantage isotope ratio mass spectrometer (IRMS). The standard NBS-19 had an average of $\delta^{18}O_{VPDB}$= -2.21±0.15 (1σ, n = 15).

The oxygen isotopic values ($\delta^{18}O_{c[VPDB]}$) in this study are derived from carbonate in the bone and teeth. They were converted to $\delta^{18}O_{dw[V\text{-}SMOW]}$ values, which can be used to compare the human data with the groundwater values recorded for Ireland and the United Kingdom (Darling et al., 2003; Pellegrini et al., 2016). The range of $\delta^{18}O_{[V\text{-}SMOW]}$ values found in the groundwater and surface waters of modern-day Ireland is about -7.5 to -4.5 ‰ (Darling et al., 2003). However, oxygen isotopic values exhibit a minimum meaningful difference of $\delta^{18}O_{[V\text{-}SMOW]}$ = 2.9 ‰ for $\delta^{18}O_{apatite}$, resulting in a range of about $\delta^{18}O_{[V\text{-}SMOW]}$ = -10.5 to -1.5 ‰ for the expected values of drinking water found in humans living in Ireland (Darling et al., 2003; Pestle et al., 2014). The original ($\delta^{18}O_{c[VPDB]}$) values were used in statistical analyses because the conversion equations introduce a small amount of error.

These equations were used to convert the oxygen isotopic values that derive from carbonate and phosphate:

(1) $\delta^{18}O_{c[VSMOW]} = (1.03091 \times (\delta^{18}O_{VPDB})) + 30.91$ (Coplen et al., 1983; Knudson, 2009)

(2) $\delta^{18}O_{c[VSMOW]} = (8.5 + (\delta^{18}O_{p[V\text{-}SMOW]})) / 0.98$ (Iacumin et al., 1996)

(3) $\delta^{18}O_{p[VSMOW]} = (0.78 \times \delta^{18}O_{dw[V\text{-}SMOW]}) + 22.70$ (Luz et al., 1984)

9. Results

9.1. Diagenesis and elemental concentrations

The concentrations of the elements uranium, calcium, and phosphorus were obtained to test that the strontium and oxygen data originate from well-preserved material. Hydroxyapatite is the mineral component of teeth and bone, and the ratio of calcium to phosphorus in this molecule is 2.1:1 (Posner, 1985). In modern humans, Ca/P is estimated to be 2.17±0.31 (n=78, 1σ), and all samples analyzed in this study fall within this range (Zaichick and Tzaphlidou, 2002). Low levels of uranium are another indicator of good preservation, and the mean U/Ca=$1.44x10^{-5}$±$2.72x10^{-5}$(n=179, 1σ) supports the conclusion that the samples are sufficiently preserved for analysis (Price et al., 2002).

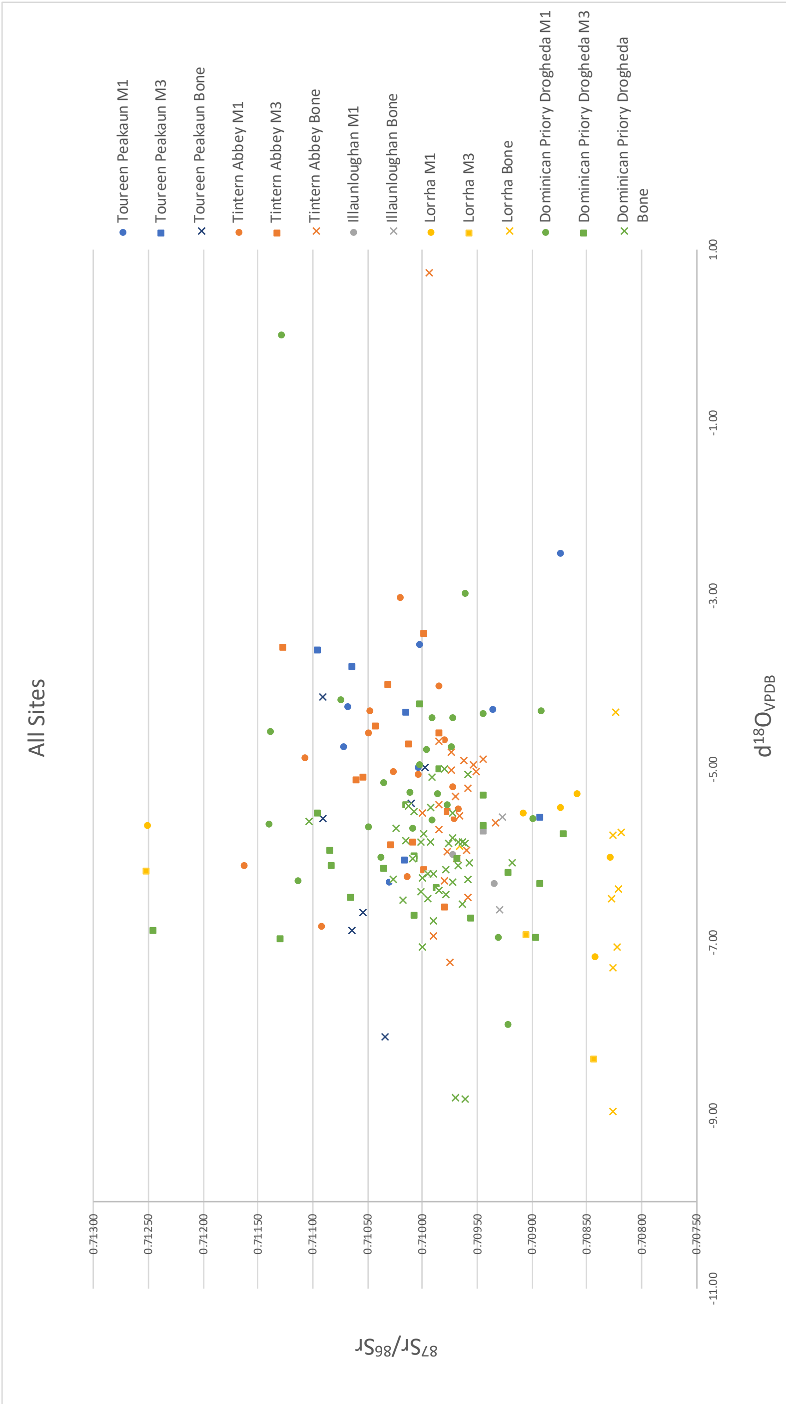
9.2. Results for human samples

The human samples comprise M1, M3, and bone samples and have a mean of $^{87}Sr/^{86}Sr$ = 0.70988 ± 0.00153 (2σ, n = 179) (see Table 1 and Figure 2). The mean ratios for each site are: Toureen Peakaun- $^{87}Sr/^{86}Sr$ = 0.71021 ± 0.00127 (2σ, n=19), Illaunloughan- $^{87}Sr/^{86}Sr$ = 0.70940 ± 0.00033 (2σ, n=6), Lorrha- $^{87}Sr/^{86}Sr$ = 0.70892 ±0.00265 (2σ, n=19), Tintern Abbey- $^{87}Sr/^{86}Sr$ = 0.71001 ± 0.00094 (2σ, n=49), and Dominican Priory Drogheda- $^{87}Sr/^{86}Sr$ = 0.70998 ± 0.00122 (2σ, n=86).

The average oxygen isotopic value for all human samples is $\delta^{18}O_{VPDB}$ = -5.6 ± 2.4 (2σ, n=177) (see Table 1). The mean ratios for each site are: Toureen Peakaun- $\delta^{18}O_{VPDB}$

= -5.0 ± 2.7 (2σ, n=19), Illaunloughan- $\delta^{18}O_{VPDB}$ = -6.0 ± 0.9 (2σ, n=5), Lorrha- $\delta^{18}O_{VPDB}$ = -6.4 ± 2.3 (2σ, n=18), Tintern Abbey- $\delta^{18}O_{VPDB}$ = -5.2 ± 2.5 (2σ, n=49), and Dominican Priory Drogheda- $\delta^{18}O_{VPDB}$ = -5.8 ± 2.2 (2σ, n=86). The value for ACL-8647 IRE-TA-12 ($\delta^{18}O_{VPDB}$ = 0.7) is reported in Table 1 but was discarded from the analyses. It is outside of the realm of naturally-occurring values in Ireland and the United Kingdom, and this value is not reported in other European areas (Darling et al., 2003).

Figure 2. Scatterplot of All Human $^{87}Sr/^{86}Sr$ and $\delta^{18}O_{VPDB}$ Data.



9.3. Bioavailable strontium baseline results

The bioavailable strontium baseline data are derived from modern plant samples (see Table 4). For each county, the mean radiogenic strontium ratios for the plant samples are: County Kerry- $^{87}Sr/^{86}Sr$= 0.071027 ±0.00154 (2σ, n=15), County Wexford- $^{87}Sr/^{86}Sr$= 0.71122 ±0.00274 (2σ, n=20), and County Louth- $^{87}Sr/^{86}Sr$= 0.71079 ±0.00256 (2σ, n=11), $^{87}Sr/^{86}Sr$= 0.71127 ±0.00418 (2σ, n=21).

Table 4. Contextual Information and Isotope Data for Plant Samples, Representing the Bioavailable Radiogenic Strontium Isotope Ratio Baseline.

Laboratory Number	**Specimen Number**	**County and Sampling Location**	**GPS Coordinates**	**$^{87}Sr/^{86}Sr$**
ACL-8526	IRE-54-22-K	Kerry (Dromatouk), Ireland	51.88647, -9.53454	0.70991
ACL-8527	IRE-54-23-K	Kerry (Bonane)	51.83066, -9.51906	0.71105
ACL-8528	IRE-53-17-K	Kerry (Skellig View)	51.85637, -10.36701	0.70937
ACL-8529	IRE-53-18-K	Kerry (Capparoe Cottages)	51.87149, -9.72215	0.70973
ACL-8530	IRE-43-5-K	Kerry (Near Blaskets)	52.15001, -10.46955	0.70948
ACL-8531	IRE-52-6-K	Kerry (Connor's Pass)	52.18187, -10.20727	0.71029
ACL-8532	IRE-64-7-K	Kerry (Magherabeg Lower)	52.27559, -10.02639	0.70922
ACL-8533	IRE-35-9-K	Kerry (Annascaul)	52.16417, -9.97561	0.70994
ACL-8534	IRE-71-28-K	Kerry (Tarbert Walk)	52.57568, -9.37279	0.71021
ACL-8535	IRE-64-26-K	Kerry (Ballyseedy Wood)	52.25273, -9.65668	0.71135
ACL-8536	IRE-64-24-K	Kerry (Headfort)	52.03941, -9.3792	0.70965
ACL-8537	IRE-71-27-K	Kerry (Glanageety Wood)	52.26909, -9.54447	0.71093

ACL-8538	IRE-64-25-K	Kerry (Listowel Park)	52.44612, -9.47538	0.71099
ACL-8539	IRE-61-29-K	Kerry (The Line Road)	52.40062, -9.75124	0.71022
ACL-8540	IRE-71-15-K	Kerry (Kilcummin Bog)	52.12866, -9.46043	0.71173
ACL-8541	IRE-35-1-W	Wexford (Oaklands)	52.37844, -6.95646	0.71126
ACL-8542	IRE-38-2-W	Wexford (Carrickbyrne Hill)	52.36394, -6.79225	0.71248
ACL-8543	IRE-31-3-W	Wexford (Tintern Wood)	52.23742, -6.83977	0.71167
ACL-8544	IRE-31-4-W	Wexford (Tintern Wood)	52.2359, -6.83584	0.71152
ACL-8546	IRE-35-6-W	Wexford (Lacken Hill)	52.40385, -6.88	0.71108
ACL-8548	IRE-5-8-W	Wexford (Monaseed Walk)	52.74776, -6.40514	0.71160
ACL-8549	IRE-4-9-W	Wexford (Ballythomashill)	52.76102, -6.35306	0.71022
ACL-8550	IRE-35-10-W	Wexford (Coolmelagh)	52.68361, -6.57938	0.71131
ACL-8551	IRE-35-11-W	Wexford (Killinieran)	52.72624, -6.27701	0.71140
ACL-8552	IRE-39-12-W	Wexford (Killinieran)	52.72499, -6.27968	0.71430
ACL-8553	IRE-8-13-W	Wexford (Mount Leinster) (actually in Waterford)	52.63729, -6.79399	0.70997
ACL-8555	IRE-38-15-W	Wexford (Templeshannon)	52.50282, -6.55561	0.71240
ACL-8556	IRE-32-16-W	Wexford (Templeshannon)	52.50282, -6.55561	0.71248
ACL-8558	IRE-30-18-W	Wexford (Shelmaliere)	52.29614, -6.58141	0.71324
ACL-8559	IRE-61-19-W	Wexford (The Raven)	52.38034, -6.36801	0.70947
ACL-8560	IRE-64-20-W	Wexford (The Raven)	52.3776, -6.3689	0.70990
ACL-8561	IRE-74-21-W	Wexford (Kilmore Quay)	52.18765, -6.60748	0.70950
ACL-8562	IRE-16-22-W	Wexford (Kilmore Quay)	52.1787, -6.59274	0.70949
ACL-8563	IRE-17-23-W	Wexford (Kilmore Quay)	52.18129, -6.59837	0.70939

ACL-8564	IRE-32-24-W	Wexford (Castlebridge)	52.38649, -6.46678	0.71177
ACL-8565	IRE-60-1-L	Louth (Ardee River Walk)	53.85347, -6.53915	0.70985
ACL-8566	IRE-61-2-L	Louth (Ardee River Walk)	53.85346, -6.54217	0.70998
ACL-8567	IRE-49-3-L	Louth (Clogher Head)	53.79659, -6.221	0.71042
ACL-8568	IRE-49-4-L	Louth (Stephenstown Pond)	53.96453, -6.45919	0.71168
ACL-8569	IRE-49-5-L	Louth (Carlingford Commons)	54.03841, -6.1934	0.71099
ACL-8570	IRE-64-6-L	Louth (Townleyhall)	53.72413, -6.42974	0.71130
ACL-8571	IRE-49-7-L	Louth (Townleyhall)	53.72481, -6.43256	0.71291
ACL-8572	IRE-42-8-L	Louth (Whiteriver)	53.79779, -6.48262	0.71289
ACL-8573	IRE-9-9-L	Louth (Ravensdale)	54.0795, -6.34852	0.70965
ACL-8574	IRE-64-10-L	Louth (Drogheda)	53.71389, -6.3591	0.70984
ACL-8575	IRE-64-11-L	Louth (Magdalene Tower Drogheda)	53.71852, -6.35147	0.70921
ACL-8576	IRE-61-1-T	Tipperary (Near Toureen Peakaun)	52.40997, -7.99141	0.70874
ACL-8577	IRE-54-2-T	Tipperary (Near Toureen Peakaun)	52.40577, -7.99255	0.71100
ACL-8578	IRE-58-3-T	Tipperary (Near Toureen Peakaun)	52.40878, -7.99376	0.71141
ACL-8579	IRE-49-4-T	Tipperary (Doonane Forest)	52.73724, -8.32494	0.71209
ACL-8580	IRE-54-5-T	Tipperary (Doonane Forest)	52.7504, -8.32001	0.71027
ACL-8581	IRE-54-6-T	Tipperary (Glengarra Wood)	52.33921, -8.10571	0.71062
ACL-8582	IRE-49-7-T	Tipperary (Devil's Bit)	52.80076, -7.96628	0.71184
ACL-8583	IRE-71-8-T	Tipperary (Grange Crag Loop)	52.65779, -7.5426	0.71321
ACL-8584	IRE-64-9-T	Tipperary (Grange Crag Loop)	52.65924, -7.54216	0.71146
ACL-8585	IRE-49-10-T	Tipperary (Tountinna)	52.8468, -8.39413	0.71150

ACL-8586	IRE-62-11-T	Tipperary (Marlfield Glenbawn)	52.34435, -7.7777	0.71057
ACL-8587	IRE-62-12-T	Tipperary (Knockanaroe)	52.95529, -8.03751	0.70902
ACL-8588	IRE-58-13-T	Tipperary (Bishop's Wood)	52.57021, -8.03042	0.71038
ACL-8589	IRE-54-14-T	Tipperary (Bishop's Wood)	52.57053, -8.03594	0.71705
ACL-8590	IRE-64-15-T	Tipperary (Cahir Park)	52.3585, -7.92196	0.70933
ACL-8591	IRE-72-16-T	Tipperary (Knockabritta)	52.56581, -7.61428	0.71229
ACL-8592	IRE-54-17-T	Tipperary (Liam Lynch)	52.26052, -7.87728	0.70973
ACL-8593	IRE-54-18-T	Tipperary (Slievenamuck)	52.43267, -8.17861	0.71080
ACL-8594	IRE-49-19-T	Tipperary (Upperchurch)	52.7076, -8.03551	0.71600
ACL-8595	IRE-62-20-T	Tipperary (Lough Doire Bhile)	52.61784, -7.68041	0.70973
ACL-8596	IRE-64-21-T	Tipperary (Lough Doire Bhile)	52.61596, -7.67574	0.70968

9.4. Estimating non-local individuals: Bioavailable strontium baseline and statistical methods

Non-local individuals can be estimated in several ways. Individuals are considered non-local if removing their values considerably lowers the standard deviation, variance, and standard error for a site's population (Tung and Knudson, 2011; Wright, 2005). In this study, individuals who fell more than two standard deviations away from the mean values for each site's population were considered outliers and trimmed from the dataset. Removing these outlier individuals did lower the above metrics, confirming that they derive from a separate population. Of the measures discussed here, this is the most conservative method of estimating non-local individuals from all of the sites.

