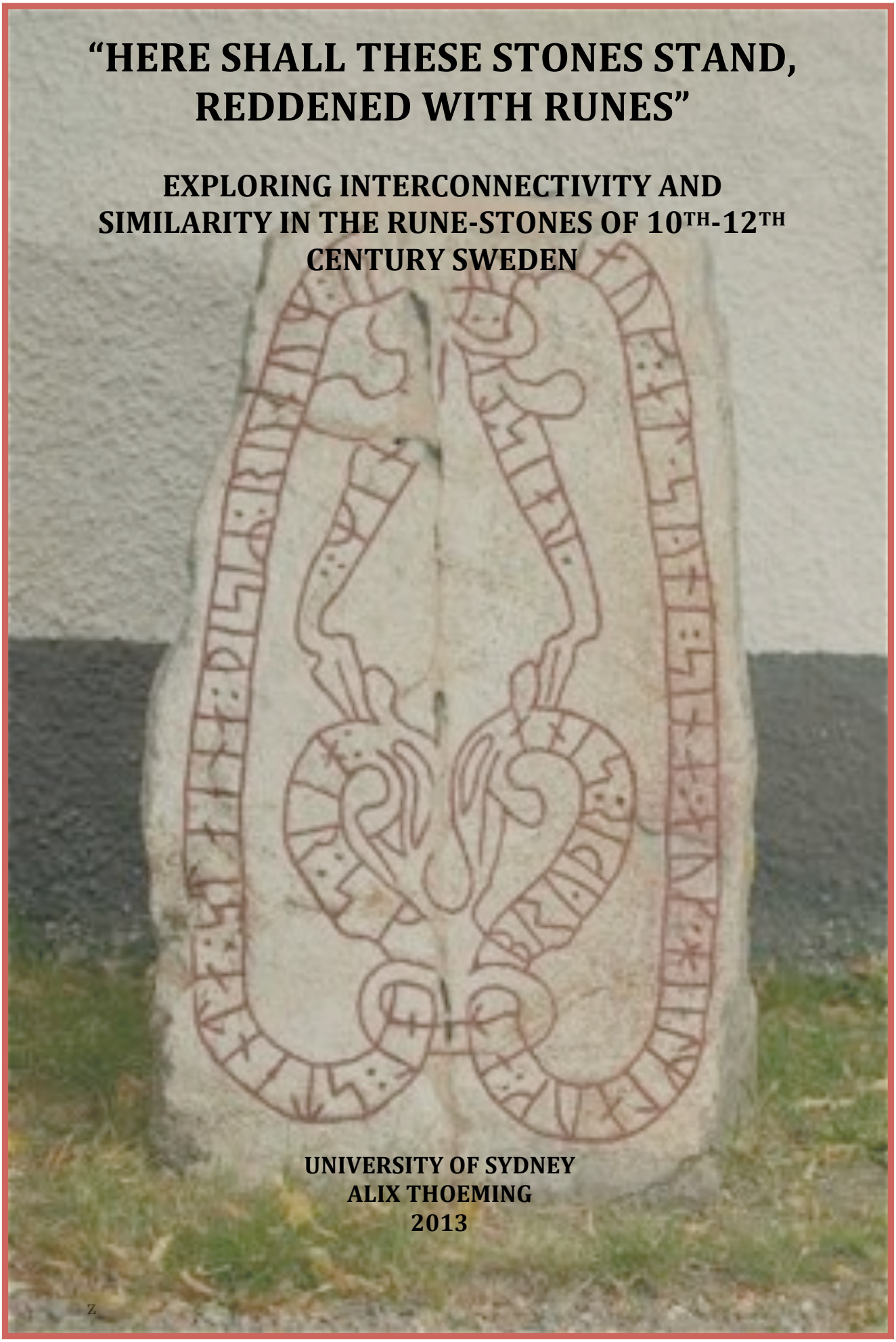
“HERE SHALL THESE STONES STAND, REDDENED WITH RUNES”

EXPLORING INTERCONNECTIVITY AND SIMILARITY IN THE RUNE-STONES OF 10TH-12TH CENTURY SWEDEN



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"Paleontology and archaeology and other skulduggery were not subjects that interested wizards. Things are buried for a reason, they considered. There's no point in wondering what it was. Don't go digging things up in case they won't let you bury them again."

-Terry Pratchett, The Last Continent

Cover Image: The rune-stone Sö 206, now located at Överselö Church, Strängäs, Södermanland, Sweden. (Lundberg, 2005)

"ér skal standa steinar thessir, rúnum rodhnir, reisti Gudhlaug at sonu sína, ok Hjalmlaug at brœdhr sína."

"Here shall these stones stand, reddened with runes: Gudhlaug raised them in memory of her sons; and Hjalmlaug in memory of his brothers."

I declare that this thesis is my own work and has not been submitted in any form for another degree or diploma at any university or other institution of tertiary education. Information derived from the published or unpublished work of others has been acknowledged in the text and a list of references provided.

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ABSTRACT

What began as a study of difference in the 10th-12th century rune-stones of Sweden has become a case study in homogeneity. These 'close-knit' people as described by Olrik in 1930 (:4) were much more interconnected than the current literature generally suggests, and clearly had communication networks running the length and breadth of settled Sweden. A result of the trade and wealth that characterised pre-Medieval Sweden, the rune-stones illustrate just how small and intertwined the world of the Scandinavians actually was. They suggest an interconnectivity that is now only just beginning to be recognised. The initial rapid proliferation of a small, highly integrated tradition that then contracted to the Mälaren Valley may be indicative of a society at a cultural 'crossroads', caught between the traditions of the past and the consequences of trade.

ACKNOWLEDGEMENTS

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My meetings at Uppsala University were one of the highlights of my time in Sweden, and I thank Professor Henrik Williams and Drs Daniel Löwenborg and Marco Bianchi for giving up their valuable time to help a confused Australian undergraduate student sift through rune-stone research in order to find a thesis topic.

To Jan-Marie Muscio, the woman who taught me that the study of the past could be so much more than just an HSC elective, and one of the best teachers I've ever had. I still consider the day I first heard a teacher utter the words 'brothel' and 'prostitute', even in the context of Pompeian ruins, as a formative moment in my life. Sorry for the ten minutes of giggles.

To Jack, without your love and support (and computer wizardry) I wouldn't have made it through this year. Thank-you for the hugs, the help, and the constant reminders to back up!

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CHAPTER ONE
ESTABLISHING THE STUDY

"*History is written by the victors, as we know, and ultimately the Vikings were not the victors. And anyway, the Vikings were more or less illiterate at the time*"

-Magnusson, 2000:156

The rune-stones of late Viking Age Sweden are the most useful, yet underutilized extant artefact of the period. As a source both archaeological and literary, the rune-stones are uniquely placed to shed light on the people of the period who are much more an ordinary feudal population of serfs and a small elite than 'Viking' in the popular sense. The word 'Viking' has no modern equivalent, and therefore definitions are problematic. It is certain, however, that it denotes an activity that took place abroad and was related mostly to elite trading and occasional raiding (Jesch, 2001:56). The term 'Viking', however, has come to typify more raiding than trading, and so the term 'Scandinavians' will be used to describe wide-ranging issues (Magnusson, 2000:156), and the term 'Swedes' for those more localised.

The area with which we are primarily concerned is just the southern half, and so this will be referred to as 'South-East Scandinavia'. It is common belief that the rune-stones were erected to commemorate those who traded and raided their way across their known world at the beginning of the second millennium CEs, but it is more accurate to assert that the rune-stones are a product of the 'less spectacular stay-at-homes' (Sawyer, B., 2000:16), or more accurately the actions of the small elite 'stay-at-home' population. What is important is that these families also included the people who were involved with long-range trading in a highly interconnected world. The rune-stones are representative of people who had an appreciation of the *oðal*, an intangible concept that refers to ancestral property ownership and is made manifest in the physical form of the rune-stones. The rune-stones are commonly seen to have replaced the ostentatious burials and burial mounds of the Vendel Period of the 7th-9th centuries (Zachrisson, 1994:219).

The Scandinavian population had very low literacy levels until quite a while after the end of the 11th century (Magnusson, 2000:156) and as we therefore have no first-hand accounts of life in Sweden from before this time, material remains become even more important. One of the rune-stone speaks to this, asking that *'the man who is rune-skilled interpret (these) runes'* (U 729, located in Ågersta in Uppland). The delicate features of the rune-stones make clear that there was much more to a stone than its runes, that there may be aspects of a 'symbiosis of oral and literary practices' in the rune-stones (Zilmer, 2010:161). The archaeology of the period has been particularly selective, with excavations having centred mostly on the major trading places located along the modern-day Stockholm archipelago and lacking focus on the general landscape. The rune-stones and their locations, however, point to settlements being much more widespread across the country (Sawyer, P., 1962:103) (Figure 1.1).

The extensive trade networks of the Scandinavians brought the considerable wealth into the country that was necessary for the rune-stone tradition to proliferate, and they therefore have been seen as a way for wealthy landowners to remember their dead in a traditional fashion in a time when the new religion, Christianity, was beginning to take hold (Sawyer, B., 1991:97). These trade networks stretched from Greenland to the Caspian Sea, and brought prestige and prestige goods, rather than everyday items into Scandinavia (Merrony, 2004:69-73). This 'complicated, mainly indirect, centre-periphery relationship' between Scandinavia and the world, combined with the strong social differentiation that has long been typical of Scandinavia satisfied the conditions for the materialization of ostentatious displays of social status (Callmer, 1994: 79).

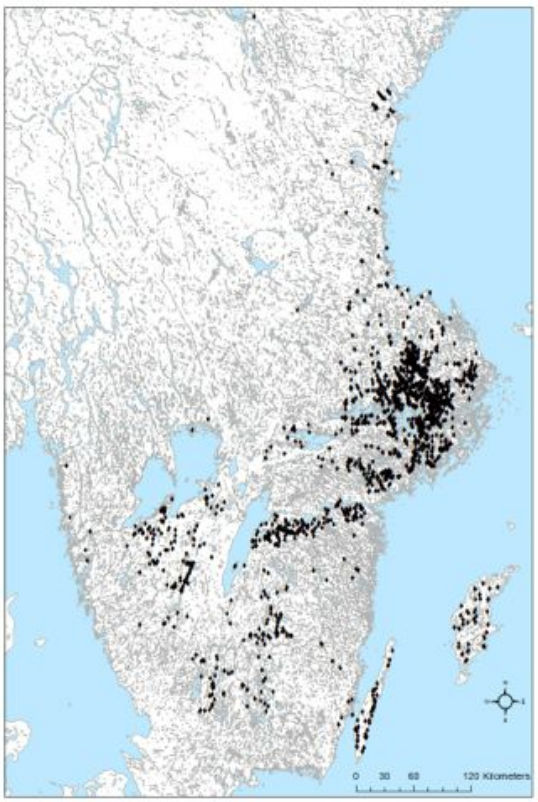


Figure 1.1 Distribution of rune-stones across Sweden, illustrating the 'South-East Scandinavia' with which we will be concerned.

RUNE-STONE RESEARCH

'It would appear that the first task of the archaeologist… is to concern himself with the careful definition of terms and the isolation of conceptual entities of value'

Clarke, 1978:26

Ever since the first cataloguing of the rune-stones in the late 19th Century, research has focussed mostly on individual stylistic or linguistic features of the stones. These micro-level studies concentrate on everything from categorising cross-features on the rune-stones (Lager, 2002) to the occurrence of single runes on the stones (Lagman, 1990). Posing a striking similarity to the early cultural-historical approach to archaeology, an approach to understanding the rune-stones as representative of a wider context has rarely been taken. This common perspective has traditionally understood that the rune-stones 'belong with', and

are highly demonstrative of, the significant changes taking place in Sweden at the time (Zilmer, 2010:161). The single-minded focus of most of these studies, while themselves valuable, renders them unable to appreciate the elementary value in the simple existence of the rune-stones. These small-scale studies result in difficulty distinguishing between 'group idiosyncrasies and group modal type' (Clarke, 1978:29), and therefore run the risk of over-exaggerating the importance of very specific differentiated features rather than the patterns of their wider context. A multi-scalar approach to contextual understanding of the interconnection between attributes and artefacts in an assemblage is likely to reveal much more than just a resolute focus on small-scale variation (*ibid*:30).

While studies have acknowledged this as somewhat of a failing of the field (Andrén, 2000, Zilmer, 2006), little effort has been made to widen the field of inquiry, with the exception of studies of the local reaction to Christianity - largely due to the fact that the monuments are the only source of information for the process outside of church-directed literature (e.g. Sawyer, 2000; Williams, 2009). Reasons for this situation vary; Sweden as a whole suffers from a relative dearth of archaeological inquiry into the pre-Medieval period (with the exception of the trading places mentioned earlier), and so the overall cultural significance and potential of the rune-stones has been somewhat overlooked. Another explanation may be that those who study the rune-stones, the 'runologists' (Barnes, 1990), tend to be pre-occupied with a more individualistic literary or art-history perspective.

It is important to note that these approaches are not detrimental to the field, per se, as 'narrow' studies of the rune-stones have shed much light on aspects of pre-Medieval Sweden that would traditionally be found in written history (Sawyer, 2000, Jesch, 2001, etc.). The rune-stones as an artefact are also very difficult to date, leaving very few approaches available other than the cultural-historical technique of seriated dating as a possibility – even this leaves around 50% of the rune-stones undated (Gräslund, 2006). Interestingly however, the field has not addressed the issue of whether the well-documented 'peoples' of Sweden, the Svear and the Götar, have left separate and distinct traces in the material record. Their separate reactions to the Christianisation as well as their political

separation in the pre-Medieval period (Blomkvist et. al., 2007, Schlyter, 1835) are well-documented, and yet work on assessing whether difference exists in their material record has not been attempted. It is important to note that Christianisation itself will not be addressed in this body of work – there is a large and well-constructed body of work on this particular area of focus that would make a thesis in itself, and therefore the topic will be addressed only briefly in Chapter 2.

The 'large' issue, therefore, that will be addressed by this thesis is what the rune-stones tell us about post-Iron Age, pre-medieval Swedish society in general. This was a time of great change within Sweden, and as the rune-stones are the most comprehensive of the remaining artefacts, their significance cannot be overlooked. This broader and less self-fulfilling approach than seen in previous literature aims to explore just what the rune-stones, by their very existence, impart about the society that produced them.

RESEARCH AIMS

The aim of this research is therefore to explore the relationship between the form and distribution of rune stones and the social landscape of southern Sweden in the 11th century CE.

In order to address this issue, three sub-questions are considered;

1) Is there evidence of significant differentiation between the rune-stones of individual provinces, or between the rune-stones of the two 'peoples' of this time, the Svear and the Götar?
2) Is this differentiation also seen in the temporal record, and therefore is it possible to complete the dating of the rune-stones through a strategy other than the visual observation of individual stylistic features?
3) What are the implications of the discovery (or not?) of large-scale differentiation in the rune-stones?

Two main areas of focus will be addressed in order to answer the overall research goal about regional and temporal differentiation. A data analysis

approach will be taken, using probabilistic and variance analysis to explore whether these 'gaps' can be filled. Principle Components Analysis (hereon PCA) has been commonly used in archaeological studies to explore variance in large data sets, and this will be used to explore whether regional differentiation can be recognised. Naïve Bayes Classifiers (hereon NBCs) are only just beginning to be implemented in the analysis of archaeological data, and this will be used to explore whether temporal differentiation can be recognised.

AREAS OF FOCUS

Material difference in the rune-stones of the Svear and the Götar has not previously been addressed (as noted above), which is strange given that this regional separation is well acknowledged in early literature (e.g. the classic Anglo-Saxon text Beowulf). This can be seen as a significant gap in the field of rune-stone research, and so the identification of this material difference will be explored. The rune-stones of Svealand, Götaland, and Norrland (the less populous northern Sweden) will be 'split' and an attempt made to identify whether the assemblage of various rune-stone featues reveal difference. The historical provinces of Sweden, into which the rune-stones are generally categorised, will also be used in this study in order to contrast the traditional and new approaches.

Temporal differentiation can be addressed broadly within the scope of the various approaches to dating the rune-stones. The currently accepted dating system for the rune-stones (Gräslund's stylistic dating (1994;2006), Figure 1.3) leave around 40% of the rune-stones unattributed, and this was identified as an area in which probabilistic analysis could be undertaken. As noted above, the only traditional approach open for dating the rune-stones is that of seriation, based on stylistic and artistic development, and therefore a new approach was sought. Distinct spatial patterning was identified in the 'movement' of the rune-stones according to Gräslund's dates, and therefore both this patterning and the stylistic phases previously identified were used to explore temporal differences – with a rather unexpected result!

DATA COLLECTION

Both of these mathematical approaches require a large amount of data, and there is extensive information about the rune-stones freely available from various academic sources. The key to undertaking any of the analysis previously described is the creation of a database incorporating all available information about the rune-stones. This was done using a variety of sources, to enable enquiry that utilises entire assemblages, or all attributes of an artefact together, rather than selecting an ideal or type attribute of an artefact, for exclusive attention. The rune-stones used are included in Appendix A.

THESIS OUTLINE

This thesis is presented in seven chapters;

Chapter 1 – Establishing the Study

Chapter 2 – Rune-Stone Research – History and Trends

Outlines previous approaches to the study of rune-stones, highlighting major trends and their various strengths and weaknesses.

Chapter 3 – 11th Century Sweden

Outlines the canvas from which the rune-stones emerged and were erected. Overall trends in the study of the Swedish Viking Age will also be discussed.

Chapter 4 – Rune-Stone Analysis - Methodology & Research Design

Explores the particulars of just what a rune-stone is, well as delving deeper into previous approaches to rune-stone study that are particularly relevant to this thesis. Also outlines the main foci of the tests that will be run in the following chapters, as well as the methodology.

Chapter 5 – Temporality

Presents the first set of tests, relating to identifying temporality in the data.

Chapter 6 –Regionality

Presents the second set of tests, relating to identifying regionality in the data.

Chapter 7 – A Story about Similarity & Concluding Remarks

Summarises the results of the previous two chapters, discussing their implications for rune-stone study, as well as assessing the original research questions in light of the discoveries from the data analysis. Future directions will also be explored.

SUMMARY

The overall purpose of this thesis is to study not just the rune-stones, but also the extent to which they communicate information about the social landscape of southern Sweden. Prior studies have focused on small details of the rune-stones and so this will be avoided, instead focusing on the overall characteristics of the rune-stones in the larger context of mobility in the landscape of the trading members of the elite.

PROVINCES OF SWEDEN

The geographical divisions used in this thesis will correspond with the 'historical provinces' of Sweden (Sawyer, B., & Sawyer, P., 1993:85), as well as the larger regions, each of which incorporates several provinces. Abbreviations, which incorporate both the region as well as the province, will be used in the data analysis, and these are detailed below along with a map of the regions (Figure 1.2).

Jämtland	N.J
Medelpad	N.M
Hälsingland	N.HS
Gästrikland	N.G
Uppland	S.U
Värmland	S.VA
Västmanland	S.VS
Närke	S.N
Södermanland	S.SO
Bohuslän	G.B
Östergötland	G.OG
Västergötland	G.VG
Småland	G.SM
Öland	G.OG
Gotland	G.G

N = Norrland
S = Svealand
G = Götaland

Figure 1.2 Provinces and regions of Sweden. Only the named provinces will be used in analysis

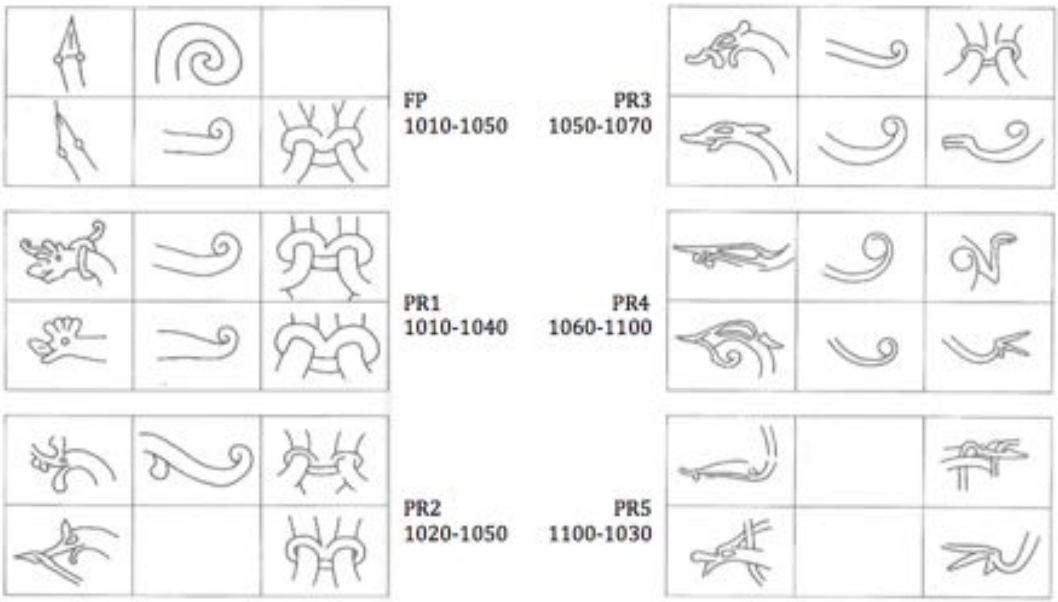


Figure 1.3 Illustrations of Gräslund's stylistic dating system (Gräslund, 2006: 132-133). More detail is included in Appendix B.

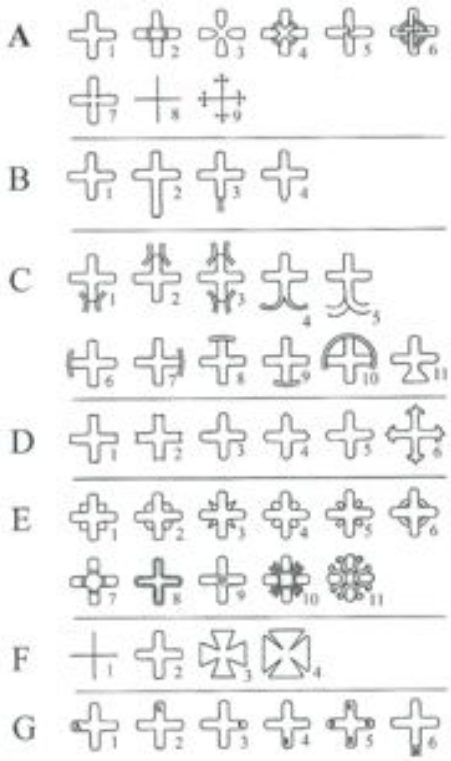


Figure 1.4 Illustrations of Lager's cross-classification system (Lager, 2002:65). More detail is included in Appendix C.

CHAPTER TWO
RUNE-STONE RESEARCH – HISTORY AND TRENDS

This chapter will review relevant publications in the field of rune-stone research, assess individual contributions, and identify overall trends in the field. While much of the research has been published in the Nordic languages, the English-language corpus is a fair representation of major trends and fields of inquiry. By beginning with exploring those engaged in runological enquiry before moving onto early scholarship, the path by which rune-stone research has reached its current state will be discussed. The trend that emerges is an overwhelming focus on individual features of the rune-stones rather than their contextual significance.

THE RUNOLOGISTS

The nature of the rune-stones attracts study by many different disciplines; linguists for the inscriptions (e.g. Lagman, 1990; Williams, 1990), historians for both the religious and cultural contexts (e.g. Sawyer, B & Sawyer, P., 1993; Sanmark, 2004), anthropologists for the study of rune magic and meaning (e.g. Flowers, 1986), and gender experts for how women are represented in the stones (e.g. Gräslund, 2010; Staecker, 2010), along with many others.

Because of the wide-ranging foci, this field of study seems to have given rise to the badly-defined 'runologist', someone who may use a single form or multiple forms of interpretation to inform their view on the rune stone (Antonsen, 1998:150). This person may range from a classically-trained archaeologist or medieval expert who simply has an interest in runic inscriptions, to the 'runological cowboy' (Barnes, 1990:11) whose work is popular among followers of the occult and the neo-paganists. One must only run a web search for 'runes' to see how this has proliferated. The 'created' specialisation leads to an interesting problem; there are no degrees in runology, and no specialist degrees available (*ibid*), making it seem like an undisciplined field within the 'undisciplined discipline' (Clarke, 1978: *xv*)

EARLY RESEARCH

The first traceable forays into the field of rune-stone scholarship begin with the Swedish antiquarian tradition of the late 16th century, involving the recording and documentation of runic inscriptions (Andrén, 2000:7). The most comprehensive early study took place in the early 1900s, with the *Sveriges Runinskrifter*, 'Sweden's Runic Inscriptions'. These published books catalogued all known rune-stones from the period by region, and have been periodically updated to record new discoveries and information. As these catalogues were the first all-inclusive work on the rune-stones, they took on the job of 'naming' the stones, and did so with both a provincial and numerical identification (e.g. **VG** 134 = Västergötland 134). As well as this the catalogues described the rune-stones and their locations, and included any other information thought relevant by the writer. All stones, unless 'lost', are accompanied by a photograph or drawing. Another catalogue of sorts was released in 1994 by Lena Peterson, in the form of the '*Svenskt Runordsregister*' (Swedish Rune-Word Register). This single volume provides a reference list of sorts for every word recorded in an inscription, and the rune-stones on which it occurs (Peterson, 1994).

Very little research in the field was evident during the middle of the 20th century, until the current company of academics began their work (Sawyer, B., 1991; Gräslund, 1987; Herschend, 1994; Willams, 1990, etc.), these publications having set the foundations for future studies of the rune-stones. The early catalogues of the 20th century are still used today, with editions recently having been prepared by a single editor, Sven Jansson. While there have been no paper publications since the early 1980s, the archive is now delivered as a digitised resource (initially *Mälsten*, and most recently *Rundata* (Petersen, 1994:308)).

LINGUISTIC STUDIES

Philological interpretations were one of the early ways in which the rune-stones were dated; earlier stones are inscribed in the 24-character Older Futhark alphabet, and younger ones in the 16-character Younger Futhark. Orthographic studies of individual letters and rune-types have taken place, generally with the aim of understanding variation and phonetic value, but two in particular have

integrated an archaeological understanding. Henrik Williams' 1990 doctoral thesis on the *os*-rune (ᚬ) explored consistency of use among carvers, as well as physical and temporal differentiation, and Svante Lagman's thesis of the same year did much the same for the dotted rune (ᚭ).

Detailed grammatical studies of certain rune-stones and orthographical variation are common (e.g. Mikolić, 2011; Thompson, 1975) due to the precise nature of runic inscriptions (Jesch, 1994:295), necessary because of self-evident size constraints. Studies of inscriptions as a whole generally focus on the occurrence and meaning of individual words or phrases (e.g. bridge-building (Jansson, 1987:106-109), and roads (Klos, 2009)) rather than a wider-scale semantic interpretation taking into account regional and temporal variation.

Recently been a 're-reading' of the inscriptions has been proposed by Andrén, who notes that taking the inscriptions out of context is dangerous, instead suggesting that translation should place more emphasis on the contextual detail of ornamentation on the stones (Andrén, 2000). Considerations about the general level of literacy in Sweden also need to be understood – as the population at the time was largely illiterate the meaning behind the rune-stones must have alsbeen conveyed in a visual and material fashion (Zilmer, 2010: 160-162), as 'contemplative monuments (Andrén, 2000:27). Zilmer also focuses specifically on Christian runic inscriptions, calling for an understanding of a 'dynamic context' that includes both temporal and religious considerations (Zilmer, 2006).

SETTLEMENT

No doubt is expressed in the research corpus that the rune-stones are representative of settled areas (Sawyer notes that the distribution of the stones 'gives a reasonable reliable indication of the areas then settled' (Sawyer, P., 1962:103)), but no distinct research in this area has taken place. but the trail ends there. Larsson (1998) explores the possibility of mapping properties, based on rune-stone locations and familial relationships, concentrating on a group of 20 stones known as the Jarlabanki stones. His conclusions re-locating the Viking

Age village of Täby to slightly outside the current location (*ibid*:644), show the potential for future work along these lines.

The possible identification of *ting*-sites (meeting or assembly places) is also explored. Many of them are mentioned on rune-stones but knowledge as to their locations has been lost (Sanmark & Semple, 2008). Klos' doctoral thesis explored connections in the spatial distribution between roads and rune-stones, theorizing that roads were of prime importance in the placement of a stone (Klos, 2009). This paper was criticized, however, for the lack of integrity in the data (there is no concrete record of roads from the period, and so modern-day ones were used), as well as for placing significance on much larger distances than is sensible (the argument being whether or not distances of 500 metres to one kilometre can be considered 'significant') (Larsson, 2010).

SOCIETY

Beyond the realm of settlement and inheritance, the significance of the rune-stones as representative of Scandinavian society has also been a topic of discussion. Descriptions of an individual's significance in society are given in the adjectives of the rune-stones. Terms such as *drengr* and *félagi* represent 'warriors' and 'comrades-in-arms' respectively (though the exact translations are always in debate) (Sawyer, B., 2000:106; Page, 1992:150), and shed light on the people who were commemorated on rune-stones, as well as those who remembered them. Moltke's work on the Danish rune-stones discusses these concepts extensively, using the rune-stones to illustrate the stratification of and positions within King Harald Bluetooth's court (1985:284). Bianchi's 2010 doctoral thesis investigated the runic inscriptions as 'multimodal texts', discovering that especially in the rune-stones of Södermanland at least two separate discourses can be identified, indicating that the rune-stones can be tied to a context of 'high social ambition' (Bianchi, 2010:4).

INHERITANCE

A significant amount of work has been conducted on the records of inheritance, as it is understood that one of the main motivations behind the erection of a stone is the familial relationship between the sponsor(s) and the commemorated

in almost all cases (Sawyer, 2000:25). Sawyer explores this in detail, cataloguing the relationships between the people mentioned on the stones and placing these inscriptions within the broader context of inheritance laws and practices, and identifying regional differences (Sawyer, B., 1990:165; 2000:47-90). Also highly related to inheritance is the concept of the *oðal*, an ancestral claim to land that has belonged to the family since 'ancient times' (Hansson, 2011:86) is also discussed as it is mentioned on several stones, and further emphasizes the intangible importance of the erection of a stone (*ibid*; Zachrisson, 1994).

WOMEN

A large amount of work conducted on the way in which the rune-stones refer to the roles of women at this time has also taken place; Sawyer gives statistics on the frequency of female mentions on the stones, noting that the commissioning of a stone seems to have been largely a male responsibility, due to, as mentioned, inheritance practices (Sawyer, B., 2000:64-66). Theories about whether the rune-stones may represent evidence of female infanticide have been posited (smaller numbers of female children occur when families are listed) (Gräslund, 1989:241-242), but the general conclusion from scholars is that the rune-stones represent a change in female roles and importance as Christianity took hold (Jesch, 1990:161). It is also noted that representation of women seems to increase in 'Christian' rune-stones, especially in the 'pilgrimage' and 'bridge-building' stones (Sawyer, B., 2003:301; Gräslund, 2010:490-491), reflecting changing attitudes towards women that are perhaps due to the introduction of the Virgin Mary (*ibid*: 492).

CHRISTIANISATION

Christianisation has become a major theme in the study of the rune-stones, both within and outside of archaeology. Historical explorations of the Christian conversion tend to gloss over the potential evidence provided by the rune-stones, instead concentrating on the largely church-produced literature of the time (see Sawyer, P. & Sawyer, B., 1997:104; Sanmark, 2004:86). As perhaps the only solid witness to the conversion process, and commonly viewed as a 'crisis symptom' (Sawyer, B., 1991), a deep engagement with the stones should be required in any study of Christianity and its ancestry in Sweden. Studies of

individual features commonly concentrate on Christian and syncretic artwork (Fuglesang, 1977; Moltke, 1985:245-283; Williams, 2009:217), and inscriptions, primarily concentrating on the prayers carved on the stones (most notably 'death in white clothes', and 'better than he deserved' (Jansson, 1987:112-116; Williams, 2012)).

'Christian' stylistic features are commonly studied, the most obvious of which is the cross found on around 40% of the rune-stones. Lager's doctoral thesis was the first to introduce a comprehensive fixed-type classification system for the rune-stone crosses (2002). Previous studies identified common features of the runic crosses, though they only provided a very basic classification system (e.g. Thompson, 1975:30). Lager explains the significance of the runic crosses as being representative of a 'Scandinavian visual language' (Lager, 2002:193). This 'language' is inextricably linked with the physical and ideological context of the cross, an 'internal decorative and practical motivation' that conveyed more than just a message of religious adherence (Zilmer, 2011:109)

Bridges are also of great importance in studying the Christianisation; bridge building was considered to be a 'good work' (Jansson, 1987:206), and many stones are erected near to or mention bridges (*ibid*, Zilmer, 2006). The importance of the rune-stones in a conversion context seems to come from their role in answering 'religious and social needs in a period of transition' (Sawyer, B., 1991:102).

DATING

Scientific dating has thus far been physically impossible (Kitzler, 2002 (1):22), so the literature on rune-stone dating focuses, by necessity, on other things. Genealogical dating in areas with high concentration of stones has been explored through tracking both stylistic changes and onomastic development (Fuglesang, 1998; Larsson, 1998). Linguistic studies have proposed the possibility of dating rune-stones on the occurrence of certain runic types (Williams, 1990; Lagman, 1990), though both concluded that temporal and spatial variation was too great for this to be possible.

Widely accepted as the current standard, Anne-Sofie Gräslund's dating system merges historical evidence placing the few known stone carvers in sequence with stylistic developments, forming a rough chronology that covers the entire time period and around 60% of the known rune-stones (Gräslund, 1994; 2006). Fuglesang notes that Gräslund's work, as it is based only on the Upplandic rune-stones and then applied retroactively to other provinces, may be rather unfairly exclusionary to the point of error (Fuglesang, 1998). She is also sceptical of the tendency to 'accept unquestioningly' the accuracy of the written sources used to establish the *terminus post quem* for the stylistic dates, noting that almost all of these sources postdate the rune-stones by several hundred years (*ibid*:197).

More modern techniques have also been employed to explore dating and the work of the carvers. Kitzler's doctoral thesis proposes surface structure analysis through the use of laser scanners to examine whether the strike patterns of rune-stones signed by carvers can indicate whether they were indeed the work of an individual, or were produced in workshops (Kitzler, 2002 (1); 2002 (2)). This work is the first of its kind in the field, mixing the 'old' approach of studying the chronology of the rune-stones by their carvers with new, more scientific technologies. Kitzler concludes with the thought that surface structure analysis could be used to examine temporal chronological differences in carving techniques, perhaps challenging the existing chronology based on the carvers as her work shows that workshop production was likely much more prevalent than currently thought (Kitzler, 2002 (1): 73-74).

SUMMARY

The foundations laid by runological study in the latter half of the 20th century have defined most of the recent research, though this is perhaps to the detriment of the field. Andrén notes that "the reduction from runic inscription to linear text… from animal art to decoration have reduced the meaning of the inscription and ultimately of the rune-stone as a whole" (Andrén, 2000:9). The point being missed by the literature at large is an understanding of the significance of the rune-stones within a dynamic and rapidly changing context along with a simultaneous consideration of the importance of all of the rune-stone features (Zilmer, 2006; 2010; 2011). Current studies focus on stylistic and linguistic

minutiae, with an interpretation of meaning inside a greater context seeming like an afterthought rather than a goal. Along with this, studies also often focus on a single geographical area such as that of Uppland; the large number of stones in this area may mean that other areas are perhaps being neglected (see Thompson, 1975; Gräslund, 2006; Sawyer, 2000 for just a few examples of this).

A contextual understanding of the rune-stones is of unquestionable significance; the rune-stones must be removed from their pigeonhole of artistic curiosity and treated as proper archaeological phenomena. The missing link that emerges in the current literature seems to be a discussion about the very significance of the very existence of the rune-stones and the extent to which they can be understood as representative of the changing landscape of Sweden in the 11th century.

CHAPTER THREE
SWEDEN IN THE 10TH- 12TH CENTURIES C.E.

"For it is in their nature that the jabberwocks of historical and antiquarian research burble in the tulgy wood of conjecture, flitting from one tum-tum tree to another"

Tolkein, 2006:9

CLASSICAL SWEDEN

The earliest depictions of the inhabitants of Sweden come from classical sources; Pliny's *Natural History* written in the first century CE mentions Scandinavia as the largest island north of what is now known as Denmark, inhabited by the 'Hilleviones' (the identity of this mysterious tribe remains unknown), who 'dwell in 500 villages and call their island a second world' (Pliny, Book IV, *xiii*:96). Another first century source is Tacitus, who in his *Germania* identifies the 'Suiones' as living in the midst of the ocean to the north of the Germanic tribes with great strength in their 'fleets' (44.1-44.2). Ptolemy's *Geography* from the 2nd century CE also mentions an island, this time named Scandia. Ptolemy notes that this island is inhabited by six tribes, one of which he names the Goutii, and even provides a map of the region (Figure 3.1) (*Geography*, Book II, 11:33-35). The Scandinavian influence on the modern world is often somewhat underappreciated – our weekly calendar, among other things, bears their mark (*Woden's Day* – Wednesday, *Thor's Day* – Thursday, etc.) (Otté, 1874:11). The Stone and Bronze Ages of Scandinavia followed much the same paths and timeframes as those of the classical world, with the shared mercantile links of the Roman Empire and the casting of weapons with iron being the catalyst for the 'Viking' activity to begin (Kent, 2008: 1-3).