Also, non-local individuals were estimated using the values of the bioavailable radiogenic strontium isotope ratio baseline derived from plant samples. Based on the 1:500,000 Bedrock Map from the Geological Survey of Ireland, the local area is defined as bedrock packages that are within 3 km of the site (Geological Survey of Ireland, 2017). One baseline plant sample, ACL-8589 IRE-54-14-T ($^{87}Sr/^{86}Sr$= 0.71705), is presented in the data tables but discarded from the interpretations. This sample is an outlier because the sample's radiogenic strontium ratio falls more than two standard deviations from both the average of the total population of baseline samples in this study (0.71095 ± 0.00310 (2σ, n = 67)) and the average of the 54-Upper Devonian/Carboniferous package (0.71130 ± 0.00474 (2σ, n = 8)). It was taken in a wooded location that appears to be within the bounds of a field that was replanted as a forest, and it was likely contaminated by modern fertilizer or some other foreign substance. The range of values is $^{87}Sr/^{86}Sr$=0.70874 to $^{87}Sr/^{86}Sr$=0.71141 (n=13, packages 54, 58, 61) for Toureen Peakaun, Co. Tipperary, $^{87}Sr/^{86}Sr$= 0.70937 to $^{87}Sr/^{86}Sr$= 0.70973 (n=2, package 53) for Illaunloughan, Co. Kerry, $^{87}Sr/^{86}Sr$=0.70874 to $^{87}Sr/^{86}Sr$=0.71146 (n=14, packages 62,64, and 65) for Lorrha, Co. Tipperary, $^{87}Sr/^{86}Sr$=0.71152 to $^{87}Sr/^{86}Sr$=0.7143 (n=3, packages 31 and 39) for Tintern Abbey, Co. Wexford, and $^{87}Sr/^{86}Sr$= 0.70921 to $^{87}Sr/^{86}Sr$=0.71291 (n=19, packages 49 and 64) for Dominican Priory Drogheda, Co. Louth (See Table 5 for ages and descriptions of bedrock packages). Due to land-access issues, it was not possible to sample the geological package underlying the Lorrha site. A substitute value is suggested to be in the range of $^{87}Sr/^{86}Sr$=

0.70874 to $^{87}Sr/^{86}Sr$= 0.71146 (n=20), which is the range of values of all samples in this study from the same Mississippian time period (~325-355 mya) (Walker et al., 2013).

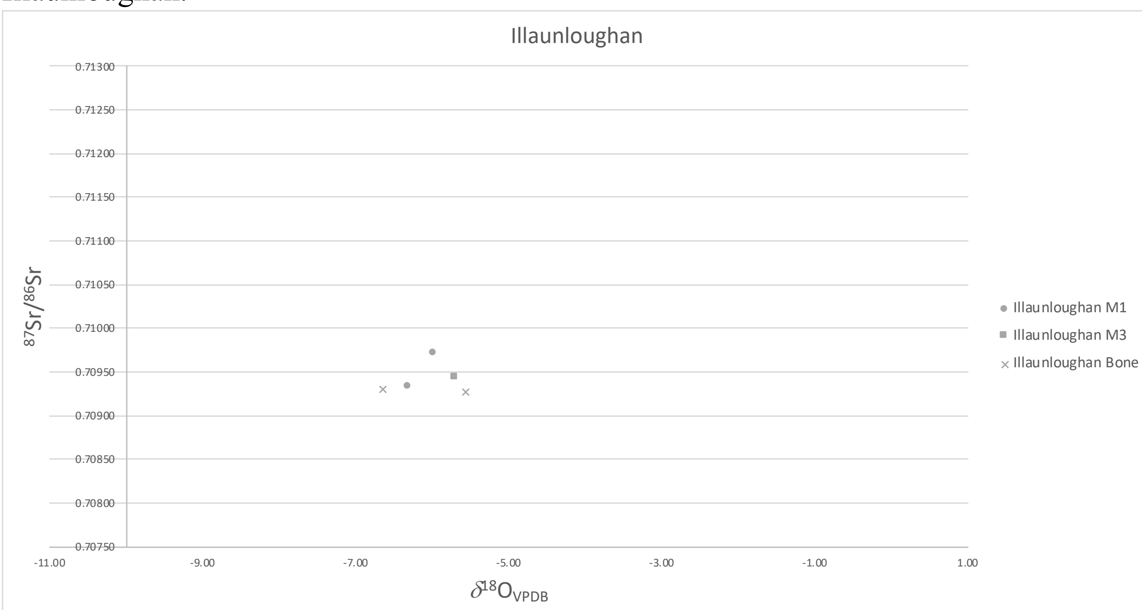
Table 5. Descriptions and Geological Ages for the Bedrock Packages Sampled During the Construction of the Bioavailable Radiogenic Strontium Isotope Baseline.

Bedrock Package	Description	Geological Age (all from the Paleozoic Era)
31	Slate, marine	Cambrian (~540-485 mya)
39	Slate, sandstone, shale, siltstone, marine	Middle to Late Ordovician (~460-445 mya)
49	Mudstone, conglomerate, greywacke, marine	Silurian (~445-420 mya)
53	Sandstone, mudstone, siltstone	Middle Devonian (~395-385 mya)
54	Sandstone, siltstone, conglomerate	Upper Devonian to Carboniferous (~385-300 mya)
58	Limestone, shale, sandstone, marine	Mississippian (~355-325 mya)
61	Limestone, shale, marine	Mississippian (~355-325 mya)
62	Limestone	Mississippian (~355-325 mya)
64	Shale, limestone, marine	Mississippian (~355-325 mya)
65	Limestone, shale, chert, marine	Mississippian (~355-325 mya)

9.5. Mobility and ecclesiastical individuals at Illaunloughan, Co. Kerry

All four individuals buried at Illaunloughan were estimated to be local to the area surrounding the site based on the statistical and baseline methods (see Figure 3). The burial population at this site consists of three early medieval ecclesiastical individuals and one late medieval lay individual.

Figure 3. Scatterplot $^{87}Sr/^{86}Sr$ and $\delta^{18}O_{VPDB}$ Data from Individuals Buried at the Site of Illaunloughan.

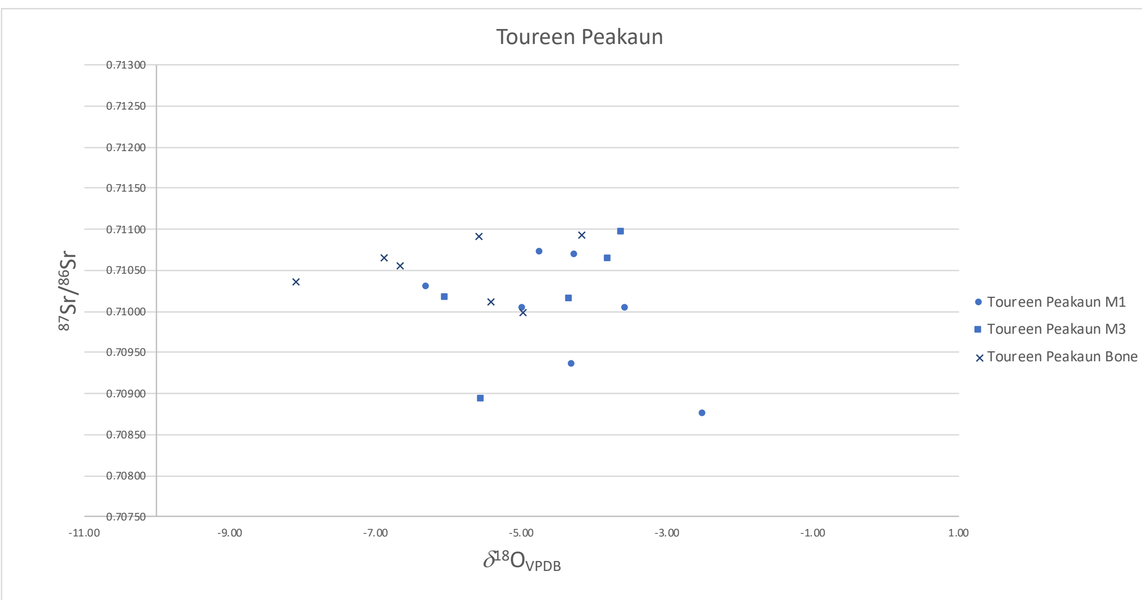


9.6. Mobility and ecclesiastical individuals at Toureen Peakaun, Co. Tipperary

Out of eight individuals analyzed from the site, two are classed as non-local to the site at some point in their lives (see Figure 4). ACL-8605 IRE-TP-0494 (M1) and ACL-8606 IRE-TP-0494 (M3) represent the same individual, and the value for ACL-8606

IRE-TP-0494 ($^{87}Sr/^{86}Sr$=0.70892) is an outlier for both the statistical and baseline methods. ACL-8605 IRE-TP-0494 ($^{87}Sr/^{86}Sr$=0.70874) is only an outlier based on the statistical methods, as its value coincides with the lowest baseline value for the Toureen Peakaun site. The second individual (ACL-8609 IRE-TP-0421) is an outlier based on its oxygen value $\delta^{18}O_{VPDB}$=-8.1. The oxygen isotope value for this sample of $\delta^{18}O_{dw[V\text{-}SMOW]}$ = -11.6 is outside of the range of $\delta^{18}O_{[V\text{-}SMOW]}$ = -10.5 to -1.5 ‰ that are estimated to be the drinking water values in Ireland. One individual of the eight at the site is classed as an ecclesiastical individual, ACL-8599 IRE-TP-0596, but this individual is not estimated to be non-local.

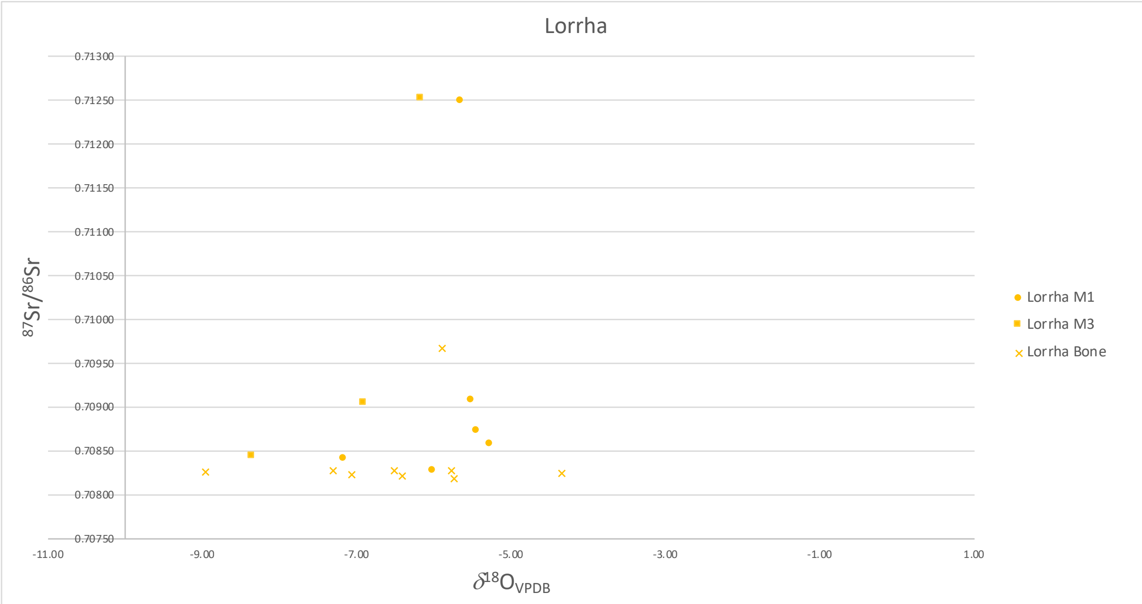
Figure 4. Scatterplot $^{87}Sr/^{86}Sr$ and $\delta^{18}O_{VPDB}$ Data from Individuals Buried at the Site of Toureen Peakaun.



9.7. Mobility and ecclesiastical individuals at Lorrha, Co. Tipperary

Two individuals were considered non-local based on statistical methods (see Figure 5). ACL-8686 IRE-LR-29 (M1; $^{87}Sr/^{86}Sr$ = 0.71249) and ACL-8687 IRE-LR-29 (M3; $^{87}Sr/^{86}Sr$ = 0.71251) represent an individual who is estimated to be non-local based on their radiogenic strontium isotope values. ACL-8673 IRE-LR-48 is estimated to be non-local due to the oxygen isotope value of $\delta^{18}O_{VPDB}$ = -9.0 and $\delta^{18}O_{dw[V\text{-}SMOW]}$ = -12.8. This value is both a statistical outlier and falls outside of the expected $\delta^{18}O_{[V\text{-}SMOW]}$ = -10.5 to -1.5 ‰ for drinking water values in Ireland. The oxygen values for ACL-8679 IRE-LR-3 ($\delta^{18}O_{dw[V\text{-}SMOW]}$ = -12.0) also falls outside of this expected drinking water range, although it is not a statistical outlier. Based soley on the geological values presented above, nine out of ten individuals would be considered non-local to the site. These are ACL-8671 IRE-LR-7, ACL-8672 IRE-LR-7, ACL-8673 IRE-LR-48, ACL-8674 IRE-LR-37, ACL-8675 IRE-LR-37, ACL-8676 IRE-LR-26, ACL-8677 IRE-LR-26, ACL-8678 IRE-LR-3, ACL-8679 IRE-LR-3, ACL-8680 IRE-LR-3, ACL-8681 IRE-LR-34, ACL-8682 IRE-LR-25, ACL-8685 IRE-LR-22, and ACL-8688 IRE-LR-29 (see Table 1 for values). However, it is possible that the baseline sampling did not adequately capture the radiogenic strontium ratio at the site of Lorrha. No individuals at Lorrha were estimated to be ecclesiastical.

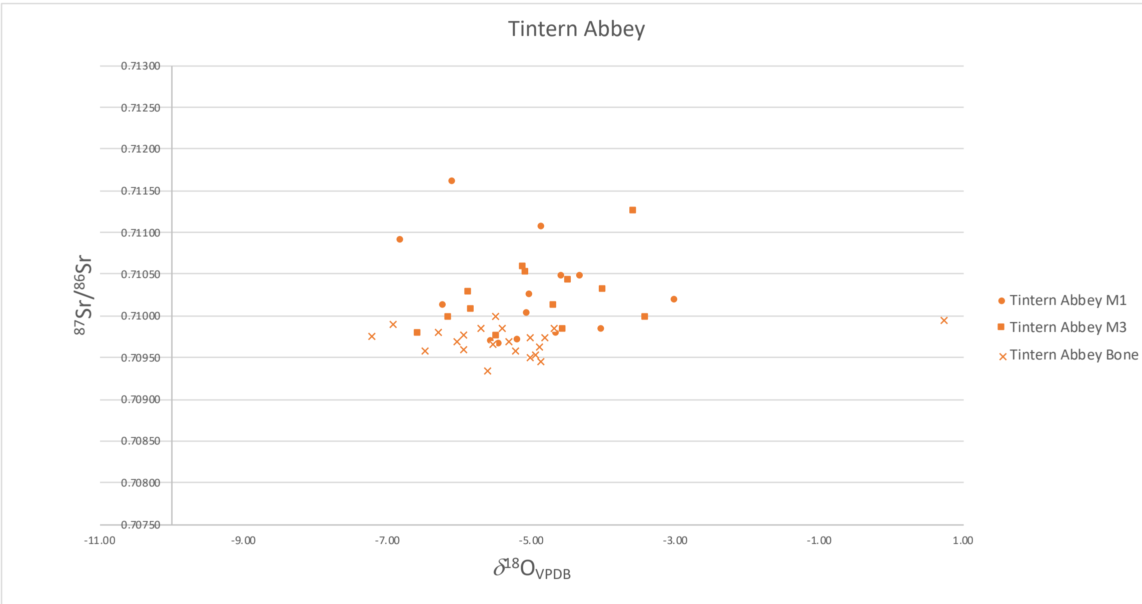
Figure 5. Scatterplot $^{87}Sr/^{86}Sr$ and $\delta^{18}O_{VPDB}$ Data from Individuals Buried at the Site of Lorrha.



9.8. Mobility and ecclesiastical individuals at Tintern Abbey, Co. Wexford

Of the twenty-four individuals analyzed at this site, two are outliers based on the statistical analysis of the radiogenic strontium isotope ratios (see Figure 6). ACL- 8619 IRE-TA-54 (M1; $^{87}Sr/^{86}Sr$ =0.71107) and ACL-IRE-TA-54 (M3; $^{87}Sr/^{86}Sr$ =0.71126) represent one non-local individual, and ACL-8626 IRE-TA-60 ($^{87}Sr/^{86}Sr$ =0.71161) represents another non-local. Based on the geological values in the vicinity of Tintern Abbey, all but one individual (ACL-8626 IRE-TA-60) would be considered an outlier. However, Tintern Abbey is less than 3 km from the ocean, and no individuals are outliers if the marine value of $^{87}Sr/^{86}Sr$=0.7092 is considered to be the lower limit of the local range (Veizer, 1989). These individuals appear to have consumed a marine source of strontium, deriving either from diet or sea spray. Nine individuals were estimated to be ecclesiastical (see Table 1 for values). Of these, one was considered non-local by the statistical analysis (ACL-8619 IRE-TA-54), and one was considered non-local by both statistical analysis and baseline bioavailable strontium values (ACL-8626 IRE-TA-60).

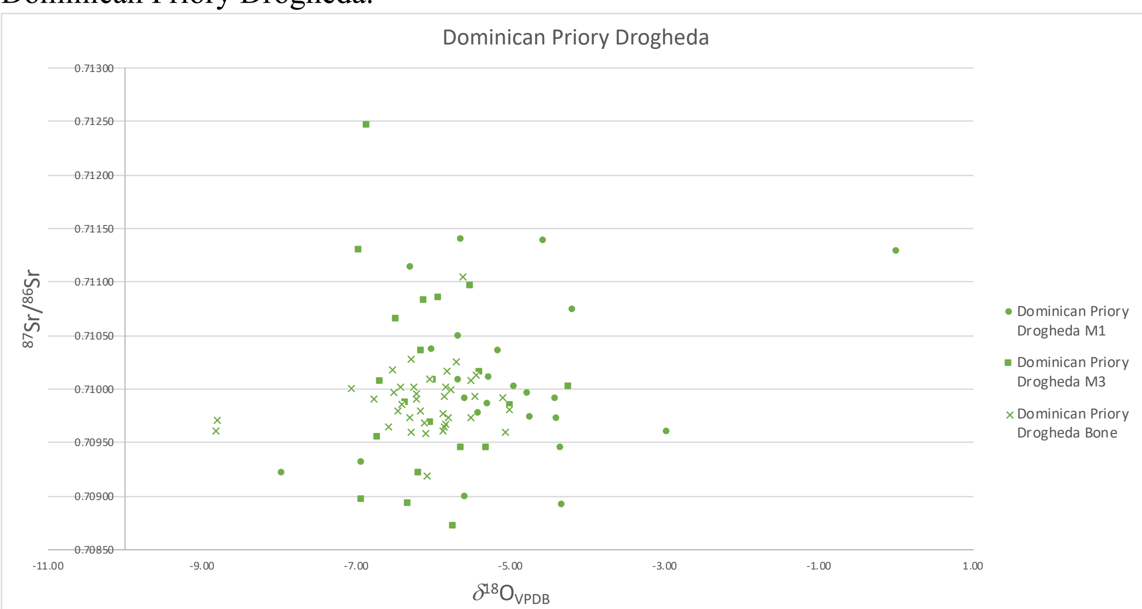
Figure 6. Scatterplot $^{87}Sr/^{86}Sr$ and $\delta^{18}O_{VPDB}$ Data from Individuals Buried at the Site of Tintern Abbey.



9.9. Mobility and ecclesiastical individuals at Dominican Priory Drogheda, Co. Louth

Six individuals are considered non-local by statistical methods (see Figure 7). Based on the radiogenic strontium ratios, ACL-8722 IRE-DPD-23, ACL-8739 IRE-DPD-28, ACL-8740 IRE-DPD-28, ACL-8762 IRE-DPD-59, ACL-8768 IRE-DPD-21, ACL-8769 IRE-DPD-21 are non-local (see Table 1 for values). The oxygen isotope values indicate that ACL-8762 IRE-DPD-59, ACL-8767 IRE-DPD-7, ACL-8771 IRE-DPD-5, and ACL-8773 IRE-DPD-5 are non-local (see Table 1 for values). Based on the expected drinking water oxygen isotope values in Ireland of $\delta^{18}O_{[V\text{-}SMOW]}$ = -10.5 to -1.5 ‰, ACL-8754 IRE-DPD-45, ACL8767 IRE-DPD-7, and ACL-8773 IRE-DPD-5 are estimated to be outliers (see Table 1 for values). Comparison to the radiogenic strontium baseline ratios suggests that another three individuals are outliers: ACL-8699 IRE-DPD-18 ($^{87}Sr/^{86}Sr$ = 0.70918), ACL-8714 IRE-DPD-40A ($^{87}Sr/^{86}Sr$ =0.70899), ACL-8715 IRE-DPD-40A ($^{87}Sr/^{86}Sr$ =0.70896), ACL-8721 IRE-DPD-23 ($^{87}Sr/^{86}Sr$ = 0.70891), ACL-8722 IRE-DPD-23 ($^{87}Sr/^{86}Sr$ = 0.70871) (also a statistical outlier), ACL-8754 IRE-DPD-45 ($^{87}Sr/^{86}Sr$ =0.70920), ACL-8755 IRE-DPD-45 ($^{87}Sr/^{86}Sr$ =0.70892). Five individuals were estimated to be ecclesiastical (see Table 1). None of these ecclesiastical individuals are estimated to be non-local to the site.

Figure 7. Scatterplot $^{87}Sr/^{86}Sr$ and $\delta^{18}O_{VPDB}$ Data from Individuals Buried at the Site of Dominican Priory Drogheda.



9.10. Comparison of percentages of local and non-local individuals

A non-parametric Chi-square test is used to determine if percentages of mobile ecclesiastical and lay people are significantly different between all of the sites (see Table 6) (Shennan, 2001). The proportions are based on the individuals estimated to be non-local by the statistical method discussed above in order to eliminate the impact of uneven sampling of geological samples on these calculations. However, the geological data support the conclusions of the statistical methods in most cases. These data indicate that ten of seventy (14.3%) of lay people in this study are non-local, and two of eighteen (11.1%) of ecclesiastical people in this study are non-local. A Chi-square test indicates that these percentages are not significantly different at a p-value of 0.05 (Chi-square=0.1225, test p-value=0.7263).

Zero of four (0%) early medieval ecclesiastical individuals are non-local, and two of fourteen (14.3%) late medieval ecclesiastical individuals are non-local. A Chi-square test cannot be used to determine if the percentages of non-local ecclesiastical people are significantly different between the early and late medieval time periods because there are no non-local ecclesiastical individuals from the early medieval period. In comparison, one of two (50%) early medieval lay people is non-local, and eight of sixty-eight late medieval lay people are non-local (11.8%). Based on these data, it is not possible to conclude that there was or was not a difference in mobility between ecclesiastical and lay people in the early medieval period due to the small sample size. However, a chi-square test indicates that there is no significant difference between the percentage of non-local ecclesiastical and lay people during the late medieval period at a p-value of 0.05 (Chi-square=0.0689, test p-value=0.7929). Finally, there is no significant difference between overall proportion of non-local people buried at the sites in the early medieval period (1/6=16.7%) and late medieval period (11/82=13.4%), based on a Chi square test at a p-value of 0.05 (Chi-square=0.0502, test p-value=0.8227).

Table 6. Proportions and Percentages of Ecclesiastical and Mobile Individuals. Ecclesiastical individuals fulfill at least 3 of the criteria listed in Table 3. Non-local individuals are estimated by the statistical method outlined above, rather than by comparing to geological samples.

	Ecclesiastical Individuals	Non-local Ecclesiastical Individuals	Percentage of Non-local Lay Individuals	Percentage of Non-local People (Total per Site)
Overall	18/88=20.5%	2/18=11.1%	10/70=14.3%	12/88=13.6%
Toureen Peakaun	1/8=12.5%	0/1=0%	2/7=28.6%	2/8= 25%
Illaunloughan	3/4=75%	0/3=0%	0/1=0%	0/4= 0%
Lorrha	0/10= 0%	0/0=0%	2/10=20%	2/10= 20%
Tintern Abbey	9/24=37.5%	2/9=22.2%	0/15=0%	2/24= 12.5%
Dominican Priory Drogheda	5/42=11.9%	0/5=0%	6/37=16.2%	6/42= 14.3%

9.11. $^{87}Sr/^{86}Sr$ over the life course

Plots of the three tissues analyzed (M1, M3, and bone) demonstrate changes in one individual’s radiogenic strontium isotope ratios over time, which can be used to represent life histories of individuals (Marsteller et al., 2017) (see Figures 8, 9, 10, and 11). The first molar crown (M1) represents the age of ~0-40 months, the third molar crown (M3) represents from 8-14 years of age, and bone represents the last 20 years of life (Christensen and Kraus, 1965; Garn et al., 1962; Gleiser and Hunt, 1955; Hedges et al., 2007). These plots show that all sites in this study except for Illaunloughan drew in people from the local area who were not raised directly adjacent to the monastery.

Figure 8. $^{87}Sr/^{86}Sr$ Over the Life Course for the Site of Toureen Peakaun.

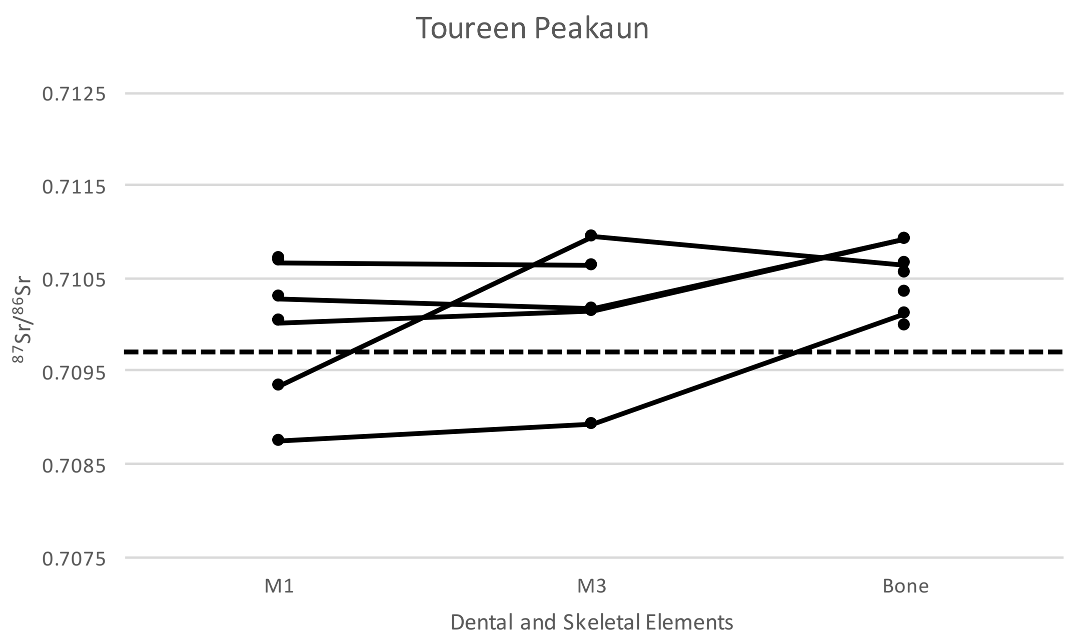


Figure 9. $^{87}Sr/^{86}Sr$ Over the Life Course for the Site of Lorrha.

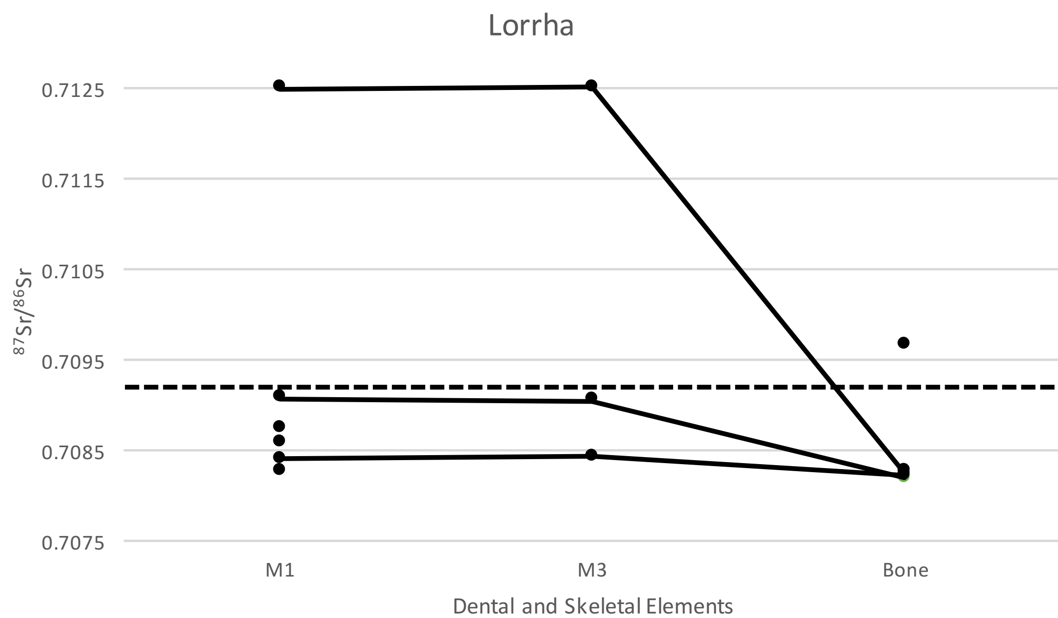


Figure 10. $^{87}Sr/^{86}Sr$ Over the Life Course for the Site of Tintern Abbey.

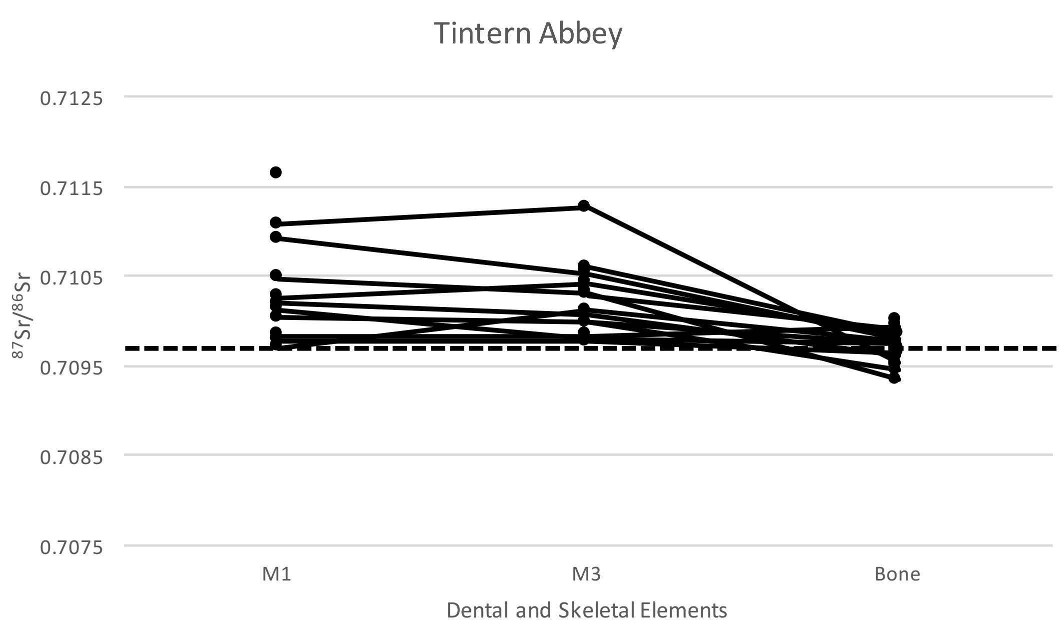
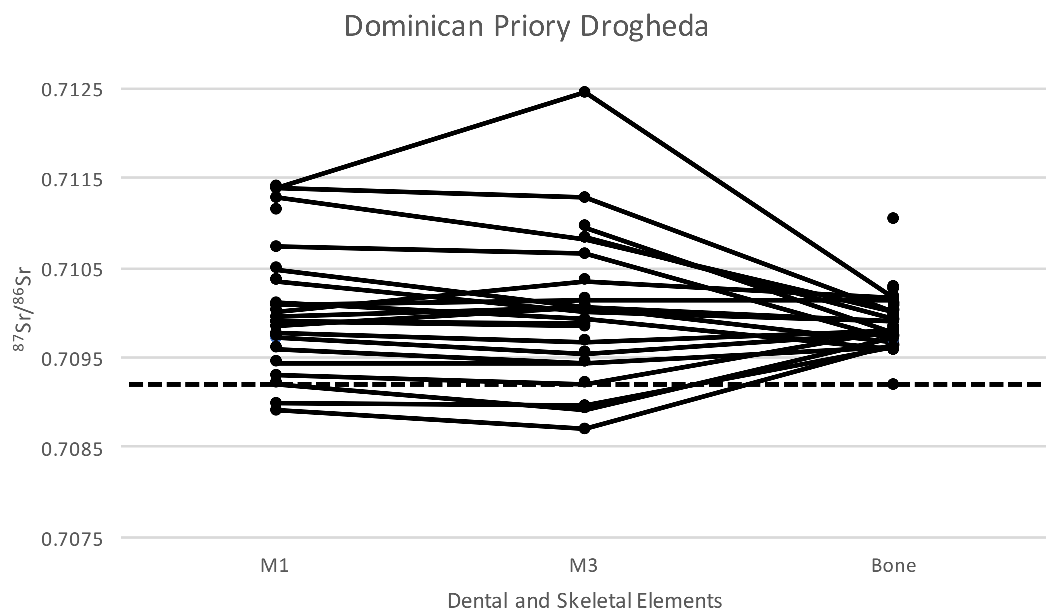


Figure 11. $^{87}Sr/^{86}Sr$ Over the Life Course for the Site of Dominican Priory Drogheda.



10. Discussion

10.1. Evidence for mobility at early and late medieval monastic sites

The early and late medieval ecclesiastical people in this study did not exhibit significantly different levels of mobility from the lay people. The evidence from the historical texts appears to be biased towards notable individuals, and a low level of mobility seems to be common for both ecclesiastical and lay populations during the early and late medieval periods. It appears that texts overemphasize the prevalence of mobility in the monastic experience, perhaps purposefully utilizing the early prominence of pilgrim saints to raise the status of these famous ecclesiastics, similar to the practice of veneration of pilgrim saints' relics (Johnston, 2016; Ó Carragáin, 2003a). However, the texts could be accurately portraying high levels of mobility for the most elite ecclesiastical people, who occur in such small numbers that it none were available to test for this study. These most elite people would be found in graves marked by cross-inscribed recumbent stones and elaborate burial settings near the eastern side of the church or the altar or they could be found in tomb shrines (Scott, 2011: 69). None of the individuals in this study were buried in such elaborate settings as to label them elite religious personnel.

Also, overall percentages of mobile individuals are not significantly different between the early and late medieval periods, even though the late medieval period involved notable interactions with other cultures via the introduction of the Continental monastic orders and the influx of Anglo-Normans (Otway-Ruthven, 1968; Stalley, 1987). The sites in this study span urban sites, such as the Dominican Priory in Drogheda, to relatively isolated sites such as Illaunloughan and Toureen Peakaun. It is interesting to see that the different contexts of these sites do not appear to correlate to measurably higher levels of mobility. However, future studies and larger sample sizes for the early medieval populations are needed to truly assess whether rates of mobility changed between the two periods.

The plots of individuals' radiogenic strontium isotope values over their life course indicate that people buried at these monastic sites converged over their lives (see Figures 8, 9, 10, and 11). Monasteries likely acted as a catchment for medieval Irish people in life and death. For instance, monasteries on the continent were recorded as having fairs and markets on their grounds that would draw crowds (Fry, 1999). The Cistercian order focused on agriculture, and lay brothers gathered to the monastery to farm and complete crafts (Stalley, 1987). Also, as in the case of Illaunloughan, education and fosterage were possible reasons for children to gather at monasteries, and this movement would have been captured in the differences of the isotopic data derived from M1 and bone if the individual died at an age of around 20 years or less (Hedges et al., 2007; Marshall and Walsh, 2005; Parkes, 2006; Parkes, 2004). Monasteries offered economic and social opportunities that seem to have encouraged people to move closer to them. Dominican Priory Drogheda and Lorrha were founded in medieval towns, and individuals were likely attracted to the monastery in addition to the town. Contrastingly, Illaunloughan, Toureen Peakaun, and Tintern Abbey were not founded by existing towns. It is telling that this pattern applies to all monasteries in this study, regardless of their placement nearby or far from a town.