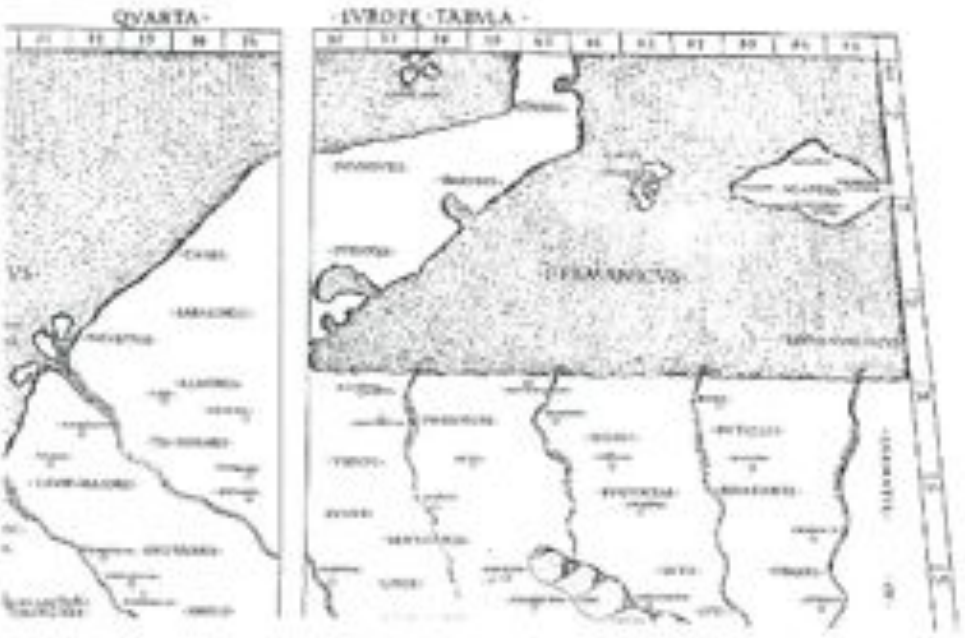


Figure 3.1 Ptolemy's map of the Baltic showing *Scandia* in the top right corner (Clarke & Ambrosiani, 1995:47)

LATE IRON AGE SWEDEN

The Scandinavian Iron Age can be characterised by two main trends; the expansion and establishment of trade networks after the break up of the Roman Empire, and the wealth and enterprise that came with it. Characterised by a flow of trade wealth, particularly into Sweden, the Migration Period of the 5th-6th centuries CE created an increasingly stratified society in which property rights became especially important, linked to a concept of ancestral inheritance known as the *oðal* (Löwenborg, 2012:19; Zachrichsson, 1994). The later Vendel Period of the 7th-9th centuries CE is so named for an exceptionally rich collection of burials filled with trade goods in the Mälaren Valley region of Uppland (Haywood, 1995:21), and this along with the centralisation of rune-stones here leads to the general opinion that power was centralised around this region until the advent of Church organisation (Kent, 2008:13; Löwenborg, 2012:21).

THE 'VIKING AGE'

The Viking Age is generally understood to have begun with the invasion of the island of Lindisfarne off Northwest England in 793 CE, the first of the Viking 'raids' (Sawyer, P., 2001:2). The word 'viking' itself specifies the activities of the period; etymologically it is a verb defines an activity characterised by sailing, trading and raiding (Figure 3.2) (Jesch, 2001:56, 1994:294). While 'Viking' hegemony extended to England and Russia, power was centralised both in importance and geography in Scandinavia, across Denmark, Norway, and the Swedish lands of Svealand and Götaland (Kent, 2008:7).

Figure 3.2 U 617, a rune-stone from Bro, in Uppland, incorporates the phrase *'He was on the viking watch with Geitir'*. (Lundberg, 1985)

The end of the Viking Age is generally dated to the end of the 11th or beginning of the 12th centuries. While there is no single event that is considered to signify the end of this period or beginning of the Medieval Period, the advent of church organization is a turning point (Haywood, 1995:134; Sawyer, B., & Sawyer, P., 1993:100-128; Sawyer, B., 2000:18).

THE ARCHAEOLOGY OF 10TH-12TH CENTURY SWEDEN

Despite the widespread settlement of Sweden during this period, which the distribution of the rune-stones tells us must have existed, there is surprisingly little indication that much archaeology has been attempted outside of the most popular sites. The sites of Sigtuna, Uppsala, Helgö, and Birka in Uppland, along with Skara in Västergötland are those most often and continuously listed on maps, with only one or two sites listed in other provinces (Lund, 2001:157; Haywood, 1995:43; Graham-Campbell, 1989:11). This is likely due to these sites being intricately connected with the trade and wealth that was flowing into Sweden at the end of the first millennium, making them the most useful and prolific in archaeological finds. Lying within the Mälar Valley, this is the only area in which 'towns', as well as 'sites', have been discovered and detailed in the literature (Figure 3.3) (Clarke & Ambrosiani, 1995:72, Batey et. al., 1994:49). The towns of this region can be said to be the first evidence of urban centres in Sweden, characterised by a diverse population ranging from the king's retinue and his military force, to slaves and missionaries (Magnus, 2002:20). As this was also likely the most populous area of the time, there was also greater mobility for the people of the area; sites were often abandoned, with people resettling close by with little effort (Callmer, 1994:73).

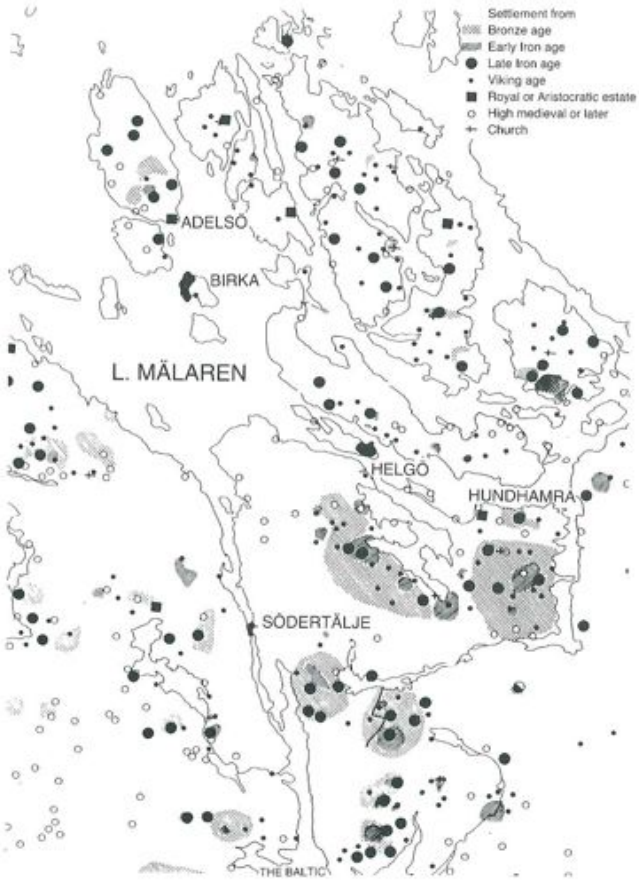


Figure 3.3 The 'towns' of the Mälar Valley (Clarke & Ambrosiani, 1995:72)

Birka, the biggest trading place in Sweden at this time, sprang up as a consequence of the establishment of the trade networks of the Migration Period (Ambrosiani, 1977:23), and was abandoned for unknown reasons in the mid-10th century (Callmer, 1994:72-73). It has been suggested that Birka was succeeded in role by Sigtuna, a newer site with a much smaller number of trade-related finds around 20 kilometres to the north (*ibid*), but a better explanation of this site is intricately linked to changes in Swedish ideology; Sigtuna was the first settlement in Eastern Sweden noted as being both 'Christian' and the site of a royal mint towards the very end of the 10th century (Sawyer, B., 1994:163).

TRADERS AND RAIDERS

It is well established that the Scandinavians were seasoned traders and travellers (Figure 3.4) and traditional interpretations of the itineraries of late iron Age travel point to geographical pragmatism; the Swedes going east, the

Norwegians west, and the Danes south. Jesch proposes, however, using the corpus of runic inscriptions, that the reality was much less straightforward (Jesch, 2001:69). The goods traded were varied, but the rich graves of the early late Iron Age and coin hoards around the Baltic seem to indicate that prestige items were of prime importance, satisfying demand from the growing elite (Kent, 2008:9). Kufic and Muslim silver from the early 9th century is the mostly commonly found item, with an indication that the Swedes may have even been instrumental in exporting it to Britain (Sawyer, P., 1962:187). Written documentation from their homelands also indicates that slaves from the Slavic countries were highly prized (Kent, 2008:9). It has been proposed that one of the reasons for the acceptance of Christianity was linked with the possibility of more incoming wealth – the conversion would have re-opened trade connections with the newly converted world (Sawyer, B., & Sawyer, P., 1999:22)

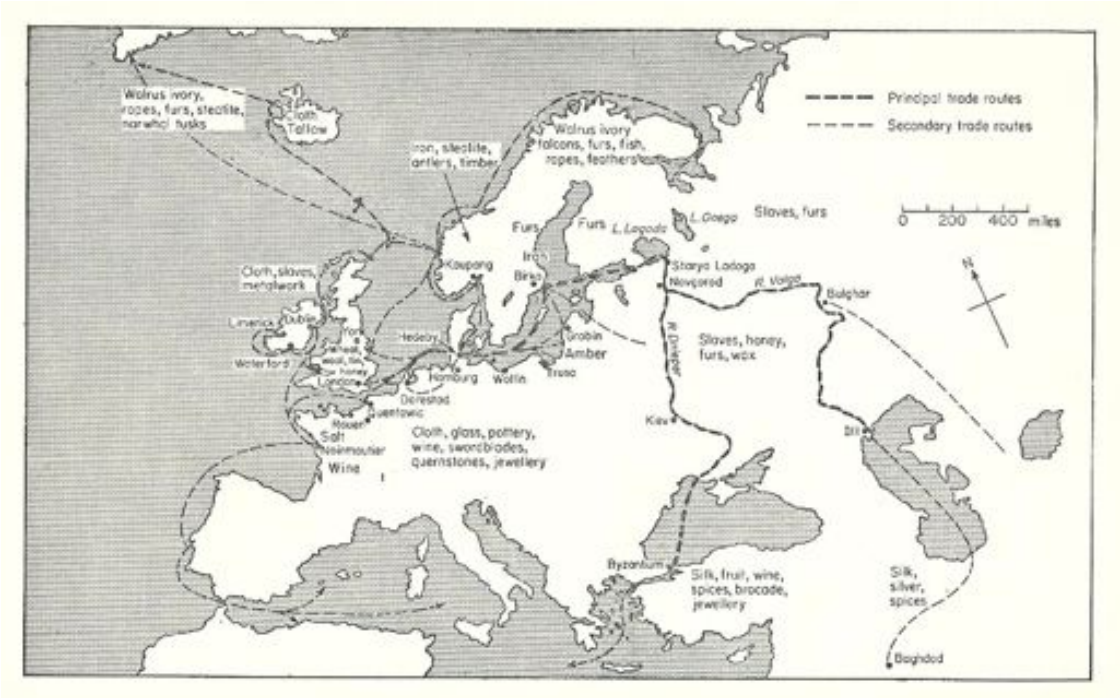


Figure 3.4 The trade routes of the Scandinavians, illustrating the traditional geographical pragmatism that informed 'who traveled where'. (Simpson, 1967:106)

SETTLEMENT SKEW

The distribution of the rune-stones, along with late Iron Age settlements (Figure 3.5) clearly show that there were people living in areas outside of the Mälar Valley, contrary to the traditional aforementioned focus. One could not suggest that ordinary village-people would have travelled from these towns into the hinterlands to erect a runic monument to a deceased loved one, as the effort would be invisible.

Figure 3.5 Late Iron Age settlements in Southern Scandinavia (Svanberg, 2003:134)

Sweden was divided into historical provinces as well the smaller *hundare,* administrative districts (Sawyer, B., & Sawyer, P., 1993:85) (see figure 3.6), which were responsible for the collection of taxes and the administration of local matters, and were made up of either single or multiple nucleated villages (Poulsen & Sinbæk, 2011:6); thirty-one *hundare* are known in Västergötland alone (Schlyter, 1835:7). Population estimates for the site of Birka sit at around one thousand inhabitants, so the smaller sites would likely have had populations comprising at least at a few hundred (Ambrosiani, 1977:19).

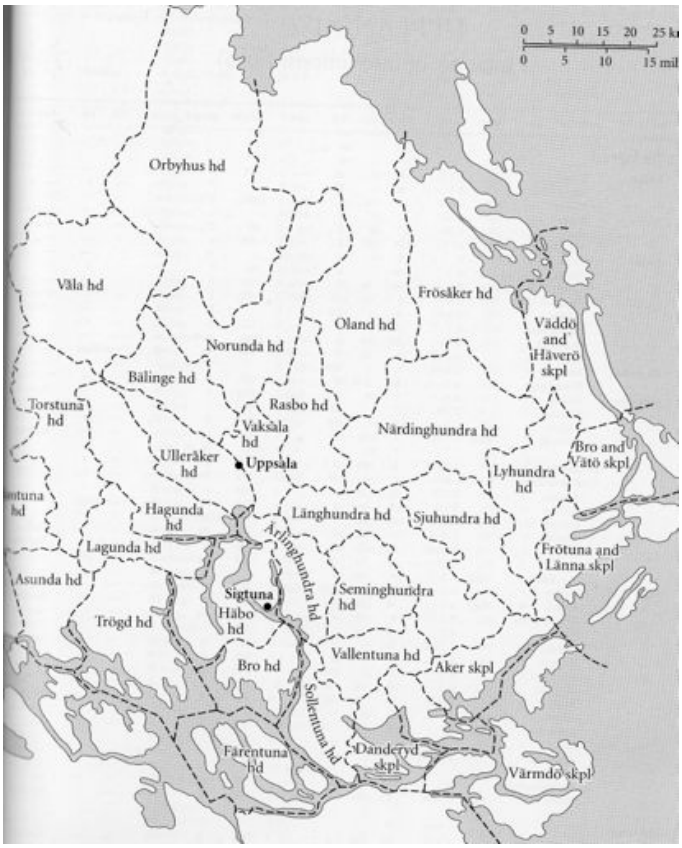


Figure 3.6 *Hundare* within Uppland. Coastal *hundare* are named slightly differently – they are *skeppslag*, which loosely translates to 'ship's district', indicating their importance in shipping and trade (Sawyer, 2000:237)

The most likely explanation for why we only have significant amounts of information only about some sites relates to the problem of continuous occupation. Sweden is geographically restrictive in terms of space that can be comfortably used for agriculture due to its dense forests (Grundsten, 1992:11, Jonasson et. al., 1938:25) (Figure 3.7), leading to the conclusion that even today, with a large farming economy, people are living in much the same places as they were in the early Iron Age (Magnus, 2002:21). Even when excavation is attempted, the layers from this period are often found disturbed due to later construction on top of the site, and therefore it is only when sites have been abandoned that they can be useful, (Sawyer, 1962:51).

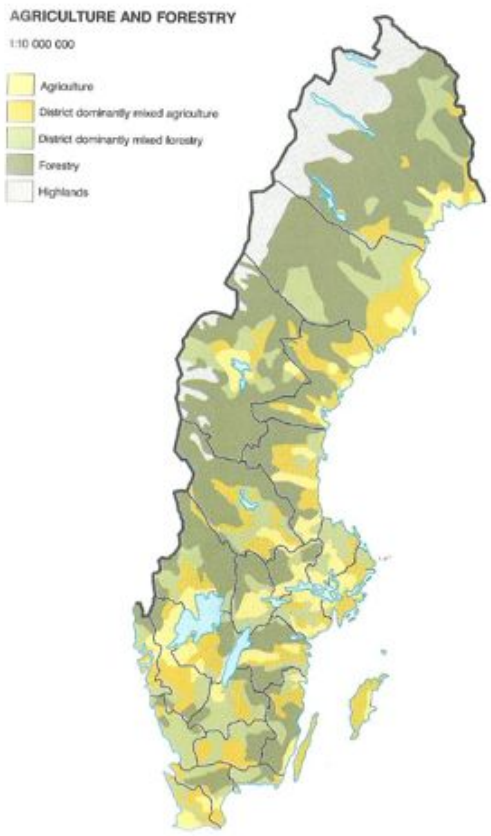


Figure 3.7 Topography of Sweden (Grundsten, 1992:11)

SETTLEMENT PATTERNS

The possibility of using the rune-stones to uncover knowledge about settlements in Sweden and their history has been briefly investigated (Larsson, 1995). The use of rune-stones to indicate lordship and land ownership (Jesch, 2011:36-41), as well as in staking inheritance claims has been demonstrated (Sawyer, B., 2000:74-91), meaning that the location of the stones would be indicative of high-status families who lived close to where there would likely have been villages. As an extension of this, the distribution of personal names has been used to identify the range of an extended family's neighbourhood (Larsson, 1995: 642-644), 10th and 11th century buildings including early churches were commonly constructed from wood, leaving them scarcely visible in the archaeological record (Figure 3.8) (Sawyer, B., & Sawyer, P., 1993:110).

Figure 3.8 Reconstruction of a 10th century Scandinavian Longhouse at the Moesgaard Museum in Denmark (Geoghegan, 2012)

The families erecting the rune-stones were likely freeholders with an *oðal* claim to their land. *Oðal* land was reocognised legally, with ownership demonstrating an ancestral claim of at least five generations of the family to the land (Magnus, 2002:11; Arrhenius, 2002:45). It has been proposed that the erection of a rune-stone is intricately linked with the concept of the *oðal* (Zachrisson:1994), indicating that the families erecting the stones had likely been fairly wealthy for a relatively long period of time (Hansson, 2011:86). The relationship between farming land and social hierarchy is one well demonstrated; Herschend proposes that the appearance of 'nodal farms' in the early Iron Age is an indication of the Roman influence on Scandinavia, that these farms mimic the social order reflected in Roman landscapes (2009:191).

INTERNAL COMMUNICATION

Just as studies of trade and exchange have concentrated on the networks outside of Scandinavia, remarkably little is known about communication networks within the homeland of the 'Scandinavians'. So just how did communication occur? Moreover, how were the large and seemingly impenetrable forests of Sweden traversed? The distance along the Swedish homeland at the time was

around 400km, not too great a distance to travel by horse and cart. The earliest map available of the roads of Sweden comes from Georg Biurman in c. 1742 (Figure 3.9). Highlighted is the 'Göta Highway', supposedly the oldest Swedish road, though despite its name there is no solid evidence that this road ever extended to Götaland proper in the 11th century; the 'known' length of the road in only from Stockholm to Södertalje. Archaeological excavations trace this short route back to the Bronze Age, so it is surely possible that the road extended to Götaland at some point (Eriksson, 1980:176). These roads, just like the settlements discussed above, may simply lie underneath their modern-day descendants.

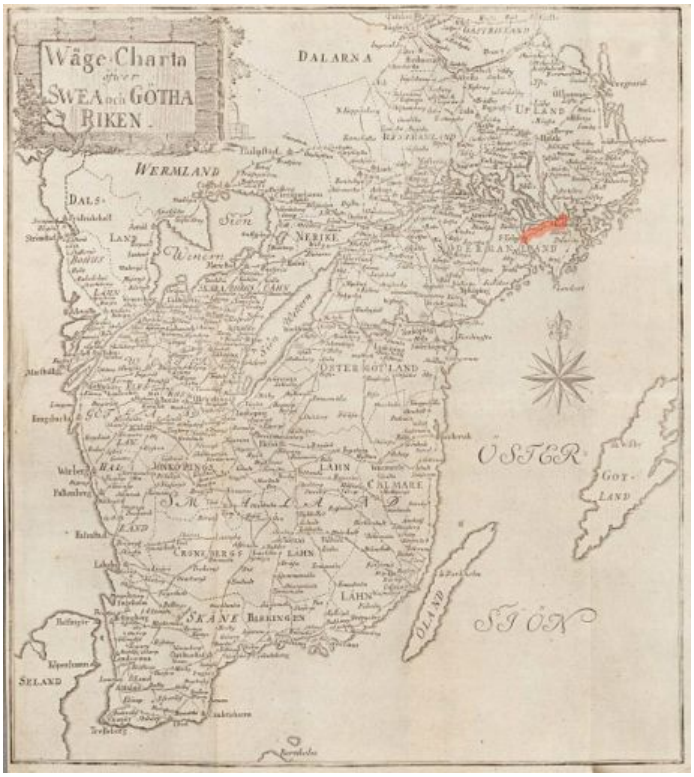


Figure 3.9 Early map of Sweden's roads (Biurman, 1742)

The internal geography of Sweden is interlaced with many watercourses; 9% of Sweden is covered by lakes, 85,000 of which are greater than a hectare in size (Grundsten, 1992:78). The sea level one thousand years ago was around five metres higher than it is today (Clarke & Ambrosiani, 1995:77), so much more of the country would have been covered in water (Figure 3.10). It is therefore at the

least possible, and at the most likely that communication was conducted via water, and inland boats found in Sweden only further this theory (Westerdahl, 2008:20).

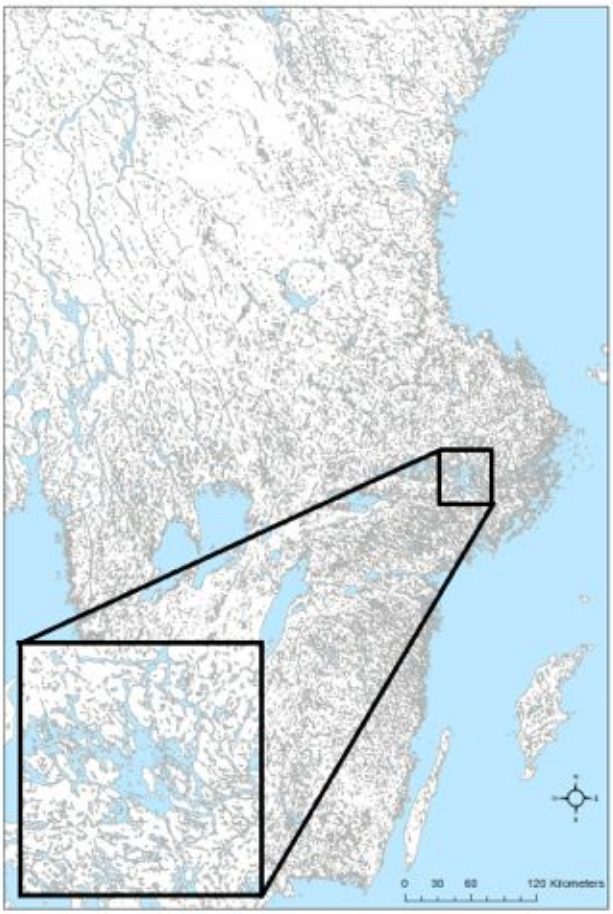


Figure 3.10 Shoreline displacement analysis for Sweden c. 1000 CE. Inset detail of the Stockholm archipelago (Modified from *Svenska geologiska undersökning* shapefile, 2012)

THE SVEAR/GÖTAR DIVIDE

As discussed earlier, the 10th and 11th centuries are generally understood as the time in which 'viking' activity was most prolific. In reality, there were many internal and much more 'normal' changes happening in Scandinavia that led to this expansion and influx of wealth. Sweden is generally spoken of as the least unified of the Scandinavian kingdoms due to the existence of two separate peoples within the land, the Svear and the Götar (Sawyer, B., & Sawyer, P., 1993:58), and thus provides a canvas to engage in this discussion.

Figure 3.11 Map of Sweden showing the regions of the Svear and the Götar

These groups are historically understood to have belonged to separate geographical areas; the Svear in the Lake Mälaren region, and the Geats towards the south near the lakes Vanern and Vättern (Figure 3.11) (Graham-Campbell, 1989:13-14, Clarke & Ambrosiani, 1995:68-69). References to these two peoples are also found in historical texts.

"Next are the states of the Suiones, in the midst of the Ocean itself, whose strength in addition to weapons and men lies in fleets"

Tacitus, Germania, 44.2

Frankish annals are also said to have referred to the 'Vikings' of Russia (normally the 'Rus') as 'Svea', perhaps shedding some light on the cultural ancestry of the Russian migrants (Kent, 2008:8)

For the Götar, or the Geats, we have a depiction in Beowulf. Though it comes from Anglo-Saxon England, the distinction between the two peoples is made quite clear meaning that the existence and differences between the two was known this far away. Tolkien argues that while the manuscript of Beowulf does not reflect historical accuracy in its recreation of the Northern world in AD500, it certainly bears 'clearly the marks of design and thought' (Tolkien, 2006:27)

"We are sprung from the lineage of the people of Geatland"

Beowulf, Book V, Line 3

"Then was crime and hostility 'twixt Swedes and Geatmen,
O'er wide-stretching water warring was mutual"

Beowulf, Book XXXV, Lines 13-14

Most references to the Svear and the Gotar speak about the political unification of Sweden at the end of the 11th century (Blomkvist et. al., 207:174). While earlier references to separate kings are hard to track down, there are numerous references to the first kings of the Svear and Götar and the kings that are said to have 'unified' Sweden in the late 10th and early 11th centuries (Sawyer, B., & Sawyer P., 1993: 58-59, Sawyer, B., 2000:21). Historical sources note that it is difficult to pin down a single moment in which the unification occurred, especially on this local level (Wallette, 2010:138) but all signs point to the late Iron Age being a time of great instability at home as well as abroad (Dahlbäck, 1993:630). Later sources show a subtle acknowledgement of a Svear superiority; the Westrogothic Law of the 13th century includes the statement "*Sveær eghokonong at taka ok sva vrækæ"*, which implies that only the Svear had the right to elect the king, as well as to expel him from the throne (Żełaniec, 2008:9). There have been no traceable attempts to explore material difference between these two groups, though studies of the commemoration formulae on the rune-stones have shown small distinctions (Sawyer, 2000:45)

THE COMING OF CHRIST

THE OLD RELIGION

The Norse religion was an animist tradition and shaped much of the Scandinavian identity. While the earliest literary record we have of Nordic religion and mythology is from the 15th century Eddic poetry of Snorri, there are traces in the archaeological record. The Rök rune-stone (Figure 3.12), which contains by far the longest inscription of all the stones, tells a folk story in memory of Væmoð, which mentions Valkyries, giants, and various Norse gods. It is generally understood, however, that the stories of the Norse pantheon existed as an oral tradition rather than in any written form (Bertell, 2006:298). Evidence of the pre-Christian religious tradition is even found in later legal documents - notably, the *Upplandslagen* ('Law of Uppland') of the mid-1300s forbade animist worship (Kent, 2008:15), something which was an integral part of religious practice (Andersson, 2006). The eventual transcription of the mythology in the 15th century leads to an obvious problem; by this time Christianity had taken firm hold in the minds of Scandinavians, and therefore the stories of the sagas as they exist today have likely seej strong Christian influence. The concept of Valhalla shows similarities to the Christian heaven (Sawyer, B., 2000:61), and the eschatological belief in Ragnarök, the end of the world, shows similarities with the apocalypse of Revelations (Hultgård, 1993:288). This potential representation of Christian beliefs within the stories of the Norse gods can be said to be largely a product of the shaky start that Christianity had in the North.

Figure 3.12 Ög 136, the Rök Rune-Stone

THE NEW RELIGION

The Christianisation of Sweden occurred later than in the rest of North and North-Western Europe, and differently than in the rest of Scandinavia. The official conversion of Denmark is generally understood to have been by decree of King Harald Bluetooth (Sanmark, 2004:404-405; Gelting, 2007:80), while the 'missionary kings' of Norway used a more gradual approach over the length of their reigns, which stretched from c. 995-1030. (Bagge & Nordeide, 2007:135-141). Sweden, its ecclesiastical administration coming - as with the rest of Scandinavia - from Hamburg-Bremen (Sawyer, B., 1985:91), is understood to have been much more of a challenge, and the written material from the time of the conversion is entirely skewed towards the perspective of the Church (Wood, 1985:39, Sanmark, 2004:551). The first attempt to Christianise Sweden in the early ninth century is detailed in the *Vita Anskarii* (The Life of Ansgar). Another church scholar, Adam of Bremen, wrote his *Gesta Hammaburgensis Ecclesiae*

Pontificum (Deeds of Bishops of the Hamburg Church) towards the end of the 11th century, when Christianity was taking a stronger hold. One of the most important parts of his writing is the detailing of the 'driving out' of King Olof Skötkonung from Uppland to Skara due to an pagan attack (Wood, 1985:36; Blomkvist et. al., 2007: 191). This is illustrated by archaeology; we have evidence of coins stamped with crosses being minted with his name in Sigtuna only from 990-1010 (Blomkvist et. al., 2007:190; Skaare, 1997:39), with his successor taking up the trend again from 1028-1030 (Sawyer, P., 1985: 77).

As mentioned earlier, the Christianisation process is often discussed as being different between Götaland and Svealand, mirroring the political separation of the time. This 'driving out' of the King strengthens this argument, and Sanmark proposes that this may have been due to the opposition of the 'Upplandic ruling elite' to the centralisation of power and unification of the regions (Sanmark, 2004:112). Different patterns between the two regions have been identified in the erection of the rune-stones, and the 'Christian' rune-stones of Uppland in particular are seen as symptomatic of a lack of religious organisation at a time when Skara had already been appointed as a bishopric (Sawyer B., 1991:102).

STAGES OF CONVERSION

In studies of religious conversion and syncretism, the process is often separated into different 'stages'. Commonly used in studies of the Swedish Christianisation is the outline developed by Birkeli which divides the process into three phases; infiltration, mission, and organisation, each a function of the religious, political, and organisational conditions in place at the time (cited in Lager, 2002:250). The phase in which we are interested is the 11th century mission phase, in which conversions begin in earnest and Christianity begins to be seen in the archaeological record, (Gräslund, 2000:272). This is also the time in which the rune-stones begin to be produced in large quantities, and it is commonly understood that they are symptomatic of this process (Lager, 2010:497). Rekligious conversion is difficult to look for in the archaeological record - we are looking not for an old religion or a new religion, we are looking for the very brief period of time where there was a co-existence, or a merging of the two, a time of experimentation as to what would 'fit' into the lives of the converted, and what

would not (Carver, 2010:4). As traces of the conversion in living Scandinavians are scarce due to the continuous occupation settlements, we must therefore look for traces in the dead.

BURIAL EVIDENCE

Graves from the conversion period have been used to illustrate the changing behaviour of the people of Sweden at the turn of the millennium, especially considering the big differences between the rich graves that characterised the Vendel Period and the simple, utilitarian graves favoured by Christians that have persisted through to today (Roesdahl, 1985:3; Kieffer-Olsen, 1997:188). The sudden absence of cremations and appearance of simple rectangular stone settings is also considered to be a telling occurrence (Nilsson, 1996:384; Sanmark, 2004:114). Graves can generally not be dated specifically enough to give a timeline for the Christianisation, but they can provide information about ideological changes. Gräslund explores the phenomena of animal burial using an example from Jämtland, in Northern Sweden. Two graves are explored, presumed to be those of a man and his son, and while the earlier grave has a horse and dog deposited along with the human corpse, the younger burial is alone. A single horse buried in its own grave is also found nearby, suggesting that while a Christian burial was desired, the customs of the old religion were still important to this man (Gräslund, 2000:270).

SUMMARY

An understanding of the changing landscape of 11th century Sweden is vital in order to properly contextualise the 'world' in which the rune-stone tradition began. The fall of the Roman Empire left trade routes open, the consequence being the influx of wealth into Scandinavia that manifested itself in the trade towns of the Mälar Valley. Political unification meant that the Swedes and the Geats were for the first time officially united, and the conversion to Christianity at the end of the 11th century left the Swedes without their traditional ways of memorialising their dead. All of these factors lead to the emergence of the rune-stones as representative of wealth and status, as well as the changing ideologies brought by this 'remodeling'.

CHAPTER FOUR

RUNE-STONE ANALYSIS - METHODOLOGY & RESEARCH DESIGN

"Material culture makes use of allusion to earlier times and other peoples; it sometimes proclaims these earlier messages, sometimes imitates them, sometimes opposes them, sometimes conceals them."

-Carver, M., 2010:4

In order to accurately address issues of temporality and regionality, previous research in these areas must be addressed. While the dating of the rune-stones has been a long process, first attempted in the early 20th century, there have been very few attempts to explore regional differentiation. Temporal investigations, however, do have their gaps, and the processes used in this thesis to address both of these issues will also be discussed.

WHAT IS A RUNESTONE?

A rune-stone is a large, shaped stone erected to commemorate the life of someone well-regarded by the sponsor. Around three thousand rune-stones exist in Scandinavia, with 250 in Denmark, 50 in Norway, and the rest in Sweden. The origin of the runic script, the *futhark* (ᚠᚢᚦᚨᚱᚲ) remains unknown, but it is commonly considered that it may have developed from Latin, Etruscan, or Greek, brought north in around the third century CE (Elliott, 1989:3,7; Moltke, 1981:61).

The first rune-stone and first instance of the entire runic alphabet are the same; the Kylver stone from the fifth century BC. (Figure 4.1). Rune-stones were only raised sporadically in Sweden before the end of the 10th century, and it is commonly considered that the large number erected up until the beginning of the 12th century were due to the major religious, political, and ideological changes of this time (Fuglesang, 1998:197; Kitzler, 2002(1):7).

Figure 4.1 G88, The Kylver Stone

The erection of the rune-stones varied regionally – the majority of the stones are found in the Uppland region and are considered to have been erected later than those in other areas (Lager, 2010:501, Figure 4.2). It seems that the rune-stone fashion began and finished comparatively earlier in the south, with a lesser overall volume. Sawyer ascribes this to to the more complex reaction to the Christianisation of the region (Sawyer, 1991:101) and Herschend to the 'stubborn paganism' of Uppland (Herschend, 1994:39). Evidence presented in the previous chapter also points to a larger percentage of the population of Sweden residing there than elsewhere.

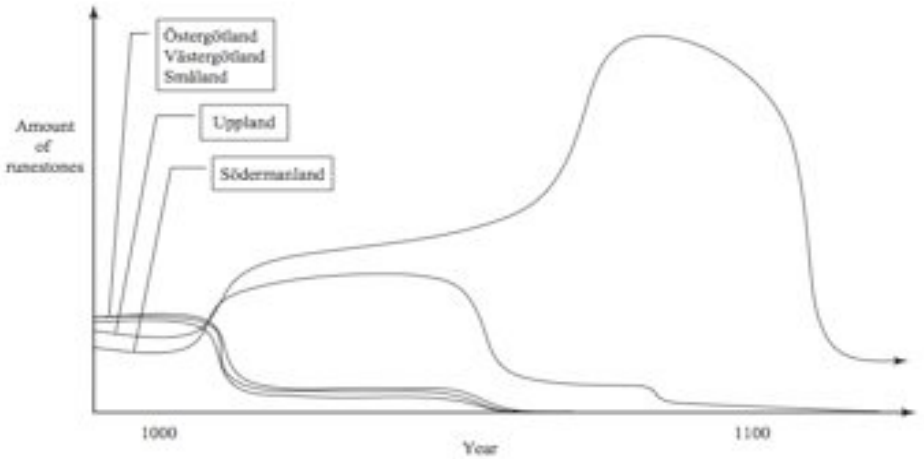


Figure 4.2 Regional patterning in the erection of the rune-stones (Lager, 2010:501)

DATING THE RUNE-STONES

The rune-stones have been relatively dated in several ways; as a stone artefact, they are complex to date using 'absolute' methods. While traces of coloured paint have been found on some remaining rune-stones, there are generally not sufficient remaining organic binding agents to be able to employ C-14 dating (Kitzler, 2002 (1):22). Most currently employed petroglyphic dating methods, including lichonometry, micro-erosion analysis, and pigment analysis are also unsuitable for rune-stones due to their exposed environments (*ibid,* Löfvendahl et al, 2001).

Very few absolute dates are available, and even those are only close-to-absolute. These dates are generally based upon journeys and historical events mentioned on the rune-stones that are also historically documented. One of the journeys that groups several of the rune-stones is that of Ingvar, the leader of an expedition to the Abbasid Caliphate (Jansson, 1987:63), and this journey is known to have lasted from the late 1030s until 1041 (Thunberg, 2010:42-51). Another group are that of the Knut stones, commemorating men who took *danegeld* in England in 1018. Gräslund speculates that these men were likely young and lived at least another 40 years (noting that osteologists put life expectancies at this time at around 60-70 years), and therefore dates them relatively late (Gräslund, 2006:127).

The earliest attempt to provide a chronology for the rune-stones came in the early 20th century, with a sequencing of the styles of the 'signed' stones. Many of the rune-stones include the signature of the carver, the most prolific of these being **Åsmund, Balli, Föt,** and **Öpir** (Lagman, 1990). The work of von Friesen placed these carvers in a 'phase' chronology (Fuglesang, 1998:200), with the inclusion of other large groups of stones (Table 4.1). This sequencing heavily influenced the work of Gräslund, the creator of the currently accepted dating system.

Unornamented stones	c. 990 -
The carvings of Åsmund	c. 1025-1050
The Ingvar Stones	c. 1040
The Föt-Balle Group	c. 1050-1070
The carvings of Visäte and the Frisian guild	c. 1060-1075
The carvings of Öpir	c.1070-1100

Table 4.1 von Friesen's intial chronology (Adapted from Gräslund, 2006:118)

Genealogical dating has also been able to provide a sequence of sorts, as has been shown with the Onäm and Jarlabanki family rune-stones. These two overlap in a similar area (Larsson, 1998) and are used to construct a chronology, which is formed by comparing stylistic changes and genealogical progressions. It can be seen that certain stylistic changes occur simultaneously with the appearance of a new generation (Fuglesang, 1998:202-205), leading to the conclusion that the stylistic changes that typify each of the phases may be more closely related to the development of rune-stone fashion than strict chronology.