Monasteries also drew people after their death. In the early medieval period, Saint's cults and relics were very popular, and these saints were often venerated at a specific site (Ó Carragáin, 2003a). Families were likely associated with a certain church or monastic site over time, and some families probably supported the running of a specific monastery, known as a proprietary monastery (Ó Carragáin et al., 2011; O'Brien, 2009). Also, the Church's burial policy emphasized the necessity of being buried on consecrated ground after the eighth century (O'Brien, 2009), which is the period covered in this study, perhaps in an effort to consolidate the community or receive remuneration for burials. The sites in this study may have acted as gathering places for the local population in both life and death.

10.2. Possible origins outside of Ireland

Although no individuals in this study exhibit radiogenic strontium isotope ratios or oxygen isotope values that clearly do not occur on the island of Ireland, several individuals exhibit combinations of both data that occur more commonly in Britain. Individuals with a $\delta^{18}O_{dw}$[V-SMOW] of less than about δ^{18}OV-SMOW = -10.5 ‰ fall outside of the reported range for drinking water in Ireland and within the range for Britain accounting for the δ^{18}O[V-SMOW] = 2.9 ‰ minimum meaning difference (see Table 1) (Darling et al., 2003; Pestle et al., 2014). The individuals with possible British origins are from the sites of Lorrha (ACL-8673 IRE-LR-48, ACL-8679 IRE-LR-3), Toureen Peakaun (ACL-8609 IRE-TP-0421), and Dominican Priory Drogheda (ACL-8754 IRE-DPD-45, ACL-8767 IRE-DPD-7, ACL-8773 IRE-DPD-5), and they display a range of radiogenic strontium isotope values from $^{87}Sr/^{86}Sr$ =0.70826 to $^{87}Sr/^{86}Sr$ =0.71035 (see Table 1). These combinations of oxygen isotope values and radiogenic strontium isotope ratios can be found in Britain, where bioavailable radiogenic strontium isotope ratios range from $^{87}Sr/^{86}Sr$ =0.7070 to $^{87}Sr/^{86}Sr$ =0.7222 and δ^{18}O[V-SMOW] = -4.5 to δ^{18}O[V-SMOW] = -9.0 (Darling et al., 2003; Evans et al., 2010). However, these data are not differentiated enough to conclude definitively that these individuals lived outside of Ireland during their lifetimes. The other six non-local individuals not mentioned here exhibit isotopic data that are present in Ireland but not in Britain.

11. Conclusion

The data suggest that people who participated in monasticism as monks or religious personnel were not demonstrably more mobile during their lifetimes than members of the lay community buried at the monasteries. Furthermore, it appears that the percentage of people who undertook mobility during their lifetimes is not demonstrably different between the early and late medieval periods, despite the different historical contexts of the periods and sites in this study. However, this study has shown that monastic sites were a focal point for local communities in early and late medieval Ireland, as people moved closer to the monasteries in the last twenty years of their lives based on the data derived from bone (see Figures 8, 9, 10, and 11) (Hedges et al., 2007). Monastic sites drew people to live near them during life, and they drew people to them for burial after death. The monastic communities seem to have been composed of mostly local people, and it is unlikely that the average monk traveled long distances to join a monastery. The written evidence suggesting that monasticism is closely tied to mobility appears to be biased towards exceptional or fictional individuals. Perhaps this participation of local people in the organization of the Church served to strengthen the bond between monastic and lay communities, supporting the Church's political and social dominance in Ireland during the medieval period.

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CHAPTER 3

ILLAUNLOUGHAN: A CASE STUDY OF LOCAL MONASTIC FOSTERAGE OF A JUVENILE IN THE EARLY MEDIEVAL CORCU DUIBNE REGION

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Author Contributions:

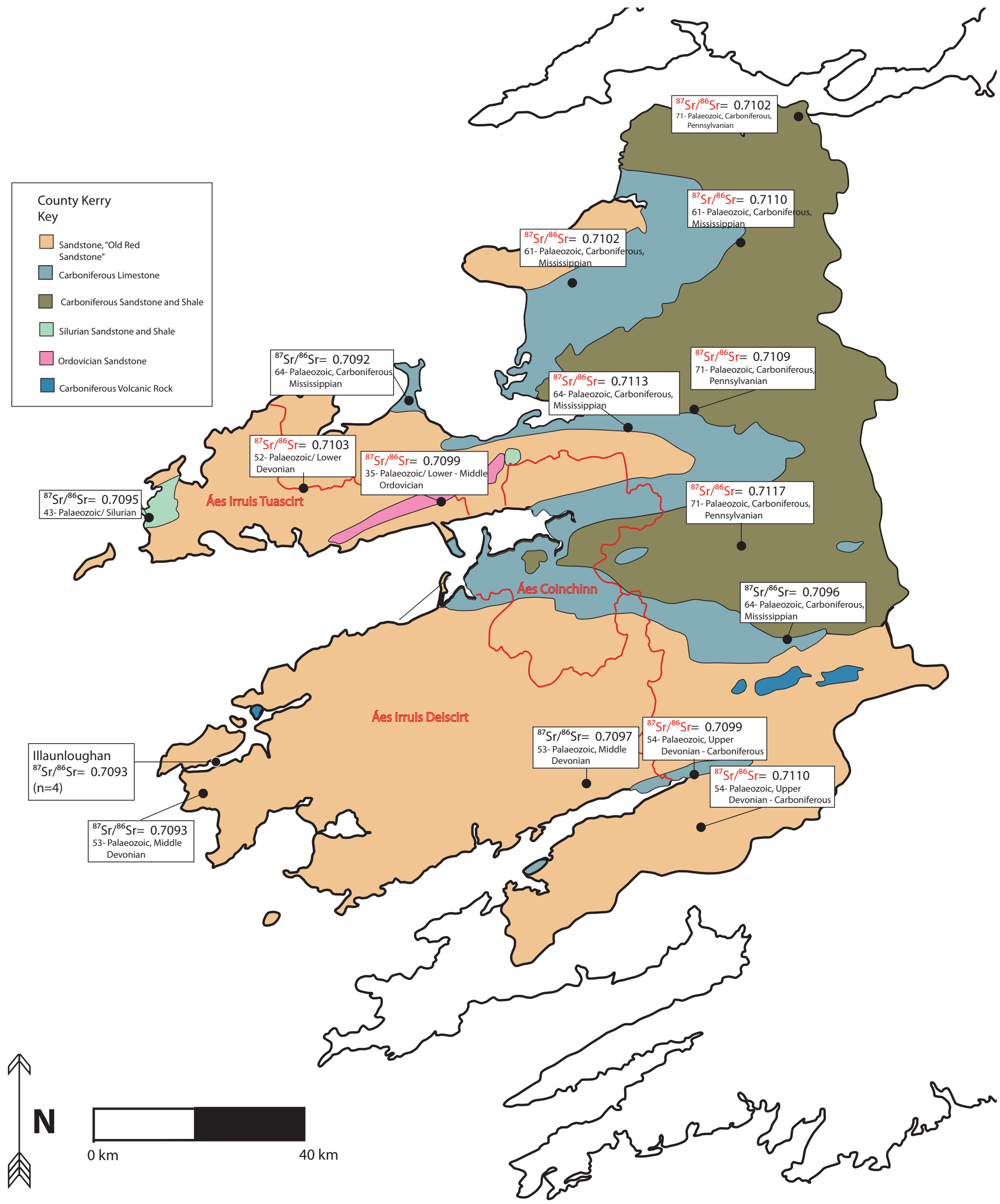
EA and KK developed the project, EA collected the samples, performed chemical analyses, and wrote the paper

1. Introduction

Illaunloughan is an early medieval monastic site that has captured the attention of Irish historians, archaeologists, and citizens because of the extensive excavation and analysis of its well-preserved architectural remains and its location on a very small island visible from the Iveragh Peninsula (Marshall and Walsh, 2005; Ó Carragáin, 2009). The presence of skeletons in a small graveyard containing males and juveniles dated to the monastic occupation creates an opportunity to examine life at an island monastery in early medieval Ireland. Illaunloughan was set within the Corcu Duibne kingdom, which comprised a well-documented grouping of three areas, each controlled by a distinct kin group (see Figures 12 and 13) (MacCotter, 2008; MacCotter and Sheehan, 2009). Furthermore, it is one of only two early medieval island monasteries where juvenile burials have been excavated, with the other being Skellig Michael (Marshall and Rourke, 2000; Marshall and Walsh, 2005; Scally, 1999; Scally, 2014). The presence of juvenile remains at Illaunloughan allows investigations of the practice of fosterage at a monastic site.

Figure 12. Geographical Context of County Kerry and Illaunloughan.

Figure 13. $^{87}Sr/^{86}Sr$ of County Kerry Baseline Samples and Human Samples from Illaunloughan with the Outline of the Corcu Duibne Region. Based on maps by MacCotter and Sheehan, 2009 and the Geological Survey of Ireland (1:500,000 map).



Fosterage was an integral part of early medieval Irish lay and monastic life (Kelly, 1988; Ní Chonaill, 1997; Parkes, 2006; Parkes, 2004; Preston-Matto, 2011). In fact, fosterage was so common that the medieval Irish words for foster-parents (*muimme* and *aitte*) were more similar to the modern form of the intimate titles mom and dad than the words for biological parents, which were more similar to the modern mother and father (Kelly, 1988:86; Stout, 2017). Medieval texts indicate that fosterage at monastic sites was key to both teaching literacy and to recruiting future members of the monastery (Kelly, 1988; Ní Chonaill, 1997; Parkes, 2006; Parkes, 2004; Preston-Matto, 2011).

Scholars of have argued that the early Irish Church consisted of diverse types of monastic communities, including isolationist hermitages and large *civitates* that ministered to the local lay community (Charles-Edwards, 2000). Questions have also arisen about the level of prestige and influence that a monastery may have had in the local and regional area. Secular power was hierarchical during the early medieval period, with high-kings, kings, and locally important families (Jaski, 2000). Likewise, monasteries may have been hierarchically arranged, with some having a large sphere of influence and some being of only local importance (Mytum, 1992; Ó Carragáin, 2003). Certain island monasteries were of major importance and recorded in historical texts, such as the nearby site of Skellig Michael, but scholars have suggested that Illaunloughan was a proprietary monastery with only local influence (Marshall and Rourke, 2000; Marshall and Walsh, 2005; Ó Carragáin, 2003). However, no records exist concerning Illaunloughan (Marshall and Walsh, 2005). The lack of textual evidence for Illaunloughan suggests that it was a lower status monastery, but archaeological research is important as another line of evidence in this case because some early medieval texts were likely destroyed.

By investigating whether the individuals buried on Illaunloughan were local or non-local to the area, this study seeks to answer the questions: (1) How was fosterage practiced on Illaunloughan? And (2) How did the monastery on Illaunloughan relate to the local community? If the individuals assessed in this study are local, this suggests that Illaunloughan was likely a proprietary monastery connected to the regional politics of the Corcu Duibne region. In contrast, the presence of a non-local foster child or non-local monks could indicate that Illaunloughan had ties to monasteries or communities outside of the local area.

2. Early medieval island monasteries in Ireland

In early medieval Ireland, ecclesiastical sites took a number of forms, including churches that tended to the lay community, church sites that were the seats of bishops and other members of the ecclesiastical hierarchy, and small churches that were likely on the land of wealthy families (Charles-Edwards, 2000; Ó Carragáin, 2011). In earlier assessments of Church organization, nearly all ecclesiastical sites containing a church were considered to be monastic sites (e.g., Hughes, 1966), where the monks would have lived by St. Columbanus' rule (Stout, 2017: 47). In addition, most small early medieval church sites were at one point considered to be hermitages (Henry, 1957). However, more recently, scholars have challenged this view by emphasizing the multiplicity of ways that Christianity may have been practiced in early medieval Ireland. The historical texts provide evidence for both monastic sites headed by abbots and episcopal sites headed by bishops (Charles-Edwards, 2000; Etchingham, 1999; Sharpe, 1984). Several scholars suggest that many of the small churches, such as those on the Iveragh Peninsula, may have been run by families (Ó Carragáin, 2003; Ó Corráin, 1981; Thomas, 1971). Textual evidence also records that abbots sometimes passed down their position to their sons or others within the family (Charles-Edwards, 2000:272). Despite this argument that many ecclesiastical sites are not monasteries, island sites have become essential representations of early medieval monasteries because their physical separation suggests that the community followed eremitical practices (Ó Carragáin, 2013).

Monasteries were founded on islands in the sea, rivers, lakes, and bogs during the early medieval period in Ireland. These monasteries inhabited a conspicuous place in the imagination of early medieval people, as they were liminal spaces between the mundane world of everyday life and the Otherworld (Ó Carragáin, 2013: 23). O'Sullivan suggests that crannogs and islands were liminal spaces that were inhabited by both the marginalized and people of great power, all of whom used the social distance of the island for different purposes (O'Sullivan, 2009). Ó Carragáin (2013: 27) also argues that island monasteries were "gendered to a greater extent than, and in a different manner to, most other settlements including other ecclesiastical sites," adding to the mystique of the islands. Furthermore, these monasteries supported a particularly performative version of ascetic monasticism that characterized early medieval monastic life in the deserts of Egypt and the marginal landscapes of Ireland.

Life on island monasteries is discussed in saints' lives, such as the Life of St. Adomnán, and by Bede in his discussion of St. Colman's monastic foundation on

Inishbofin (Campbell, 1968; Sharpe, 1995). Like St. Anthony's desert monastery, early Irish monasteries may have followed a doctrine of asceticism (Bitel, 1994; Rousseau, 1978). Asceticism is "a monastic endeavor that combines the cultivation of virtuous qualities with self-denial and mortification, manifest in practices such as sexual and dietary abstinence" (Bitel, 1994; Follett, 2006: 25; Rousseau, 1978). However, food remains found on the island monastery sites of Iona in Scotland and Illaunloughan indicate that, contrary to written evidence, early medieval monks had a varied diet that included domestic animals such as cows, wild animals such as red deer, seafood, and grains (Murray et al., 2004).

Early medieval island monasteries, especially those on the west coast of Ireland, share a common architectural style. They typically contain a stone church or oratory surrounded by a circular stone wall known as an enclosure, and domestic buildings that took the form of stone huts known as *clóchans* (Ó Carragáin, 2011). Monastic cells were sometimes built into the enclosure wall, such as at Inishmurray (O'Sullivan and Ó Carragáin, 2008). Graves of religious and some lay individuals were located within the enclosure and near the church at early medieval monasteries, such as at High Island (Marshall and Rourke, 2000).

Texts indicate that the Church encouraged lay people to be buried on Church land beginning around the late seventh or early eighth centuries (O'Brien, 2009). Some monasteries were founded on larger islands that supported permanent lay communities and thus combined the ascetic ideals with lay ministry. These include the monasteries on Inishmurray, Omey Island, several sites on the Aran Islands, and St. Colman's Abbey, founded on Inishbofin in AD 667 as recorded by the Venerable Bede (Campbell, 1968; Ó

Carragáin, 2011; O'Sullivan and Ó Carragáin, 2008; Scott, 2011). Church Island, which is also close Valencia Island and Illaunloughan, possibly contains the burials of a lay population, but the presence of one female in thirty extant burials suggests a biased burial population that may be more indicative of a monastic population (O'Kelly, 1957). Lay people were likely not buried at some early medieval monasteries on small or inaccessible islands during the monastic occupations. For instance, monastic phase burial populations of Skellig Michael, Illaunloughan, and High Island are overwhelmingly male and consistent with the likely small number of individuals that could be housed in the monastic communities at each site (Bourke et al., 2011; Buckley, 2005; Horn et al., 1990; Marshall et al., 2005; Scally, 1999; Scally, 2014). Some of these monastic sites were used for burial of the lay population after the monastic phase, such as on Illaunloughan and Inishmurray (Marshall and Walsh, 2005; O'Sullivan and Ó Carragáin, 2008). Ó Carragáin (2013: 25) notes that many island monasteries were founded on previously unused land; however, it is possible that sites in areas with previous occupation do not show evidence for the clear distinction between the monastic and lay communities and thus are less likely to be identified as monasteries.

Whether or not they ministered directly to a lay community living on the same island, evidence suggests that these island monasteries likely interacted with outsiders in order to procure food and new members, who may have been foster children. For instance, faunal remains indicate that Illaunloughan accepted frequent tributes of young cows, and the monastery on Iona in Scotland received red deer (Murray et al., 2004: 185). Importantly, children are found in the monastic burial populations, and their presences suggests that the practice of fosterage occurred at the island monasteries.

3. Fosterage in early medieval Ireland

Fosterage, well-documented in early medieval Ireland, was a practice in which a child was raised by non-biological parents to be raised for an extended period, sometimes more than ten years (Charles-Edwards, 2000; Johnston, 2000; Kelly, 1988; Parkes, 2006; Parkes, 2004; Preston-Matto, 2011). The practice is recorded in the fragmentary early medieval law text “Law of the Fostering Fee” (*Cáin Íaraith)* (Parkes, 2006: 362). The biological parents of the child would pay the foster parents a fee (*íarrath*) when the foster period was completed, unless the fosterage was rendered out of affection (Kelly, 1988: 88). Fosterage typically lasted at most from age 7 to 17 years, but the *Críth Gablach,* a law text that focuses on status*,* suggests that fosterage ended at age 14 years (Kelly, 1988: 88). In some situations, fosterage began in infancy, which may have served to especially strengthen the pseudo-familial bonds between foster siblings, which sometimes translated into political alliances (Kelly, 1988: 89). It was common for the child of a king to be fostered by someone of lower rank alongside the biological children of the foster parent (Kelly, 1988: 89), and it was also common practice for royal children to be fostered by a succession of several different foster parents, to learn many different necessary skills (Charles-Edwards, 2000: 126; Parkes, 2004: 599). Members of the lower classes typically learned farming skills during fosterage (Kelly, 1988: 87).

Ecclesiastical fosterage focused on educating children in reading, writing, and other scholarly skills, and it was common by the ninth century (Parkes, 2006). It was similar to the “literary fosterage” of the earlier druidical schooling and the Brehon law schools (Karl, 2005: 256; Kelly, 1988: 91; Parkes, 2006: 370). Children were fostered by male and female ecclesiastics at both monastic and ecclesiastical sites. For instance, St Íte was foster mother to St Brendan of Clonfert and to St Mo Chóemóg, who was her nephew (Johnston 2000, 7). Some evidence suggests that ecclesiastical fosterage began around 7 years, after a period of secular fosterage in early childhood (Parkes, 2006: 371).

Archaeological evidence for fosterage in Ireland is scant because it can be difficult to distinguish the presence of children in the archaeological record through artefacts and features, and it is nearly impossible to show the presence of non-local children in cemetery populations without biogeochemical analyses of human remains. However, two early medieval monastic cemeteries reveal evidence for ecclesiastical fosterage in the form of children buried in a cemetery seemingly reserved for members of the monastic community. Skellig Michael is a small, rugged island in County Kerry that housed an early medieval monastic community but did not support a resident lay community (Bourke et al., 2011; Horn et al., 1990). It was likely a principal church of the Corcu Duibne region (Ó Carragáin, 2003). Excavations in various areas of the terraced site have yielded three articulated burials and disarticulated skeletal elements, representing a minimum number of individuals (MNI) of five adults and four juveniles (Bourke et al., 2011: 376). The juveniles were aged between 9 and 12 years at death (Lynch, 2011).

Similarly, during the early medieval period, Illaunloughan's cemetery was likely used exclusively for burial of ecclesiastical individuals (Marshall et al., 2005). Of the seventeen surviving skeletons dating to the early medieval period, the twelve who were preserved well enough to be analyzed were estimated to be male, and three were juvenile (Buckley, 2005; Marshall and Walsh, 2005: 84). This does not represent a normally distributed population of a mixed-sex lay community, supporting the claims that the cemetery was used for ecclesiastical burials during this period. The children buried on Illaunloughan whose age could be estimated are 1.5-3.5 years, 2.5-3.5 years, and 5-7 years (Buckley, 2005: 2). Due to poor preservation of the bone at the site, only one juvenile (5-7 years old) could be tested for this study.

4. The social and ecclesiastical context of Illaunloughan in the Corcu Duibne region

The monastery at Illaunloughan was set within the kingdom of Corcu Duibne, which was in existence by the late eighth century until the time of the Anglo-Normans (MacCotter and Sheehan, 2009; Ó Carragáin, 2003). The kingdom was split into three regions- Áes Irruis Deiscirt, which comprises most of the Iveragh peninsula and houses Illaunloughan, Áes Conchinn to the east, and Áes Irruis Tuascirt on the Dingle Peninsula (MacCotter and Sheehan, 2009: 148) (see Figure 13). Annalistic records indicate that these regions were ruled by the O'Falvey, O'Shea, and O'Connell families, respectively, by the twelfth century arrival of the Anglo-Normans. These families supplied kings to the overarching kingdom of Corcu Duibne (MacCotter and Sheehan, 2009:148). These areas might have been split further into *tuatha,* which are the smallest political unit in early medieval Ireland and were likely based on real or perceived blood ties (Byrne, 1971: 131). Current scholarly opinion suggests that churches were allied to each other within the bounds of secular political areas such as the three regions of the Corcu Duibne, and this intra-region network of churches included both powerful principal churches and smaller, less influential ecclesiastical sites (Etchingham, 1993; Ó Carragáin, 2003: 130).

Illaunloughan likely was not a principal church of the Corcu Duibne kingdom. The three principal churches that have been identified, Inis Úasal, Kilmalkedar, and Skellig Michael, have much larger and more impressive architecture than Illaunloughan (Ó Carragáin, 2003: 131). Also, Illaunloughan is not mentioned in annals or historical sources (Marshall and Walsh, 2005: 5). Several scholars have argued that some of the small ecclesiastical sites in the Corcu Duibne region represent proprietary churches, which may have been run and passed down by families (Mytum, 1992; Ó Carragáin, 2003). Based on the distinct architectural styles of ecclesiastical architecture in the northern Iveragh peninsula, "local identities were more forcefully expressed" in this region than in other areas of Ireland during the eighth and ninth centuries, and Illaunloughan and other Corcu Duibne ecclesiastical sites may have had some autonomy from the wider system of Christianity (Ó Carragáin, 2003: 146).

Because Illaunloughan was likely a proprietary church rather than a principal church, one might assume that the group of people that the monastic community drew from was relatively small and local. Perhaps the monastery favored people from the Áes Irruis Deiscirt area of Corcu Duibne because the kin group that may have been tied to Illaunloughan was centered in Áes Irruis Deiscirt. Fosterage may have occurred on a local level at Illaunloughan, perhaps within a kin group, as seen in the story of St Íte fostering her nephew (Johnston, 2000: 7).

5. Illaunloughan: An introduction to the archaeological context

The island of Illaunloughan lies about 100 m north of shore of the Iveragh

Peninsula and 300 m south of the shore of Valencia Island, and it is visible from both locations. It is interpreted as a monastic site rather than an ecclesiastical site because the monastic occupies the entirety of the small island, the presence of domestic buildings that likely housed the monastic community, and the exclusively male burial population (Marshall and Walsh, 2005; Ó Carragáin, 2009). The early medieval monastic settlement is the first known domestic occupation of Illaunloughan, as no earlier materials were found during excavations (Marshall and Walsh, 2005). The first phase of monastic occupation dated from the mid seventh century to mid eighth centuries, based on a radiocarbon date obtained from ash found in a hearth (Marshall and Walsh, 2005: 11). During this period, the monastic site comprised a sod oratory, three sod domestic huts, possibly two shrines, and several graves. The site was heavily paved with flat stones, similar to the paving found at other island monasteries such as Skellig Michael (Bourke et al., 2011; Ó Carragáin, 2013) and Inishark (Lash et al., In Press). The excavators found evidence for metalworking near one of the huts and in the midden in the form of clay molds and a sheep's scapula that was a test piece for metalworking designs (Marshall and Walsh, 2005: 19). Marshall and Walsh (2005: 11) estimate that twelve individuals were buried during this first period, before a very small sod structure replaced the previous sod oratory (Marshall and Walsh, 2005: 19, 32-36).

In the eighth and ninth centuries, the site was changed by the addition of a drystone hut with a corbelled roof; a sample of animal bone found beneath the hut was radiocarbon dated to AD 775-961 (2σ cal, 95.4% probability) (Marshall and Walsh, 2005: 42). A drystone oratory was also added during this phase. The oratory was built in one phase of construction using native rock, and there is stone paving in the form of a path leading to the door (Marshall and Walsh, 2005: 44). A *leacht*, which is an altar or prayer station commonly found at early medieval monastic sites, was built adjoining the north wall of the oratory during this phase. The only other known *leacht* built into the wall of an oratory on an early medieval monastic site occurs on the nearby island of Skellig Michael (Marshall and Walsh, 2005: 49, 55, 61). A gable reliquary shrine was also constructed during this phase in an enclosed, raised area over two translated burials of adult males, which were radiocarbon dated to AD 686-794 and AD 666-777 (2σ cal, 95.4% probability). Such reliquary shrines likely housed the remains of important religious personnel, such as the founder of the site. They linked the early medieval monasteries to the broader Christian cult of relics, which may have been used by smaller ecclesiastical and monastic sites to assert independence by highlighting a connection to a locally venerated founding saint (Ó Carragáin, 2003: 143; Etchingham, 1993). A skull of an infant, radiocarbon dated to AD 660-780 (2σ cal, 95.4% probability), was also buried beneath the shrine (Marshall and Walsh, 2005: 62). Unfortunately, the preservation of these skeletal remains is not sufficient for biogeochemical analysis; however, they are significant as the only human remains to be found *in situ* underneath a gable shrine (Marshall and Walsh, 2005).

Illaunloughan is in an uncommon geographical setting because the island is small and almost entirely taken up by the monastic settlement. There would have been no room for a lay community to live on the island, yet the island is so near to the shore that all activities could be observed by those outside of the community (see Figure 14). This contrasts with the monastic community of High Island, where the church and monastic enclosure are not visible from any other surrounding landform except for the western half of Inishark. Ó Carragáin (2013: 26) suggests that the local lay community could see "the rhythms of monastic observance practices" undertaken by the monks on Illaunloughan, and the monks would have offered the lay people "a model of the ideal Christian existence." This lay community likely lived at or near the several early medieval ringforts on Valencia Island and the western Iveragh Peninsula (O'Sullivan et al. 2013:49). He also suggests that the visibility of the monastery would have prevented "radical changes or a fall in standards" due to the constant inspection of the local lay community (Ó Carragáin, 2013: 26). Illaunloughan's setting reinforces both the isolationist and performative aspects of ascetic monasticism. Along with the presence of domestic huts, the site's setting also confirms that this is a monastic settlement, rather than an ecclesiastical site without a monastic community. Church Island is another monastic site set on a similarly small island near Valencia Island, and this site also contains domestic buildings indicating the presence of a monastic community (O'Kelly, 1958).

Figure 14. View of Illaunloughan from the Shore to the South of the Island. Valencia Island is in the background.

6. The burial population at Illaunloughan

6.1. Overview

During the early medieval period, approximately 24-25 graves were dug on Illaunloughan (Marshall and Walsh, 2005: 84). Excavators recovered seventeen skeletons from these graves, which were situated near the oratory and in a cemetery area near the gable shrine (Marshall and Walsh, 2005: 81). Of these individuals, three were juveniles, twelve were male, and two were not able to be sexed (Buckley 2005: 3). The style of the graves varied, with those near the oratory being more elaborate and fully lined with stone, and others ranging from simple dug graves to stone-lined or linteled cist graves (Marshall and Walsh, 2005: 84). Only two graves contained two individuals, and Marshall and Walsh (2005: 66) suggest that these superimposed burials occurred at a later date when space was tight.

Based on the well-supported conclusion that Illaunloughan was a monastic site, the burials dating to the seventh to ninth century were likely monks or children being trained by monks. It is possible that others were buried at the site, such as visitors or those who were newly initiated into the community. In saints' lives, there are several instances where visitors to island monasteries die shortly after landing on the island and becoming members of the religious community. For instance, in the short narrative "*The saint's prophetic vision of two pilgrim brothers*" in *Adomnán's Life of St. Columba*, two lay people traveled to Iona as pilgrims, but St. Columba insisted that they take monastic vows and join the community. Shortly after they did so, they died and were buried at the monastery (Sharpe, 1995: 135). It is likely that those buried on Illaunloughan traveled to the site in order to participate in monasticism in some way. It is also possible that some of the individuals were transported to Illaunloughan after death in order to be buried. The excavators and osteologist, however, suggest the graves on Illaunloughan contained only members of the monastic community, based on their small number of graves and the absence of female burials (Marshall and Walsh, 200: 84; Buckley, 2005: 3).

6.2. Individuals sampled for this study

The remains of three individuals buried in the early medieval period were sampled for this study. These skeletons represent one of the three juveniles and two adult males of the fourteen adults of the burial population that was excavated on Illaunloughan (see Table 7). The osteological analysis was undertaken by Laureen Buckley in 1996, and it was included as an appendix in Marshall and Walsh's (2005) publication on the excavations of Illaunloughan.

Burial 172- This individual is a juvenile aged 5-7 years whose remains are fragmentary. Buckley (2005: 46) noted cribra orbitalia in one orbital fragment, and enamel hypoplasia that likely occurred between two and four years. Due to preservation, only the deciduous first molar and permanent first molar was analyzed from this individual (Buckley, 2005: 46). The enamel crowns of these teeth form at the ages 0-10 months (Fanning, 1961) and 0-40 months respectively (Christensen and Kraus, 1965; Gleiser and Hunt, 1955).

Burial 180- This individual is a possible adult male. The only pathology noted was some lipping on the femoral intercondylar area (Buckley, 2005: 49-50). Due to preservation, only a rib was analyzed from this individual, the mineral fraction of which formed within the last twenty years of life (Hedges et al., 2007).

Burial 120- This individual is an older adult male. Several pathologies were noted, including porotic hyperostosis, osteoarthritis, and periodontal disease (Buckley, 2005: 40). The only element of this skeleton available for analysis is a rib, whose mineral fraction was formed within the last twenty years of life (Hedges et al., 2007).

7. Biogeochemical background

Radiogenic strontium isotopes have been used to interpret mobility in archaeological contexts since Ericson's (1985, 1989) work in California. In Ireland, isotopic data have been used to understand migration in Viking Dublin (Knudson et al., 2012; Montgomery et al., 2014), the Iron Age (Cahill Wilson and Standish, 2016), and the Neolithic and Bronze Age (Snoeck et al., 2016). Radiogenic strontium isotopic ratios can be used to estimate whether an individual lived in the local area of the burial site because strontium substitutes for calcium in the mineral fraction of bone (Bentley, 2006; Knudson et al., 2012; Turekian and Kulp, 1956). The radiogenic strontium isotopic system ($^{87}Sr/^{86}Sr$) varies with the age of the underlying geology (Dasch, 1969; O'Connor, 1988; Wallace et al., 1994), as the radioactive decay of ^{87}Rb creates increasing amounts of ^{87}Sr over time and the amount of ^{86}Sr remains constant. This isotopic ratio is retained from the geological values throughout the tropic levels of the ecosystem because strontium isotopes do not undergo fractionation or biopurification in relation to each other (Blum et al., 2000). The bioavailable strontium can be affected by processes of erosion, pedogenesis or soil formation, and movement of soils due to glaciation (Bentley and Knipper, 2005; Knudson et al., 2014). Bioavailable strontium isotopes can also be affected by sea spray, which has a constant radiogenic strontium isotope ratio ($^{87}Sr/^{86}Sr$=0.7092) (Veizer, 1989; Whipkey et al., 2000). However, a study of bioavailable radiogenic strontium isotopic ratios in plants on the island of Inishark, Co. Galway, indicates that sea spray does not necessarily overwhelm the bioavailable strontium isotopic ratios in coastal settings, although it does contribute a high percentage of strontium in some soil contexts (Alonzi et al., In Preparation). Based on the variation of radiogenic strontium ratios within the human body, mobility should only be interpreted when differences in the ratios occur in the third or fourth decimal place (Knudson et al., 2016).

8. Biogeochemical baseline and the geology of County Kerry

As part of this research, a biogeochemical baseline of modern plant samples from County Kerry was created to represent the bioavailable strontium isotopes likely to be incorporated into the human body (e.g., Evans et al., 2010; Evans and Tatham, 2004; Knudson et al., 2012; Knudson et al., 2014; Lamb et al., 2012; Leach et al., 2009). These plants were taken from forested and/or undisturbed areas that are not in modern fields. Fields were avoided because of the possibility of modern fertilizers or high quantities of non-local animal dung that could alter the strontium isotope ratios. These samples were taken in accordance with the guidelines agreed on by members of the Irish Isotopes Research Group (Daly et al., 2016). Viable sampling locations are reduced because large areas of land are in agricultural use and privately owned in County Kerry. The goal of the sampling strategy is to analyze a sample from each geological package, as identified by the GSI 1:500 bedrock maps, based on availability of the samples. The samples were exported for analysis under USDA APHIS Permit no. PCIP-14-00573.

The geology in County Kerry is dominated by sandstone (Fay et al., 2007: 9) and comprises areas of sandstone, siltstone, mudstone, conglomerate, shale, limestone, schist, greywacke, tuff, and coal with intrusions of basalt and andesite. These date from the Ordovician, Silurian, Devonian, and Carboniferous periods of the Palaeozoic Era (Geological Survey of Ireland, 2017). The most prevalent soils in County Kerry are podzols, lithosols, gleys, and peat (Fay et al., 2007: 12), which correlate with County Kerry's grazing lands, mountains, and bogs.

County Kerry was covered by the Munster General Glaciation from 200,000 to 130,000 years ago, and the norther tip of the county may have been impacted by the Midlandian General Glaciation from 75,000 to 10,000 years ago (Fay et al., 2007: 11). The first glacial period left boulder clay over much of the county, although there are areas where this layer is quite thin. Glaciation causes geological materials to be picked up and moved, but it is unlikely that these materials moved more than 2 to 5 km (Fay et al., 2007: 11). Further, much of the county's mountains are covered in thin layers of soil, promoting the influence of the lithology in the formation of the soils. Therefore, although the soils of County Kerry were undoubtedly influenced by glaciation, they would exhibit $^{87}Sr/^{86}Sr$ that mostly corresponds with the underlying bedrock.

9. Methods

9.1. Sample preparation for elemental concentration and radiogenic strontium analysis

The samples were prepared in the Archaeological Chemistry Laboratory at Arizona State University following laboratory protocols (Knudson et al., 2016). The samples are photographed and cast in plaster to preserve the morphology of the tooth. The outside of the bone or tooth is then mechanically cleaned using a diamond-tipped Dremel drill. Cancellous bone is discarded due to the likelihood of diagenetic, or post-depositional, contamination, and only lamellar bone is used for analysis. The bone samples are chemically cleaned to remove contaminants. They are cleaned in a Millipore water bath in an ultrasonic cleaner for 30 minutes, and then they undergo an acid wash of 0.8 mL of acetic acid (CH_3COOH) in the ultrasonic cleaner for 30 minutes. The samples are washed in an ultrasonic bath of Millipore water for five minutes and dried in an oven at 50°C for one hour. The bone is then ashed for 10 hours at 800°C in a furnace. Ashed bone and enamel powder are then dissolved in 500 μL trace metal grade (15.5-16M) nitric acid (HNO_3).