LINGUISTIC DATING

Linguistic studies have proposed the possibility of dating rune-stones on the occurrence of certain runic types (Williams, 1990; Lagman, 1990), though both concluded that temporal and spatial variation was too great for this to be possible (Gräslund, 1994:117). The chronological development of runic writing is not known with enough specificity to be able to trace the changes and variations in the script (Antonsen, 1998:151).

GRÄSLUND'S STYLISTIC DATING

Anne-Sofie Gräslund's work of the 1990s and early 2000s dates the Upplandic rune-stones on stylistic grounds (Gräslund, 2006), and the majority of runic experts have accepted this system. Like the datings based on the stone-carvers,

this system began with the development of changes in the carved ornamentation on the stones. An initial temporal separation of the rune-stones was formed by the Mamman-Ringerike and Urnes artistic styles identified on the rune-stones (Christansson, 1959), Gräslund's work having developed further from there.

Most of the Swedish rune-stones incorporate both runic writing and an 'animal' of some sort into the design (Sawyer, 2000:192-193). These animals are variously interpreted as dragons, snakes, dogs, and more, and Gräslund's work is able to incorporate the shape of the heads, the tails, the feet, etc., to assign a sequence to the variations (see Appendix B). In order to assign dates to this chronology the dates for the carvers, the sequencing of the artistic styles, as well as other 'absolute' dates for journeys mentioned on the stones, etc., were used (Table 4.2) (Gräslund, 2006:126-127).

RAK	c. 990-1015 CE
FP	c. 1010-1050 CE
PR1	c. 1010-1040 CE
PR2	c. 1020-1050 CE
PR3	c. 1045-1075 CE *
PR4	c. 1070-1100 CE
PR5	c. 1100-1130 CE

Table 4.2 Gräslund's stylistic date ranges (Adapted from Gräslund, 2006:126)

*Gräslund notes the end date for 'PR3' as being *en generation framåt* (a generation forward), which is here and in other literature taken to be 30 years (Sawyer, 2000: 196).

Notably this study focuses only on the rune-stones of Uppland, and has been applied retroactively to the rune-stones of the rest of Sweden (Gräslund,

2006:130). The preponderance of stones in Uppland undoubtedly makes them the most suitable for a large-scale stylistic study, as has been seen in even earlier literature (Thompson, 1975), but there must be questions raised as to whether this may obscure regional variation.

THE PROBLEM OF ÖPIR

As mentioned earlier, the first attempt to sequence the stones used the signatures of the rune-carvers. Öpir, the most prolific of the carvers, has a signature on 51 rune-stones, and around 50 more have been attributed to him. Figure 4.2 shows quite a common signed inscription (Sawyer, 2000:37).

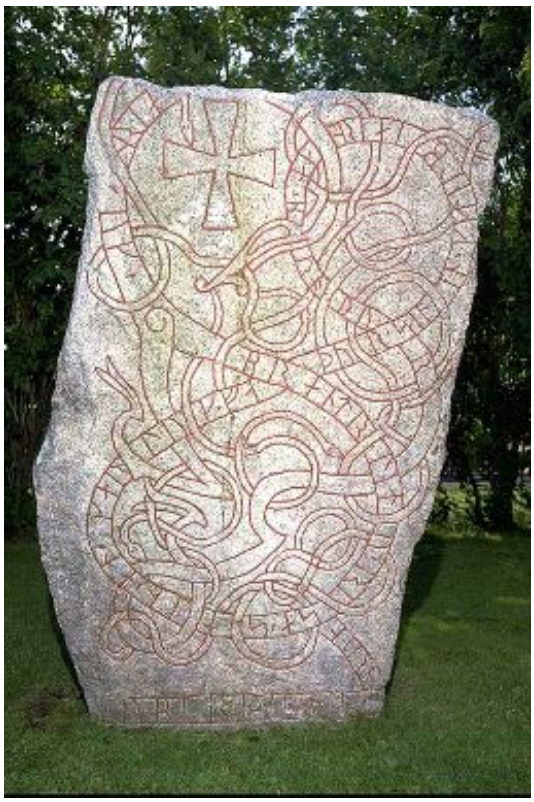


Figure 4.3 The rune-stone U 1976;107, displaying the signature of the rune-carver Öpir. The inscription is detailed below.

"...bjôrn(?) ok Brandr létu reisa stein at Kôrlung, fôdhur sinn, en Ketilbjôrn at bródhur. Œpir risti rúnar."

"...-bjôrn and Brandr had the stone raised in memory of Karlungr, their father; and Ketilbjôrn in memory of (his) brother. Œpir carved the runes."

Recent archaeological studies, however, have brought to light the fact that the rune-stones may have been produced in workshops, and that the signatures may represent groups, rather than individuals. Laser-scanning analysis of cut-marks on both ancient and recently created 'test' rune-stones has revealed that it may be possible to identify multiple carvers on many of the stones (Kitzler, 2000, 2002(1), 2002(2)), with the work of at least four individuals found on some of the Öpir rune-stones (*ibid*: 2001:54). However, the effort, time, and equipment involved in completing this work has been prohibitively large and/or expensive, meaning that very little work has been completed (*ibid*, 2002(1):27).

LOCATING THE STONES

As discussed in chapter two research generally focuses on one aspect or feature of the rune-stones, and this does not change in regional studies. The Uppland region contains around 50% of the Swedish rune-stones, and it is surely not surprising to learn that this is where the bulk of the research is focused. Claiborne's 1975 book *Studies in Upplandic Runography* justifies his limited focus by highlighting the role of Uppland as the social, political, and religious centre of Sweden (Thompson, 1975:4). Herschend also focuses on the Mälar Valley, the geographical surrounds of Uppland, in his study of how the rune-stones with prayers on them change over time (Herschend, 1994). He notes that the percentage of 'prayer'-stones is similar in each province, at around 18.5%, though does not explain whether he considers the prayer patterning to be similar throughout the provinces (*ibid*:30).

Sawyer briefly covers regional differences in find-spot and existence of crosses (Sawyer, B., 2000:28)., though much more detailed deconstructions of the regional differences in linguistic features are given, in relationships between sponsors and deceased, inheritance patterns, and titles (among others) (*ibid*:35-46), and this lead to the opinion that it may be possible to replicate these differences using features other than linguistic indices.

RUNE-STONES AND THE CHRISTIANIZATION OF SWEDEN

One of the largest areas of scholarship involving the rune-stones is that of their role in the Christianisation of Sweden. Viewed as one of the few representations of the conversion, or of Birkeli's 'mission' period (Lager, 2010:498), the rune-stones are considered to be of primary importance in measuring the reaction to, and acceptance of, Christianity (Sawyer, P., & Sawyer, B., 1993:11). It has been commonly argued that the reason for the upswing in rune-stone erection at the time of the Christianisation is due to the personal and emotional needs of people to honour their dead in a traditional fashion (Sawyer, B., 1991:101). Three features of the rune-stones are commonly used to study the Christianization, and these are discussed below.

LINGUISTIC EVIDENCE - DAUÐR I HVITAVAÐUM

The rune-stone inscriptions are very commonly discussed as evidence for individual reaction to the Christianisation of Sweden, due to the overtly Christian nature of the texts. The importance of this lies in the interpretation of the texts to paint a picture of the individual commemorated or perhaps more correctly the agenda of the person who commissioned the rune-stone and decided the text (Sawyer, 2000:47).

This inscription '*dauðr i hvitavaðum'* is found on seven runes-stones, and translates loosely to 'he died in white clothes' (Jansson, 1987:112).The 'white clothes' of the inscription are generally regarded as baptismal robes (Williams, 2009:3), and while the literal translation is undebated, this interpretation is problematic. A traditional and generally accepted interpretation is that of Jansson, an archaeologist, who suggests that the text commemorates one who was baptized on his or her deathbed (Jansson, 1987:112). Williams (2009, 2012), a linguist with a background in the rune-stones, argues that the small number of stones could not represent the entirety of the baptized population, instead proposing that the 'white clothes' could suggest the sacrament of confirmation, due to the benefits the absolution of sin would afford in the afterlife (Williams, 2012:12).

RUNIC CROSSES

The most common 'Christian' feature of the rune-stones are the runic crosses, and just under half of the Swedish rune-stones incorporate these (Lager, 2010:498). Some crosses are quite ornate, others are fairly simple (Figure 4.4), and some even incorporate Norse imagery (Figure 4.5). The crosses are unquestionably understood to represent an acceptance of Christianity by either the sponsor or the commemorated, but it was only recently that a static classificatory system was set up. As part of her doctoral thesis, Linn Lager set up a classificatory system which can be used to allocate all runic crosses based on subsets of 7 main features (Appendix C) Some of these cross types are temporally distributed, with simpler crosses and 'fixed types' appearing in the later part of the 11th and early 12th centuries (Lager, 2002:248). Lager concentrates on temporal rather than regional differences in the appearance of individual cross features, noting that there are some that appear only on earlier rune-stones (*ibid*: 103).

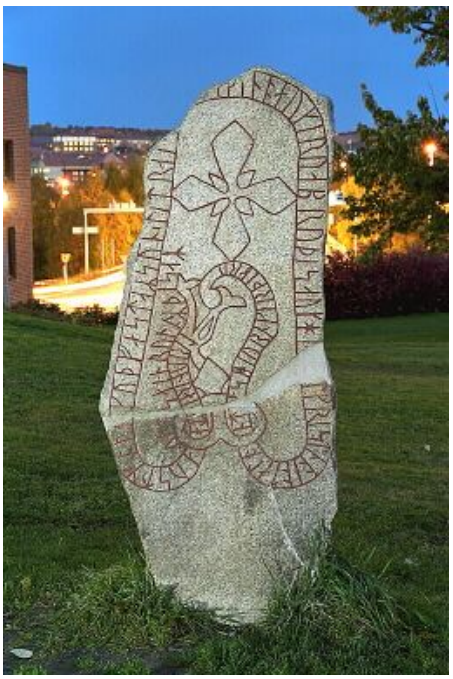


Figure 4.4 J RS1928;66, the single Jämtland rune-stone, incorporates a fairly simple cross (Lundberg, 1998)

Figure 4.5 U1163, a 'Sigurd-stone' from the province of Uppland, showing the Norse legend of Sigurd slaying the dragon Fafnir (Lundberg, 1985)

AIMS

The aim of the data analysis being undertaken is to treat the questions and issues discussed above in a rather more mathematical fashion than has been previously used. These approaches to archaeology are not new; Clarke's 1968 'Analytical Archaeology' called for observations to be treated, in all possible instances, 'numerically and statistically' (Clarke, 1978:30). Mathematical analysis allows incontrovertible and unquestionable conclusions to be made about data that is often interpreted (especially in the field of rune-stone research) in a rather subjective manner.

The overall objective of the data analysis to explore how the rune-stones as an assemblage - rather than their individual separated features – are representative of the social landscape of 11th century Sweden. . This goal is explored in terms of two main areas of inquiry, temporality and regionality. Each area is assigned its own chapter and set of tests, which will be explained further later on.

SELECTING THE DATA

The data collected for this thesis is not complete; there are a fair number of rune-stones that are missing certain attributes or features. This is generally due to stones having been 'lost' since their initial cataloguing and today. The *Sveriges Runinskrifter* volumes keep all entries, regardless of whether the rune-stones still exist today, and therefore many rune-stones now exist only as descriptions (e.g. U1101 from Bälinge Parish, Uppland) or as drawings (e.g. U1114 from Skuttunge Parish, Uppland). Many rune-stones have also been broken up and moved from their original context, the most numerous of which are the 61 broken Köpingsvik rune-stones of Öland that are stored in a church tower (Kitzler, 2009:91) (see Figure 4.6). It was hoped that despite this missing data, there would be enough remaining to revel any underlying patterns. The data contained, and percentage of stones with these values associated, is detailed in Figure 4.7.

Figure 4.6 The rune-stone fragments of Köpingsvik (Kitzler, 2009:84)

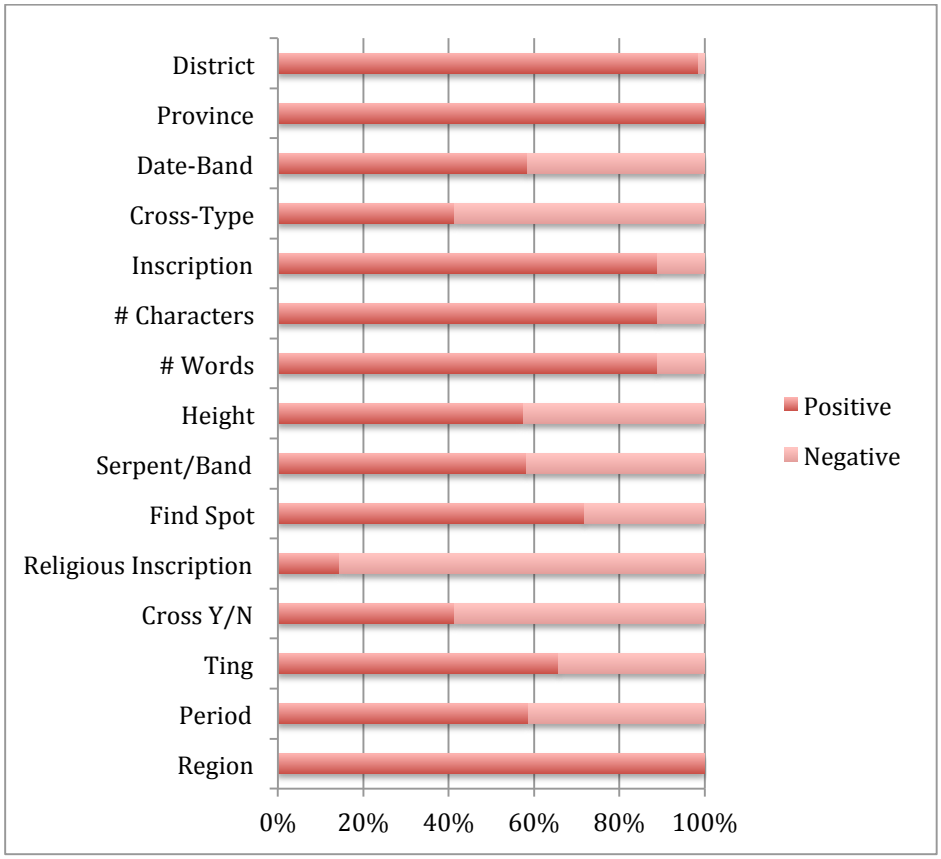


Figure 4.7 Percentage of stones with each value attributed

The data used for all of the tests was taken from an optimised spreadsheet created from the *Samnordisk runtextdatabas* (Bianchi, Källström & Owe, 2010), data collected from the catalogue in the appendices of Birgit Sawyer's *The Viking-Age Rune-Stones* (Sawyer, 2000), and data added by the author. All of the rune-stones used are listed in Appendix A.

RUNDATA

The *Rundata* spreadsheet was first cut down to include only entries from Sweden (fortunately the rune-stones in the provinces Skåne, Blekinge and Halland, historically belonging to Denmark (Moltke, 1981:15), are listed as such). As that database lists all items with runic inscriptions, only entries identified as *runsten* or *bergvägg* ('road-stone' - refers to 15 rune-stones whose placements were specifically on old Uppland roads) were kept. Fragmentary stones were also included, as many of them can be dated on the basis of their remaining stylistic elements. The spreadsheet was then further cut down to include only

rune-stones dated by Gräslund's system, as these represent the period in which we are interested. Gräslund's dating was already included in the spreadsheet (though only stones that belonged to a single period were included – many stones were listed as belonging to multiple 'date-bands'), as was Lager's cross-classification system. An extra date is included named KB, this refers to a rune-stone type exclusive to Södermanland (Bianchi, Källström & Owe, 2010),. Inscription data was provided along with the spreadsheet in a text file, and this was used to generate counts of the words and characters of each inscription.

OTHER SOURCES

From Sawyer's *The Viking-Age Rune-Stones* several variables were included, these being **height, serpent/band, find-spot,** and **religious inscription** (Sawyer, 2001). These were manually copied from the book to the spreadsheet due to no digital copy being available. **Height** is given in centimetres, **serpent/band** details Sawyer's breakdown of this stylistic element, **find-spot** gives the recorded location of the rune-stone, and **religious inscription** is a simple yes/no.

GENERATED FOR THIS THESIS

Some data was purpose-generated for this thesis based on existing data. The first was the attribution of a **Region** to each stone, based on the historical provinces that belong to Götaland, Svealand, or Norrland. The second was the addition of a **Period** based on Gräslund's dating, explained in more depth later in this chapter. The third was the addition of a ***ting*-site** and distance from these sites, as per the traditional meeting-places or assembly-sites of the Swedes. As the locations of regional *tings* are largely unknown, only the largest ting-sites of Skara, Gamla Uppsala, and Lionga were added. The site of Skara is known as the *ting of all Geats*, Gamla Uppsala as the *ting of all Swedes*, and a special alternate ting for Óstergotland, due to the geographical separation between east and west, is named as Lionga, modern-day Linköping (Schlyter, 1835:6)

TESTS USED

NAÏVE BAYES CLASSIFIER

The first form of analysis undertaken was with the use of a Naïve Bayes Classifier, chosen because of its growing popularity in both archaeological and computer science research. Archaeologists working in statistics and mathematics have previously espoused the virtues of the 'Bayesian' approach (Orton, 1992:139, Buck et. al., 1996:1). Essentially a form of rule-based classifier, an NBC is best utilised when there are 'knowns' that can be used to 'train' the classifier, in order to calculate the probability of an individual belonging to a pre-defined class. In other words, it allows us to start from a state of 'partial understanding' (Orton, 1992:139) in order to measure our 'strength of belief' (Buck, et. al., 1996:1) as to the probability of a sample belonging to a class. It is important to note that no classifier can give a solid 'yes' or 'no' to any single unit belonging to the category it is attempting to fill out, and simply offers the probability of it belonging to each of the variables within the category (Tan et. al., 2006:235).

This approach has been used previously in several archaeological circumstances. Regional prediction via classification using Levantine ivory sculptures has been attempted by a team from Cambridge and Harvard, with a 98% accuracy rate. This classifier, however, was created solely as a test, as all of the findspots of the ivory sculptures were already known, and the remaining (incorrect) 2% attributed to outliers (Gansell, et. al. 2006:488). A secondary study used an NBC to classify Neolithic barrow dates, given a certain number of previously given C-14 dates. This very sophisticated classifier uses a large number of possible dates, and represents visually the probability of each barrow belonging to each date. The experiment points out the importance of realising that all models are, by their nature, representative rather than inherently truthful (Bayliss et. al., 2007:1). This use of an NBC will become much more common; with the cost of multiple C14 datings often prohibitively high, an NBC can be used to fill in the blanks. An example of an NBC is given in Appendix D.

PRINCIPAL COMPONENTS ANALYSIS

The Principal Component Analysis has become a standard-issue tool for when a large amount of data is available, but no coherent similarities can be easily or visually identified (Van Poole & Leonard, 2010:286). Its benefits lie in being able to capture the 'strongest patterns' evident in the dataset using the fewest number of variables (Tan, et. al., 2006:701-702). The use of a PCA with the rune-stones is not unprecedented. A similar analysis was used in Kitzler's recording of the grooves and cutmarks in of rune-stones (Kitzler Åhfeldt, 2002: 35,47). Benchmarked against modern, 'known' rune-stones, the aim was to 'group' the rune-stones according to how many carvers they indicate. As in this study, as much relevant data as possible was captured about each rune-stone before it was run through a PCA. This is why the PCA was chosen – while we know that there is a single characteristic that ties the rune-stones to a temporal timeframe, the identification of quantifiable regional differences across the board has not yet been possible.

A complete PCA was not possible, due to the differing types of data, which have to be separated from each other; some of the data available is ordinal and some of it continuous. The continuous data is represented by the word and character counts, along with the heights, and so these could be combined to form a test. The cross-types and find-spots are ordinal data, and therefore these were tested in isolation.

TESTS UNDERTAKEN

IDENTIFYING TEMPORALITY

The first set of tests will attempt to explore whether anything other than the stylistic features of the rune-stones are able to form a solid chronology. The hypothesis being assessed was that quantifiable temporal differences would be evident in the rune-stones, and would likely correspond to either Gräslund's stylistic dating or a spatial patterning identified in spatiotemporal mapping of the stylistic dating. The null hypothesis was that there would be no differentiation. Four stages in the spatial patterning were identified, loosely

corresponding to Gräslund's stylistic stages, and due the patterning, they were named **Early, Middle 1, Middle 2,** and **Late.** Figure 4.8 illustrates how the periods uncovered through spatial patterning correspond to Gräslund's dating. Gräslund's stylistic dating system is mapped in Appendix E, and the spatial distribution pattern in Appendix F All tests undertaken in this section will be run both in relation to Gräslund's system as well as the spatial 'periods' identified.

Only stones that belong to a single of Gräslund's dates were used in order to identify distinct patterns; some of the stones that are attributed to multiple dates correspond to a single 'period', and these were included.

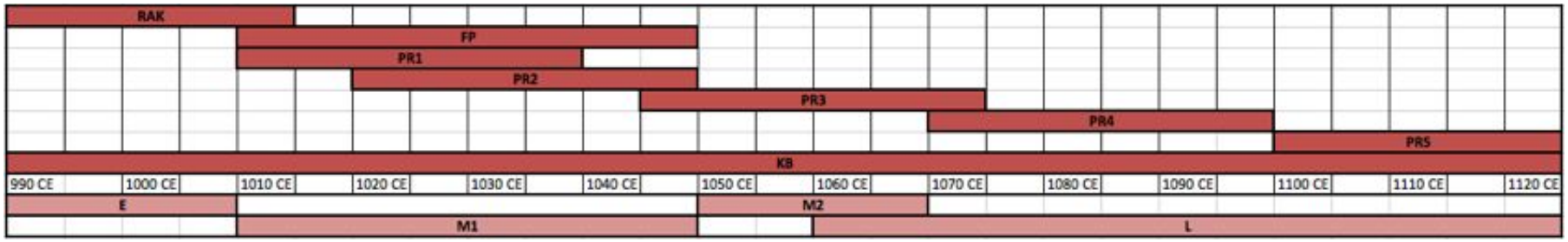


Figure 4.8 Comparison between Gräslund's stylistic dating and the spatial patterning identified in this thesis.

Above are Gräslund's dates, and below are the periodic dates.

IDENTIFYING REGIONALITY

The second set of attempts to explore whether quantifiable regional or provincial differences are evident in the rune-stones. The hypothesis proposed is that these differences will correspond directly to the separation between the Svear and the Götar explored in Chapter 3, and the null hypothesis that there would be no differentiation. All of the tests undertaken will be done in two stages; first in reference to the 'region', that being Svealand, Götaland, or Norrland, and second in reference to the historical province (Uppland, Södermanland, Småland, etc.). This is due to existing work generally being in reference to historical provinces, as well as the aim of this chapter being to find larger-scale regional differences in the rune-stones.

SUMMARY

Outlining both the most important information needed to understand issues of temporality and regionality in the rune-stones and the way in which tests can be conducted to measure their difference, this chapter has provided the necessary background to frame the research portion of this thesis. The source of the data to be used as well as potential problems due to its lack of comprehensiveness have also been discussed, with the conclusion that enough of the data remains for accurate conclusions to be made. The analysis being undertaken in this thesis follows somewhat of a new approach in rune-stone research, the PCA having only been previously used in the work of Kitzler (2002 (1)) and an NBC never previously attempted. It is hoped that this logical conclusion of the statistical and analytical approach to archaeology (Clarke, 1978) will provide both useful tools for the field of archaeology, and useful conclusions for the field of rune-stone research.

CHAPTER FIVE
TEMPORAL DIFFERENTIATION

With only 60% of the rune-stone corpus dated and no approach in place to bridge this gap, this area was identified as one which data analysis could offer a contribution. The aim of these tests is not to discredit Gräslund's stylistic dating system, rather to offer an alternative based on spatial distribution that may be able to date the rest of the rune-stones.

When running an NBC, the accuracy of the data is first examined through a 'ten-fold cross-validation', in which ten 'tests' of the known data are run. In these, a proportion of the 'known' data is selected to train the classifier and the remaining data is used to test the classifier. The classifier will then use all of the 'known' data to infer the probability of each 'unknown' rune-stone belonging to each class. Figure 5.1 illustrates the process undertaken in running the NBC.

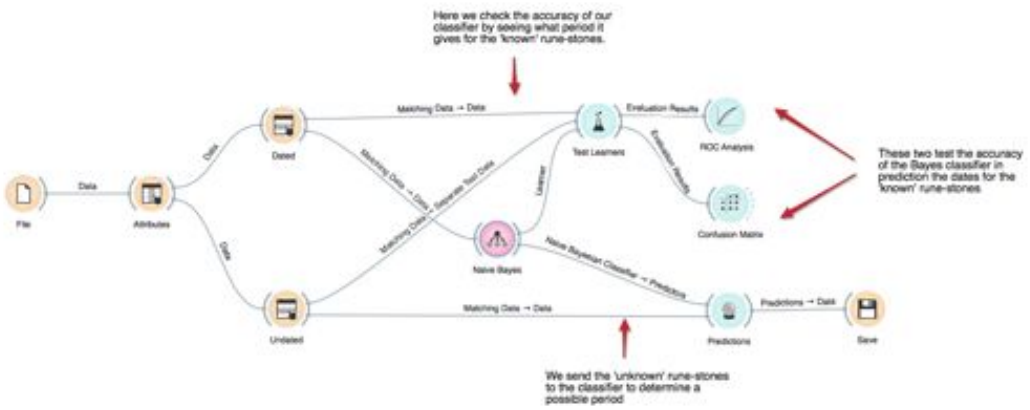


Figure 5.1 Visual representation of the Naïve Bayes Classifier generated by Orange

Three tests will be attempted; the first will use Lager's (2002) cross features, the second will use the inscription text, and the third will use all of the attributes gathered together in the dataset. Additionally, the third test will explore whether

the combination of the Svea and Göta rune-stones forces a skew in the data, and will therefore be run twice more with this regional separation.

CONFUSION MATRIX

The first way in which the accuracy of the classifier is tested is the confusion matrix, which displays the overall number of correct and incorrect classifications. If the classifier is able to predict the class of the 'known' data to a high degree of accuracy (e.g. 480 out of 500 instances), then the final results of the classifier can be considered valid. Figure 5.2 shows an example confusion matrix.

		Predicted Class		
		Class 1	Class 2	Class 3
Actual Class	Class 1	*n11*	*n12*	*n13*
	Class 2	*n21*	*n22*	*n23*
	Class 3	*n31*	*n32*	*n33*

Figure 5.2 Example Confusion Matrix

In this example, the data in cells *n11, n22,* and *n33* shows correct classifications. Cells *n12* and *n13* are the items in Class 1 that were miss-classified as Class 2 and Class 3 respectively.

ROC CURVE

The second evaluation of the classifier's accuracy is an ROC Curve. One of these is produced for every individual class within the classifier, displaying visually the accuracy of the classifier in predicting the 'known' data. The X-axis represents false positives, the Y-axis true positives, and the data is reproduced as a curve made up of points along these axes. Figure 5.3 shows a comparison of how the shape of different ROC Curves indicate accuracy, or a lack thereof.

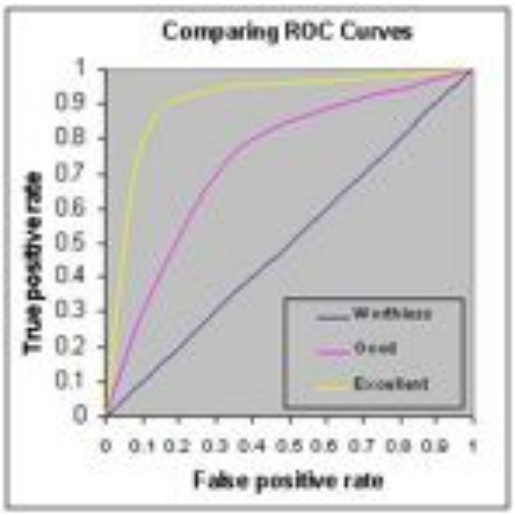


Figure 5.3 Comparison of ROC Curves (Tape)

PREDICTIONS

The final output of a Bayes Classifier is a prediction spreadsheet, showing as a percentage the likelihood of each of the 'unknowns' belonging to each of the classes, along with a final decision on the most likely class of the item. This data is only as accurate as the classifier, and so can only be considered as useful if both the Confusion Matrix and ROC Curves indicate a certain degree of accuracy.

TEST 1 – TEMPORAL DIFFERENTIATION IN CROSS FEATURES

This test has been designed to assess whether the combinations of cross features that make up a single cross can be used to assign a date-range for the rune-stone. Each rune-stone is given an identifier, based on Lager's classification system (2002 – Appendix C). Lager identified some temporal differentiation based on Gräslund's dating in some individual cross features (*ibid*:103), but did not attempt a larger or contextual study of these difference.

In order to run the NBC, Lager's system needed to be converted into a system more easily readable. This data is given in a combined format in *Rundata* whereby all evident cross features are presented, and this cannot be understood by the classifier. The cross features were therefore decomposed into a system in which every rune-stone with a cross was assigned a value of in the range of 0 (where a feature was non-existent)– 4 (evident in only three stones, all of which

had multiple crosses) for all of the features (Figure 5.1.1). Single crosses are the most common, though those with multiple crosses do occur.

Figure 5.1.1 U 489, The Morby Stone, dated to PR4 and therefore the Late period (Lundberg, 1985)

The rune-stone above is designated in *Rundata* as U 489, otherwise known as the Morby Stone. Its cross is presented as A1;B3;C8;C9;D1;F3. In the system developed for these tests, the runic cross is presented as below.

A1	A2	A3	A4	A5	A6	A7	A8	A9	B1	B2
1	0	0	0	0	0	0	0	0	0	0
B3	B4	C1	C2	C3	C4	C5	C6	C7	C8	C9
1	0	0	0	0	0	0	0	0	1	1
C10	C11	D1	D2	D3	D4	D5	D6	E1	E2	E3
0	0	1	0	0	0	0	0	0	0	0
E4	E5	E6	E7	E8	E9	E10	E11	F1	F2	F3
0	0	0	0	0	0	0	0	0	0	1
		F4	G1	G2	G3	G4	G4	G6		
		0	0	0	0	0	0	0		

PART 1 – CROSS FEATURES & GRÄSLUND'S DATING

At present, 76% of the 992 rune-stones with crosses on them have been dated based on Gräslund's system, leaving 24%, or 235 stones, undated (Figure 5.1.2).

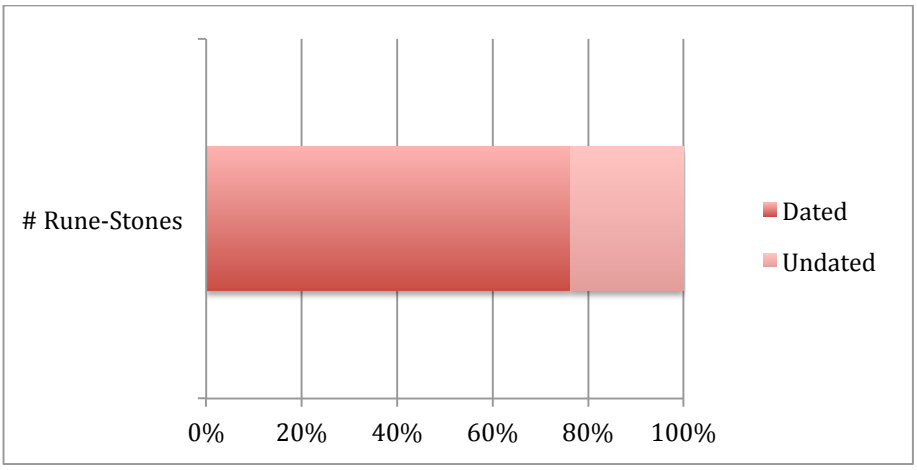


Figure 5.1.2 Percentage of dated vs. undated rune-stones

The results of the ten-fold cross-validation do not give a significant enough distinction between the rune-stones with crosses to link dates to those without. The confusion matrix (Figure 5.1.3) shows us that PR1 and PR5 in particular are not predicted with any accuracy. PR4, however, is predicted with 62% accuracy.

	FP	KB	PR1	PR2	PR3	PR4	PR5	RAK	
FP	42	0	7	4	18	15	0	34	120
KB	1	21	0	1	2	3	0	1	29
PR1	8	0	0	5	10	7	1	17	48
PR2	17	1	2	17	16	22	0	15	90
PR3	8	2	5	13	36	33	1	14	112
PR4	5	1	1	2	22	148	7	19	205
PR5	2	0	1	0	0	14	2	7	26
RAK	10	2	4	5	9	21	2	74	127
	93	27	20	47	113	263	13	181	757

Figure 5.1.3 Confusion Matrix showing prediction accuracy

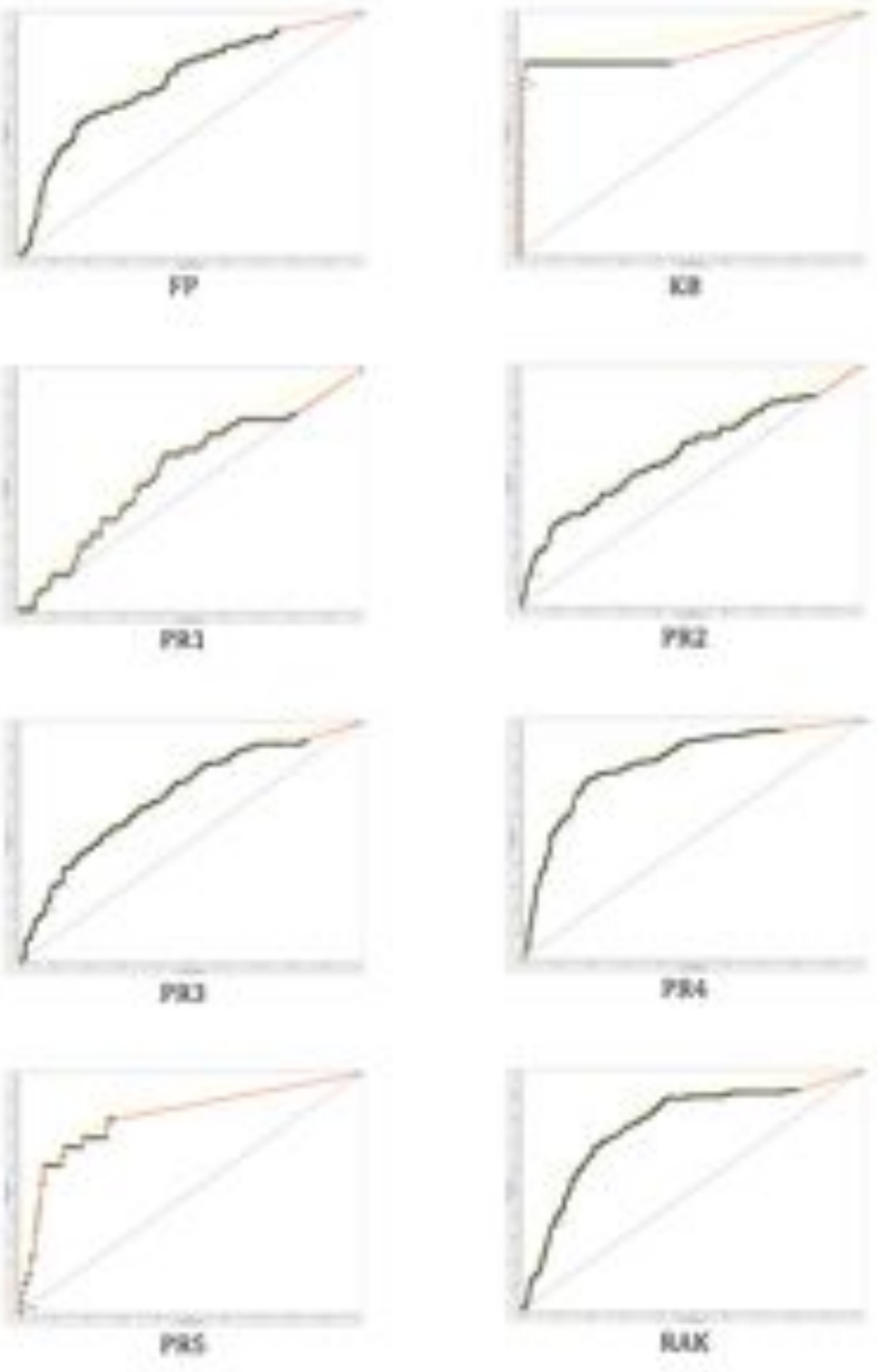


Figure 5.1.4 ROC Curves showing prediction accuracy

The results given above indicate that there is not a high level of accuracy in the predictions given by the classifier. While the ROC curves (Figure 5.1.4) for PR4 and RAK look to be better than the others, they are nowhere close to being excellent. The curves given for KB and PR5 do not display the smoothness of the others, indicating that the sample size is too small to be accurate. Based on these results, the predictions given for the un-dated rune-stones (see Appendix G) cannot be considered accurate.