9.2. Elemental concentrations

Elemental concentrations of major, minor, and trace elements, including uranium, neodymium, calcium, and phosphorus were analyzed in the W.M. Keck Foundation Laboratory for Environmental Biogeochemistry (KFLEB) at Arizona State University to assess the level of diagenesis or contamination. Any sample with unexpectedly high or low concentrations of these elements would have been excluded from further analyses. To analyze the elemental concentrations, 0.0030 g of cleaned powdered tooth enamel or bone ash is dissolved in 0.5 mL of VWR trace metal grade 16 M HNO_3 and 3.50 mL of purified Millipore water (18.2 MΩ) to create a stock solution of the sample dissolved in 2 M HNO_3. Of this solution, 0.53 mL is diluted with 14.47 mL of twice-distilled 0.32 M HNO_3, and the samples are analyzed with a Thermo-Finnigan X-series quadrupole inductively coupled plasma mass spectrometer (Q-ICP-MS). These samples are compared to a calibration curve of different concentrations of internal standards and NIST 1400.

9.3. Separation and analysis of strontium isotopes

Strontium was separated in the KFLEB using glass columns packed with SrSpec EiChrom resin that had been washed repeatedly to eliminate strontium contamination (see Knudson et al., 2012). Based on the concentrations calculated through the above process, the amount of 2 M stock solution needed to provide 100 µg of calcium was calculated. The plant samples' strontium was dissolved in 1 mL of 5 M HNO_3 and diluted in 1.4 mL of purified Millipore water (18.2 MΩ), and the human samples' strontium was dissolved in 0.23 mL of 5 M HNO_3 and diluted in 3.37 mL of Millipore water. The radiogenic strontium ratios were then analyzed using a Neptune multi-collector inductively coupled plasma mass spectrometer (MC-ICP-MS) (see Knudson et al., 2012). The standard SRM-987, run at 25 ppb, resulted in a ratio of $^{87}Sr/^{86}Sr$= 0.710255±

0.000030 (2σ, n = 118). These data fall within the accepted range of $^{87}Sr/^{86}Sr$=0.710235±0.000020 (2σ, n = 76) (Hodell et al., 1989).

10. Results and discussion

10.1. Elemental concentrations and diagenesis

Elemental concentrations of calcium, phosphorus, and uranium were analyzed to ensure that the strontium data presented were derived from a sufficiently preserved biological source. The expected ratio of calcium to phosphorus atoms in human bone hydroxyapatite is 2.1:1, based on the theoretical molecular structure of bone hydroxyapatite, which composes the mineral fraction of bone (Posner, 1985). By analyzing the percentage of these elements in modern bone by weight and comparing these values to their atomic weights, Zaichick and Tzaphlidou (2002) estimated Ca/P in modern humans to be 2.17±0.31 (n=78, 1σ). Ca/P for all archaeological samples reported here fall within that range, indicating that the radiogenic strontium isotope ratios are of biogenic origin. Also, Price et al. (2002) argue that low levels of uranium correlate with good preservation. In the samples presented here, the mean $U/Ca=6.3\times10^{-5}\pm1.25\times10^{-4}$(n=4, 1σ) indicates sufficient preservation.

10.2. Radiogenic strontium isotopic ratios and mobility

The individuals buried at Illaunloughan exhibit a high degree of homogeneity in their strontium isotopic ratios that likely indicates a local origin for these individuals and/or a long residence time on the island of Illaunloughan. All three individuals and all four samples at this monastery exhibit values of $^{87}Sr/^{86}Sr$=0.7093±0.0 (n=4, 1σ) (see Table 7). As there are no outliers, these data can be interpreted as representing individuals who were local to the site. However, the number of samples is small and the ratio is close to that expected for sea spray ($^{87}Sr/^{86}Sr$=0.7092), so other coastal areas that are not in close proximity to Illaunloughan may exhibit these values as well. Therefore, the strontium data do not conclusively indicate that these individuals were from Illaunloughan or immediately adjacent areas. However, by utilizing the baseline data, it is possible to exclude some areas of Corcu Duibne from which these individuals likely did not originate.

The radiogenic strontium ratios in some areas of County Kerry are very close to the values found in the ocean ($^{87}Sr/^{86}Sr$ =0.7092). In coastal areas, this may be due to the impact of sea spray, but the local bioavailable strontium in areas not near the ocean indicate that the radiogenic strontium of the bedrock is likely close to $^{87}Sr/^{86}Sr$ =0.7092 as well (see Table 8 and Figure 13). Although sea spray undoubtedly has an effect on the radiogenic strontium ratios found in Kerry, values similar to that of seawater can be found at inland sites as well.

Table 7. Results of Human Sample Analysis.

Skeleton	Specimen	Age Represented by Strontium in Specimen	Age at Death (from Buckley 2005)	Sex (from Buckley 2005)	Radiocarbon Date (from Marshall and Walsh)	Ca/P	U/Ca	$^{87}Sr/^{86}Sr$
Sk. 180, ACL-8665	Rib	Within the last twenty years of life (Hedges, et al., 2007)	Adult?	Male	NA	1.96	6.18E-7	0.7093
Sk. 120, ACL-8668	Rib	Within the last twenty years of life (Hedges, et al., 2007)	Older Adult	Male	UB-4103, 1191±22 BP; AD 777-891, 95.4% probability	1.88	2.51E-4	0.7093
Sk. 172, ACL-8669	First Molar, deciduous	~0-10 months old (Fanning, 1961)	5-7 years old	NA	AD 683-805 (Radiocarbon statistics not published)	2.00	2.40E-8	0.7093
Sk. 172, ACL-8670	First Molar, Permanent	~0-40 months old (Christensen and Kraus, 1965; Gleiser and Hunt, 1955)	5-7 years old	NA	AD 683-805 (Radiocarbon statistics not published)	1.97	1.04E-7	0.7093

Based on the reported values for County Kerry and the Corcu Duibne region, the individuals at Illaunloughan are constrained to the western portion of the Iveragh Peninsula (see Table 8 and Figure 13). Although it is possible that these individuals grew up in other peninsular areas of Ireland, areas to the north of the study area exhibit more radiogenic values, even in very coastal regions (Alonzi et al., In Preparation). Therefore, it is most likely that these individuals represent locals either from the Áes Irruis Deiscirt or Áes Irruis Tuascirt regions within Corcu Duibne who lived in this region either during childhood (Sk. 172) or for at least the last twenty years of their lives (Sk. 180 and 120) (see Table 7). If this is true, the monastic community on Illaunloughan likely represents a proprietary church whose members were supplied by the local family or kin group, as argued by Mytum (1992) and Ó Carragáin (2003). Fosterage occurring at the monastery thus seems to have been within a local group, rather than the long-distance fosterage between elite families recorded in the historical sources. The juvenile buried on Illaunloughan represents the fosterage of a locally-born child at an Irish monastic site, and the two probable monks provide the evidence for religious personnel who were members of the local community before monastic life, unless they moved to Illaunloughan more than twenty years prior to their deaths.

Table 8. Results of County Kerry Baseline for Bioavailable Radiogenic Strontium Ratios. Geology age is from the Geological Survey of Ireland's 1:500 Bedrock Geology Map.

Sample	Type	Location	Geology Age	$^{87}Sr/^{86}Sr$
ACL-8526 IRE-54-22-K	Poa spp.	51.88647, -9.53454	54- Palaeozoic, Upper Devonian – Carboniferous	0.7099
ACL-8527 IRE-54-23-K	Poa spp.	51.83066, -9.51906	54- Palaeozoic, Upper Devonian - Carboniferous	0.7110
ACL-8528 IRE-53-17-K	Poa spp.	51.85637, -10.36701	53- Palaeozoic, Middle Devonian	0.7094
ACL-8529 IRE-53-18-K	Poa spp.	51.87149, -9.72215	53- Palaeozoic, Middle Devonian	0.7097
ACL-8530 IRE-43-5-K	Poa spp.	52.15001, -10.46955	43-Palaeozoic/ Silurian	0.7095
ACL-8531 IRE-52-6-K	Poa spp.	52.18187, -10.20727	52- Palaeozoic/ Lower Devonian	0.7103
ACL-8532 IRE-64-7-K	Poa spp.	52.27559, -10.02639	64- Palaeozoic, Carboniferous, Mississippian	0.7092
ACL-8533 IRE-35-9-K	Poa spp.	52.16417, -9.97561	35- Palaeozoic/ Lower - Middle Ordovician	0.7099
ACL-8534 IRE-71-28-K	Fern; Genus-Athyrium	52.57568, -9.37279	71- Palaeozoic, Carboniferous, Pennsylvanian	0.7102
ACL-8535 IRE-64-26-K	Poa spp.	52.25273, -9.65668	64- Palaeozoic, Carboniferous, Mississippian	0.7113
ACL-8536 IRE-64-24-K	Poa spp.	52.03941, -9.3792	64- Palaeozoic, Carboniferous, Mississippian	0.7096
ACL-8537 IRE-71-27-K	Poa spp.	52.26909, -9.54447	71- Palaeozoic, Carboniferous, Pennsylvanian	0.7109
ACL-8538 IRE-64-25-K	Poa spp.	52.44612, -9.47538	64- Palaeozoic, Carboniferous, Mississippian	0.7110
ACL-8539 IRE-61-29-K	Poa spp.	52.40062, -9.75124	61- Palaeozoic, Carboniferous, Mississippian	0.7102
ACL-8540 IRE-71-15-K	Poa spp.	52.12866, -9.46043	71- Palaeozoic, Carboniferous, Pennsylvanian	0.7117

11. Conclusion

The three individuals that were buried on Illaunloughan during the early medieval monastic phase appear to be local to the area for the last twenty years of their lives or had moved to Illaunloughan at a very young age, before fosterage is recorded to begin. These results support the argument that Illaunloughan represented a proprietary or locally important monastery, as suggested by Mytum (1992) and Ó Carragáin (2003). The individuals in this study did not appear to be attracted to insular monastic life or fosterage from far away, but instead may have been part of the local kin groups in the Áes Irruis Deiscirt or Áes Irruis Tuascirt regions within Corcu Duibne. These skeletons represent only a small sample (ca. 12%) of the approximately twenty-five burials made on Illaunloughan during the monastic phase, and their mobility cannot be generalized to represent the whole population. However, due to the restricted burial population and small size of island monastic sites, preserved skeletons from the early phases of these island monasteries are very rare (e.g., Lynch, 2011; Sheehan, 2009; O'Donnabhain, 2014). The subjects of this case study represent three individuals who came from the local area of Illaunloughan, likely having to undertake only a short boat journey from the mainland to join the monastery.

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CHAPTER 4

THE SEA SPRAY EFFECT AND ITS IMPACT ON BIOAVAILABLE RADIOGENIC STRONTIUM RATIOS IN COASTAL ENVIRONMENTS

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Author Contributions:

EA and KK developed the project, EA collected the plant samples, prepared the samples for analysis, and wrote the article, SPF and GG analyzed the samples, and IK lead the project during which the samples were collected

1. Introduction

Archaeologists use radiogenic strontium isotopic ratios to evaluate where people lived and how they moved in the past by comparing isotopic ratios found in humans to those found in the environment (Bentley, 2006; Ericson, 1989; Ericson, 1985; Knudson et al., 2012). The ratio of two types of strontium, ^{87}Sr and ^{86}Sr, varies with the age of the underlying bedrock because the amount of ^{87}Sr increases over time through radioactive decay (Dasch, 1969; O'Connor, 1988; Wallace et al., 1994). This ratio remains constant throughout the ecosystem, from bedrock to plants to humans, because these isotopes do not experience fractionation as they undergo the chemical processes of weathering and biological processes (Blum et al., 2000). Therefore, the mineral fraction of human bones and teeth is expected to exhibit radiogenic strontium isotope ratios that are similar to that of the bioavailable strontium of the underlying bedrock, which depends on processes of weathering and soil formation (Bentley and Knipper, 2005; Knudson et al., 2014; Turekian, 1956).

The Sea Spray Effect refers to the possible homogenization of the bioavailable strontium isotope ratios in coastal regions due to the deposition of ocean-derived strontium on the land. This effect is thought to inhibit the ability of archaeologists to interpret human mobility because the variability of $^{87}Sr/^{86}Sr$ of the underlying bedrock may be masked by the ocean-derived strontium (Montgomery et al., 2007). The radiogenic strontium isotope ratio of ocean water is a nearly constant value of $^{87}Sr/^{86}Sr=0.7092$ around the world (McArthur et al., 2001; Veizer, 1989). Archaeological chemists have attributed unexpected $^{87}Sr/^{86}Sr$ in plants, animals, and humans that differ from the ratios of the underlying bedrock to the impact of sea spray (Montgomery et al., 2007). Soil scientists have determined that 50% -83% of bioavailable strontium was derived from sea spray in soil at one location 50 m from the Hawaiian coast (Whipkey et al., 2000). However, to date, no study has systematically quantified the impact of the Sea Spray Effect on bioavailable strontium at regular intervals from the coast.

This paper addresses the Sea Spray Effect through the analysis of fifteen plant samples that were systematically collected along three identical transects on the coast of the island of Inishark, Co. Galway, Ireland. Three control samples from the interior of the island represent the local signature influenced by bedrock and local rainfall. A mixing equation identifies the percentage contribution of sea spray and the local signature, and the archaeological implications of these results are discussed. Best practices for bioavailable strontium sampling in coastal regions are outlined, and further study of coastal environments is suggested to better understand the Sea Spray Effect.

2. The Sea Spray Effect

The Sea Spray Effect refers to the influence of marine-derived radiogenic strontium isotopes that find their way onto land through the mist and spray coming off the ocean when waves collide with the coastline (Whipkey et al., 2000). Ocean water has a constant radiogenic strontium isotope ratio worldwide at any given time, between $^{87}Sr/^{86}Sr=0.709211\pm 0.000037$ and $^{87}Sr/^{86}Sr=0.709241\pm0.000032$ (Elderfield, 1986: 77) due to the mixing of all strontium sources (Capo et al., 1998; Elderfield, 1986; McArthur et al., 2001; Veizer, 1989). Strontium in the ocean is derived from mid-ocean hydrothermal ridges, rivers, and ground water inputs, which then enter the mixing cycle of the ocean (Albarede et al., 1981; Clemens et al., 1993; Jones et al., 2012). Despite the multitude of input sources, ocean $^{87}Sr/^{86}Sr$ does not vary spatially because the ocean completely mixes about every 1,000 years (Goldberg, 1963), and the residence time of strontium in the ocean is between approximately 2.3 million years (Broecker and Peng, 1982; Jones et al., 2012) and 4 million years (Elderfield, 1986). Input sources such as rivers have generally very low concentrations of strontium in comparison to the ocean, so the mixing effect of the ocean masks local $^{87}Sr/^{86}Sr$ variability even at the mouths of rivers (Faure et al., 1967; Veizer, 1989). For instance, the Hudson Bay has an $^{87}Sr/^{86}Sr$ that is the same as the Atlantic Ocean, despite the Hudson Bay having salinities about half that of the ocean due to the input of river waters (Faure et al., 1967; Veizer, 1989).

Radiogenic strontium ratios vary over time but not at a rate that is relevant to archaeological studies. Large climatic changes alter the homogenous $^{87}Sr/^{86}Sr$ of the ocean based on changes in glaciation, chemical weathering rates, and proportions of strontium coming from rivers, ground water, and mid ocean hydrothermal ridges (Clemens et al., 1993; Dia et al., 1992; Hodell et al., 1989). Also, strontium is added to the ocean during periods of changing sea levels, which trigger the release of strontium through recrystallization of shelf aragonite and dissolution of shelf carbonates (Stoll and Schrag, 1998: 1116). Millions of years ago, these sources of strontium likely changed the marine $^{87}Sr/^{86}Sr$, but they have not measurably affected the equilibrium of the ocean's $^{87}Sr/^{86}Sr$ during the Pleistocene due to the high frequency of glaciation (Stoll and Schrag, 1998: 1117). Cycles of $^{87}Sr/^{86}Sr$ stability are around 100,000 years long, depending on specific climatic conditions, which is long enough that only the oldest of archaeological specimens are affected (Clemens et al., 1993; Dia et al., 1992; Richter and Turekian, 1993; Stoll and Schrag, 1998).

The influence of ocean-derived strontium on terrestrial coastal areas may cause a worldwide homogenization of radiogenic strontium isotopic ratios in the bodies of people living near the coast because local geological values are masked by the constant value attributed to oceans. This is especially relevant in areas susceptible to sea spray due to high winds and crashing waves (Montgomery et al., 2007; Whipkey et al., 2000). Whipkey et al. (2000) found that the percentage of labile or bioavailable strontium in coastal Hawaiian soils that can be attributed to sea spray varies from around 50% to 83%; however, bioavailable radiogenic strontium isotopic signatures are tied to bedrock values in most inland areas (Bataille et al., 2012; Bentley, 2006; Knudson et al., 2014).

While sea spray may not completely mask the contribution of bedrock, it likely produces a difference between the radiogenic strontium isotopic ratio of the bedrock and that of the bioavailable strontium incorporated into the human skeleton (Montgomery et al., 2007). It has been argued that sea spray affects the isotopic ratios of humans, animals, and plants from the Outer Hebrides which have an average isotopic ratio of around 0.0010 lower than would be expected if the underlying bedrock was the only contributing factor (Montgomery et al., 2007; Montgomery et al., 2003; Montgomery and Evans, 2006). To date, no systematic studies have assessed the impact of sea spray using plant samples taken from a location adjacent to the ocean at regular intervals.

A small study of bioavailable radiogenic strontium in Irish soils was conducted on the island of Inishark, Co. Galway (Alonzi et al., 2015). Ten soil samples were taken 10 meters apart along a transect perpendicular from the coast, and they were tested for bioavailable strontium by taking a partially dissolved fraction of the soil, meant to mimic the strontium that would be able to enter the human body (Blum et al., 2000; Knudson et al., 2014). Results indicated that the contribution of bioavailable radiogenic strontium ratios from the local geology is not overwhelmed by the spraying ocean water ($^{87}Sr/^{86}Sr$ =0.7144 to 0.7224, n=11). However, it should be noted that these samples were taken in a sheltered location near the historical village on Inishark, which is not prone to visible sea spray as are the transects discussed in this paper.

Due to the homogenous radiogenic strontium isotope ratio of seawater worldwide, it is recommended that caution be used when interpreting the origin of individuals from coastal regions based on strontium ratios. Although the Sea Spray Effect will likely not mask all of the isotopic variation due to bedrock formations (Bentley, 2006), it could influence the distribution of isotopic ratios within a population. The movement of an individual between coastal and inland environments would be more easily detected than the movement of an individual who moved along the coast using radiogenic strontium isotope ratios. This study seeks to clarify the contexts in which individual's radiogenic strontium isotope ratios are dictated by ocean-derived strontium rather than strontium derived from the underlying bedrock.

3. Biogeochemistry of coastal areas

The Sea Spray Effect describes the deposition of ocean-derived water droplets on coastal land. These droplets are effectively atmosphere-derived sources of strontium, which are often isotopically distinct from the underlying bedrock. Testing of radiogenic strontium values has found that more than half of the strontium in soil may be derived from atmospheric sources (Bentley, 2006; Miller et al., 1993). Chadwick and colleagues (2009) found evidence that Hawaiian soils contain a high proportion of ocean derived calcium and strontium deposited by dust and wind. However, because it weathers too slowly, this dust does not contribute to bioavailable strontium as much as the strontium in rainfall and sea spray because it weathers too slowly (Chadwick et al. 2009:73). Quade and colleagues (1995:115) also found that the majority of calcium in coastal soils is ocean-derived and transported by dust and sea spray, based on soil from coastal sites in Victoria and South Australia and on Kangaroo Island. Therefore, bioavailable radiogenic strontium isotopic ratios of soils in some coastal areas may be affected by both dust and sea spray, but sea spray seems to be present to some degree in all coastal regions.

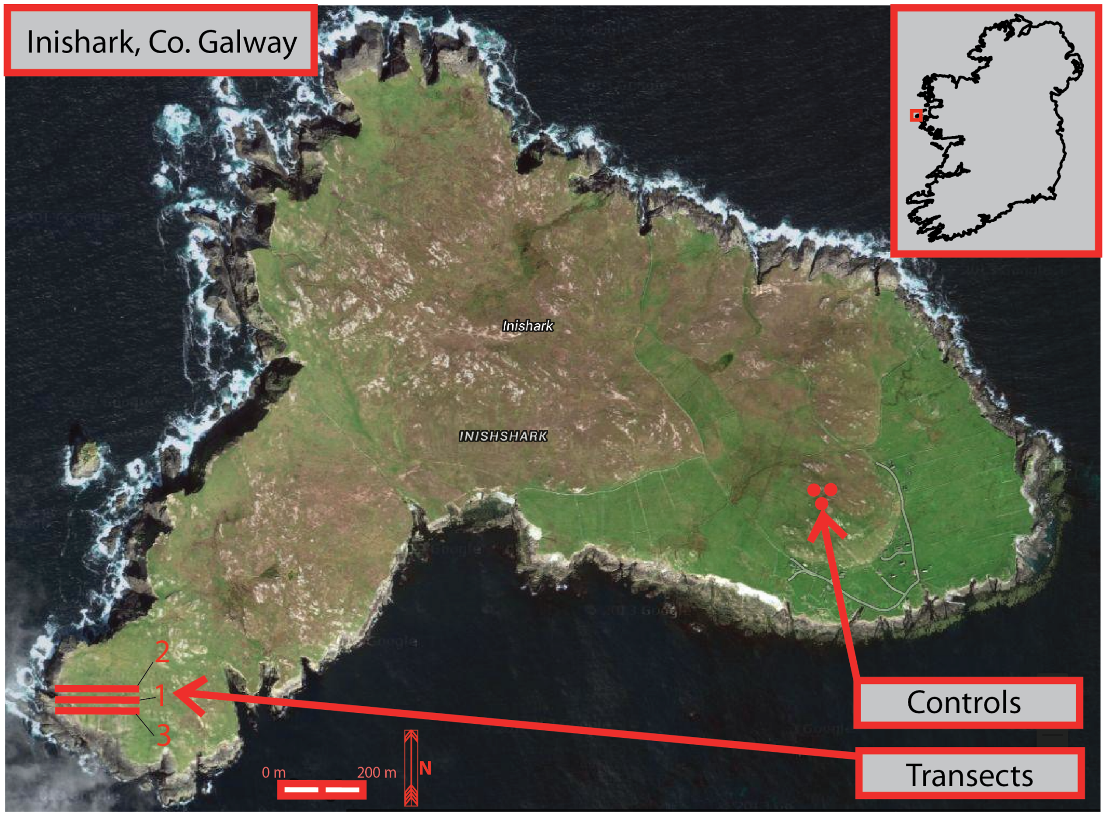
Another complicating factor is the isotopic similarity of rainwater to sea water in coastal environments. Rainwater can deposit soluble compounds, such as calcium carbonate if the rain is acidic (Chiquet et al. 1999; Nakano et al., 2012:5576) and sea salt

(Nakano and Tanaka 1997:4237). If these materials are derived from the ocean, they would also have an isotopic ratio similar to that of sea water ($^{87}Sr/^{86}Sr=0.7092$) (McArthur et al., 2001; Veizer, 1989; Whipkey et al., 2000). In addition, rainwater near the coast has an $^{87}Sr/^{86}Sr$ value near that of sea water, which could artificially inflate the appearance of the contribution of directly ocean-derived strontium (Montgomery et al., 2007; Négrel et al., 2001).

4. Sea Spray Effect case study on the island of Inishark, Ireland

Inishark is one of Ireland's most westerly islands (see Figure 15). The island is an ideal natural laboratory, as it has been uninhabited since it was evacuated by order of the Irish government in 1960. It experiences relatively few visitors per year, and therefore it is very unlikely that the study site has any contamination from foreign sources. Inishark lies 8 miles (12.9 km) from the mainland, directly in the path of storms and winds coming in off the Atlantic. It was inhabited periodically from the Neolithic to modern periods (Kuijt et al., 2015; Kuijt et al., 2010). The western end of the island, the location of this study, has no evidence of habitation from any period, likely because it is exposed to the elements and experiences strong winds. Medieval and 19th-20th century habitation centered on the southeastern end of the island, sheltered by a large hill called Cnoc Leo (Kuijt et al., 2015; Kuijt et al., 2010). Average yearly precipitation is approximately 1200 mm per year, based on Met Éireann weather data from 1981 to 2010 (Walsh, 2012).

Figure 15. Map of Inishark, Including Transects and Controls.



Inishark's geology consists of schist and glacial deposits (Geological Survey of Ireland, 2017). Bedrock outcroppings were formed into streamlined hard beds, which were weathered to smoothness by the Quaternary activity of glacial ice streams (Krabbendam et al., 2016; Meehan, 2013). The island is currently used as open grazing land for sheep, the majority of which live on Inishark their whole lives. The sheep are at a low density on the island, and they congregate near the historical village on the eastern side. Thus, contamination by sheep dung of foreign origin is unlikely, and particularly unlikely near the location of this study at the western end of the island.

5. Materials and methods

5.1. Location of the transects

Samples were collected at regular intervals along three straight paths to ensure that samples were uniform distances from the coastline. It should be noted that the transects in this study were placed in the location of the highest level of visible sea spray on the unprotected, coastal island of Inishark. Although most human habitation probably occurs in areas less exposed to the elements, this is an ideal situation for a study of sea spray because it is easily observable in this area (see Figures 15 and 16).

Figure 16. Image of Sea Spray and Red Pin Flag Denoting Position 1 of Transect 1.

5.2. Sample collection

Samples were collected on Inishark by E. Alonzi, T. O'Hagan, and W. Donaruma in June 2014, during the Cultural Landscapes of the Irish Coast archaeological project, directed by Dr. Ian Kuijt of the University of Notre Dame. Three parallel transects, each 200 meters long and 20 meters apart, were measured out from west to east at the westernmost edge of Inishark (see Figure 15 and 16). This length of transect was chosen to expand on the 50 m transect of the pilot study that utilized soil samples. Five plant samples (*Poa* spp.) of about 100 ml volume each were collected at 50 m intervals along each transect. All plants were between 1-3 cm in height, and only blades of grass were sampled. Plants were chosen for this study because they represent bioavailable strontium, whereas soil samples must go through chemical leaching procedures to approximate the strontium that is bioavailable (Maurer et al., 2012). Three control samples were taken from atop Cnoc Leo, the hill on the eastern end of the island near the historical village (see Figure 15). This location was chosen as the control area because the eastern end of the island is more sheltered from wind and inclement weather than the western end, and the hill provides extra distance from the coastline. Thus, the differences in values between the control and transect samples relates to the impact of sea spray rather than rain, as both the transects and the control location would have experienced nearly identical rainfall.

The samples were exported from Ireland to the Archaeological Chemistry Laboratory in the School of Human Evolution and Social Change at Arizona State University under USDA APHIS Permit Number PCIP-14-00573. The samples were mechanically and chemically cleaned to prepare for strontium separation and analysis. The samples were first cleaned and dried. They were washed three times with Millipore water, sonicated in Millipore water for 10 minutes, and dried in an oven at 50 ^{o}C for about 48 hours. The samples were then ashed in a furnace for about 10 hours at 800 ^{o}C. The ashed plant samples were dissolved in concentrated nitric acid (HNO_3) and hydrochloric acid (HCl) and dissolved on a hot plate for one week. The samples were dried and then rehydrated in concentrated nitric acid (HNO_3). The elemental concentrations of the samples were tested using a Thermo-Finnigan X-series quadrupole inductively coupled plasma mass spectrometer (Q-ICP-MS), which is housed in the W.M. Keck Foundation Laboratory for Environmental Biogeochemistry (KFLEB). Then, strontium was separated using the PrepFast System in the KFLEB based on published methods (Romaniello et al., 2015). The radiogenic strontium isotope ratios were measured using a Neptune multi-collector inductively coupled plasma mass spectrometer (MC-ICP-MS) (see Knudson et al., 2012). Runs of the standard SRM-987 at the time of analysis produced a ratio of $^{87}Sr/^{86}Sr=0.710250\pm0.000003$ (2σ, n = 37). This is within the expected range of $^{87}Sr/^{86}Sr=0.710235\pm0.000020$ (2σ, n = 76) (Hodell et al., 1989).

6. Results

6.1. Radiogenic strontium isotope ratios

The range of values for the transect samples is $^{87}Sr/^{86}Sr=0.70925$ to $^{87}Sr/^{86}Sr=0.71040$, with an average of $^{87}Sr/^{86}Sr=0.70953\pm0.00038$ (n=15, 1σ). The range of values for control samples is $^{87}Sr/^{86}Sr=0.70974$ to $^{87}Sr/^{86}Sr=0.711151$, with an average of $^{87}Sr/^{86}Sr=0.71037 \pm 0.00099$ (n=3, 1σ). See Table 9 for the values, averages, and standard deviations of each transect.

6.2. Contribution of sea spray to $^{87}Sr/^{86}Sr$

A mixing equation calculates the proportionate contribution of the local signature derived from the control samples ($^{87}Sr/^{86}Sr=0.71037 \pm 0.00099$ (n=3, 1σ) and the input of sea spray ($^{87}Sr/^{86}Sr=0.7092$) to the radiogenic strontium ratios of the transect samples (Bentley, 2006; Clauer and Semhi, 2016; Graustein, 1988; Graustein and Armstrong, 1983; Nakano et al., 2012). It is the standard equation used in isotope geochemistry to calculate the inputs of two endmembers to a radiogenic strontium isotope ratio, which are assumed to have a linear relationship:

$$(^{87}Sr/^{86}Sr)_{transect} = f_{control\text{-}sea}\,(^{87}Sr/^{86}Sr)_{sea} + (1-f_{control\text{-}sea})(^{87}Sr/^{86}Sr)_{control} \quad (1)$$

This equation is used to calculate the ratio of the contribution of sea spray in comparison to the contribution of the underlying bedrock and local rainfall to the transect samples. These ratios have been converted to percentages for ease of analysis. The first endmember, $(^{87}Sr/^{86}Sr)_{sea}$, represents the radiogenic strontium isotope ratio of seawater, and the second endmember, $(^{87}Sr/^{86}Sr)_{control}$, represents the average radiogenic strontium isotope ratio of the control samples. The contribution of sea spray to the $^{87}Sr/^{86}Sr$ values of the transect samples ranges from 0% to 96.0%, with an average of 71.7%±32.4%

(n=15, 1σ) (see Table 9). For the purpose of this equation, it is assumed that the control samples have minimal to no input from sea spray, although they may incorporate inputs from rainwater. While rainwater may have similar values to sea spray near the coast, but it would have affected the transect and control samples in the same manner (Nakano and Tanaka, 1997; Nakano et al., 2012).

6.3. *Variation within the transects*

The transects have roughly similar patterns of variation. The most radiogenic $^{87}Sr/^{86}Sr$ value occurs at the site closest to the ocean, and the other samples in the transect appear to be closer to the isotopic ratio of sea spray. Only one point on the transects (Transect 3, position 3, $^{87}Sr/^{86}Sr$=0.71040) is as radiogenic as the control sample average ($^{87}Sr/^{86}Sr$=0.71037 ±0.00099 (n=3, 1σ)) (see Figures 17, 18, and 19). Besides this point, the three samples taken nearest the coast exhibit the lowest contribution of sea spray (Transect 1, Position 1=28.7%, Transect 2, Position 1=48.7%, and Transect 3, Position 1=14.4%). This indicates that there is a factor other than distance from the ocean influencing the effect of sea spray on bioavailable strontium in plants.

Table 9. $^{87}Sr/^{86}Sr$ Data for All Samples and Percentage $^{87}Sr/^{86}Sr$ Attributed To Sea Spray.

	$^{87}Sr/^{86}Sr$ Transect 1	Percentage attributed to sea spray	$^{87}Sr/^{86}Sr$ Transect 2	Percentage attributed to sea spray	$^{87}Sr/^{86}Sr$ Transect 3	Percentage attributed to sea spray
Position 1, 0 m	0.71003	28.7	0.70982	46.7	0.71020	14.4
Position 2, 50 m	0.70925	96.0	0.70931	90.7	0.70926	94.8
Position 3,10 0 m	0.70929	92.2	0.70927	93.9	0.71040	0.0
Position 4, 150 m	0.70931	90.8	0.70947	77.1	0.70938	84.4
Position 5, 200 m	0.70932	89.4	0.70930	91.3	0.70938	84.7
Average	0.70944		0.70943		0.70972	
Standard Deviation	0.00030		0.00023		0.00053	
Controls						
Control 1	0.71151					
Control 2	0.70974					
Control 3	0.70986					
Average	0.71037					
Standard Deviation	0.00099					

Figure 17. $^{87}Sr/^{86}Sr$ Distribution for Transect 1.

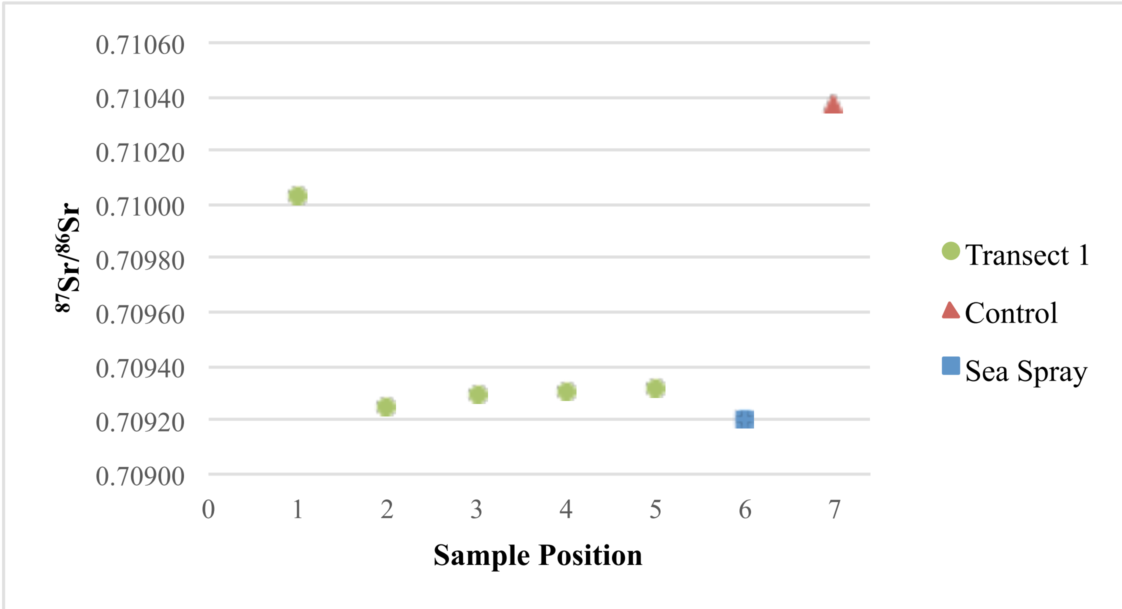
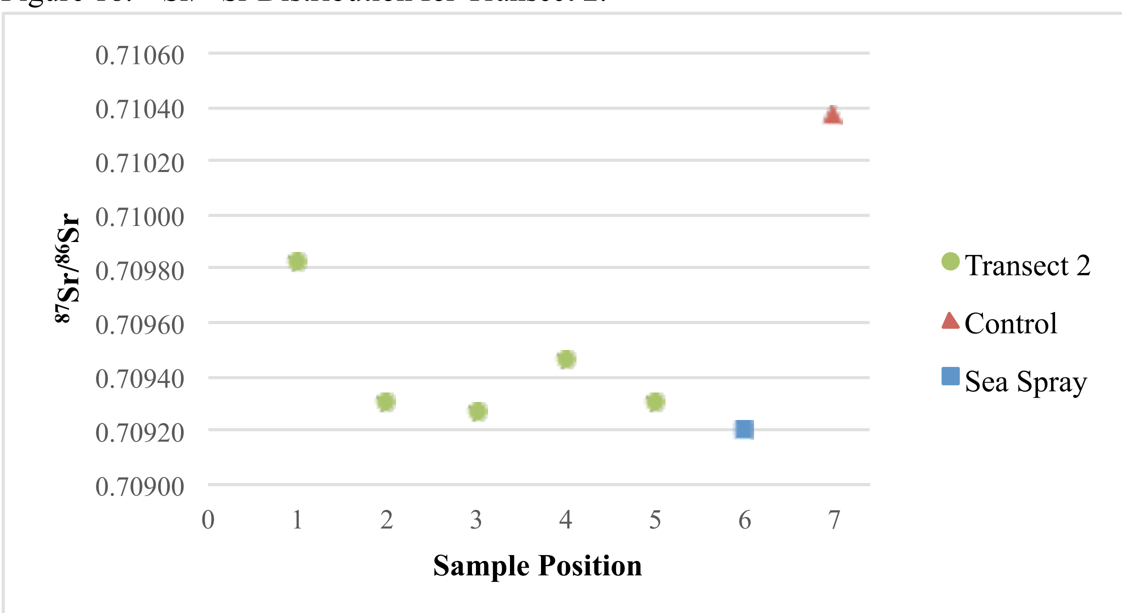
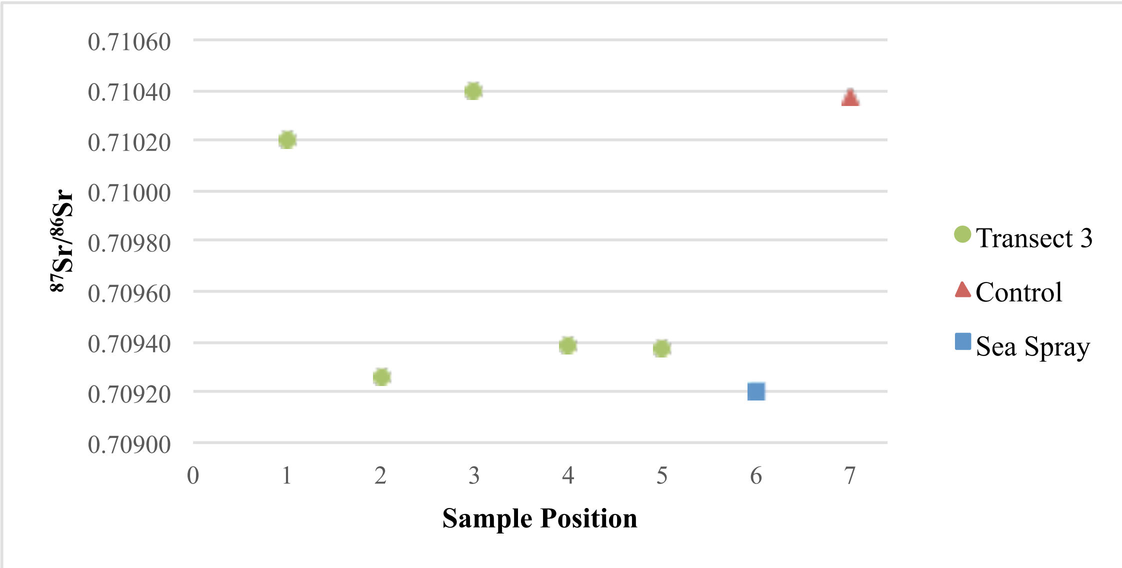