PART 2 – CROSS FEATURES & SPATIAL DATING

Of the 992 rune-stones with crosses 75% have been dated, leaving 248 rune-stones undated (Figure 5.1.5).

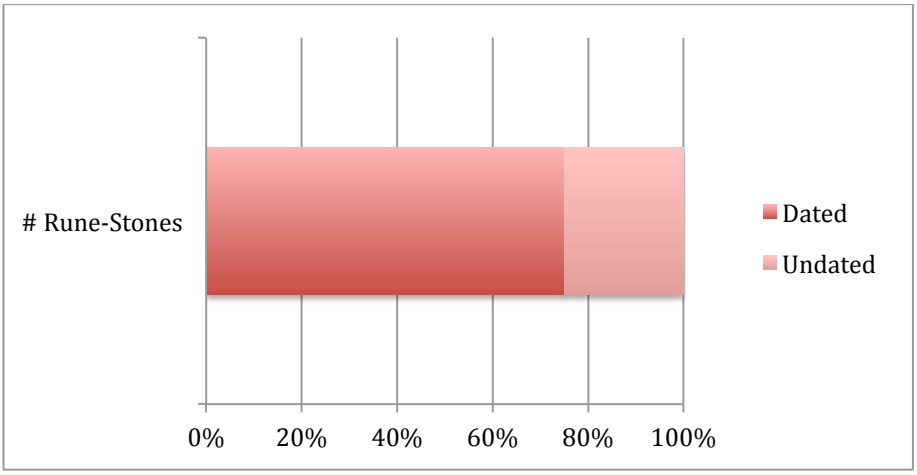


Figure 5.1.5 Percentage of dated vs. undated rune-stones

The results of the predictions given by the confusion matrix (Figure 5.1.6) are a little more accurate than those from the previous test, but they are still not ideal. M1 and L have been predicted with more accuracy than E and M2.

	1 - E	2 - M1	3 - M2	4 - L	
1 - E	57	34	12	24	127
2 - M1	50	142	29	51	272
3 - M2	11	34	35	32	112
4 - L	23	19	21	170	233
	141	229	97	277	744

Figure 5.1.6 Confusion Matrix showing prediction accuracy

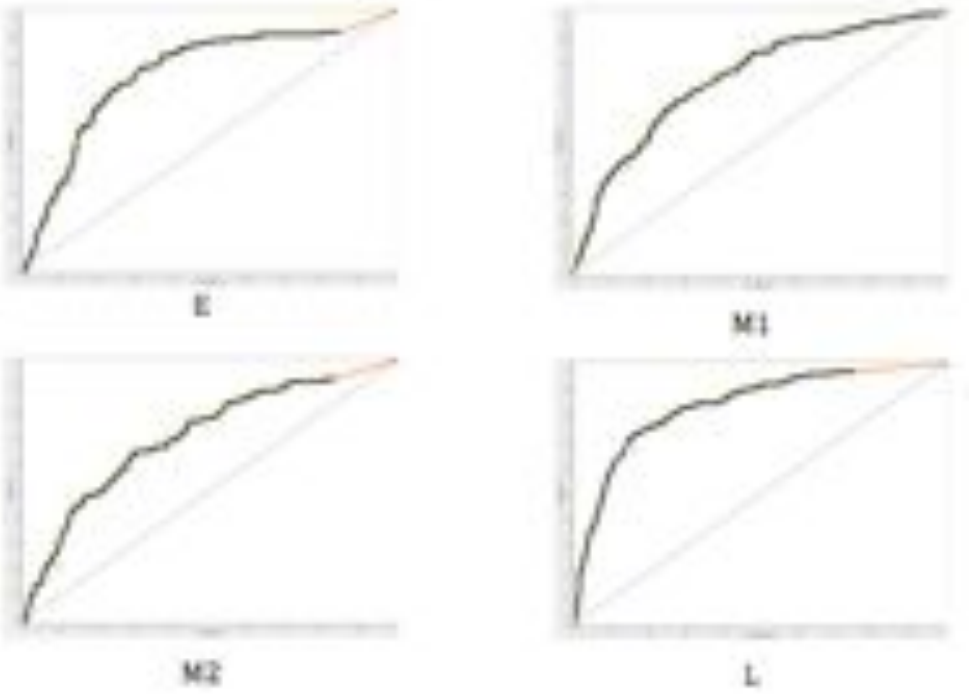


Figure 5.1.7 ROC Curves showing prediction accuracy

The ROC curves (Figure 5.1.7) reveal that E and L seem to be more reliable date-ranges for the classifier, though there are no big differences between the four. The results are still not overwhelmingly accurate, and therefore the predicted classes again cannot be considered reliable (see Appendix H).

TEST 2 – TEMPORAL DIFFERENTIATION IN INSCRIPTION TEXT

This test is intended to assess if the combinations of words in the inscriptions on the rune-stones, can in any way provide a date for the rune-stones. As the inscriptions are in the runic alphabet, the data used had been transliterated into Latin script, without any translation into modern Swedish. As was done with the cross features, every rune-stone is assigned a value relating to every word in the corpus, most commonly ranging from 0-4. As discussed in previous chapters, work attempting to explore temporal differentiation in the occurrence of individual characters has been unsuccessful, but work integrating the entire inscription of a rune-stone has not been done.

The first aim of these tests is to identify whether the inscription text is at all related to the dates given to them (both stylistic and spatial), and the second, if the first test is successful, is to assign dates to those rune-stones that remain undated. Only 268 rune-stones do not have inscription text, making this test fairly comprehensive.

PART 1 – INSCRIPTION TEXT & GRÄSLUND'S DATING

Part 1 of this test uses the dates assigned by Gräslund's stylistic system to the rune-stones with inscriptions recorded. At present, 66% of the 2129 rune-stones with inscriptions recorded on them have been dated based on this system, leaving 34%, or 730 stones, undated (Figure 5.2.1).

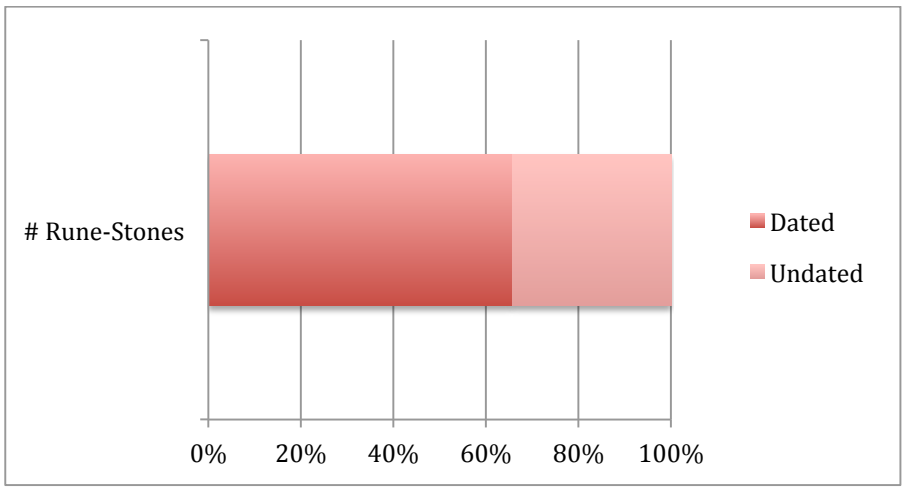


Figure 5.2.1 Percentage of dated vs. undated rune-stones

The results of the ten-fold cross-validation do not show significant accuracy. KB, PR1, and PR5 in particular show very little reliability, with their rune-stones being predicted more often as belonging to an entirely different class than to the correct one. The confusion matrix (Figure 5.2.2) shows that PR4 and RAK are predicted with some degree of accuracy, but neither break 60%.

	FP	KB	PR1	PR2	PR3	PR4	PR5	RAK	
FP	40	18	8	19	15	32	4	56	192
KB	4	3	1	2	5	7	0	10	32
PR1	9	10	4	4	4	11	2	24	68
PR2	17	19	4	18	23	34	4	27	146
PR3	12	19	4	22	49	69	4	31	210
PR4	13	38	7	30	38	184	21	35	366
PR5	1	6	0	3	4	38	3	4	59
RAK	30	16	11	25	14	39	6	185	326
	126	129	39	123	152	414	44	372	1399

Figure 5.2.2 Confusion matrix showing prediction accuracy

The ROC curves (Figure 5.2.3) re-iterate what has been seen in the confusion matrix. This indicates that the inscription text shows very little correlation with Gräslund's stylistic dating, and therefore that the predictions output by the classifier are unlikely to be at all reliable.

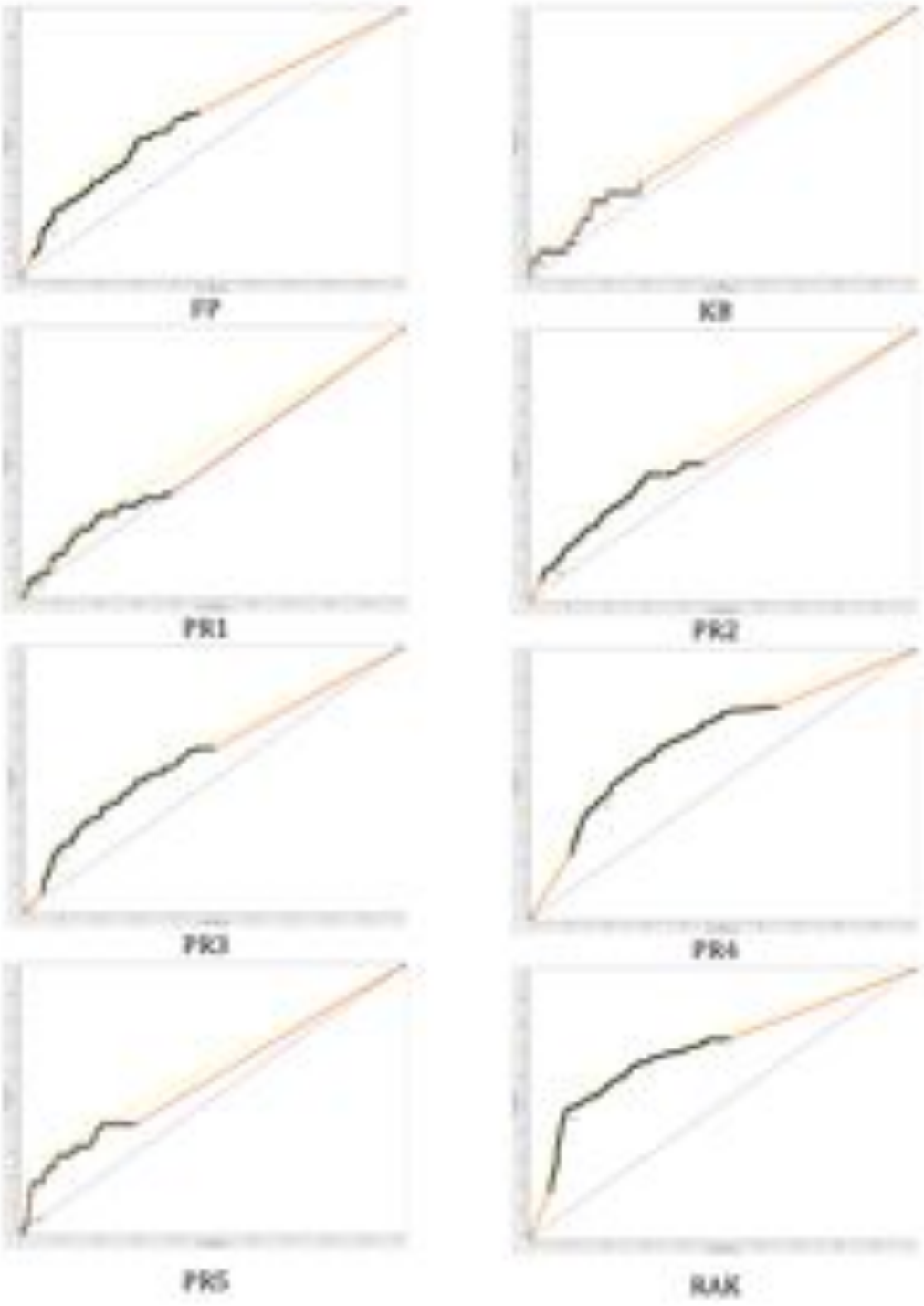


Figure 5.2.3 ROC Curves showing prediction accuracy

PART 2 – INSCRIPTION TEXT & PERIODIC DATING

In this test, of the 2129 rune-stones that have inscriptions recorded 66% have been dated, leaving 724 rune-stones undated (Figure 5.2.4)

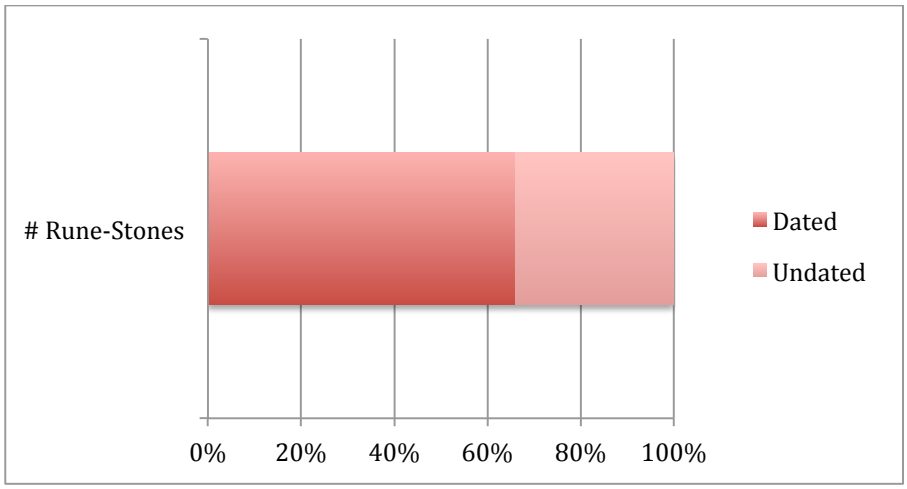


Figure 5.2.4 Percentage of dated vs. undated rune-stones

	1 - E	2 - M1	3 - M2	4 - L	
1 - E	170	91	18	47	326
2 - M1	123	171	45	95	434
3 - M2	22	61	52	75	210
4 - L	44	77	48	266	435
	359	400	163	483	1405

Figure 5.2.5 Confusion Matrix showing prediction accuracy

The results of the confusion matrix (Figure 5.2.5) are across the board somewhat more accurate than those seen in the previous test, and there are no major weaknesses, though the results hover between 30% and 50% accuracy. The ROC curves (Figure 5.2.6) indicate a similar trend, that the predictions have a very low degree of accuracy. Again, the predictions output by the classifier cannot be considered to be at all accurate.

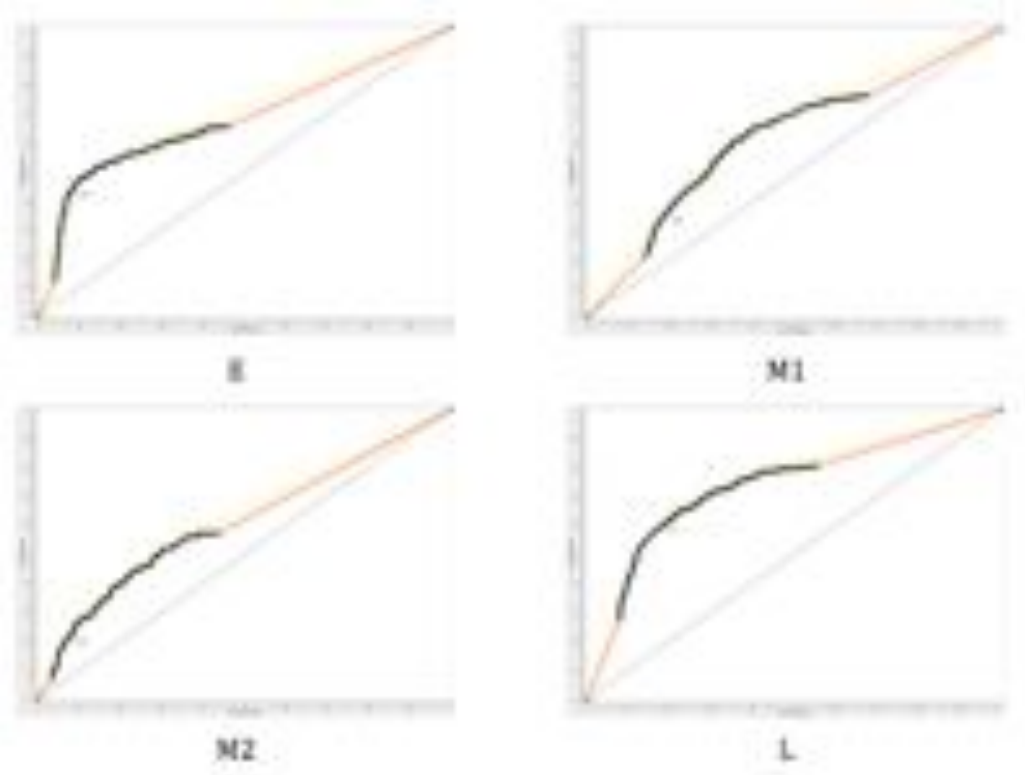


Figure 5.2.6 ROC Curves showing prediction accuracy

TEST 3 – TEMPORAL DIFFERENTIATION IN ALL FEATURES

This set of tests is intended to assess whether including all recorded features of the rune-stones can allow any more accuracy in predicting dates. The cross features and inscription data were both used, along with more data relating to stylistic features and distances from the *ting*-sites discussed in previous chapters.

Chapter Six explores regional differences in the rune-stones, and so it was hypothesized that that significant regional differentiation could skew the results. Therefore, these tests were also run in a regional set, first with of the rune-stones, then with the rune-stones from the Svea and Götar provinces separated. All 2397 of the rune-stones in the database were incorporated.

PART 1 – ALL FEATURES & GRÄSLUND'S DATING

The first part of these tests uses Gräslund's dates on all of the rune-stones, which can be applied to around 58% of the rune-stones (Figure 5.3.1). There are slightly more Svea than Göta rune-stones dated (Figures 5.3.2 and 5.3.3 respectively), which is to be expected given that this stylistic dating system was based on the Uppland rune-stones (Gräslund, 2006: 117). There are significantly fewer rune-stones in Götaland (686) than in Svealand (1648).

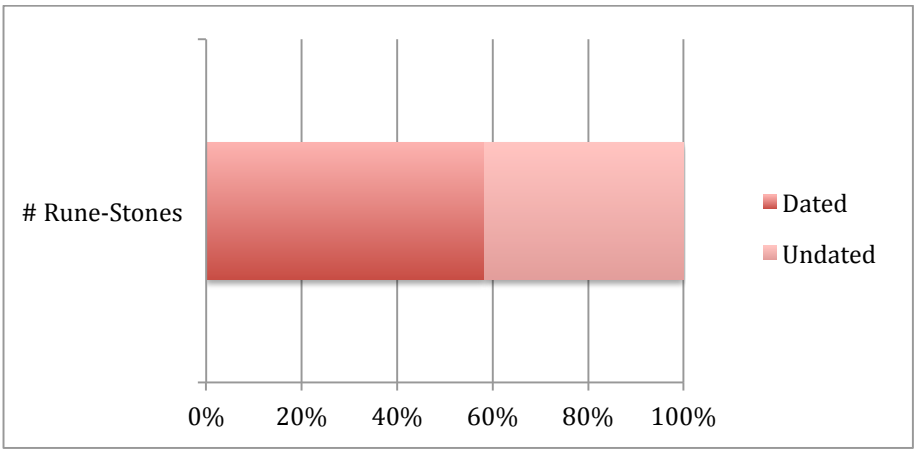


Figure 5.3.1 Percentage of all 2397 rune-stones dated

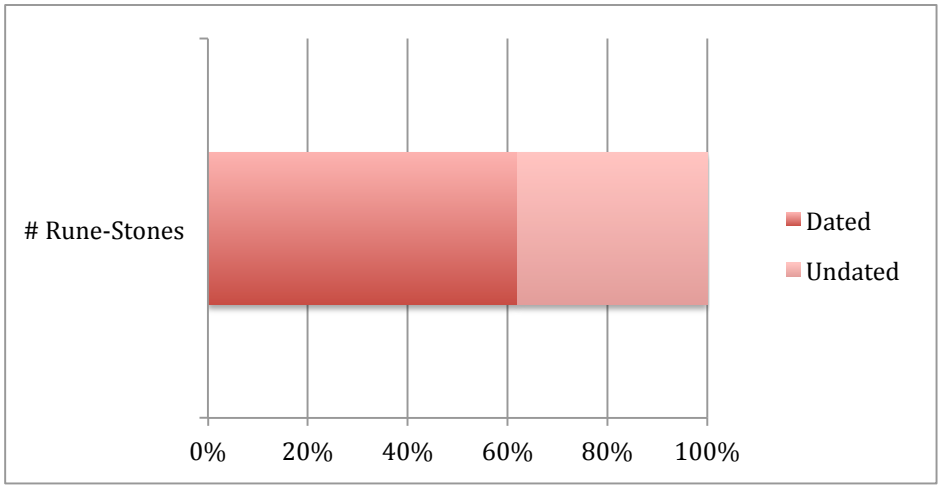


Figure 5.3.2 Percentage of Svea rune-stones dated

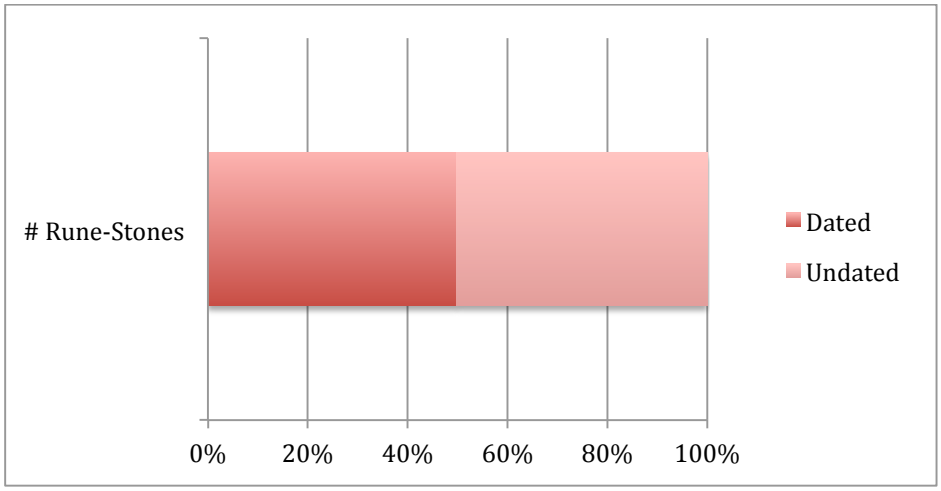


Figure 5.3.3 Percentage of Göta rune-stones dated

The ten-fold cross-validations of the prediction accuracy is not consistent across all three sets of data; 39% of all rune-stones, 34% of the Svea rune-stones, and 62% of the Göta rune-stones were predicted accurately. In the confusion matrix incorporating all of the rune-stones (Figure 5.3.4), it can be seen that the rune-stones that are predicted incorrectly are found to be fairly consistent; especially in PR1 and PR2 there are around as many rune-stones predicted incorrectly in each date range as there are in the correct date-range. This indicates that in these classes there are very few features that provide an accurate classification. The Svea rune-stones are predicted very similarly (Figure 5.3.5)

It can be seen in the Göta rune-stones (Figure 5.3.6) that around 75% of the rune-stones belonged to a single period, that of RAK, the earliest of the date-ranges (from c. 990-1010). This mimics an earlier observation that the Göta rune-stones were likely erected earlier than the Svea (Lager, 2010:501). It is likely that RAK possesses fairly definitive characteristics, as 75% of these rune-stones were predicted correctly.

	FP	KB	PR1	PR2	PR3	PR4	PR5	RAK	
FP	57	9	3	25	18	27	2	51	192
KB	1	7	0	2	3	6	0	13	32
PR1	12	7	6	8	5	14	0	16	68
PR2	16	18	4	21	32	29	2	24	146
PR3	14	14	3	15	52	62	6	44	210
PR4	5	35	7	20	42	188	17	52	366
PR5	0	4	0	3	4	30	7	11	59
RAK	27	10	8	11	21	38	6	205	326
	132	104	31	105	177	394	40	416	1399

Figure 5.3.4 Confusion matrix for all rune-stones

	FP	KB	PR1	PR2	PR3	PR4	PR5	RAK	
FP	48	18	4	14	10	35	7	3	139
KB	1	8	0	2	4	11	3	0	29
PR1	7	10	5	6	4	17	2	5	56
PR2	12	16	3	14	29	42	3	2	121
PR3	17	16	3	24	48	66	10	0	184
PR4	13	41	4	20	34	199	33	5	349
PR5	0	3	0	3	3	38	10	1	58
RAK	11	13	7	7	4	18	7	19	86
	109	125	26	90	136	426	75	35	1022

Figure 5.3.5 Confusion Matrix for the Svea rune-stones

	FP	KB	PR1	PR2	PR3	PR4	PR5	RAK	
FP	12	0	0	1	3	0	3	33	52
KB	1	0	0	0	0	0	1	1	3
PR1	2	0	1	0	0	0	1	5	9
PR2	2	0	0	1	0	1	1	7	12
PR3	7	0	0	2	2	0	1	12	24
PR4	1	0	0	0	5	1	1	6	14
PR5	0	0	0	0	0	0	0	1	1
RAK	11	0	1	0	10	1	11	198	232
	36	0	2	4	20	3	19	263	347

Figure 5.3.6 Confusion Matrix for the Göta rune-stones

The ROC curves (Figures 5.3.7, 5.3.8 and 5.3.9) also show a relative lack of accuracy. It can be seen that the curves representing the Göta rune-stones are particularly staggered, showing the relatively small sample size. With these small numbers the classifier cannot be run reliably. Overall the lack of accuracy in predicting the classes of the known rune-stones suggests that including all of the features assigns no more accuracy, at least for Gräslund's dating.

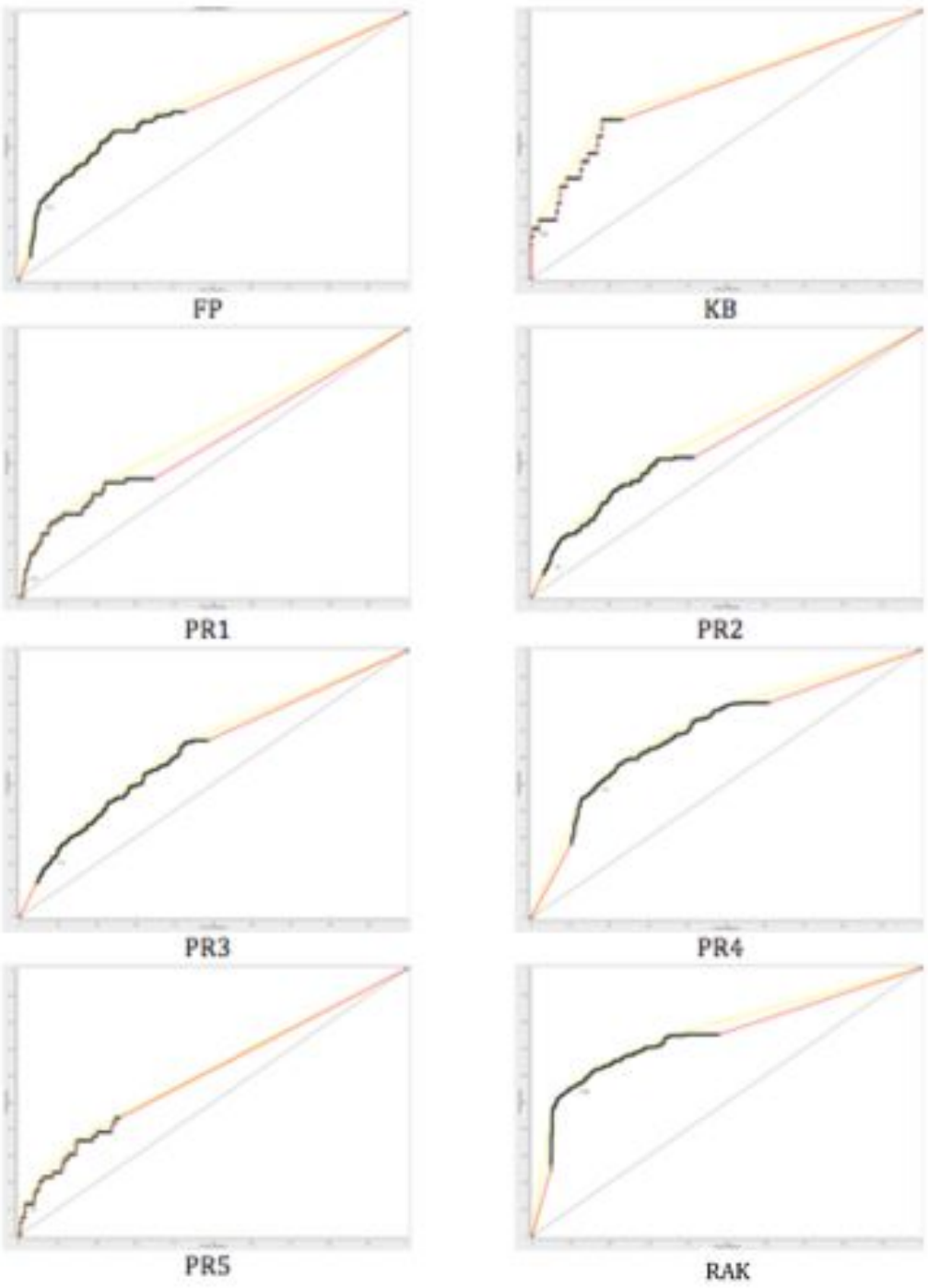


Figure 5.3.7 ROC Curves for all rune-stones

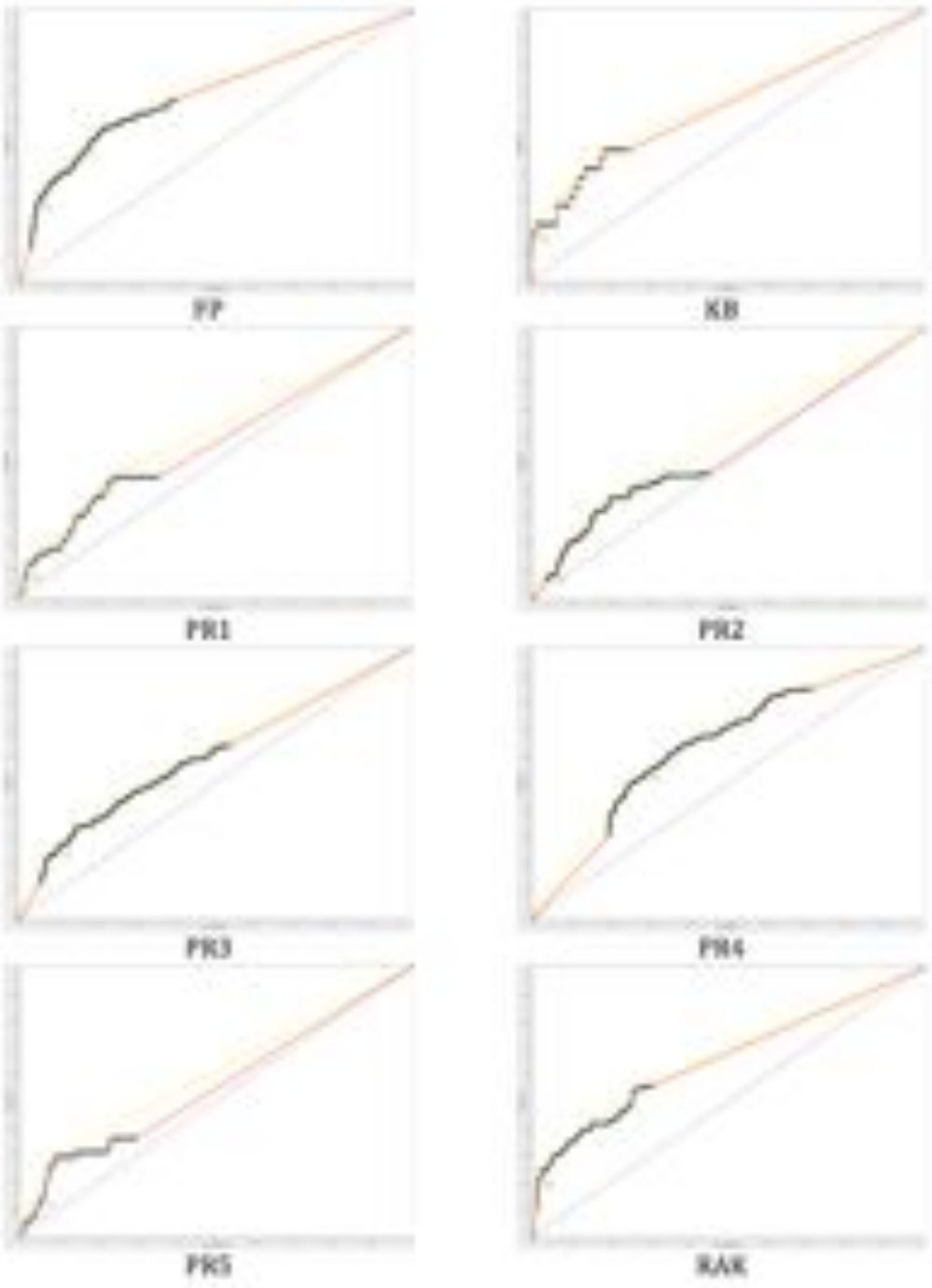


Figure 5.3.8 ROC Curves for the Svea rune-stones

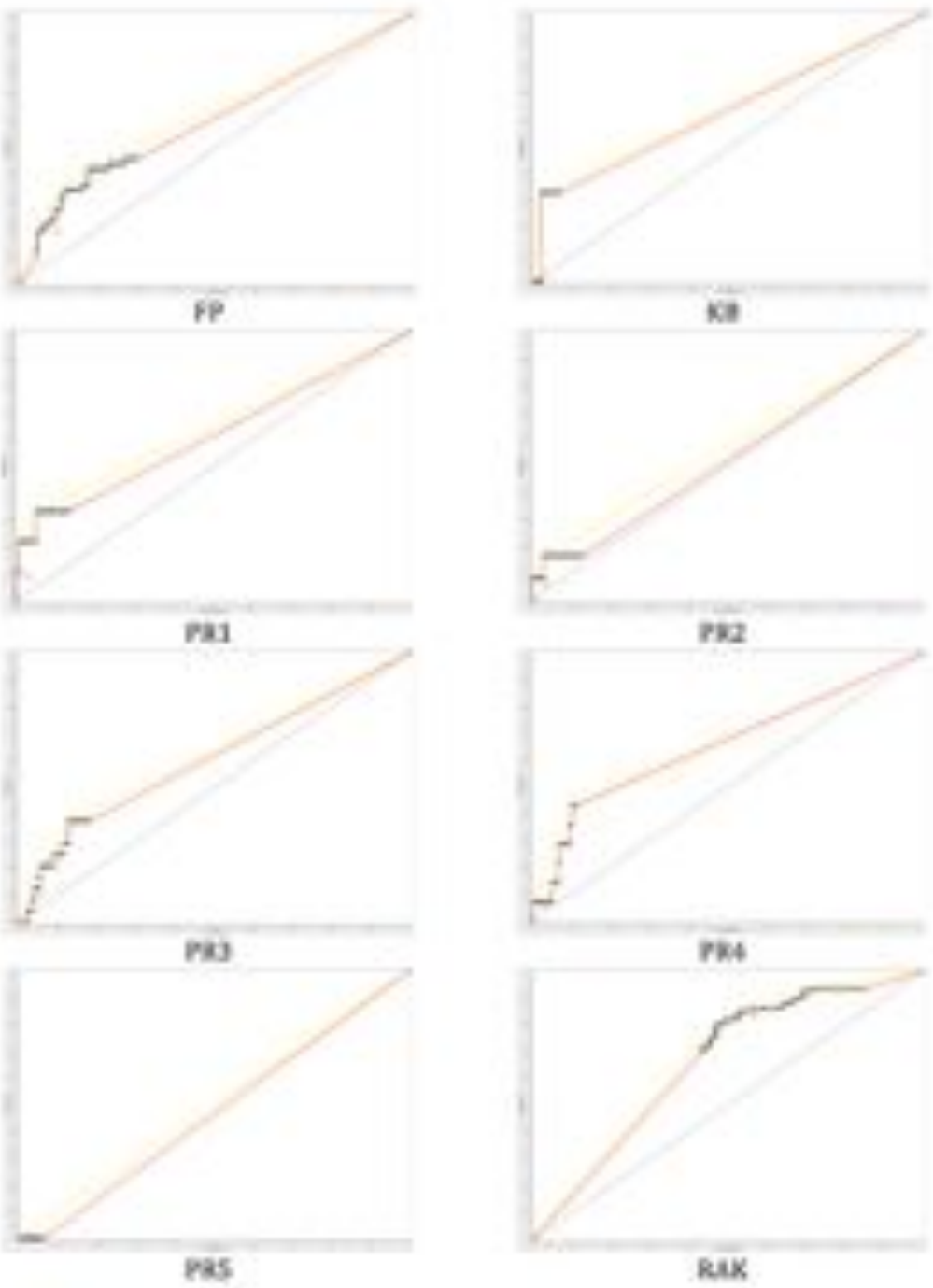


Figure 5.3.9 ROC Curves for the Göta rune-stones

PART 2 – ALL FEATURES & SPATIAL DATING

The percentages of dated vs. undated rune-stones in this test are quite similar to the previous – the test including all of the rune-stones has around 58% dated (Figure 5.3.10), the Svea rune-stones have over 60% dated (Figure 5.3.11), and the Göta rune-stones sit at around 50% dated (Figure 5.3.12).

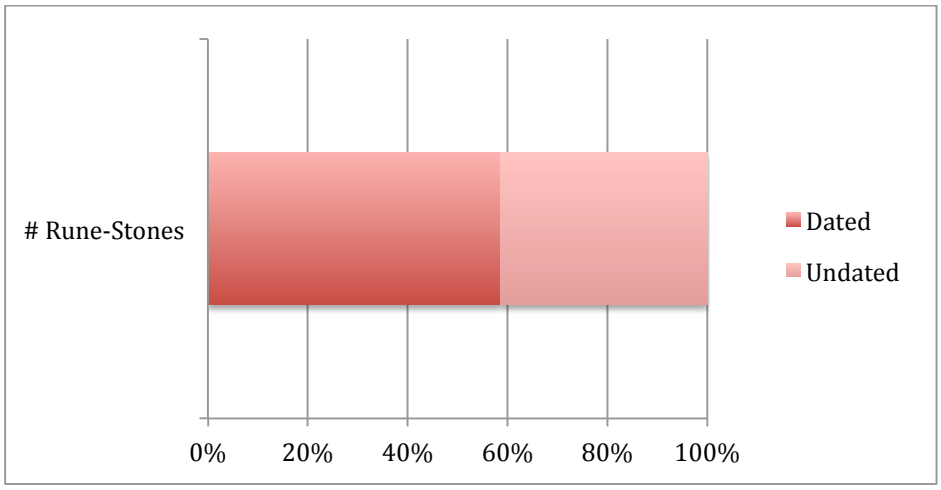


Figure 5.3.10 Percentage of all dated rune-stones

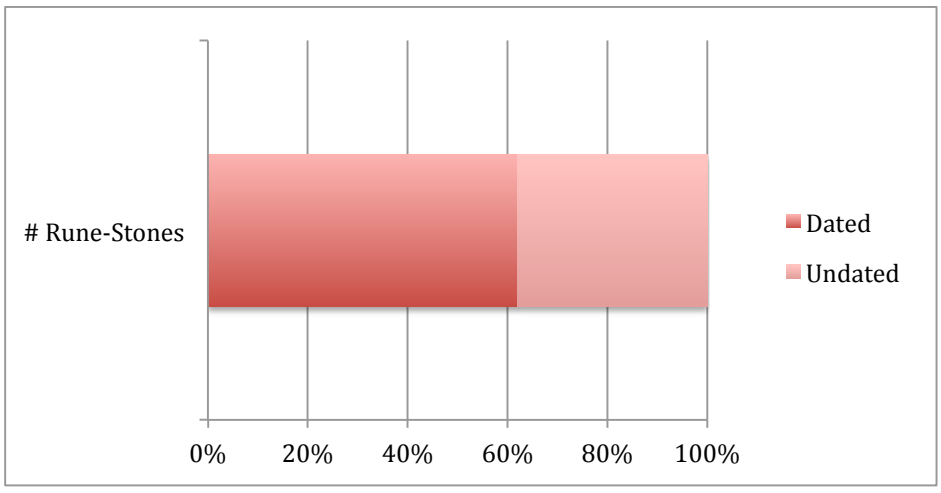


Figure 5.3.11 Percentage of dated Svea rune-stones

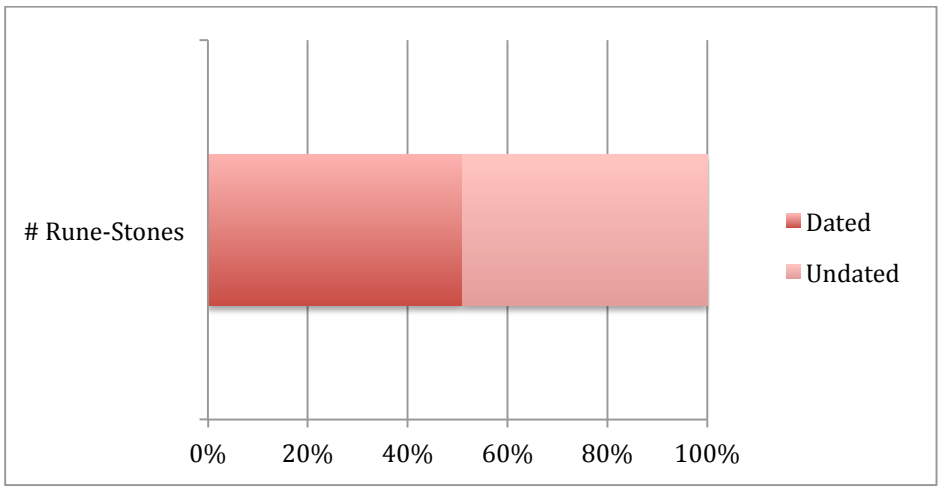


Figure 5.3.12 Percentage of dated Göta rune-stones

The confusion matrices are again not consistent across all three sets of data, but show more accuracy than those dated in Gräslund's system. The overall accuracy sits at around 51% (Figure 5.3.13), with L predicted with the most accuracy across the first two datasets, and M2 the lowest. The Svea rune-stones are also predicted with 51% accuracy (5.3.14), and the Göta rune-stones are higher, with 62.5% (5.3.15). As seen previously, the Göta rune-stones are again predicted with more accuracy in the earlier classes, with the E period (encompassing the RAK style) predicted to 76% accuracy.

	1 - E	2 - M1	3 - M2	4 - L	
1 - E	192	86	15	33	326
2 - M1	98	205	52	79	434
3 - M2	32	59	50	69	210
4 - L	54	67	40	274	435
	376	417	157	455	1405

Figure 5.3.13 Confusion Matrix for all rune-stones

	1 - E	2 - M1	3 - M2	4 - L	
1 - E	18	38	5	25	86
2 - M1	19	168	37	111	335
3 - M2	1	60	49	74	184
4 - L	9	78	38	292	417
	47	344	129	502	1022

Figure 5.3.14 Confusion Matrix for the Svea rune-stones

	1 - E	2 - M1	3 - M2	4 - L	
1 - E	189	22	16	5	232
2 - M1	44	24	7	6	81
3 - M2	12	5	4	3	24
4 - L	4	3	5	3	15
	249	54	32	17	352

Figure 5.3.15 Confusion Matrix for the Göta rune-stones

The ROC curves mimic these results – all curves for all of the rune-stones (Figure 5.3.16) and the Svea-only rune-stones (Figure 5.3.17) are not particularly useful, and most of the Göta-only curves have too small a sample to be accurate (Figure 5.3.18).

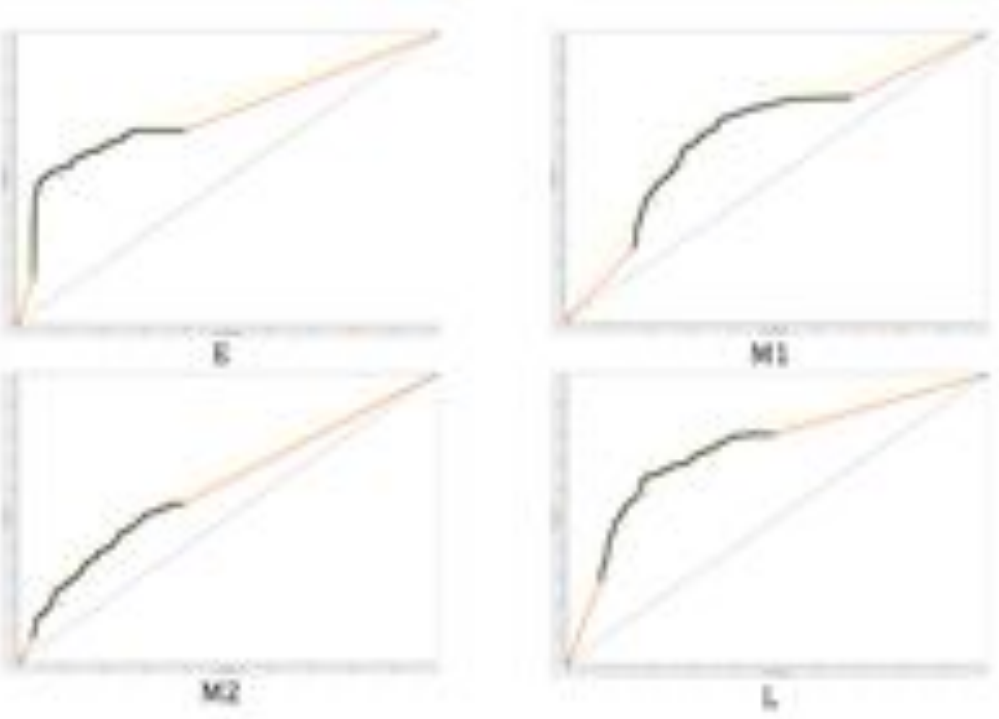


Figure 5.3.16 ROC Curves for all rune-stones

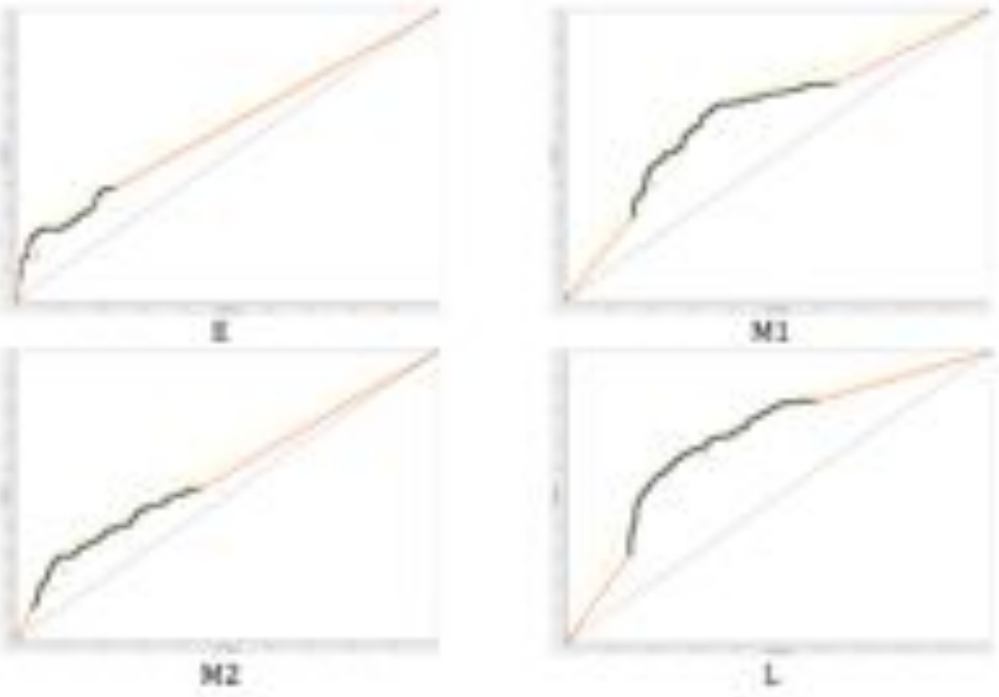


Figure 5.3.17 ROC Curves for the Svea rune-stones

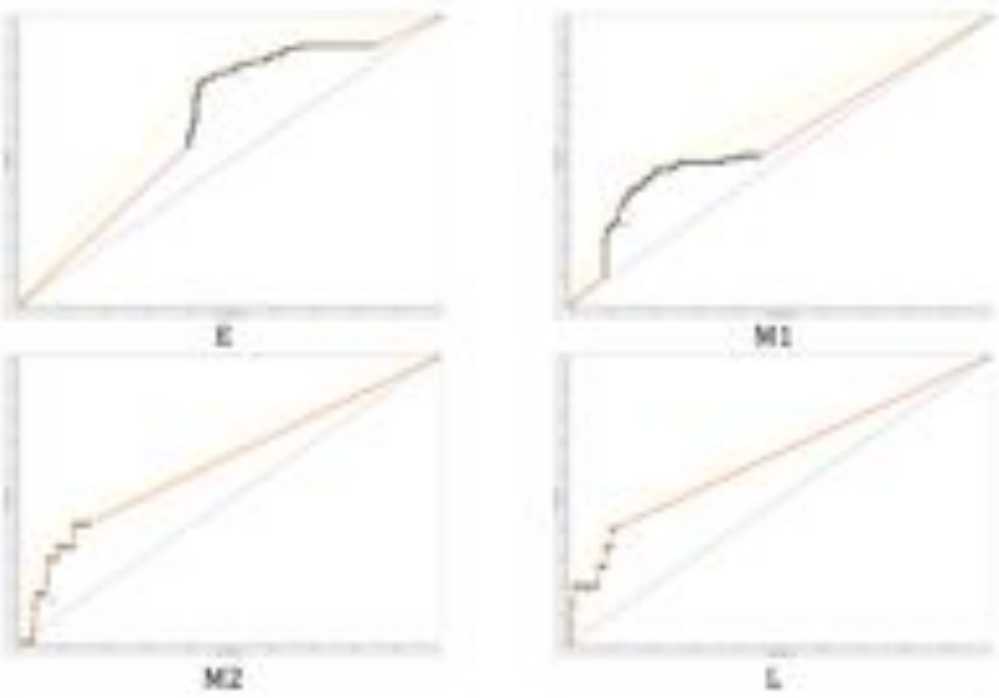


Figure 5.3.18 ROC Curves for the Göta rune-stones

SUMMARY

It is evident that the results of the tests show very little accuracy – instead of difference, homogeneity is indicated. Overall the 'period' dates are predicted with more accuracy than stylistic dates, but this is likely due to the simplification of the data from eight classes to four. They also include more rune-stones - two of the periods encompass more than one stylistic phase they therefore incorporate rune-stones that share this attribute which were left out of the stylistic calculations to ensure data integrity.

In the first test set two rune-stones are given predicted values of 1 indicating confidence that they belong to the period FP. These stones are Sö129 and U212, leading to even more doubt on the accuracy of the classifier; U212, one of the Jarlabanki stones (Figure 5.4), has been dated in Gräslund's system to PR2/PR3 but was excluded due to not belonging to a single stylistic date.

Figure 5.4 U212, dated to PR2/PR3 (Lundberg, 1985)

The second set of tests indicate that the inscriptions on the rune-stones cannot be used to assign dates to the un-dated corpus. A simple observation of one of the 'Christian' inscriptions, *dauðr i hvitaðum* (death in white cloth/clothes) (Williams, 2012:3) (Figure 5.5), re-enforces this; of the seven occurrences of this phrase, six rune-stones are dated, and these dates vary. Two are dated to PR3, one to PR3-PR4, another one to PR4, and the last two are tentatively dated to PR1 and PR4.

Figure 5.5 U613, bearing the phrase '*dauðr i hvitaðum'* (Lundberg, 1990)

The hypothesis for the final set of tests was that combining all attributes would create more accuracy than in previous iterations, as well as that the integration of the rune-stones from the two major regions of Sweden may skew the data. It was seen that overall the results did not become any more accurate with the separation of the data, suggesting that there may not be major differences between the rune-stones of Svealand and Götaland. The rune-stones may in fact be more homogenous than previously thought.

The results of this chapter's tests are somewhat the reverse of what was expected – it was thought that the NBC would be able to use the features provided to distinguish between rune-stones attributed to different dates, but the opposite was discovered - significant errors occurred when the classifier attempted to predict the dates of the pre-dated rune-stones. Overall, at least temporally, the rune-stones seem symptomatic of an overwhelming homogeneity.

CHAPTER SIX
REGIONALITY DIFFERENTIATION

One of the large gaps previously identified in the research is that in identifying regional trends. The general focus of current and past research is either on the entire corpus or on a single province, without consideration of the differences and similarities between the provinces. There has also been no significant or singular work dedicated to identifying difference patterns between the regions inhabited by the Svear and Götar, and this is the main focus of the following tests.

TEST 1 – REGIONALITY IN FIND-SPOTS

This test is designed to assess whether there are regional patterns evident in the find-spots of the rune-stones. The Principle Components Analysis is run by first selecting the rune-stones to be included (those with a find-spot), and then the attributes to be measured (the find-spots), with the result being a linear projection giving a visual representation of the data (see Figure 6.1.1).

Figure 6.1.1 Visual representation of the PCA generated by Orange

Originally each findspot was given a number (1-10), but for easy readability each rune-stone was assigned a value of 1 or 0 for each findspot (see below – VG 61 is located close to both a bridge and a roadside).

VG 61			
Countryside	0	River/Lake/Sea	0
Church	0	Bridge	1
Field	0	Roadside	1
Farm	0	Ancient Grave	0
Dump	0	Thing-Spot	0

The data in this set are not complete - around 1719 have locations associated. A number also have more than one find-spot attributed to them (Figure 6.1.2).

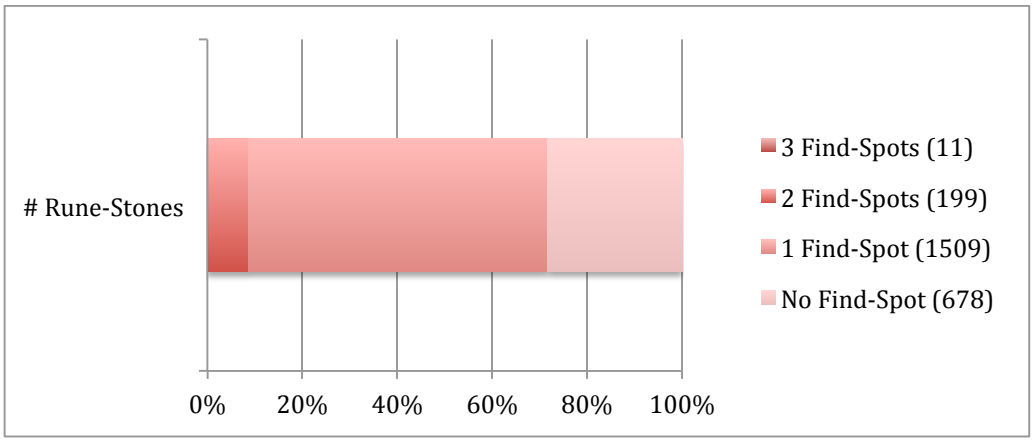


Figure 6.1.2 Number of find-spots associated with each rune-stone

The percentage of find-spots across the provinces is not consistent; in Västmanland 87% of the rune-stones have find-spots, whereas in Öland only 23% have find-spots represented. (Figures 6.1.3-6.1.5.) Each graph has a different scale due to differing overall numbers of stones.

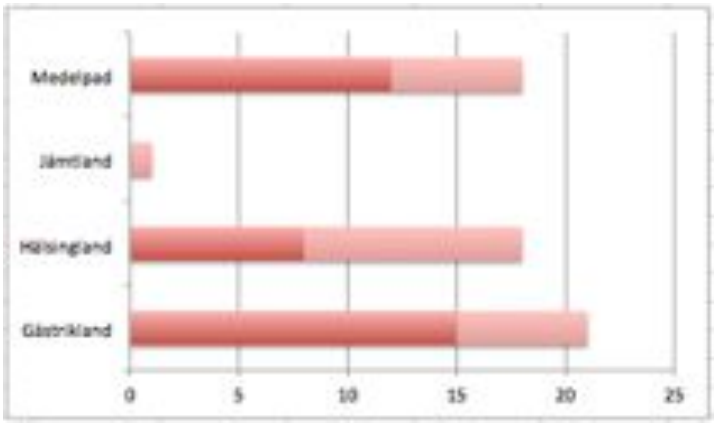


Figure 6.1.3 Norrland rune-stones with find-spots listed

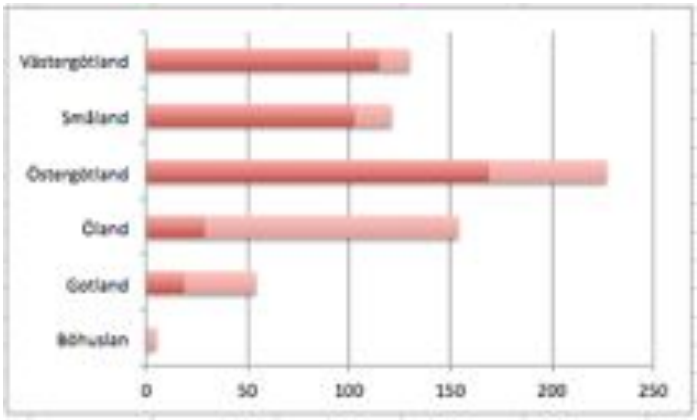


Figure 6.1.4 Götaland rune-stones with find-spots listed

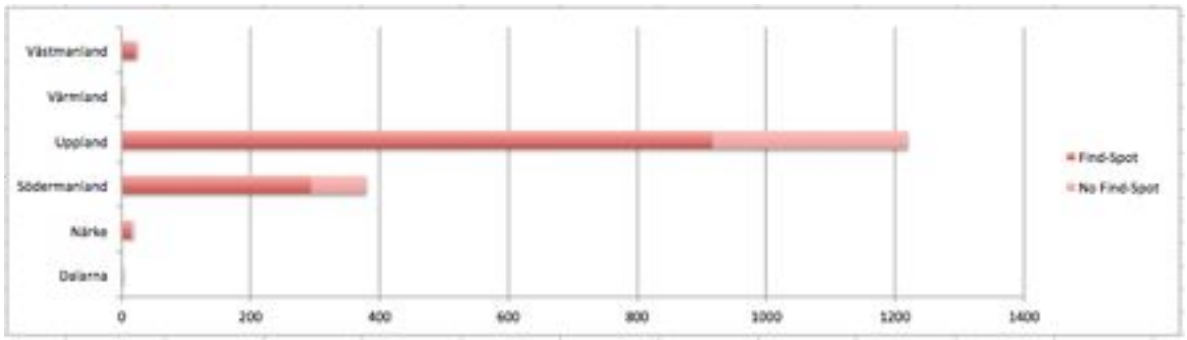


Figure 6.1.5 Svealand rune-stones with find-spots listed

PART 1 – FIND-SPOTS IN PROVINCES

Part 1 of this test explores differentiation in the find-spots of the rune-stones of different historical provinces. The spread of the rune-stones initially indicates that the spots Church and Roadside are the most common (Figure 6.1.6).

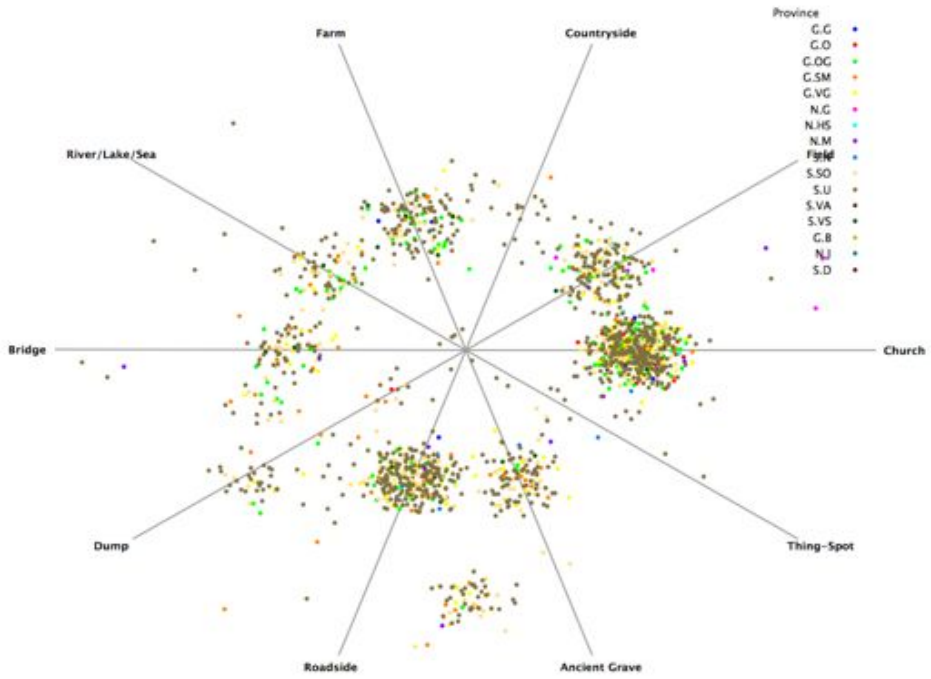


Figure 6.1.6 Spread of rune-stones before the PCA is run.

After the PCA is run (Figure 6.1.7), it can be seen that there is very little evidence of differentiation in the provinces, and that the clusters seem arbitrary rather than being linked to provinces.

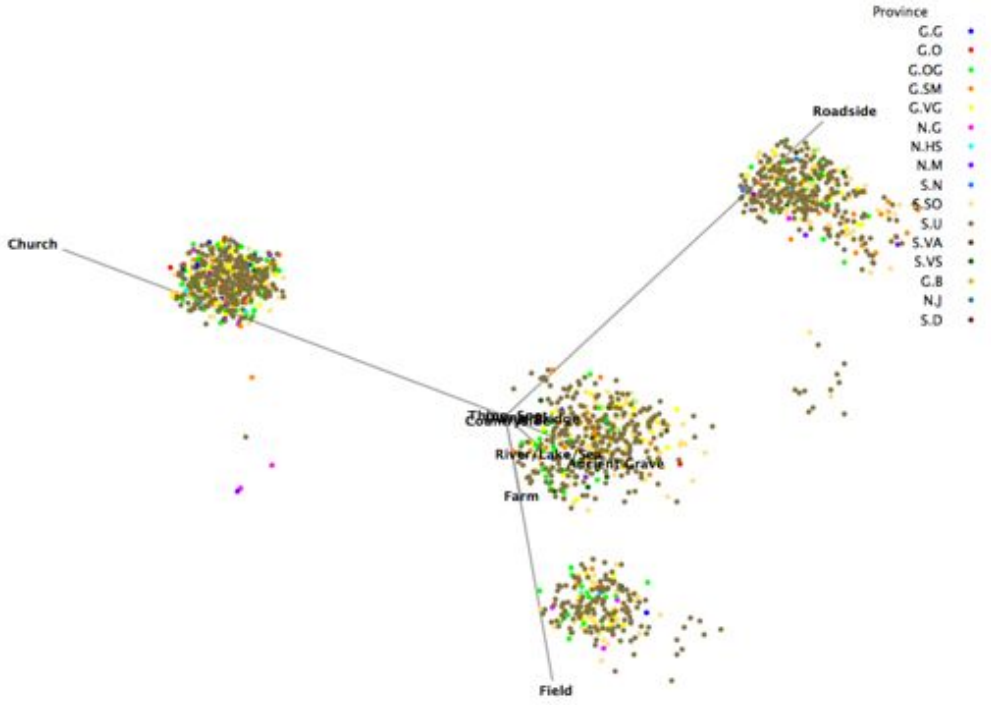


Figure 6.1.7 Spread of rune-stones after the PCA is run.

After the data are optimised (Figure 6.1.8), the single find-spot that is evident in only one province is revealed, that being 'Countryside' in Uppland.

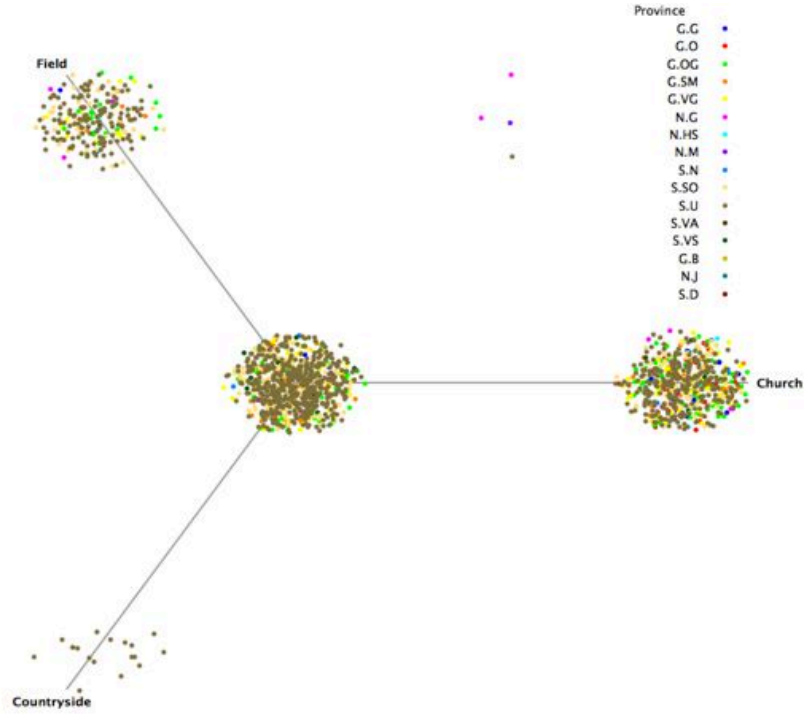


Figure 6.1.8 Optimization of the PCA data

In order to explore this further, the existence of each find-spot relative to region was reproduced in graph form (Figure 6.1.9). It can be noted that S.B, S. D, and N. J do not have have find-spots associated. As mentioned earlier, 'Countryside' is associated only with the Uppland region, something that likely points to inconsistencies in the data rather than the reality. It is very unlikely that there were no rune-stones located in the 'countrysides' of the other provinces, as farming was the primary focus of most settlements at the time (Graham-Campbell, 1994:58). Appendix I provides an outline of the statistical similarities between each of the provinces.

Province	G.B	G.G	G.OG	G.O	G.SM	G.VG	S.D	S.N	S.SO	S.U	S.VA	S.VS	N.G	N.HS	N.J	N.M
# Rune-Stones	5	54	227	154	121	130	2	19	380	1220	2	25	21	18	1	18
Ancient Grave																
Bridge																
Church																
Countryside																
Dump																
Farm																
Field																
River/Lake/Sea																
Roadside																
Thing-Spot																

Figure 6.1.9 Prevalence of find-spots in each province**.**

PART 2 – FIND-SPOTS IN REGIONS

Part 2 of this test explores differentiation in the find-spots of the rune-stones of different regions, Götaland, Svealand, and Norrland. After the data have been run through the PCA (Figure 6.1.10), one interesting trend is identified. While three of the clusters are visually very similar, the Church find-spot has many more Götaland rune-stones associated than the others. This can again be seen in the optimised projection (Figure 6.1.11), which also displays Countryside, one of the two find-spots that are only identified in Svealand - the other being *Ting*-Spot.

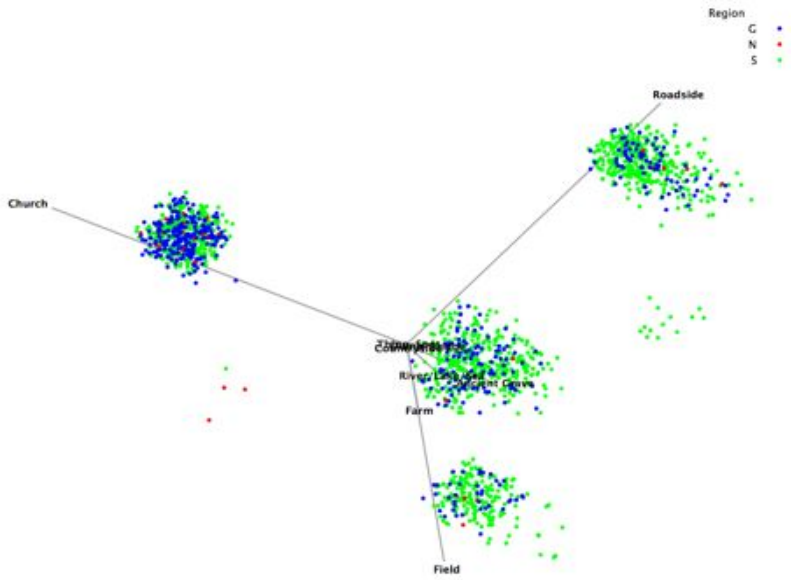


Figure 6.1.10 Spread of rune-stones after the PCA is run

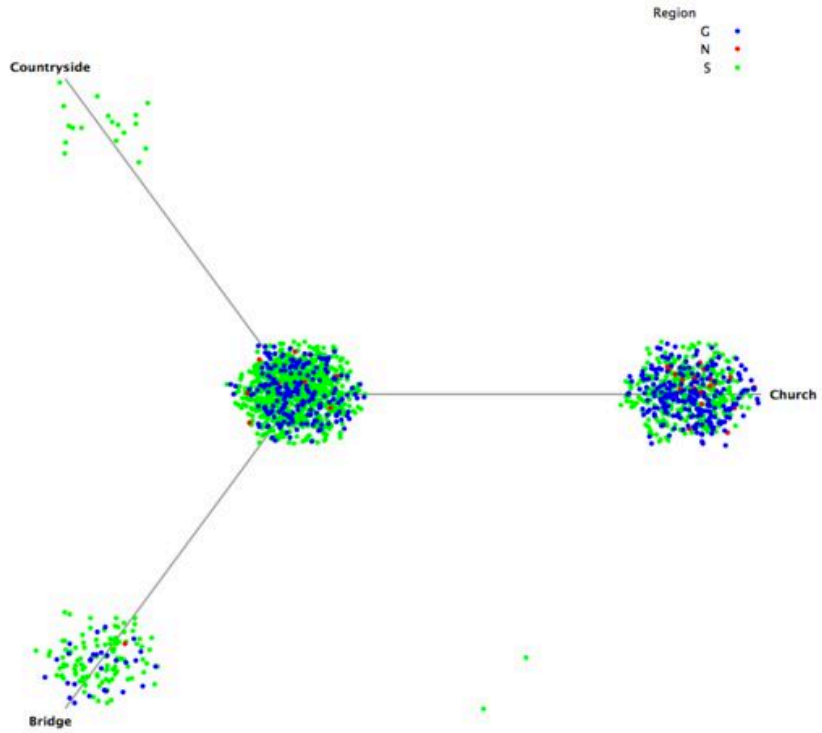


Figure 6.1.11 Optimisation of the PCA data

This data was again re-produced in graph form (Figure 6.1.12), and mimics the trends seen in the first part of this tests – Svealand encompasses all the find-spots, Götaland fewer, and Norrland the least. Appendix I provides an outline of the statistical similarities between the regions.

Region	G	S	N
# Rune-Stones	691	1648	58
Ancient Grave			
Bridge			
Church			
Countryside			
Dump			
Farm			
Field			
River/Lake/Sea			
Roadside			
Thing-Spot			

Figure 6.1.12 Existence of find-spots in each region

TEST 2 – PRINCIPLE COMPONENTS ANALYSIS OF PHYSICAL CHARACTERISTICS

This test was designed to investigate if there is any evidence of regional differentiation in the physical characteristics of the rune-stones. The data used for this test will be the heights of the stones, and the length of the inscriptions. It was hypothesized that 'larger' rune-stones would be found in the Uppland region, due to their later production and greater overall number.

The Principal Components Analysis is run by first selecting the rune-stones to be run (only those with a value given for height, words and characters,), then the attributes to be measured (these being the heights, and number of words and characters) with the result being a linear projection giving a visual representation of the data (see Figure 6.2.1).

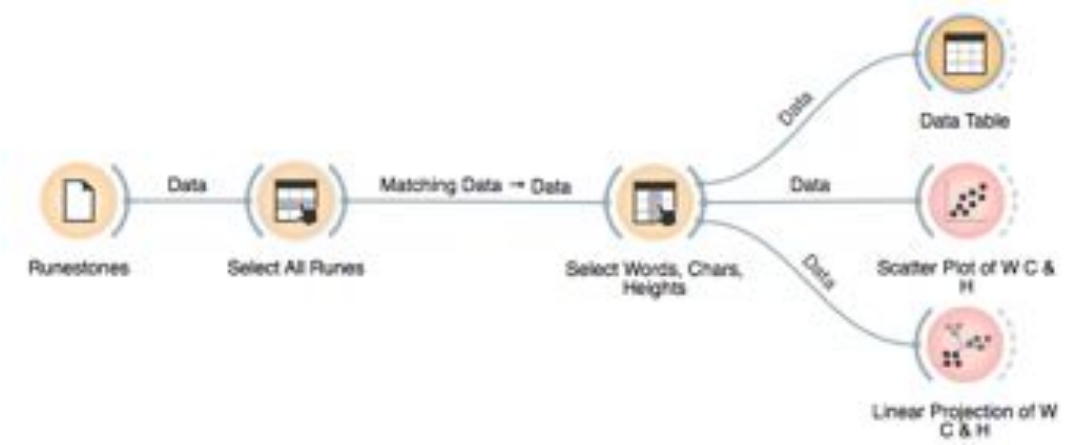


Figure 6.2.1 Visual representation of the PCA generated by Orange

The data in this test are partially incomplete; in the case of the words and characters, this is likely due to stones that had been 'lost' since their initial recording or environmental factors that rendered the inscriptions illegible. The height values are affected by the fragmentary stones, which have been left out of these calculations due to their potential to skew the data. Figure 6.2.2 shows the relative percentages of data. All of the factors listed above led to there being 1315 viable rune-stones for these tests.