Figure 18. $^{87}Sr/^{86}Sr$ Distribution for Transect 2.



Figures 19. $^{87}Sr/^{86}Sr$ distribution for Transect 3.



6.4. Variation between positions

The average percentage contribution from sea spray to the radiogenic strontium ratio between all three transects is 30.0% ±16.2% (n=3, 1σ) for Position 1, 93.8% ±2.8% (n=3, 1σ) for Position 2, 95.4% ±4.1% (n=3, 1σ) for Position 3, 84.1% ±6.9% (n=3, 1σ) for Position 4, and 88.5% ±3.4% (n=3, 1σ) for Position 5 (see Table 9). The lowest contribution from sea spray occurs directly next to the coastline, with all other positions having on average at least 84.1% contribution from sea spray.

7. Interpretations, Discussion, and Future Research

7.1. Variations in the contribution of sea spray to bioavailable strontium

The results of this study show that sea spray does not uniformly contribute to a plant's bioavailable strontium in coastal areas, as the percentage contribution of sea spray ranges from 0% to 96.0% (n=15, 1σ=34.4) in these samples. The Sea Spray Effect should not be conceptualized as uniform effect of sea water on bioavailable strontium in coastal regions. Instead, it should be considered a process that introduces variability into radiogenic strontium isotope ratios in coastal environments. Levels of the contribution of sea spray at less than 100% indicate that individuals living in coastal areas may exhibit $^{87}Sr/^{86}Sr$ that differ from that of ocean water ($^{87}Sr/^{86}Sr$=0.7092) and may be either higher or lower than this value, depending on the underlying bedrock.

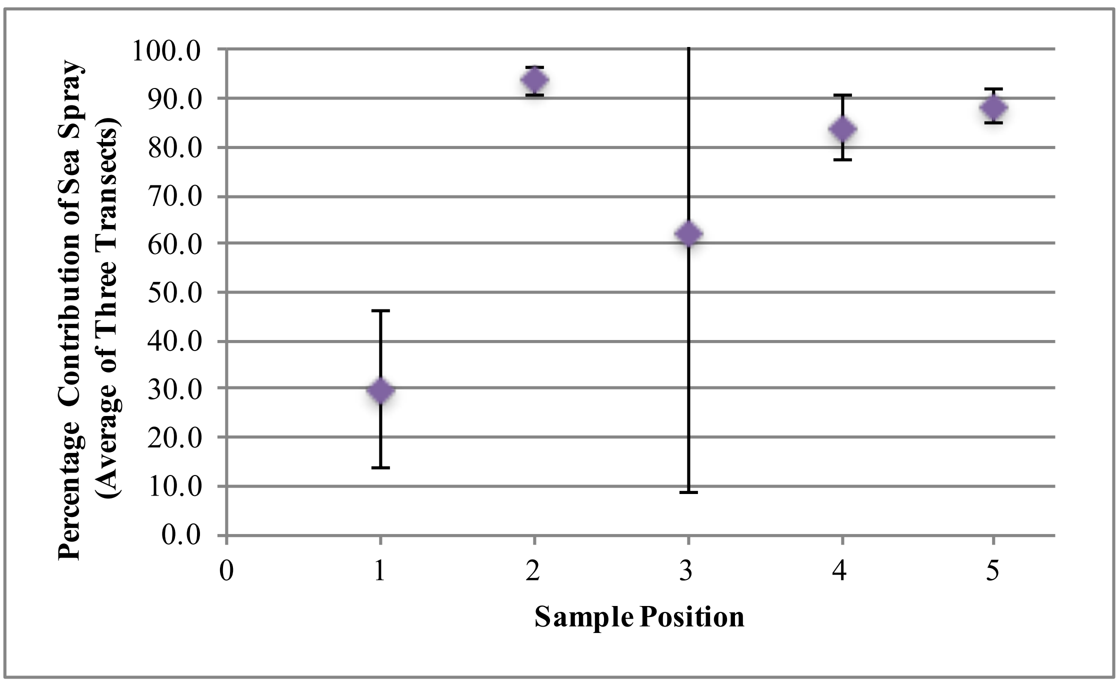
7.2. The possible effects of soil depth and permanence requiring further study

The positioning of these transects is such that the samples in Position 1 lay on relatively thin soil, just at the point where grass grows closest to the ocean cliff edge on Inishark. Observations of the sampling site indicate that the bedrock is approximately 2-5 cm below the grass at these points, although no formal measurements were made during this study. Perhaps the percentage contribution of sea spray for these plants was lower because they do not have as much soil to distance the roots from the bedrock. Further, the soils in this area may experience a high turnover rate, as the rough winter storms are known to tear up the sod and toss rocks onto the cliffs of Inishark. The soil in these locations may have been disturbed as recently as January 2014 (six months before the plant samples were collected), when a particularly large storm came through the area, destroying the pier on neighboring Inishbofin (Siggins, 2014). In contrast, the other samples in the transect lie on soil that fully covers the bedrock, although again no formal measurements were made of soil depth. This indicates that the contribution of sea spray to the radiogenic isotope ratios may not just be a function of the amount of sea spray encountered during the life of a plant but may also be a function of the amount of sea spray and ocean derived material held in the soil which acts as a reservoir. Unfortunately, published data on soil depths are not available for Inishark, Co. Galway (Fay et al., 2007). Further data on the depth of soils will be needed to assess the correlation between soil depth and the impact of sea spray on coastal radiogenic strontium values in future studies.

7.3. Archaeological implications

Radiogenic strontium isotopic ratios are often used by archaeologists studying individuals' mobility. Some archaeologists, such as Montgomery (2003, 2007), have suggested that sea spray completely obfuscates the value of underlying bedrock, such as in the Hebrides, thus limiting the ability to understand mobility through radiogenic strontium isotope ratios in coastal settings. The results of this study have brought to light some interesting implications for the expected $^{87}Sr/^{86}Sr$ values of people who lived near the coast. Results show that the strontium in food products, either plants that grew in fields up to 200 meters from the coast or the animals eating those plants, are likely composed of at least 70-100% ocean-derived sources (see Figure 20). However, strontium in plants that grew near the coast on thin soil profiles may be relatively unaffected by sea spray, with a contribution of 0-60% of strontium from ocean-derived sources (see Figure 20). The impact of sea spray may continue at distances further from the coast that were not addressed in this study.

Figure 20. Average of the three transects' percent contribution of sea spray, with error bars of one standard deviation.



These results suggest that investigations of coastal populations through radiogenic strontium isotopes require consideration of cultural context. For instance, there may be a difference in influence of sea spray on the diet if fields were improved through the addition of soil, seaweed, or animal products, such as they were in near the 19th century village on Inishark (Kuijt et al., 2015). The creation of soil through the addition of these substances could both increase the distance between plant root and bedrock and increase the reservoir of marine-derived isotopes available to the plants. Further, it would be necessary to understand if people were growing crops in fields adjacent to the ocean or in fields further away from the ocean. Soils that are directly adjacent to the coast, which derived little bioavailable strontium from the ocean in this study, may also contribute to the diet, as areas unable to support crops may be used for animal grazing. Animals may have only been close to the coast seasonally due to practices like field management and herd movement, such as the practice known as *booleying* in medieval Ireland (Boyle, 2004; McCormick et al., 2011).

7.4. Implications for creating bioavailable $^{87}Sr/^{86}Sr$ baseline maps and local ranges

These results also have implications for procedures for sampling plants for the creation of $^{87}Sr/^{86}Sr$ baseline maps and local ranges that are used to assess the values expected of individuals local to a certain area. Such maps have been created for the Andes (Knudson et al., 2014), the Isle of Skye (Evans et al., 2009), and Great Britain (Evans et al., 2010). The Irish Isotopes Research Group is currently building a map of bioavailable strontium for Ireland (Daly et al., 2016). This study indicates that a wide range of $^{87}Sr/^{86}Sr$ values exist in coastal areas, so a thorough sampling strategy for these baselines should, if possible, include sampling directly adjacent to the coast, at least 50 meters from the coast, and in a location protected from the sea spray in order to capture the full variability of the area.

8. Conclusions

The results of this study indicate that the contribution of sea spray is large enough that it indeed has the capability of masking the impact of underlying geological variability on radiogenic strontium isotopic ratios in some situations. However, sea spray does not have as large of an effect on the plants living on the coast and in sheltered areas. In these locations, it is possible to have a larger contribution of strontium from the underlying bedrock than from sea spray, as is the common assumption in the field of archaeological isotopic studies. The variability of $^{87}Sr/^{86}Sr$ introduced by ocean-derived strontium should be measured and accounted for when interpreting mobility, as it is not valid to assume that isotopic variability of bioavailable strontium is completely washed away by the Sea Spray Effect.

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CHAPTER 5

CONCLUSION

1. Introduction

The three studies presented here represent an endeavor to advance the fields of biogeochemistry and medieval archaeology in Ireland. The first paper (Chapter 2) summarizes biogeochemical data derived from eighty-eight individuals buried at five early and late medieval monastic sites in Ireland. The results of this paper show an unexpected level of similarity between all populations, suggesting a degree of continuity in mobility over time and in different communities. Also, this paper presents baseline bioavailable radiogenic strontium isotope ratios for sixty-seven plants from four counties (Co. Kerry, Co. Louth, Co. Tipperary, and Co. Wexford) that can be used by other researchers to interpret mobility in Irish archaeological contexts.

The results of the second paper (Chapter 3), concerning fosterage on Illaunloughan, suggest that this monastic community was composed at least partially of local males and juveniles. The hypothesis that this was a proprietary and perhaps family-run monastery is supported. These archaeological data provide a unique picture because no records exist for Illaunloughan (Marshall and Walsh, 2005).

The results of the third paper (Chapter 4) suggest that the impact of the Sea Spray Effect on bioavailable strontium in coastal regions is not uniform. These findings have implications for future sampling to create bioavailable strontium maps, as several samples are needed to capture the range of values in coastal areas. The goal of these studies is to address the intersection of bioarchaeology, biogeochemistry, and medieval archaeology in order to demonstrate the value of using multiple lines of evidence to shed light on life in medieval Ireland.

2. The future of isotopes and archaeology in Ireland

The bioavailable strontium baseline data, in addition to other baseline data being generated by the members of the Irish Isotopes Research Group, will expand the potential for studies of archaeological mobility within Ireland. Prior to more extensive baseline testing, it was most accurate to identify individuals as non-local whose stable oxygen and radiogenic strontium isotope data clearly fell outside the range known in Ireland. However, further testing will allow researchers to identify non-local individuals with origins in different areas of Ireland. Because much of Ireland's geography is Paleozoic, some maps have mischaracterized Ireland's radiogenic strontium values as homogenous and not suitable for studies of mobility (e.g., Montgomery et al., 2014:56). However, Ireland's Paleozoic bedrock spans a period of approximately 250-540 mya, in comparison to the Mesozoic geologies of Wales and England that span a shorter period of 65-252 mya (Montgomery et al., 2014; Walker et al., 2013). Because radiogenic strontium isotope ratios change as the bedrock ages, a span of 290 million years of bedrock deposition provides sufficient variability to detect mobility within Ireland, as shown in Chapter 2 (Dasch, 1969; O'Connor, 1988; Wallace et al., 1994). Mobility within medieval Ireland may be a fruitful future research topic, illuminating interactions between kingdoms and kin groups, which occupied areas with known boundaries (Kelly, 1988; MacCotter, 2008; MacCotter and Sheehan, 2009).

Also, an expansion of sample sizes is needed to advance the field of archaeological chemistry in Ireland. Due to concerns about destructive sampling, the majority of biogeochemical analysis has occurred on individuals found in unique or unusual archaeological contexts, such as the portal tomb of Poulnabrone (Lynch, 2014) or the ornate monastic site of High Island (Scally, 2014). However, it is difficult to interpret levels and types of mobility in notable individuals without an understanding of mobility in the general population through time. Summaries of data representing individuals from a certain time period are extremely useful as comparative tools (e.g., Cahill Wilson and Standish, 2016). When possible, samples from a range of contexts should be considered in each study, and an effort should be made to investigate mobility in larger cemetery contexts in order to better understand how mobility functioned and changed throughout the history of Ireland.

3. Future theoretical directions concerning monasticism in Ireland

The findings of this dissertation suggest that monasticism was a much more inward-focused, local phenomenon than that portrayed in historical texts, which venerate figures who traveled often. Monasticism was practiced for about a millennium in Ireland, between the introduction of Christianity in the fifth century and the dissolution of nearly all of the Irish monasteries in the sixteenth century (Charles-Edwards, 2000; Ellis, 1990; Hughes, 1966; Stalley, 1987). If constant mobility and incomers were not maintaining interest in the monastic life, what factors caused this unique lifestyle to persist through so many other cultural changes? The work of Rodney Stark, a sociologist who examines spread of religion, may shed some light on the mechanisms by which monasticism and other forms of religious life spread. In his work on the spread of Mormonism and the Unification Church, Stark (1996) argues that very high rates of growth and practice of religion can be achieved through community interactions. For instance, he reasons that once more than half of a person's social circle are engaged in a certain religious practice, that person is likely to convert (Stark 1996:16). This suggests that once established, monastic practices in Ireland did not require constant reinvigoration from religious communities established elsewhere. Instead, communities may have only looked to external sources for teachings on religious practices during times of religious transition, such as the Easter Controversy or the formation of dioceses at the Synod of Ráth Breasil (Hughes, 1966; O'Hagan, 2012).

The longevity of monasticism in Ireland can also be explained by the close connection between religious and secular power. Christianity arrived in an already hierarchically arranged society, and it offered another avenue for prestige in a very prestige-driven hierarchy (Byrne, 1971; Jaski, 2000). Future examinations of the practice of monasticism in Ireland should be crafted to better compare the social classes that were so evident in the laws of early medieval Ireland (Boyle, 2004; Kelly, 1988). Although it is difficult to distinguish class in the archaeological record for the early medieval period, it may be possible to distinguish late medieval burial locations that catered to different classes within a site due to the higher number of burials extant from this period.

4. Closing thoughts

Archaeological investigations, including the studies presented here, are highlighting that textual evidence may only depict the experiences of certain, most often elite, portions of society. Other biases due to preservation and the Osteological Paradox must be taken into account when using archaeological data (Wood et al., 1992), but there is still potential to better understand life in medieval Ireland through the bioarchaeological study of human remains. Future studies of monastic mobility should aim to collect larger datasets, so that it may be possible to detect patterns of mobility that correspond to Tilly's (1978) categories- Local, Circular, Chain, and Career migration. For instance, most of the mobility of venerated religious figures described in medieval texts coincides with Tilly's (1978) description of Career migration. The findings of the studies presented in Chapters 2 and 3 suggest that monastic mobility was more likely to occur within the local area. Sampling strategies that include several dental and skeletal elements per individual could help to capture migration that occurred within the local area over the lifetime (e.g., Marsteller et al., 2017).

Future studies on the intersection between religious and lay communities are needed to provide a more nuanced picture of life in medieval Ireland. This is an important endeavor because religious institutions still hold a central role in Irish life, notably by running State-owned schools and hospitals. Whereas medieval texts make religious communities seem set apart and even otherworldly, this project has shown less difference between the lives of medieval religious and lay people than was expected. As religious practice continues to change in current society, it will be valuable to understand the multitude of ways that religion was practiced and the commonalities that people's lives share despite religious differences.

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