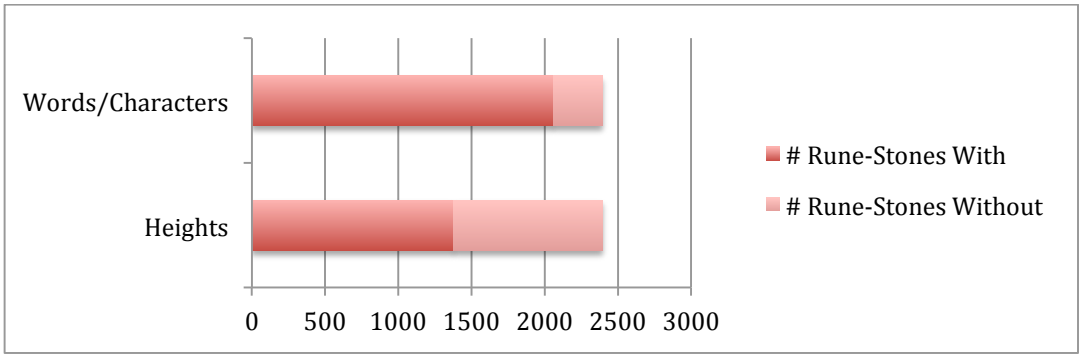


Figure 6.2.2. Number of rune-stones with words, characters, and heights.

PART 1 – WORDS, CHARACTERS & HEIGHTS IN PROVINCES

Part 1 of this test explores differentiation in the physical characteristics of the rune-stones of different historical provinces. Figure 6.2.3 shows the 'spread' before the PCA is run. The line evident in this diagram indicates that the word and character variables correspond.

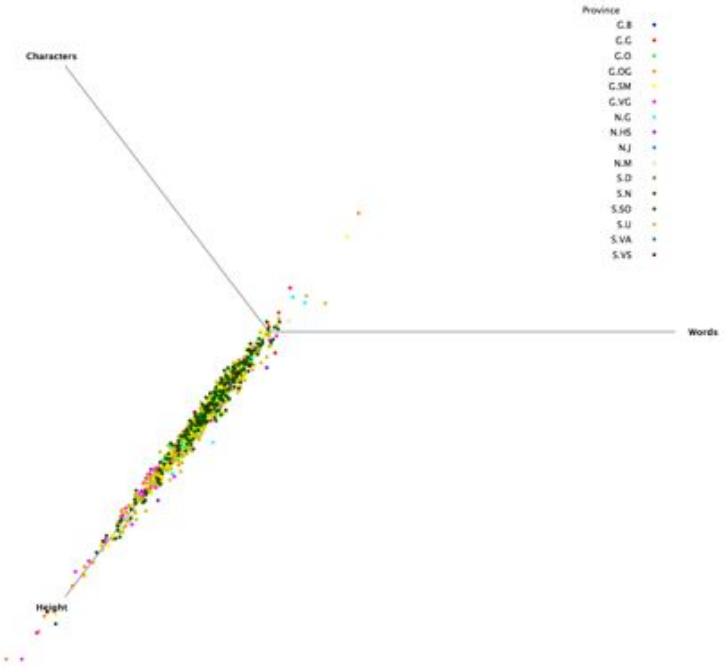


Figure 6.2.3 'Spread' of rune-stones before the PCA is run.

After the PCA is run and optimised, it becomes clear that, as suspected and shown in Figure 6.2.4, the words and characters are extremely similar. There are

no visible clumps or clusters, indicating that no regional differences are evident in this data.

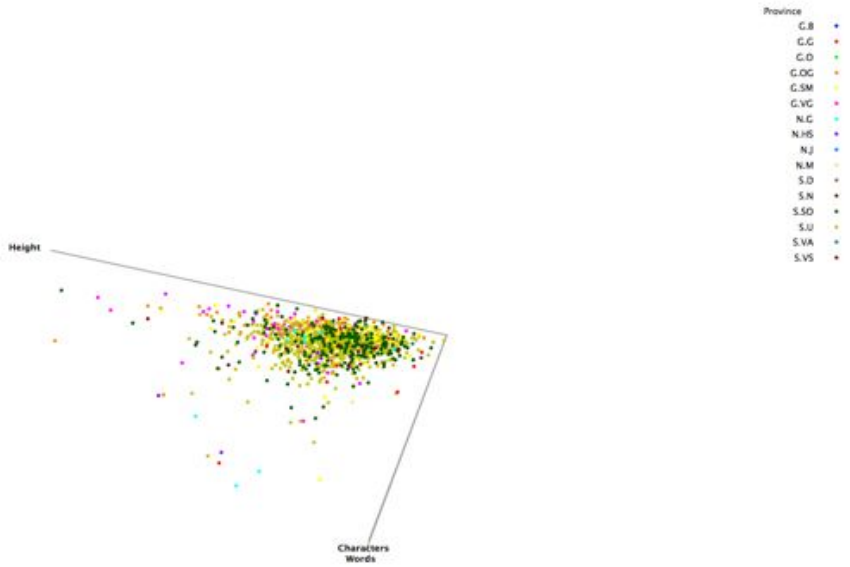


Figure 6.2.4 Optimised PCA visualising the physical characteristics of the rune-stones

PART 2 – WORDS, CHARACTERS & HEIGHTS IN REGIONS

Part 2 of this test explores differentiation in the physical characteristics of the rune-stones of different regions. After the PCA based on the rune-stone regions is run, it becomes obvious that just as there is no provincial separation, there is no regional separation (Figure 6.2.5).

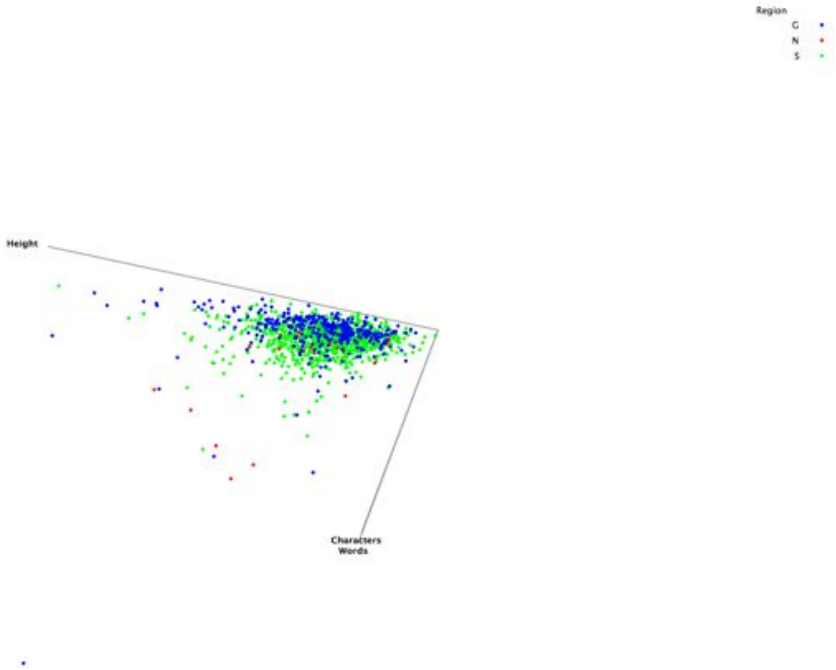


Figure 6.2.5 Optimised PCA visualising the physical characteristics of the rune-stones

TEST 3 – REGIONALITY IN CROSSES

This test incorporates two parts – the first explores whether there is any regional significance in the existence of a cross, and the second explores whether regional differences can be identified in the cross-classification system proposed by Lager (2002). The data used for each of the tests will differ slightly, with the first using all of the rune-stones and the second only those with a cross recorded. Around 41%, or 992 of the rune-stones have crosses, though this percentage is not consistent across the provinces or regions.

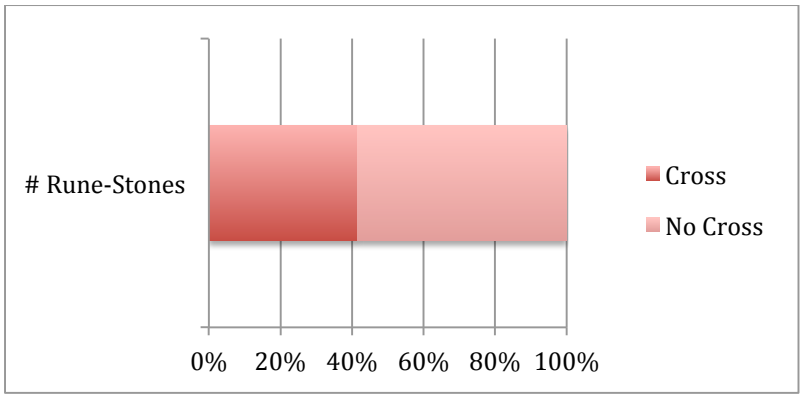


Figure 6.3.1 Percentage of rune-stones with crosses

It is important to note that this test will attempt to infer trends relating to the rune-stones as a whole, rather than just the crosses. The cross design is intricately linked with the original construction of the stone (Kitzler, 2002 (1):46-47, and any regional differences in the crosses on the stones would be highly related to regional differences in the entire rune-stone corpus.

PART 1 – THE EXISTENCE OF A CROSS

This test is somewhat simpler than the previous two, and simply measures whether there is any significance in the existence of rune-stones with crosses in the historical provinces and regions of Sweden. Orange must first select the rune-stones to be represented (all), then the attributes to be measured (these being whether or not there is a cross), with the result being a scatterplot showing the relative quantities of rune-stones with crosses in each class (Figure 6.3.2).

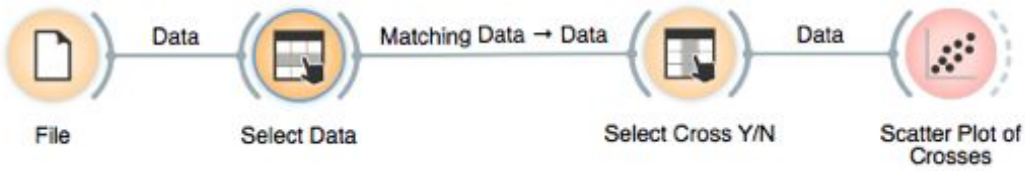


Figure 6.3.2 Visual representation of the scatterplot generated by Orange.

PART 1A – CROSSES IN PROVINCES

Part one of this test explores simply whether there is differentiation evident in whether or not the rune-stones of different provinces have crosses. Figure 6.3.3 shows the results. It can be seen that except in the provinces with very small numbers of rune-stones (e.g. S. VA, S.NA, S.D, N.J & G.B) the percentage of stones with and without crosses is relatively similar. There seem to be two exceptions to this, the first being Öland, where only very few of the rune-stones are identified as having crosses. This is likely due to the fragmentary nature of most of Öland's Köping rune-stones (Kitzler, 2009). The second is Gotland, and this is

likely due to the fact that many of the rune-stones imitate the 'picture-stone' format, in which crosses are rarely seen.

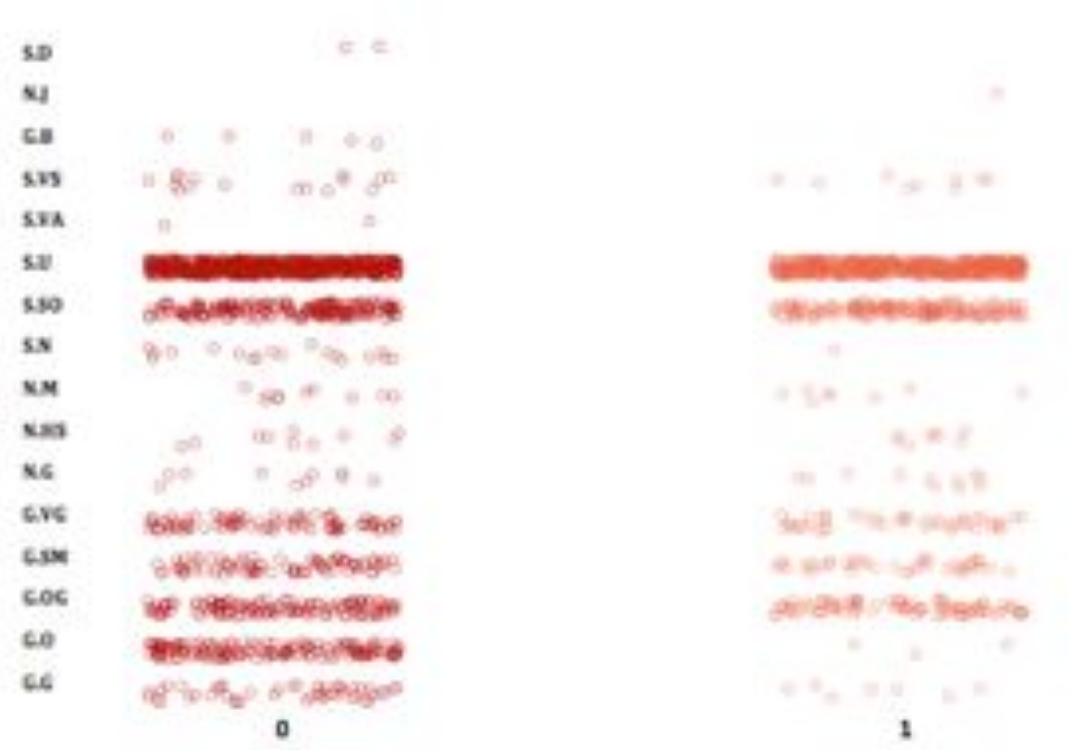


Figure 6.3.3 Scatterplot of rune-stones split by province, with 0 representing no cross, and 1 representing the existence of a cross

As mentioned above, there is no regional consistency in the existence of a cross. Overall, 41% of the rune-stones have crosses (Figure 6.3.1), though in Södermanland 48% of the rune-stones have crosses, and in Gotland only 13% have crosses (see Figures 6.3.4-6.3.6 for relative quantities). The patterning in these provincial results seems to display a regional pattern; the percentage of Götaland rune-stones with crosses sits solidly below half, whereas the Norrland and Svealand rune-stones sit around 50%.

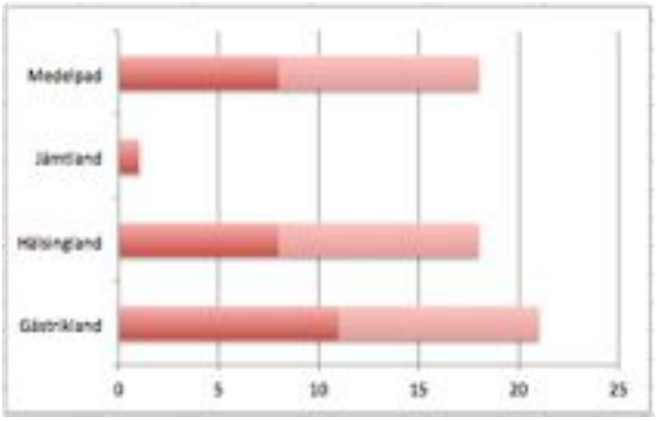


Figure 6.3.4 Number of Norrland rune-stones with/without crosses

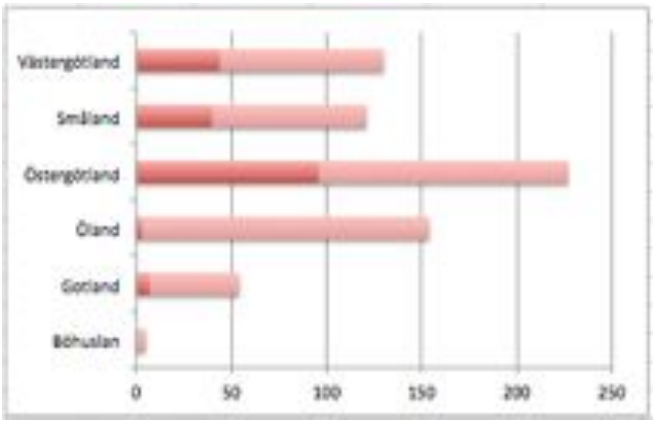


Figure 6.3.5 Number of Götaland rune-stones with/without crosses

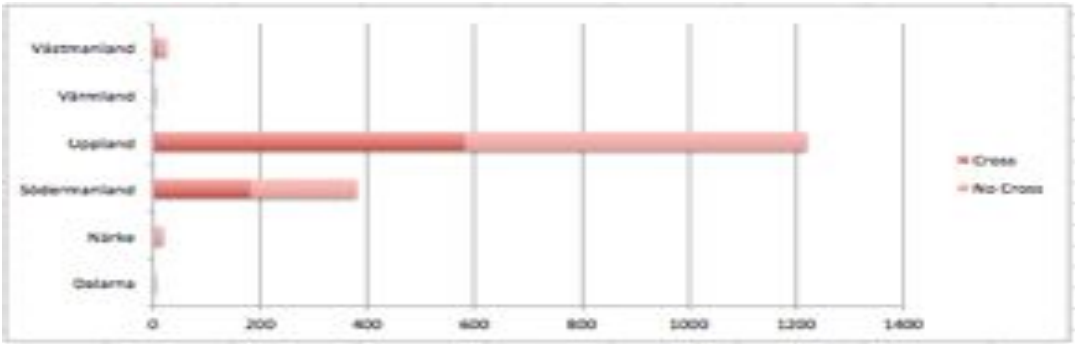


Figure 6.3.6 Number of Svealand rune-stones with/without crosses

PART 1B – CROSSES IN REGIONS

The second part of this test explores whether there is large-scale differentiation evident in the percentages of rune-stones in each region that do or do not have crosses. Figure 6.2.7 shows this in the form of a scatterplot. It can be seen that in Svealand and Norrland, the numbers of rune-stones with and without crosses are roughly the same, though Götaland has significantly less rune-stones with crosses. These results are similar to those seen in part one of these results, and it seems that the results may reveal a regional pattern, instead of one linked to individual provinces.

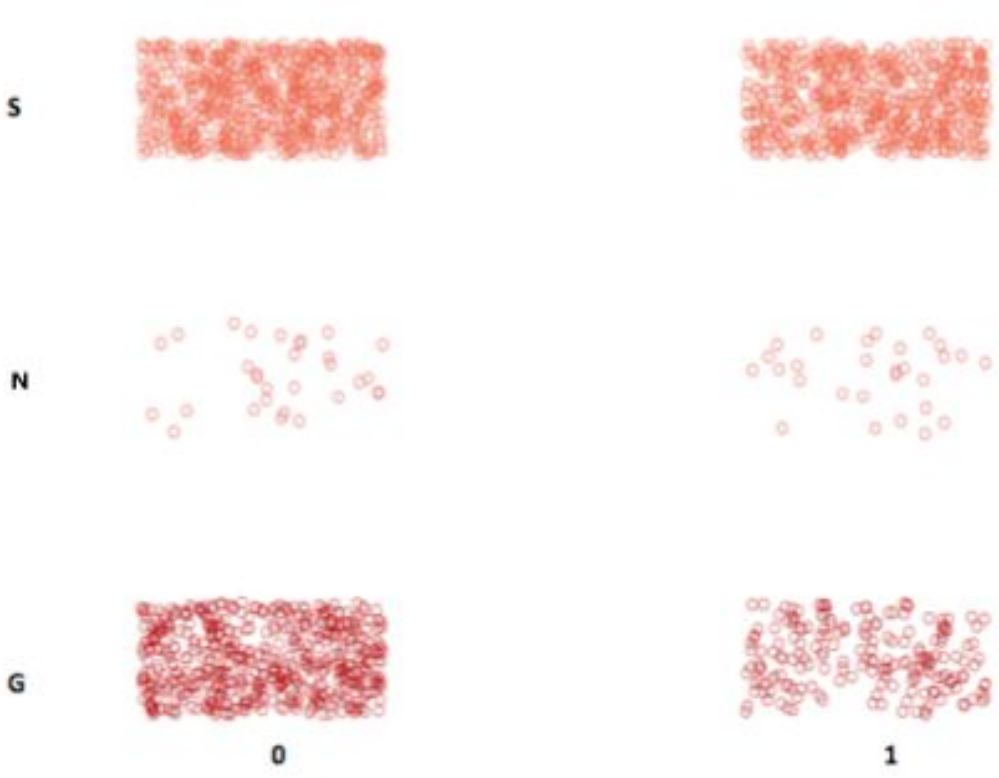


Figure 6.3.7 Scatterplot of rune-stones split by region

These slight regional differences echo currently understood theories about the Christianisation process in Sweden. As discussed in Chapter 4, the conversion of Götaland is said to have been much more 'straightforward', and rune-stones were not used as reaction for or against the process as they were in Svealand (Sawyer, B., 1991). This argument holds that the people of the Götar did not have the same need to show their faith in their rune-stones as was seen in Svealand, as Christianity was widely accepted much earlier. Figure 6.3.8 depicts in graph

form the number of rune-stones in each province that have or do not have crosses.

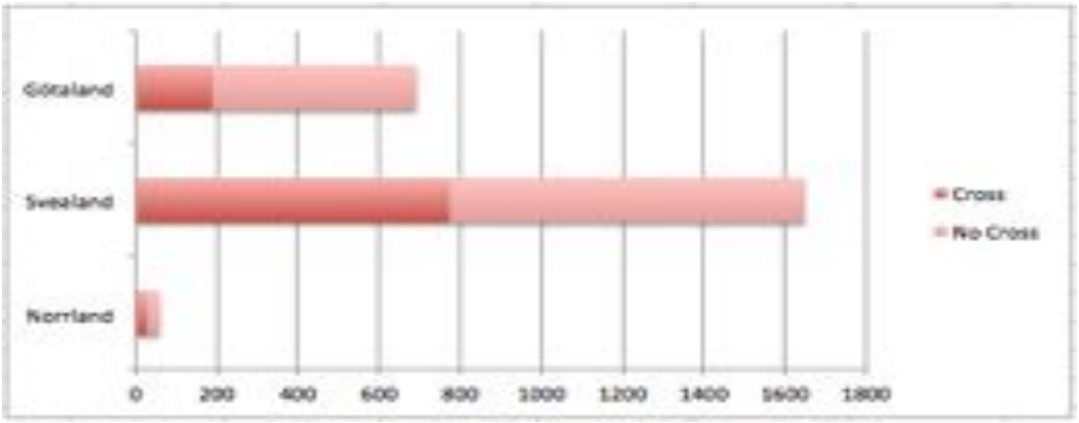


Figure 6.3.8 Number of rune-stones across the regions with/without crosses

It is known that the bulk of the rune-stones of the Göta provinces were erected earlier than those in Svea provinces, but it is unknown whether this has any bearing on the patterns that have been revealed in this test.

PART 2 – REGIONALITY IN CROSS FEATURES

This test is designed to explore whether any regional differences can be identified in the cross-classification system (Appendix C) put together by Lager (2002). It was hypothesized that perhaps the more ornate cross features (especially in the D and E sets) may exist only in some regions, and that the plainer ones would be more wide spread (sets B and G). This is in line with Gräslund's observation that there is much greater variation in the styles of the Uppland rune-stones (Gräslund, 2006:131).

As with the previous PCA tests run in this chapter, it was first necessary to select the rune-stones to be run (those with a cross), then the attributes to be measured (each of the cross features), and then set the output as a linear projection (Figure 6.3.9).

Figure 6.3.9 Visual representation of the PCA generated by Orange

PART 2A – CROSS FEATURES IN PROVINCES

Part one of this test explores whether there is any provincial differentiation in the cross-features provided by Lager's classification system. The Uppland rune-stones again make up the bulk of the data, with almost 600 rune-stones included. The next largest representation comes from Södermanland with almost 200, and Jämtland brings up the rear with only a single cross (see Figure 6.3.10 for data before the PCA is run).

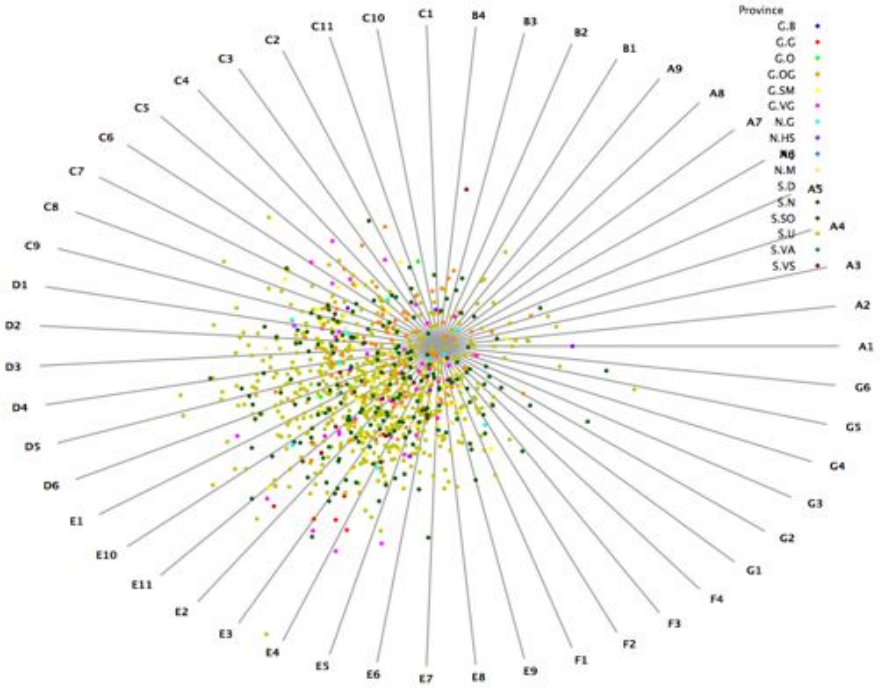


Figure 6.3.10 **S**pread of rune-stones before PCA is run.

Once the data have been run through the PCA (Figure 6.3.11), the first thing that can be seen is that the features C6 and C7 are highly correlated. There is also very little regional separation evident. It can be seen that E3 and C10 are the most commonly identified features, and that E3 is identified in a much larger proportion of Uppland rune-stones than in any other region. The only other regions with the E3 feature in their crosses are the neighbouring regions of Södermanland and Gästrikland, as well as two instances in Östergötland.

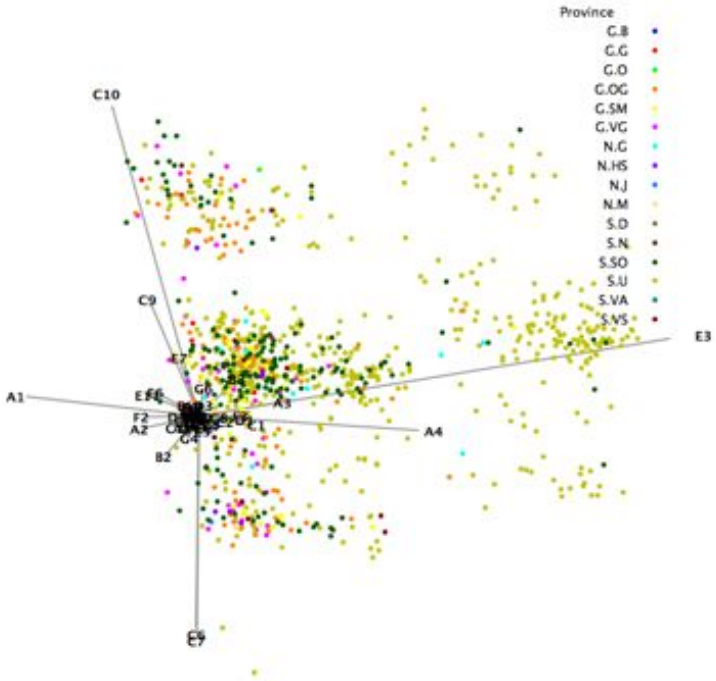


Figure 6.3.11 Spread of rune-stones after the PCA is run

After running an optimisation of the data (Figure 6.3.12), it can be seen that along with E3, A3 is also only identified in the Uppland and Södermanland regions. There is only a single occurrence of the feature G1, and this also occurs in Uppland.

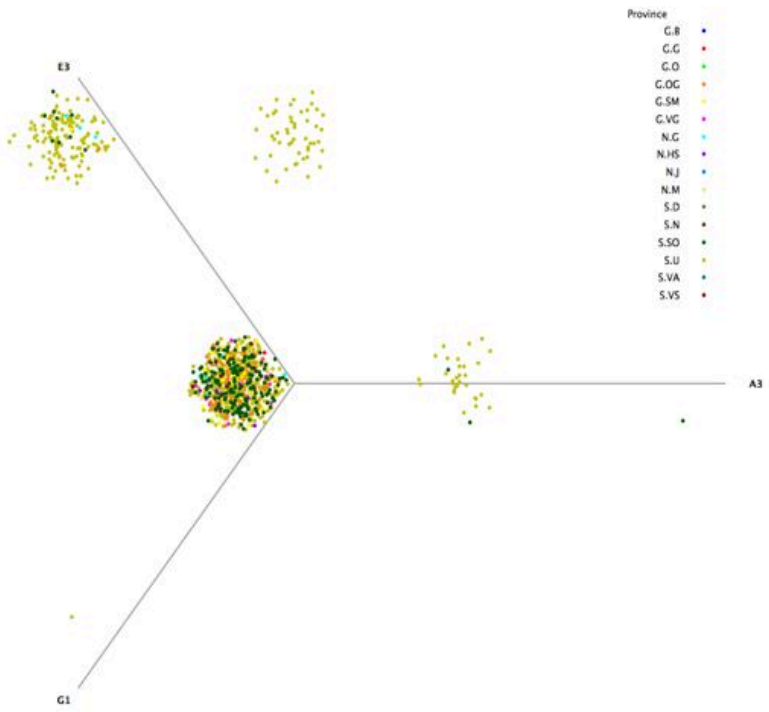


Figure 6.3.12 PCA after optimisation

In order to explore this further, the existence of each feature in each region was also produced in a graph form (Figure 6.3.13). As expected, almost all features are found in the provinces with the largest number of crosses, Uppland and Södermanland. The Svea rune-stones have the largest number of features, the Göta rune-stones have slightly less, and the Norrland rune-stones have the least number of features. Appendix J provides an outline of the statistical similarities between each of the provinces. G.B, S.D, and S. VA are excluded due to their lack of crosses.

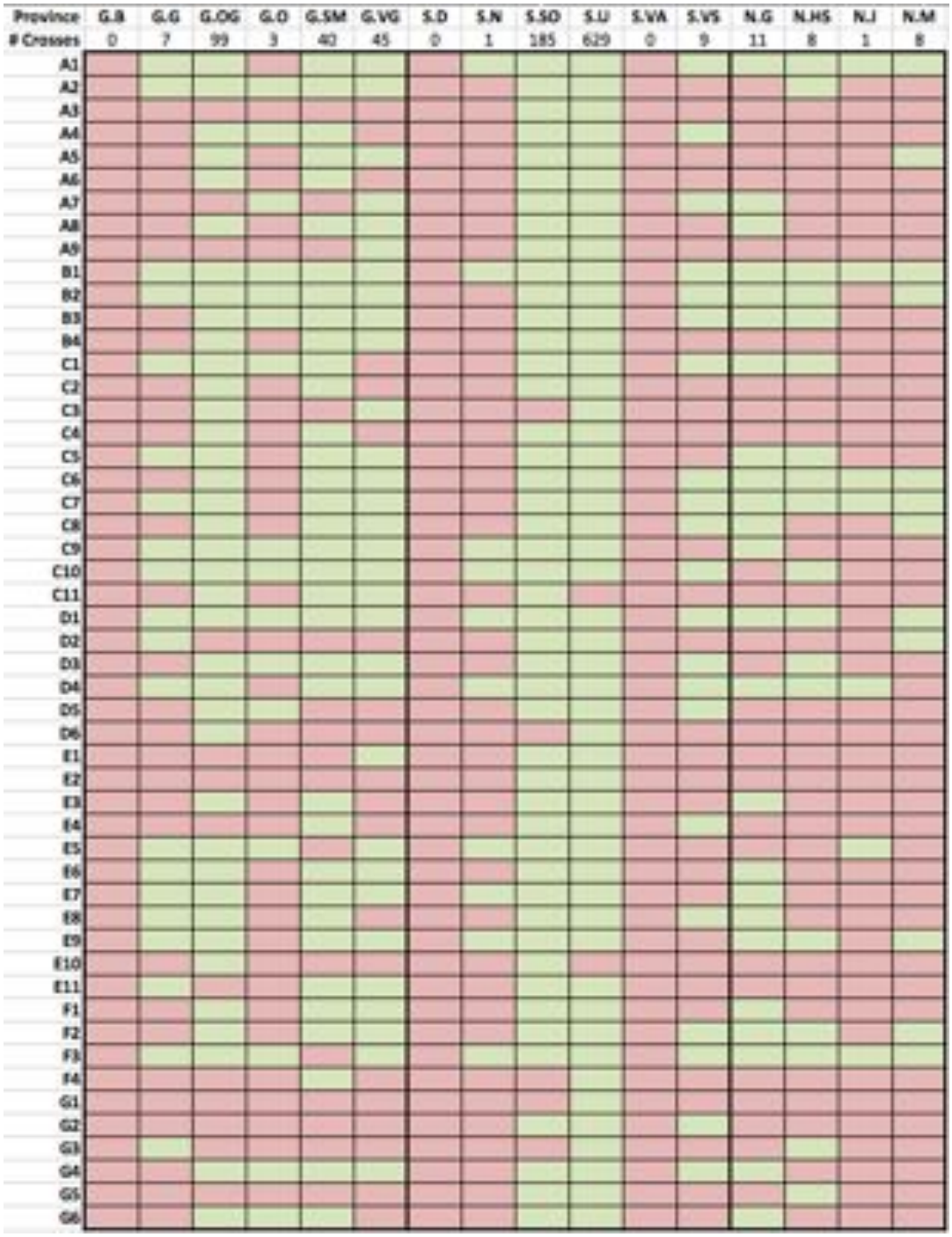


Figure 6.3.13 Cross-features in each province. Green indicates that the cross feature exists in the province, red indicates that it does not.

PART 2B – CROSS FEATURES IN REGIONS

Part two of this test explores differentiation in the cross features of the rune-stones of the three different regions of Sweden, Götaland, Svealand, and Norrland. An overrepresentation is again seen in the Svealand rune-stones, with almost 800 rune-stones with crosses in this province, contrasted with Götaland's almost 200. Norrland has only 28 rune-stones with crosses.

Once the data have been run through the PCA (Figure 6.3.14), the same patterns that emerged in the previous test are seen. A data optimisation (Figure 6.3.15) is provided to show three separate features, A3, E4, and A7, each of which is representative of a different number of regions (one, two, and three respectively).

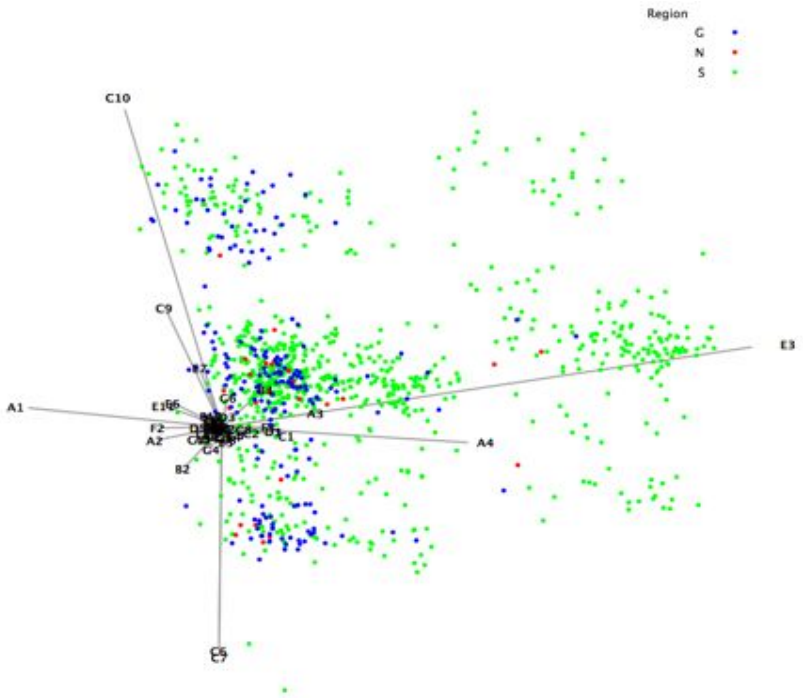


Figure 6.3.14 Spread of the rune-stones after the PCA is run

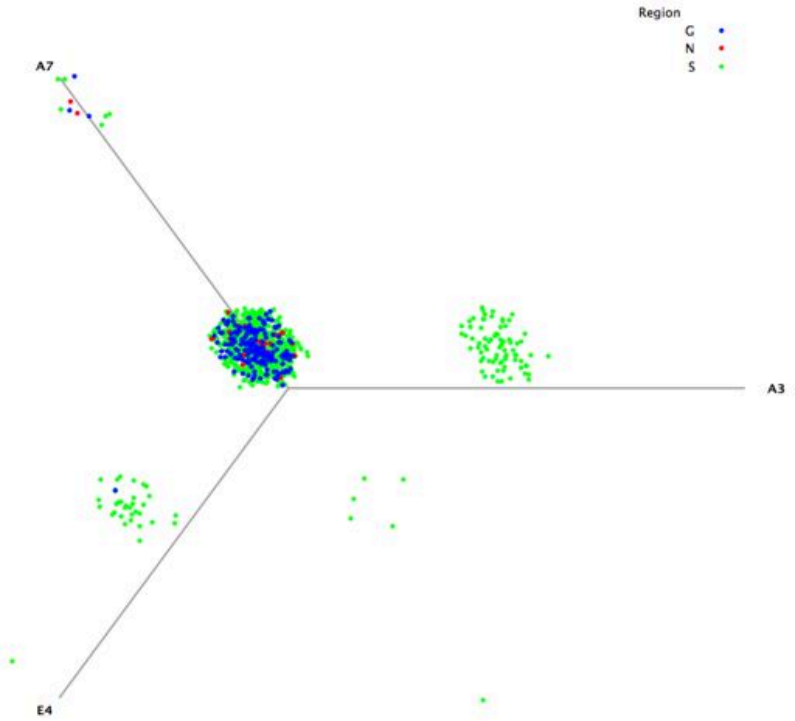


Figure 6.3.15 Optimisation of the PCA showing three separate attributes

This data were again tabulated and is represented in Figure 6.3.16. It can be seen that 100% of the cross features are evident in Svealand, 88% in Götaland, and around 65% represented in Norrland. Five features are therefore exclusive to Svealand. Interpretation of this data is tricky, given the significantly larger amount of rune-stones in Svealand. Appendix J provides information on the statistical similarities between the regions.

Region	G	S	N
# Crosses	194	824	28
A1			
A2			
A3			
A4			
A5			
A6			
A7			
A8			
A9			
B1			
B2			
B3			
B4			
C1			
C2			
C3			
C4			
C5			
C6			
C7			
C8			
C9			
C10			
C11			
D1			
D2			
D3			
D4			
D5			
D6			
E1			
E2			
E3			
E4			
E5			
E6			
E7			
E8			
E9			
E10			
E11			
F1			
F2			
F3			
F4			
G1			
G2			
G3			
G4			
G5			
G6			

Figure 6.3.16 Cross-features in each region

SUMMARY

The overall patterning seen in these results points to homogeneity rather than differentiation, mimicking the results of the previous chapter. The first test investigated find-spots, and did not find any significant differentiation. The find-spots likely do not accurately indicate the original location of the rune-stones; it has been well established that many rune-stones have been re-located since their initial erection (Klos, 2010:4), especially to churchyards, and that many rune-stones were even broken and built into the walls of medieval churches (Williams, 1997:65) (see Figure 6.1). The singular identification of 'countryside' rune-stones in Uppland is also likely incorrect, again casting doubt on the integrity of this data.

Figure 6.1 A Gotlandic rune-stone that was build into the walls of a medieval church in Bro, Gotland (Thoeming, 2012)

The second part of this chapter investigated physical differences in the rune-stones, with little indication of differentiation found. Figures 6.2 – 6.4 show the average values for each of the measured attributes, by province. The Norrland provinces of Gästrikland and Hälsingland have much longer inscriptions than the

rest of the rune-stones though there are only nine and seven rune-stones, respectively, represented. This small sample size may make comparison somewhat inequitable, so it is difficult to decide if this is significant. No single province stands out in terms of height, with all but two of the provinces between 150 and 220cm. The two 'short' provinces, Medelpad and Varmland, have only ten and two rune-stones, respectively.

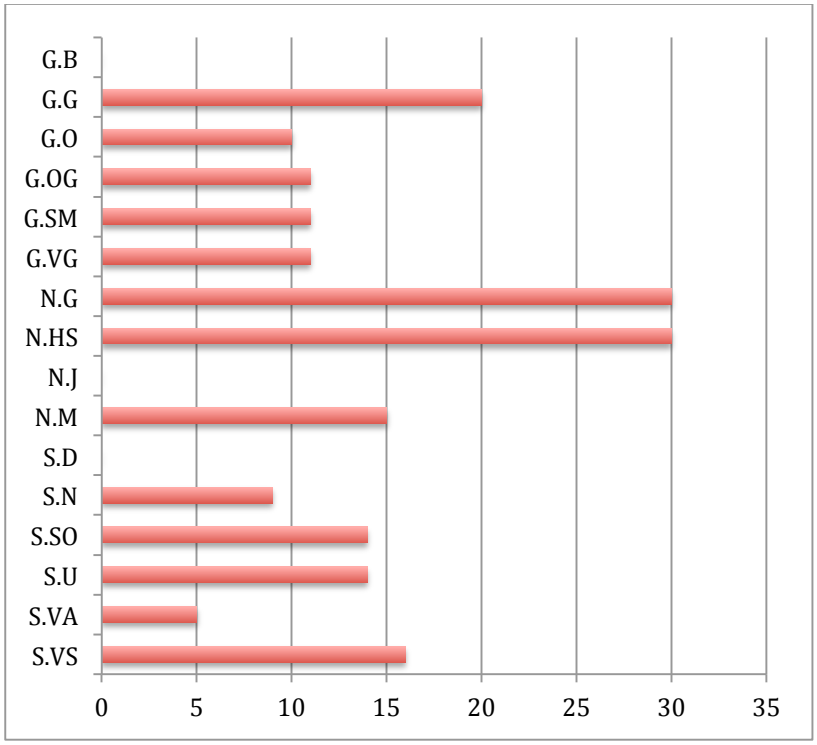


Figure 6.2 Average number of words

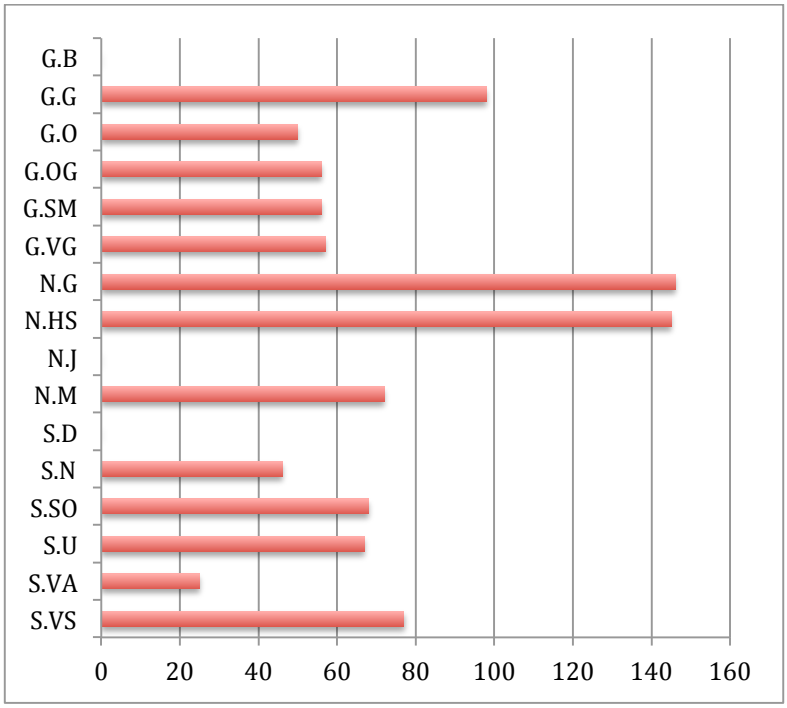


Figure 6.3 Average number of characters

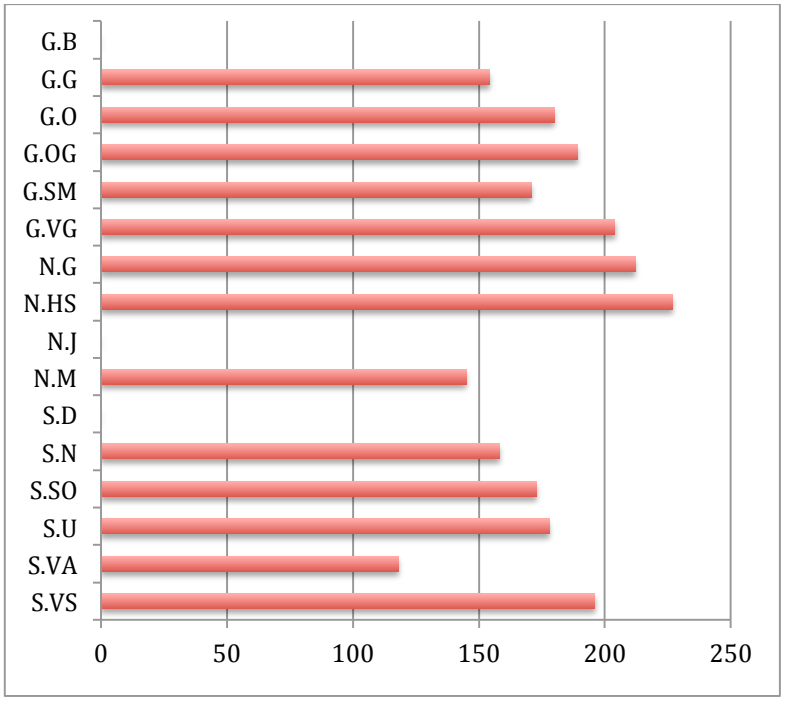


Figure 6.4 Average heights of the rune-stones

The regional results (Figure 6.5) indicate the same patterns. The average height is almost exactly the same between the three regions, though the Norrland rune-stones do have longer inscriptions, with an average of 16 words (Svealand and Götaland have eleven and nine respectively).

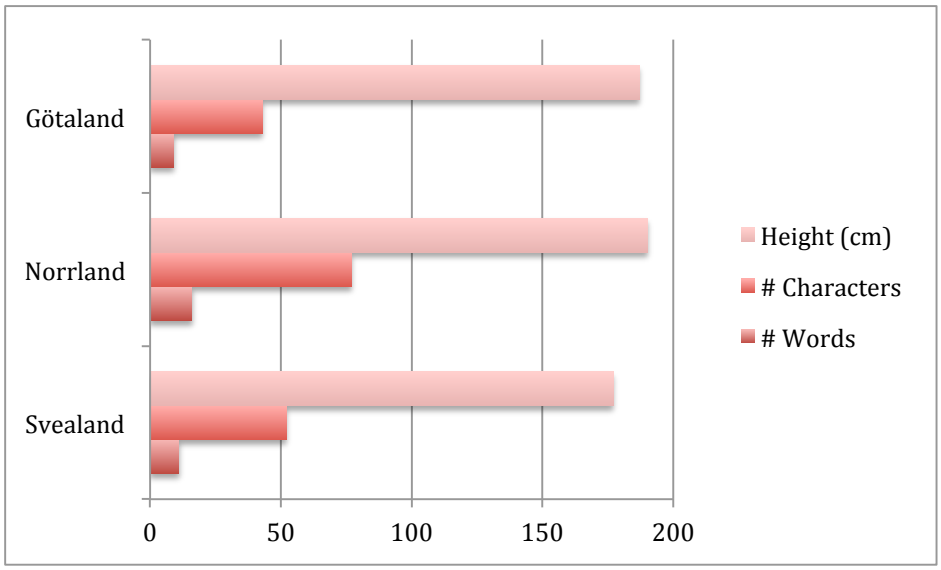


Figure 6.5 Average values for measured attributes by region

The outlier in the PCAs is represented by the Rök Stone in the province of Östergötland (Figure 6.6). Its inscription contains 820 characters and 161 words (Jansson, 1987:31-34), and therefore has been removed from the above figures so as to not unfairly skew the data. This brought down the average number of characters in Östergötland from 57 to 51.

Figure 6.6 The Rök Stone (Lundberg, 1994)

The cross tests were also not able to identify any significant regional differentiation. The Götaland rune-stones showed a slightly lower proportion of crosses, but it has previously been suggested that there are many more rune-stones with overtly 'Christian' features in the Svea region due to the more problematic Christianisation process (Sawyer, 1991:102). There is only one feature that exists only in a single province, G1 in Uppland, and very few that exist only in two or three provinces. The features that do exist in a limited number of provinces are generally exclusive to Uppland, which is to be expected given the larger number of rune-stones. The hypothesis regarding the features was that the more 'ornate' would exist only in the Svea provinces, something that the results have not revealed. All of these results considered together indicate, as suggested, that very little differentiation is evident in the Swedish rune-stones. The implications of this will be discussed in the next chapter.

CHAPTER SEVEN
A STORY ABOUT SIMILARITY & CONCLUDING REMARKS

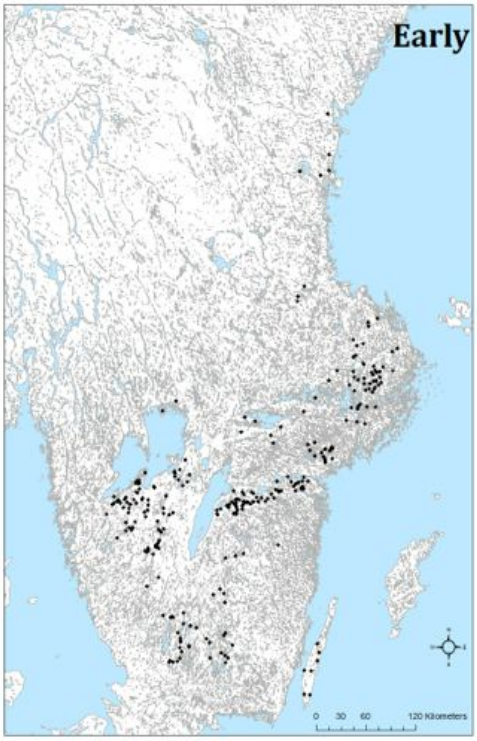
"Great confusion arises when arguments proper to one sense of the term are transferred to the other, or what is worse, when attempting to define a population of assemblages one artefact type is arbitrarily defined as 'typical', thus prejudicing the definition of and the content of the group as a whole"

David Clarke, 1978:28

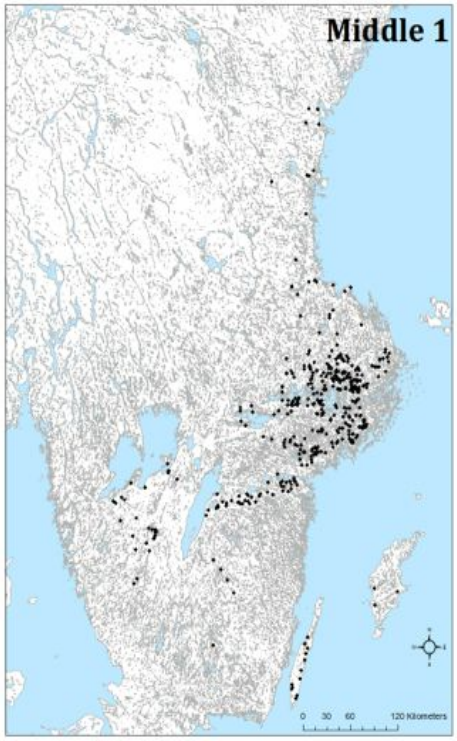
The rune-stones are one of the few readily accessible artefacts extant from 11th and 12th century Sweden, and so they are of prime importance in reconstructing the barely-known past. One of the aims of this thesis was to include all currently available features of the rune-stones to investigate degrees of differentiation, rather than just including the features that do show difference. It was expected that this would produce statistically valid results, and it has, fulfilling the anticipation of the null hypotheses that the levels of differentiation would be very low. While the inclusion of more features may reveal more information, the use of all possible attributes and their lack of differentiation must be understood as symptomatic of the overall similarity of the rune-stones. With this overwhelming indication of homogeneity in the attributes tested, the rune-stones must now be considered in terms of what this discovery indicates for their wider context.

SPATIAL DISTRIBUTION

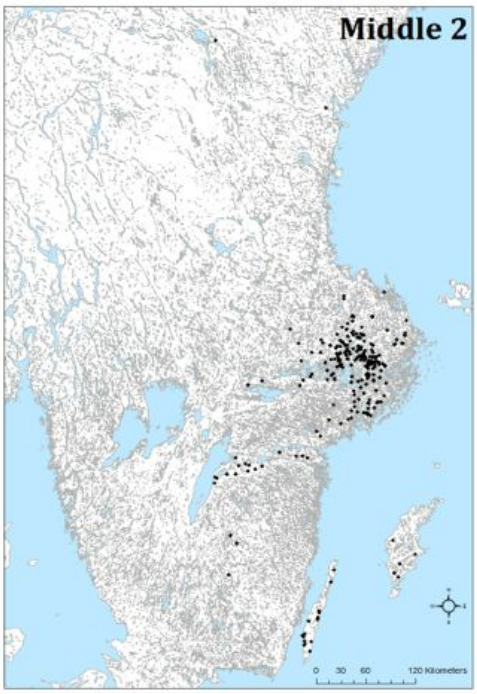
As discussed briefly in Chapter Four, a spatial patterning related to the temporal arrangement of Gräslund's 'date-band' dating (Gräslund, 2006) was identified that is both distinct and unexpected. The overall patterning of the rune-stones is that of a diminishing, contracting tradition. The Early stage is highly dispersed, Middle 1 and Middle 2 move towards the Svealand region, and the Late stage is almost entirely localised within the province of Uppland. No differentiation is evident in the features and attributes of the rune-stones to bookend each of these stages, but the existence of this pattern is quite evident. A traditional



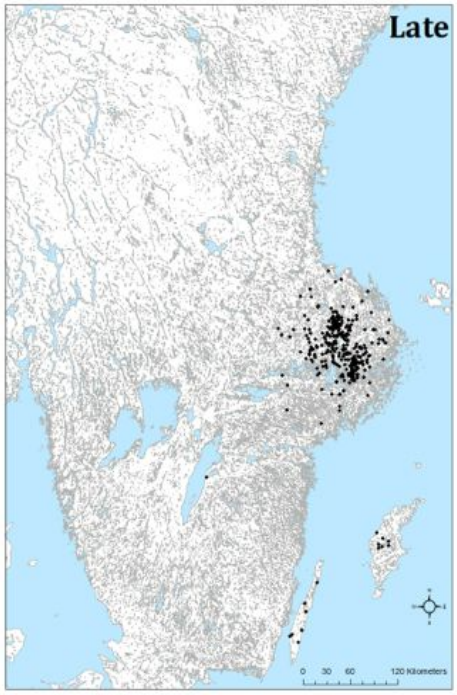
c. 990-1010 CE



c.1010-1050 CE



c.1050-1070 CE



c.1060-1130 CE

Figure 7.1 **Spatial Patterning**

Hägerstrandian interpretation of spatial patterning in his theory of innovation diffusion holds that an innovation begins at a single point and expands outwards as patches (Hägerstrand, 1965). Here, we see just the opposite. (Figure 7.1) The distribution seems almost to display a reverse nucleation, beginning with a high level of dispersal and ending in a concentrated group in the region of Uppland. It is somewhat ironic that the work of Torsten Hägerstrand, the greatest Swedish social geographer, has not previously been utilized to explore the distribution of such a quintessentially Scandinavian phenomena. Herschend (1994:59) describes the pattern as having moved in 'waves' from Southwest to Northeast, but this does not seem to be evident in this patterning.

The reverse dispersal of the fashion mimics that of a deteriorating tradition, though the sudden appearance of the rune-stones in the landscape indicates that this cannot be the case. It could be suggested that the rune-stones replaced some other expression of faith and identity being lost in the process of Christianisation, and it is this tradition, an ideological rather than a physical one, that we see declining in the landscape. Sawyer's assertion is that the runes-stones 'answered emotional needs among the newly converted' (Sawyer, 1991:101) who still felt a deep connection to their old religion. The overall distribution pattern of the rune-stones has not previously been addressed in depth in the literature, and this may be due to the counter-intuitive patterning that has been observed.

TEMPORAL DIFFERENTIATION

The work involved in dating the rune-stones on stylistic grounds has moved slowly, and in general been widely accepted. While it has been noted above that the rune-stones seem to 'appear' all of a sudden rather than diffusing through the landscape, the traditional acceptance of the rune-stones as definitively 11th century (Gräslund, 2006:117), as well as the dating of the two well-established artistic styles on which an early rune-stone categorisation was based (Christiansson, 1959), support the time-frame beyond question.

The tests undertaken in Chapter Five attempted to use both the spatial patterning discussed above along with Gräslund's stylistic dating to ascertain if

any of the recorded features could be used to 'confirm' the spatial patterning, or apply a phase or period to the un-dated ~40% of the corpus. The results of these tests showed a substantial lack of differentiation between any of the stages in either system of dating. The classifier could not predict the periods or phases of any of the dated rune-stones to a satisfactory degree of accuracy, and therefore the prediction output cannot be considered reliable. In practical terms, the data used and results of the classifier show that there is no clear chronological development in either the features that make up a runic cross, the interplay of the words used in a runic inscription, or the other attributes tested.

It is important to note that the intent behind this work was not to discredit the accuracy of Gräslund's dating or the stylistic classification that came before it, rather to seek to re-enforce it through the use of attributes other than style. Ultimately it seems that the stylistic fashions are indeed the only way to chronologically separate the rune-stones. The Jarlabanki stones of Täby, Uppland, are very useful for illustrating these stylistic changes. These stones establish a family tree, four generations of Jarlanbanki's forefathers and sons (Fuglesang, 1998:204, Larsson, 1998:644), and show the changes in style over the ~100 years in which they were erected (Figure 7.2).

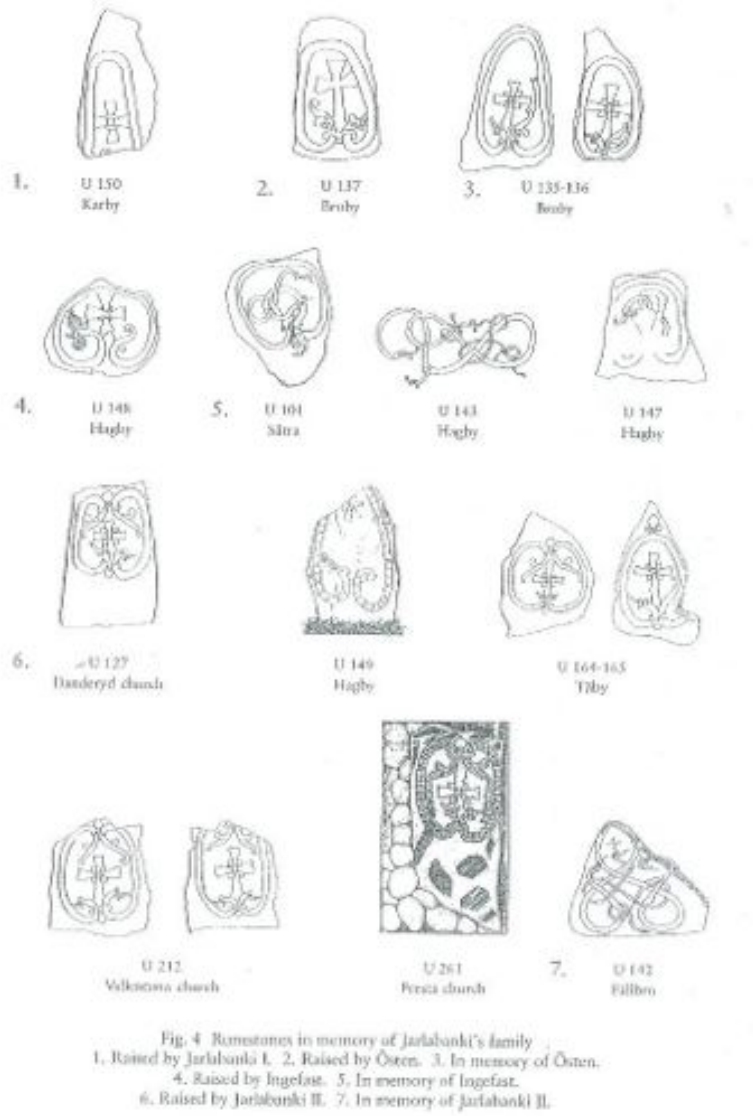


Fig. 4 Runestones in memory of Jarlabanki's family
1. Raised by Jarlabanki I. 2. Raised by Östen. 3. In memory of Östen.
4. Raised by Ingefast. 5. In memory of Ingefast.
6. Raised by Jarlabanki II. 7. In memory of Jarlabanki II.

Figure 7.2 The Jarlabanki Stones (Fuglesang, 1998:213)

This evidence of changes in style, however, is not always seen in the rune-stones in such a cut-and-dried manner. The Ingvar rune-stones (their usual *terminus post quem* being the return of the expedition from the Abbasid Caliphate in 1041 (Thunberg, 2010:3)) are mostly dated to Gräslund's *FP* category, which stretches from c.1010-1050. It is, however, only the stones that mention Ingvar that stretch the FP category out to their end in c. 1050; the other rune-stones dated to this phase are thought to belong to the decades of its inception (Gräslund, 2006:126). Fuglesang therefore proposes that perhaps the texts that date

Ingvar's voyage should be disregarded, and the Ingvar stones placed with their contemporaries between 1000-1025 (Fuglesang, 1998:206).

While differentiation may not be evident on a macro scale, it is likely that there was stronger, very local differentiation that crossed between provinces and can be attributed to artisan-identified difference in localised production (Fuglesang, 1998:206). It is generally understood that craftsmen specialising in the production of small goods were highly mobile (Magnus, 2002:19), so why should this not be the case for the rune-carvers? It may also be the case that the signed rune-stones are more representative of a workshop or atelier rather than a person. Kitzler's surface-scanning work on the Öpir rune-stones has identified at least four separate carvers (2001:154), with the same conclusion. The very first chronology for the rune-stones - and subsequent basis for modern dating systems - proposed by von Friesen used signatures and styles of the carvers to distinguish between them (Gräslund, 2006:118), so perhaps this hypothesis should be re-examined with the integration of these techniques.

Statistical analysis was required to show that the overall similarity of the rune-stones is complementary to, but different from, highly restricted differences in small numbers of very localised attributes. It is greatly to the credit of all researchers engaged in chronologising the rune-stones on stylistic grounds that they sought to make their arguments through observation alone, though the lack of temporal differentiation across the other features of the rune-stones therefore show that these changes are simply that of fashion. While there is clear evidence of both stylistic development and a directional spatial pattern, it seems the erection of the rune-stones existed over such a short period of time, and in a landscape that was so interconnected that they end up being indicative of uniformity rather than clear development.

Regional Differentiation

A large gap in the current body of work concerned with the rune-stones is a focus on regional differentiation. Individual provinces have been studied (most often Uppland) and intra-provincial differentiation has been touched upon (Sawyer, 2000:87-90), but studies rarely investigate the degree of material

difference between the historically quite separate peoples of Svealand and Götaland. The information provided by Sawyer claiming regional differentiation places too much stock in small features that are not representative of the corpus as a whole (*ibid*:28). The results provided in Chapter Five seem to indicate that in general the rune-stones are, rather than being regionally differentiated, largely undifferentiated. The incomplete nature of the find-spot data and differing amounts of detail in each of the provinces (Uppland with by far the most) may skew the data slightly, but overall very little differentiation is found. Physical features of the rune-stones of various regions and provinces also show very little differentiation, and - despite a theory that the rune-stone crosses of the Uppland region would display much more variation, in line with the observations of Lager (2000:24) - the results of the tests undertaken indicate that there are very few discrete regional patterns in rune-stone cross features.

This identification of difference in a largely undifferentiated corpus is a consequence of the focus of most rune-stone research on very small features on or of the stones, as discussed in Chapter Two. Klos's work on the relationship between the rune-stones and the hypothesis that their locations are intricately connected to roads is a good example of this (Klos, 2009). The 'roads' used to discuss significance are modern-day roads, as there is no solid record of 10th-12th century roads in Sweden (Larsson, 2010:251). Klos concludes that around 15% of the rune-stones in their original locations lie 'close' to either roads or bridges, with 8% naming a bridge or road. The conclusions of the thesis were that these numbers reveal that roads and bridges were 'special places'. As it is agreed that the rune-stones were erected close to settlements because of their function (Sawyer, 1962, Larsson, 1998), could it not be argued that the location of stones 'close' to roads can be explained away by the predilection of roads to exist 'close' to settlements, and for bridges to be very common in a landscape full of rivers?

Clarke cautions against this tendency to place significance in very specific attributes, noting that the proclivity among archaeologists to announce that a single artefact type or feature is 'typical', or broadly significant, runs the risk of 'prejudicing the definition and the content of the group as a whole' (Clarke, 1978:28). Most scholars engaged in rune-stone research attempt to identify

difference, to justify 'their' feature as being the 'most different' of all features, in an attempt to explain the strange and sudden fashion of the raising of rune-stones. The alternative is to consider the overall context that led to the erection of the rune-stones, in which they are representative of an interconnected world flush with wealth and the need to state one's claim to their prestige.

Figure 7.3 U194 mentioning taking payment in England (Lundberg, 1987)

A group of rune-stones, known as the *Englandsstenarna* (England Rune-stones) are so named because they mention taking Danegeld, the tribute paid by English towns ruled by Knut the Great in the early 11th century ((Fig. 7.3) (Lawson, 1984:721). Of these 30 *Englandsstenarna,* 28 are in Sweden, with 18 of those in Svealand (Figure 7.4). None but the Danes, however would have been eligible to take Danegeld, and this indicates that there was a significant amount of contact between the Danes and the Swedes. It is possible that the Swedish and the Danish populations were closely related, that the Danes may have retired to Sweden, or that there was some other interchange between the two peoples – interconnectivity is the broad indication. Recent investigations of population

genetics within Sweden indicate that the southern provinces neighbouring Denmark show strong correlation with Danish haplogroups, as other counties related with Norway and Finland show their haplogroups – no 'strong internal genetic borders' exist within Sweden (Lappalainen et. al., 2009:71). An investigation of country or provincial-specific differences and interrelatedness of personal names on the rune-stones could provide more information on the historic engagement between the two countries.

Figure 7.4 Map of the *Englandsstenarna* in Sweden

The lack of differentiation indicates a certain degree of non-correspondence between the known social and material phenomena. It could be said that this relates to the political unification of the 11th century, but the rune-stones existed before and after this unification in the same form. It is much more likely that what we are seeing is the 'material as behaviour', and the fulfilment of the proposal that levels of dissonance between the material and the social are

indicative of a degree of change (Fletcher, 2006:135). The rune-stones are, in their own way, recording much more about the changes happening in Swedish society at the time than the historical record ever could.

COMMUNICATION NETWORKS

One of the issues highlighted by the earlier chapters of this thesis is a lack of information about communication networks in 10th to 12th century Sweden. The picture of just how the country was forged at this time is nowhere close to complete, and this poses a problem when attempting to investigate communication networks. The Swedes were highly mobile abroad, and the homogeneity of the rune-stones uncovered by this thesis seems to indicate that they were just as mobile at home. The name of the Göta road indicates that it surely stretched to Götaland at some point (Figure 7.5), and it is likely that there were many other smaller roads and trails connecting the towns that the rune-stones indicate dotted the southern half of the country. Swedes likely travelled for numerous reasons; to attend *ting*-meetings (Schlyter, 1835:6), to worship at Gamla Uppsala (Olrik, 1930:4), and to visit the trade towns of the Mälar Valley (Clarke & Ambrosiani, 1995:75).

Figure 7.5 Map of the Stockholm region showing the towns of 1812 with Stockholm in the middle, and the route of the Göta highway as proposed in Eriksson (1980:178) (Adapted from Landell, 2000)

The recording and analysis of rune-stones concerned with travels at home has been overlooked, and this is likely a consequence of early approaches to runic studies, which regarded the 'voyage-stones as the *proper* rune-stones' (Sawyer, 2000:16), i.e. a very 'viking' focussed approach. Jansson even links the end of the rune-stone tradition 'in the proper sense of the term' to the shutting-up of the old trade routes, the implicit message being that the rune-stones that followed were merely shadows (Jansson, 1987:38).

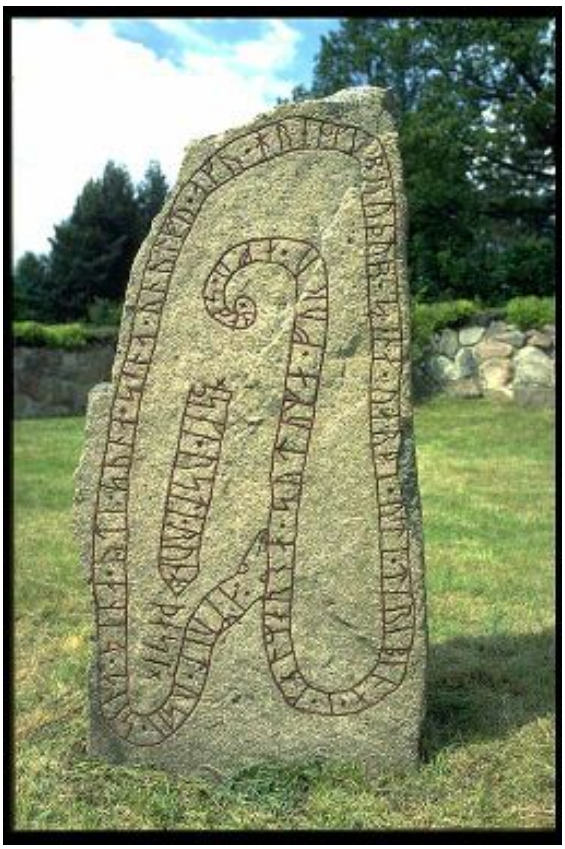


Figure 7.6 Sö 333, located in Strängnäs Municipality, Södermanland (Lundberg, 1985)

"Ámundi raised this stone in memory of his son Rúnulfr and Hringr, his brother. He was killed out in the Kalmarnir sound, as they travelled from Scania. Ásgeirr carved these runes."

Rune-stones that mention travel by sea within Scandinavia (Figure 7.5) have been identified. The stone depicted mentions death in '*Kalmarnir sound, as they travelled from Scania'* (Figure 7.6), which refers to the narrow stretch of water

between the city of Kalmar and Öland (Figure 7.7), as well as the province of Skåne (then belonging to Denmark). It is rational to consider that the ruling elite of this time would feel a need to control communication routes due to their use for goods transport from the trade towns of the Baltic (Carlie, 2008:128). The towns of late Iron Age Scania, then part of Denmark, have been used to re-construct inland communication networks (*ibid*), and it is quite likely that the same could be done in Sweden if more was known about historic settlement patterns. Another piece of possible information about communication networks is that of bridges; Chapter Three described the landscape of Sweden as incorporating numerous rivers and streams, and most roads would surely have had to pass over bridges on multiple occasions. The identification of bridges from this period combined with the knowledge that rune-stones are likely to be representative of communication networks (along with their relationship to bridges previously established) could go a long way in filling this gap.

Figure 7.7 Map showing the Kalmar Sound

While we know very little about the spatial arrangement of the everyday communication networks of the Swedes, the overwhelming similarity in the rune-stones uncovered by the results of studying their regional differentiation indicate that this was a highly interconnected country. The rune-stones' physical locations illustrate communication networks; they existed where people could see them. The potential for rune-stones to identify 11th century communication networks, has been overlooked, and should be subject to much more focus.

REVIEW

The results of this thesis were, in part, foreshadowed by Fuglesang in her work on the Ingvar and Jarlabanki rune-stones, noting very little large-scale differentiation in motif or style across the provinces in which they are found, despite there being evidence of slight variation in the work of different rune-masters (Fuglesang, 1998:200, 206). Work on the inscriptions has also indicated that there is a lack of differentiation both temporally and regionally, with Williams noting that the homogeneity in these inscriptions likely indicates that they only represent a limited group within society (Williams, 1996). Yet this cohesion and consistency has not become a major focus of rune-stone studies.

While the communication networks of these 'close-knit' people (Olrik, 1930:4) may still be largely unknown, the rune-stones paint a picture of a highly interconnected and very small landscape with very little material difference, yet this cohesion and consistency has not become a major focus of rune-stone studies. The results of these investigations have uncovered what can fairly be described as the reverse of what was sought, and with this in mind a new research question has been identified, one which this thesis has addressed, but which indeed requires much more investigation;

What does the high degree of coherence in the rune-stones of 11th century Sweden indicate about the societal, religious, and political changes that were taking place, and how might we examine this issue?

CONCLUSION

The major goal of this thesis was to address the lack of information in the existing literature about how the rune-stones as an assemblage - rather than their individual separated features – are representative of the social landscape of 11th century Sweden. To this end, three specific questions were pursued

1) Is there evidence of significant differentiation between the rune-stones of individual provinces, or between the rune-stones of the two 'peoples' of this time, the Svear and the Götar?

In short, no. One of the problems identified by the early chapters of this thesis is a lack of analysis of objective data aimed to identify whether there were any significant differences in the wider corpus. The results indicated that neither the rune-stones of individual provinces or those of the Svear and Gotar regions show significant differentiation.

2) Is this differentiation also seen in the temporal record, and therefore is it possible to complete the dating of the rune-stones through a strategy other than stylistic?

Again, very little overall differentiation was evident. In exploring both Gräslund's stylistic dating and the spatial patterning uncovered by this thesis, the data collected and utilised was unable to identify any significant differentiation in the assemblage of general attributes. This indicates that the development of very specific features and styles as recorded by the work of von Friesen (1913), Christiansson (1959), and Gräslund (2006) capture the only chronological change evident in the corpus. The rune-stones as a whole are fairly homogenous, with distinct variation only seen in the highly specific changing fashions of stylistic development.

3) What are the implications of the discovery (or not?) of large-scale differentiation in the rune-stones?

The lack of differentiation in the rune-stones is as telling as if there had been a large amount of differentiation. As posited above, the wide-scale 'differentiation' identified can be considered to be simply the result of the concentration of research on stylistic minutiae. When differentiation is evident, it is only at a local level and at a very small scale. The lack of differentiation suggests that hypotheses should be re-considered; that the rune-stones can and need to be understood in a broader context, as symptomatic of more than just artistic development.

In any case it is similarity, rather than difference, that stands out. What becomes evident through the identification of wide-ranging similarity in the stones is that the world of Sweden at this time was a very small, interconnected one in which the rune-stones are representative of the degree to which people habituated to long range trading, were able to move around, and the wealth resulting from the trade networks of the post-Roman age.

FUTURE RESEARCH

This work has identified many areas in which future research can be directed, the largest of which would be the expansion of such research across the whole of Scandinavia. While the two 'peoples' of Sweden are rarely spoken of as having separate rune-stone traditions, the rune-stones of Denmark, Norway and Sweden are always studied discretely. The integration of these rune-stones into one large study, to examine the extent to which they are differentiated is entirely possible and would be quite interesting.

The statistical results that have been generated by this study would also be worth pursuing in more detail. For example, Appendices G and H, generated alongside the Principle Components Analysis provide detail on statistical similarity on the cross features and findspots between the various provinces. Investigating this in the context of which provinces are more similar than others could provide some interesting results.

The three main areas in which Sweden saw change in the 11th century were in a social, political, and religious context. The extent to which these three contexts at

a crossroads are represented in the rune-stones could shed some more light on the changes happening at this time. While the Christianity has been explored, there is certainly more room to investigate this with a more contextual focus.

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APPENDICES

APPENDIX A- RUNE-STONES UTILISED

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U ATA2753/74
U ATA3019/65
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U ATA322-3229-2005
U ATA322-326-2000
U ATA323-3559-2003
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U ATA3599/65
U ATA3600/65
U ATA365/61A
U ATA365/61B
U ATA365/61C
U ATA3916/47
U ATA4027/61
U ATA423-4018-1999
U ATA4589/45
U ATA4753/75
U ATA4822/64
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U ATA5735/59
U ATA5856/75
U ATA5923/69
U ATA6243/65
U ATA6263/56
U ATA7269/60A
U ATA7269/60B
U ATA7269/60C
U ATA7269/60D
U ATA7269/60E
U ATA7269/60F
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U Fv1948;168
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U Fv1953;266
U Fv1953;268
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U Fv1953;272
U Fv1953;274
U Fv1954;4
U Fv1955;216
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U Fv1969;304A
U Fv1969;304B
U Fv1969;305
U Fv1971;209
U Fv1971;211A
U Fv1971;211B
U Fv1971;212A
U Fv1971;212B
U Fv1971;213A
U Fv1972;172
U Fv1972;271
U Fv1972;272
U Fv1972;274A
U Fv1972;274B
U Fv1972;274C
U Fv1972;274D
U Fv1973;146
U Fv1973;191
U Fv1973;194
U Fv1973;198C
U Fv1973;198D
U Fv1973;199
U Fv1974;203
U Fv1974;213
U Fv1975;168
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U Fv1975;172
U Fv1976;104
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U Fv1977;162B
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U Fv1979;244A
U Fv1979;244B

U Fv1979;245
U Fv1980;237
U Fv1983;228
U Fv1986;220A
U Fv1986;84
U Fv1988;243
U Fv1990;32A
U Fv1990;32B
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U Fv1992;156
U Fv1992;157
U Fv1992;159A
U Fv1992;164A
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U Fv1993;233
U Fv1993;235
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U NOR1995;19
U NOR1996;18F
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U NOR1998;23B
U NOR1998;26
U NOR1998;27A
U NOR2000;37
U NOR2002;33A
U NOR2002;33B
U NOR2002;33C
U NOR2002;33D
U NOR2002;33E
U NOR2002;33F
U NOR2003;23
U Owe1996b;119
U RR1987;134
U SHM28883:54
U Strämbeck1993;710
U THS10;58
U THS30;78
U THS30;83
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Vg 90
Vg 92
Vg Fv1980;238
Vg NOR1997;27
Vg NOR1997;28
Vg SkalundaRaä50
Vr 2
Vr 3
Vs 1
Vs 11
Vs 13
Vs 15
Vs 16
Vs 17
Vs 18
Vs 19
Vs 20
Vs 21
Vs 22
Vs 23
Vs 24
Vs 25
Vs 27
Vs 28
Vs 29
Vs 3
Vs 30
Vs 32
Vs 33
Vs 4
Vs 5
Vs 9
Vs Fv1988;36

APPENDIX B – GRÄSLUND'S DATING

FP
1010-1050

PR3
1050-1070

PR1
1010-1040

PR4
1060-1100

PR2
1020-1050

PR5
1100-1030

RAK

Unornamented

FP/B-E-V

Overall Impression: Rather unresilient; the rune animals are often slightly angular and the bow line pressed together

Head: A snake's head seen in bird's eye view

Eye: Two round, sometimes almost rhomboid pop-eyes, normally to a certain degree outside the contour of the head. The eyes may be connected by two parallel transverse lines

Ear: Is missing

Mouth: Often suggested by a line, sometimes continuing into a sting

Feet: Are missing

Tail: Lightly rolled up, sometimes solely thickened at the end. Real rollups occur, but only half a round

Additional Snakes: Are missing

Layout: Usually one rune animal along the edge with union knot. Two rune animals also occurs, sometimes with overcrossing

Cross: Very frequent, with elongated cross arm

PR1

Overall Impression: Compact, close and blunted. The curves of the rune animals are often a little angular and the bow line pressed together

Head: Normally with a very snub nose with a thick upper lip and a strong, steeply cut-off lip lappet

Eye: Round

Ear: High set, round and erect. The ears and one or more scrolls often form a 'crown'

Mouth: Normally open, with a rather short lower lip

Feet: Do not occur

Tail: Rolled up, sometimes with a thumb-like protuberance downwards, or consisting of several scrolls of similar length

Additional Snakes: Do not occur

Layout: One rune animal along the edge of the carved area is the most common, but two rune animals also occur. Normally there is no over-crossing.

Cross: Very frequent

PR2

Overall Impression: Most often unresiliant and angular, although less so than in PR1. The rune animals are rather substantial, but there are also some thinner examples

Head: Characterised by a concave line from ear to nose tip

Eye: Round or drop formed, sometimes with a point in it

Ear: High set, erect, or slightly set forward

Mouth: Normally open, sometimes with a tongue, the upper lip and the nose tip strongly bent upwards. There is often a balance between the upward line of the ear and that of the nose. Distinct, round lip lappet. Marked lower lip in a semi-circular bow

Feet: Occur only seldom, slightly rounded on short legs

Tail: Rolled up, often with a thickened end and a thumb-like protuberance downwards. The rolled tail and the protuberance generally correspond to the shape of the head

Additional Snakes: Occur seldom, a neck crest or a union knot is sometimes transformed into long tendrils, giving the same decorative impression as a snake

Layout: One (sometimes two) rune animal(s) along the edge

Cross: Very frequent

PR3

Overall Impression: Firmly rounded with moderately sweeping lines, neither too thick and unresilient nor too sweeping

Head: Characterised by a thick convex line from ear to nose tip

Eye: Almond shaped, not too large in proportion to the head

Ear: Low set, rounded and slightly bent backwards

Mouth: Normally open. The lower lip, usually smaller than in PR2, slightly bent downwards. The lip lappet forms an S-line, starting at the somewhat turned-up nose tip. There is a balance between the curve of the ear and that of the nose

Feet: Occur sometimes, rounded with two toes on relatively short legs

Tail: Rolled up, often with a thickened end and a thumb-like protuberance downwards

Additional Snakes: Occur

Layout: One (sometimes two) rune animal(s) along the edge, with or without over-crossing

Cross: Frequent

PR4

Overall Impression: Elegant and graceful through the elongated sweeping bow lines. Straight lines almost never occur. PR4 introduces the feeling of classic Urnes style

Head: Strongly elongated, often softly bent and with a pronounced step down in the line from head to neck

Eye: Elongated, almond shaped, very large in proportion to the head, almost filling up the head and following its outline. Parallelism between the line of the head and that of the eye was obviously desirable. However, in some few cases the PR4 head lacks an eye

Ear: Very low-set and markedly bent backwards, sometimes in the shape of a slightly bent, pointed flap. Neck crests occur frequently, often long and thin in big loops, sometimes transformed into figure-of-eight shapes

Mouth: Normally closed. The lower lip is short and straight, ending in a slight roll downwards, corresponding to the lip lappet. The nose tip is straight or only slightly rolled up, lip lappet only downwards

Feet: Set at the end of long, angulated legs with a distinct hock, normally rather tight with two straight toes and a rounded spur. The angle between leg and foot has the form of a hook

Tail: The roll is not symmetrical but consists of a large thick circle and a thin tail, sometimes split up with a downward tendril elongated into an elegant loop. The tail often has a "hock" typical for the Urnes style. The rune animal ends either in a rolled up tail or in a foot

Additional Snakes: Frequent in large, loose loops, often figure-of-eight shaped

Layout: Generally one rune animal along the edge with over-crossing. Angles or knees occur in the lower part of the carving where head piece and tail piece meet. Figure-of-eight shaped layout is also common, sometimes with an extra loop added to the side at the bottom

Cross: Occurs

PR5

Overall Impression: Characteristic, tight check pattern, formed by parallel lines crossing each other at right angles, usually horizontally and vertically on the carved area, lines that are parts of the loops of the rune animal and the snake

Head: Two types occur, a) one triangular with clear roots in PR3, PR4, etc., which ends at the back in the typical hook shape, constituting the step down to the neck. b) one with a rounded skull and stop of the same kind as in Irish metalwork from the beginning of the 12th century

Eye: a) can be thin, straight or almond shaped but is generally lacking b) round or reverse almond shaped

Ear: a) very low set and strongly bent backwards, often only faintly outlined b) either leaning backwards or lacking. Neck crests occur sometimes

Mouth: a) straight underline, straight, closed mouth with a small lip lappet downwards, nose tip slightly bent upwards b) often half open (occasionally closed) with a lower lip thickened downwards. Upper lip rolled in downwards

Feet: Normally with two straight toes and a pointed spur, which may continue in a loop-shaped tendril. The hook shape is found at the angle between the long leg with knee and the foot

Tail: Normally replaced by a foot

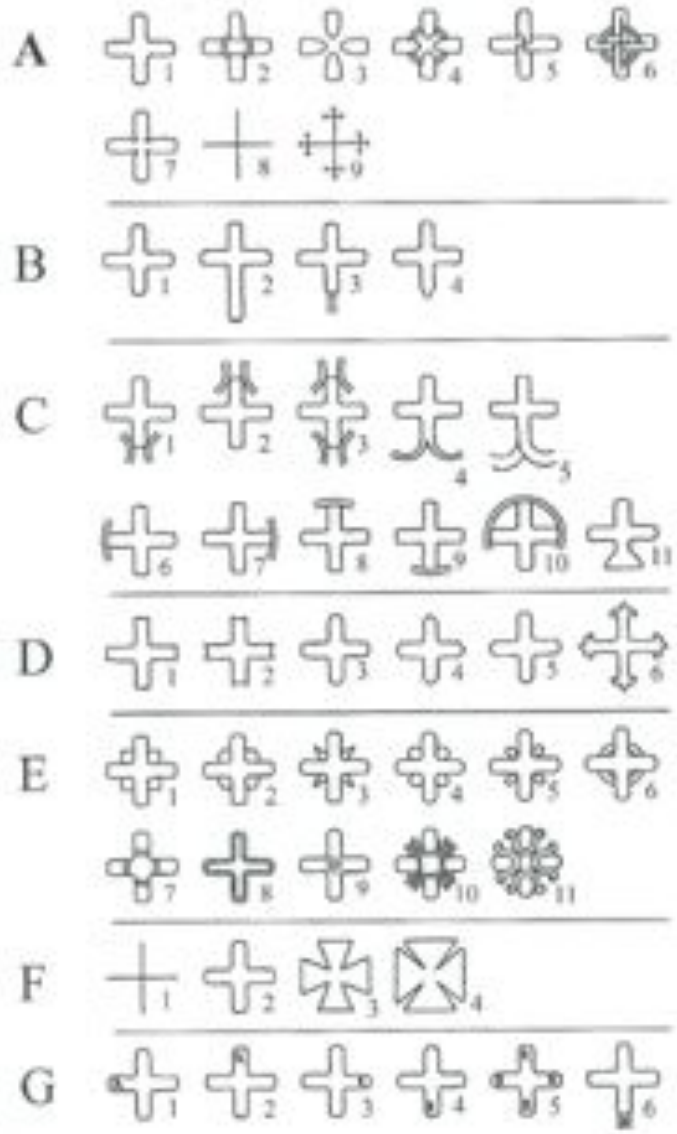
Additional Snakes: Essential, occur always, without them there would be no PR5 pattern

Layout: One rune animal along the edge with over-crossing. Angles or knees at the lower part of the carving where the head piece and tail piece meet are frequent, giving symmetry to the composition and creating the typical hook shape that recurs in the form of heads and feet

Cross: Occur sometimes

Gräslund, 2006:119-124

APPENDIX C – LAGER'S CROSS-CLASSIFICATION SYSTEM



"The groups of variables concern the construction of the middle of the cross, the shape of the cross, how the cross is stabilised in the runic band (if this is the case), the design of the end of the cross-arms, decorative ornaments, the thickness of the cross and finally if, and in that case where, there are any runes on the cross" (Lager, 2002:65,246)

APPENDIX D - NAÏVE BAYES CLASSIFIER EXAMPLE

In this example, the probability of a car being stolen is generated, given three variables. The car in question is a red, domestic SVU, and it should be noted that this type is not included in the below 'example' grid.

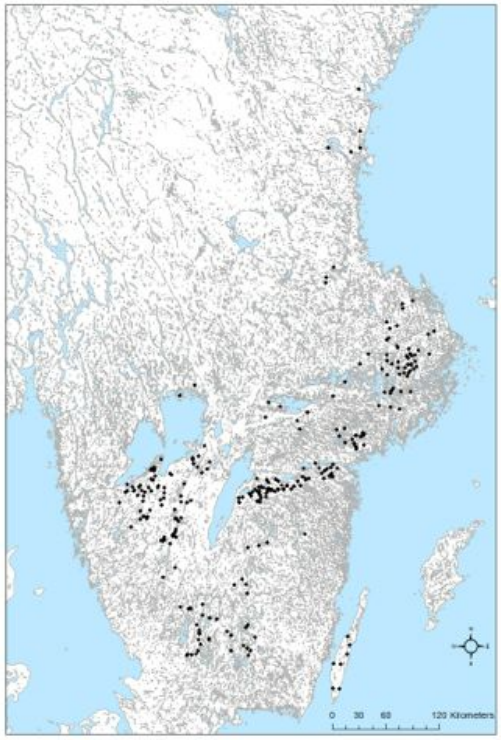
Example No.	Colour	Type	Origin	Stolen?
1	Red	Sports	Domestic	Yes
2	Red	Sports	Domestic	No
3	Red	Sports	Domestic	Yes
4	Yellow	Sports	Domestic	No
5	Yellow	Sports	Imported	Yes
6	Yellow	SUV	Imported	No
7	Yellow	SUV	Imported	Yes
8	Yellow	SUV	Domestic	No
9	Red	SUV	Imported	No
10	Red	Sports	Imported	Yes

Given a set of discrete attributes, (red/yellow, sports/SUV, domestic/imported), and whether or not the cars above were stolen, we can construct a probabilistic model which allows us to predict whether or not a car will be stolen as long as these attributes are known.

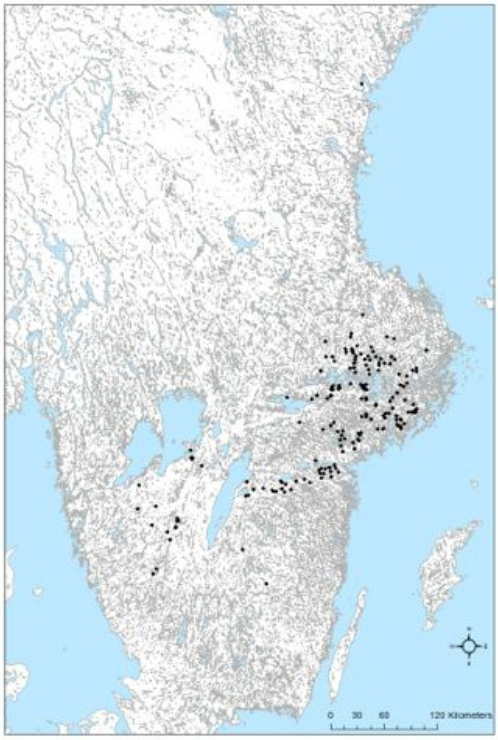
A test instance, in the form of a red, domestic SVU is run, and it is found that the probability of it being stolen is .037, and the probability of it not being stolen is 0.069. Given these numbers, the example is classified as a 'No' result.

(Modified from Mesiner, 2003)

APPENDIX E - GRÄSLUND'S STYLISTIC CHRONOLOGY



RAK c. 990-1015 CE



FP c. 1010-1050 CE

PR1 c. 1010-1040 CE

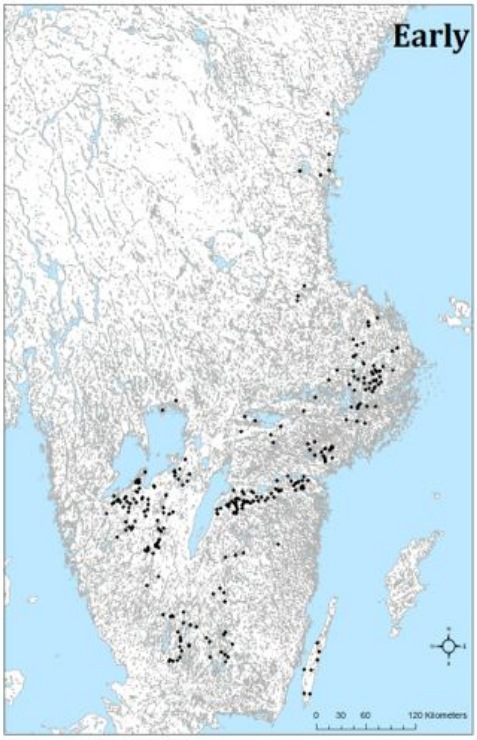
PR2 c. 1020-1050 CE

PR3 c. 1045-1075 CE

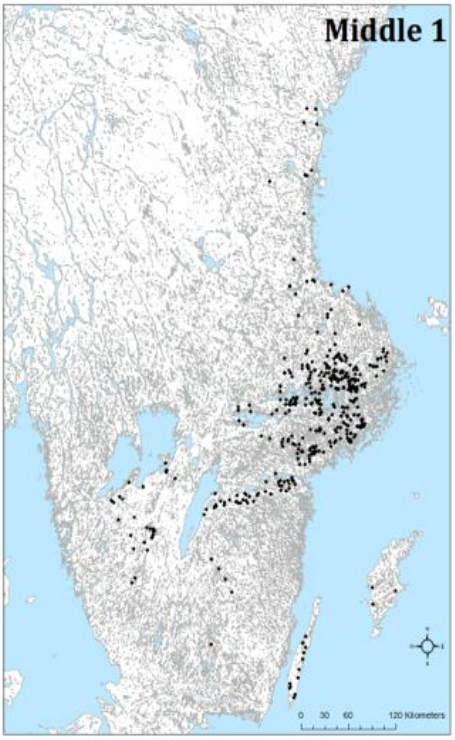
PR4 c. 1070-1100 CE

PR5 c. 1100-1130 CE

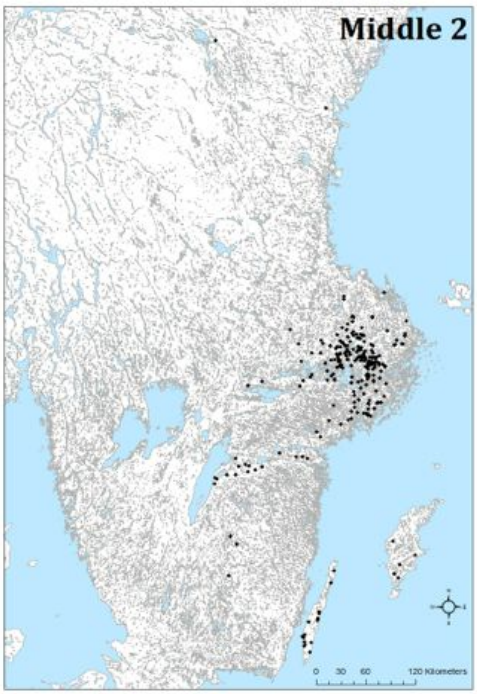
APPENDIX F – SPATIAL PATTERNING AND DATES



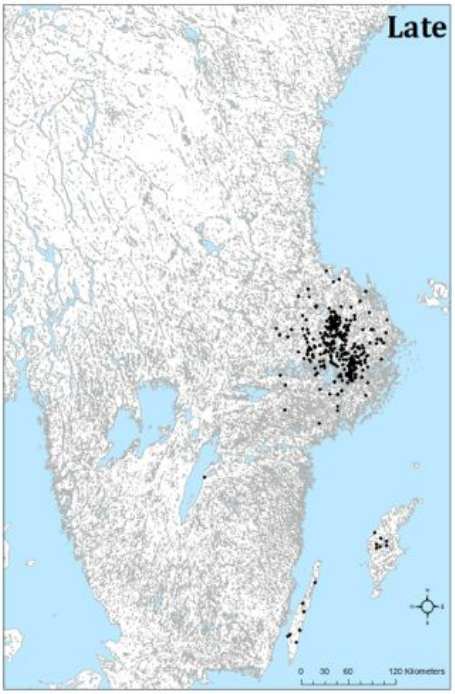
c. 990-1010 CE



c.1010-1050 CE



c.1050-1070 CE



c.1060-1130 CE

APPENDIX G - PREDICTIONS FROM PART 1 TEST 1

Rune-Stone	FP	KB	PR1	PR2	PR3	PR4	PR5	RAK	Predicted Class
G 116	0.103	0	0.161	0.017	0.003	0	0	0.715	RAK
Gs 18	0.01	0	0.011	0	0	0.19	0.453	0.336	PR5
Hs 14	0.043	0	0.034	0.074	0.14	0.338	0.06	0.311	PR4
Hs 9	0.105	0	0.05	0.078	0.049	0.463	0.06	0.195	PR4
M 3	0.048	0	0.016	0.046	0.003	0.015	0	0.872	RAK
M 7	0.168	0.001	0.04	0.146	0.04	0.22	0.031	0.354	RAK
M 8	0.137	0	0.031	0.037	0.01	0.172	0	0.613	RAK
Ög 108	0.413	0	0.313	0	0.274	0	0	0	FP
Ög 109	0.219	0	0.15	0.482	0.082	0.003	0	0.063	PR2
Ög 110	0.021	0.002	0.037	0	0	0.02	0.015	0.904	RAK
Ög 125	0.789	0.001	0.013	0.036	0.146	0.002	0	0.013	FP
Ög 130	0.102	0	0.077	0.064	0.058	0.311	0.073	0.314	RAK
Ög 135	0.377	0	0.182	0.234	0.159	0.021	0	0.027	FP
Ög 138	0.054	0	0.021	0	0.007	0.28	0.295	0.343	RAK
Ög 144	0.269	0.007	0.046	0.153	0.059	0.056	0	0.41	RAK
Ög 145	0.243	0.002	0.063	0.164	0.104	0.098	0.01	0.316	RAK
Ög 150	0.105	0	0.05	0.078	0.049	0.463	0.06	0.195	PR4
Ög 152	0.086	0.134	0	0	0.029	0.023	0	0.729	RAK
Ög 163	0.453	0	0	0.17	0.053	0	0	0.323	FP
Ög 180	0.137	0.001	0.124	0.069	0.097	0.047	0	0.525	RAK
Ög 181	0.028	0	0.08	0.177	0	0	0	0.715	RAK
Ög 19	0.25	0.002	0.025	0.099	0.079	0.155	0.012	0.378	RAK
Ög 206	0	0	0	0.175	0.116	0.709	0	0	PR4
Ög 209	0.377	0	0.182	0.234	0.159	0.021	0	0.027	FP
Ög 224	0.596	0	0.029	0.062	0	0	0	0.314	FP
Ög 226	0.259	0.001	0.068	0.133	0.487	0.012	0	0.039	PR3
Ög 26	0.074	0.001	0.05	0.197	0.031	0.083	0.004	0.56	RAK
Ög 46	0	0.664	0	0.023	0.13	0.182	0	0	KB
Ög 48	0.105	0	0.05	0.078	0.049	0.463	0.06	0.195	PR4
Ög 62	0.058	0	0.033	0.799	0.094	0.011	0	0.005	PR2
Ög 77	0.559	0.001	0.11	0.103	0	0	0	0.227	FP
Ög 83	0.176	0	0	0.247	0.23	0.346	0	0	PR4
Ög 95	0.453	0	0	0.17	0.053	0	0	0.323	FP
Ög Fv1959;241	0.048	0.001	0.103	0.176	0.068	0.294	0.043	0.267	PR4
Ög Fv1970;310	0.022	0	0.034	0.123	0.059	0.52	0.158	0.085	PR4
Öl 36	0.193	0	0.227	0.016	0.522	0.023	0	0.019	PR3
Sm 100	0.105	0	0.05	0.078	0.049	0.463	0.06	0.195	PR4
Sm 107	0.048	0	0.016	0.046	0.003	0.015	0	0.872	RAK
Sm 113	0.311	0	0.107	0.128	0	0	0	0.454	RAK
Sm 122	0.276	0	0	0.107	0.053	0	0	0.564	RAK
Sm 127	0.084	0.001	0.086	0.069	0.037	0.025	0.006	0.692	RAK
Sm 128	0.044	0	0.052	0.044	0.091	0.693	0	0.077	PR4
Sm 135	0.021	0.002	0.037	0	0	0.02	0.015	0.904	RAK

Sm 136	0.118	0	0	0.27	0.392	0.176	0	0.045	PR3
Sm 140	0.105	0	0.05	0.078	0.049	0.463	0.06	0.195	PR4
Sm 142	0.105	0	0.05	0.078	0.049	0.463	0.06	0.195	PR4
Sm 148	0.192	0	0.013	0.061	0.016	0.189	0.172	0.356	RAK
Sm 152	0.193	0	0.073	0.075	0.045	0.188	0.126	0.3	RAK
Sm 157	0.193	0	0.059	0.639	0.089	0.005	0	0.015	PR2
Sm 163	0.088	0	0.013	0.078	0.157	0.637	0.017	0.011	PR4
Sm 169	0.18	0	0.238	0.082	0.026	0	0	0.474	RAK
Sm 31	0.105	0	0.05	0.078	0.049	0.463	0.06	0.195	PR4
Sm 73	0.048	0	0.016	0.046	0.003	0.015	0	0.872	RAK
Sm 78	0.035	0.001	0.063	0.096	0.024	0.019	0.004	0.758	RAK
Sm 89	0.242	0	0.496	0	0.263	0	0	0	PR1
Sm 90	0.08	0	0.103	0.062	0.062	0.175	0.089	0.428	RAK
Sm 92	0.021	0	0.065	0.026	0	0	0	0.888	RAK
Sm 99	0.264	0	0.525	0	0.21	0	0	0	PR1
SÖ 103	0.066	0	0.16	0.067	0.484	0.208	0	0.014	PR3
SÖ 104	0.049	0.005	0.063	0.087	0.031	0.004	0	0.762	RAK
SÖ 114	0.286	0	0.191	0.047	0.007	0	0	0.469	RAK
SÖ 126	0.051	0	0.152	0.054	0.063	0.093	0.037	0.549	RAK
SÖ 129	1	0	0	0	0	0	0	0	FP
SÖ 13	0.046	0	0.006	0.077	0.135	0.631	0.087	0.018	PR4
SÖ 130	0.139	0	0.029	0	0.008	0.371	0.358	0.096	PR4
SÖ 145	0.044	0	0.139	0	0	0	0	0.816	RAK
SÖ 148	0.01	0	0.122	0.007	0	0	0	0.862	RAK
SÖ 15	0.145	0	0.072	0	0	0	0	0.784	RAK
SÖ 150	0.298	0.002	0.045	0.163	0.094	0.167	0.008	0.223	FP
SÖ 153	0.094	0.001	0.072	0.047	0.164	0.424	0.03	0.167	PR4
SÖ 157	0.298	0.002	0.045	0.163	0.094	0.167	0.008	0.223	FP
SÖ 160	0.219	0	0.18	0.561	0	0.041	0	0	PR2
SÖ 168	0.283	0	0.03	0	0.008	0.224	0.234	0.222	FP
SÖ 17	0.25	0.002	0.025	0.099	0.079	0.155	0.012	0.378	RAK
SÖ 182	0.25	0.002	0.025	0.099	0.079	0.155	0.012	0.378	RAK
SÖ 189	0.062	0	0.01	0.044	0.018	0.057	0	0.81	RAK
SÖ 215	0.016	0	0.063	0.144	0.02	0.084	0.015	0.656	RAK
SÖ 22	0.014	0	0.002	0.008	0.231	0.742	0	0.002	PR4
SÖ 23	0.127	0	0.013	0.076	0.412	0.368	0	0.004	PR3
SÖ 238	0.073	0	0.009	0.043	0.065	0.758	0.032	0.02	PR4
SÖ 245	0.426	0.002	0.052	0.121	0.067	0.053	0.013	0.267	FP
SÖ 247	0.269	0.007	0.046	0.153	0.059	0.056	0	0.41	RAK
SÖ 249	0.345	0.001	0.027	0.082	0.045	0.13	0.012	0.358	RAK
SÖ 25	0	0.971	0	0.026	0	0.003	0	0	KB
SÖ 260	0.105	0	0.05	0.078	0.049	0.463	0.06	0.195	PR4
SÖ 264	0.33	0	0.191	0.238	0	0.241	0	0	FP
SÖ 269	0.089	0.006	0.136	0.212	0.116	0.086	0	0.356	RAK
SÖ 270	0.588	0	0.016	0.345	0.037	0.001	0	0.012	FP
SÖ 276	0.066	0	0.268	0.045	0.056	0.065	0	0.499	RAK
SÖ 287	0.283	0	0.671	0.008	0	0.038	0	0	PR1
SÖ 300	0.098	0	0.01	0.033	0.011	0.672	0	0.178	PR4

SÖ 349	0.127	0	0.013	0.076	0.412	0.368	0	0.004	PR3
SÖ 351	0.145	0	0.072	0	0	0	0	0.784	RAK
SÖ 374	0.024	0	0.095	0.018	0.03	0.153	0.198	0.482	RAK
SÖ 42	0.185	0.002	0.025	0.04	0.023	0.014	0	0.711	RAK
SÖ 43	0.168	0.001	0.04	0.146	0.04	0.22	0.031	0.354	RAK
SÖ 44	0.183	0	0.099	0.113	0.012	0	0	0.593	RAK
SÖ 47	0	0.02	0.196	0	0	0	0	0.784	RAK
SÖ 7	0.302	0.001	0.151	0.119	0.361	0.03	0	0.036	PR3
SÖ 70	0.032	0	0.182	0.108	0.124	0.123	0.027	0.404	RAK
SÖ 82	0.08	0	0.103	0.062	0.062	0.175	0.089	0.428	RAK
SÖ 95	0	0.303	0.022	0.102	0.509	0	0	0.064	PR3
SÖ 97	0.14	0	0.062	0.048	0.062	0.341	0	0.347	RAK
SÖ 6163/61	0.075	0.001	0.179	0	0	0	0	0.745	RAK
SÖ Fv1954;22	0.105	0	0.05	0.078	0.049	0.463	0.06	0.195	PR4
SÖ Fv1969;298	0	0.034	0.03	0.246	0.448	0.082	0	0.16	PR3
SÖ Fv1979;240	0.269	0.007	0.046	0.153	0.059	0.056	0	0.41	RAK
U 1000	0.196	0	0.093	0.076	0.147	0.254	0.02	0.212	PR4
U 1012	0.029	0	0.05	0.016	0.023	0.222	0.369	0.29	PR5
U 1017	0.199	0	0.06	0.093	0.123	0.377	0.017	0.131	PR4
U 1031	0.16	0	0.015	0.021	0.346	0.428	0	0.03	PR4
U 1041	0.044	0	0.005	0.045	0.324	0.581	0	0.001	PR4
U 1043	0.218	0	0	0.117	0.579	0.084	0	0.002	PR3
U 1049	0.034	0	0.04	0.137	0.123	0.525	0.031	0.11	PR4
U 1054	0	0	0	0.109	0.166	0.724	0	0.002	PR4
U 106	0	0	0.014	0.024	0.271	0.689	0	0.002	PR4
U 1061	0.337	0.004	0.018	0.153	0.028	0.096	0.027	0.339	RAK
U 1064	0.044	0	0.011	0.063	0.06	0.75	0.057	0.015	PR4
U 107	0.087	0	0.009	0.095	0.03	0.622	0.083	0.074	PR4
U 1077	0	0	0.002	0.003	0.022	0.972	0	0.001	PR4
U 108	0.033	0	0.007	0.031	0.022	0.787	0.097	0.025	PR4
U 1090	0.033	0	0.007	0.031	0.022	0.787	0.097	0.025	PR4
U 1126	0.086	0	0.102	0.016	0.289	0.487	0	0.02	PR4
U 1142	0	0	0	0.612	0.347	0.031	0	0.01	PR2
U 1145	0.086	0.001	0.094	0.088	0.064	0.315	0.032	0.321	RAK
U 129	0.034	0	0.037	0.041	0.085	0.683	0.078	0.042	PR4
U 149	0	0	0.003	0.015	0.104	0.877	0	0	PR4
U 151	0	0	0	0.098	0.899	0	0	0.002	PR3
U 157	0.233	0.001	0.012	0.162	0.384	0.2	0	0.008	PR3
U 16	0.071	0	0.055	0.151	0.71	0.013	0	0	PR3
U 164	0	0	0.024	0.363	0.599	0	0	0.014	PR3
U 183	0.033	0	0.007	0.031	0.022	0.787	0.097	0.025	PR4
U 212	1	0	0	0	0	0	0	0	FP
U 25	0.139	0	0.029	0	0.008	0.371	0.358	0.096	PR4
U 255	0	0	0.003	0.015	0.104	0.877	0	0	PR4
U 26	0.287	0	0	0.291	0.224	0.118	0	0.08	PR2
U 261	0	0	0.024	0.363	0.599	0	0	0.014	PR3
U 268	0	0	0.003	0.015	0.104	0.877	0	0	PR4
U 27	0.549	0	0	0.274	0	0	0	0.177	FP

U 293	0.116	0.131	0	0	0.68	0.024	0	0.048	PR3
U 294	0.067	0	0.009	0.028	0.221	0.671	0	0.004	PR4
U 296	0	0	0.02	0.007	0.099	0.872	0	0.001	PR4
U 316	0	0	0	0	0.457	0.521	0	0.022	PR4
U 322	0.297	0	0	0.126	0.549	0.021	0	0.007	PR3
U 339	0.168	0.001	0.045	0.088	0.452	0.208	0	0.038	PR3
U 342	0.052	0	0.01	0.023	0.058	0.752	0.045	0.06	PR4
U 345	0.27	0	0.374	0.096	0	0.26	0	0	PR1
U 346	0.127	0	0.013	0.076	0.412	0.368	0	0.004	PR3
U 367	0	0	0.003	0.028	0.112	0.848	0	0.009	PR4
U 381	0.013	0	0.008	0.359	0.62	0	0	0	PR3
U 385	0	0	0	0	0.172	0.828	0	0	PR4
U 387	0.116	0.001	0.055	0.064	0.032	0.22	0.059	0.453	RAK
U 39	0.233	0	0	0.248	0.514	0.005	0	0	PR3
U 393	0.074	0.001	0.05	0.197	0.031	0.083	0.004	0.56	RAK
U 394	0.224	0	0.113	0.047	0.465	0.151	0	0	PR3
U 397	0.41	0.001	0.039	0.069	0.441	0.023	0	0.017	PR3
U 420	0	0	0.007	0.024	0.136	0.83	0	0.002	PR4
U 437	0.051	0	0.1	0.56	0.245	0.035	0	0.009	PR2
U 443	0.205	0.001	0.025	0.176	0.227	0.303	0.016	0.046	PR4
U 447	0.036	0	0.074	0.665	0.209	0.002	0	0.014	PR2
U 452	0.205	0.001	0.025	0.176	0.227	0.303	0.016	0.046	PR4
U 46	0.041	0	0.012	0.07	0.083	0.66	0.03	0.105	PR4
U 462	0	0	0.003	0.015	0.104	0.877	0	0	PR4
U 464	0.116	0.005	0.024	0.128	0.215	0.298	0	0.214	PR4
U 467	0.412	0	0	0.305	0.216	0.021	0	0.046	FP
U 470	0.282	0	0.058	0.089	0.315	0.212	0	0.044	PR3
U 472	0	0	0.003	0.015	0.104	0.877	0	0	PR4
U 488	0.127	0	0.013	0.076	0.412	0.368	0	0.004	PR3
U 493	0.355	0	0.153	0.212	0.215	0.052	0	0.012	FP
U 498	0.03	0	0.096	0.127	0.18	0.232	0.054	0.281	RAK
U 50	0.09	0	0.023	0.037	0.037	0.331	0.388	0.094	PR5
U 520	0	0	0.005	0.012	0.071	0.91	0	0.002	PR4
U 531	0.519	0.007	0.017	0.147	0.056	0.063	0.006	0.184	FP
U 542	0.065	0.002	0.043	0.207	0.092	0.403	0.022	0.166	PR4
U 549	0.026	0	0.053	0.08	0.06	0.467	0.066	0.247	PR4
U 550	0.298	0.002	0.045	0.163	0.094	0.167	0.008	0.223	FP
U 555	0.11	0.001	0.023	0.224	0.103	0.396	0.071	0.074	PR4
U 576	0.409	0.002	0.043	0.15	0.232	0.091	0	0.072	FP
U 587	0.16	0.007	0.108	0.244	0.252	0.025	0	0.203	PR3
U 598	0.192	0	0.013	0.061	0.016	0.189	0.172	0.356	RAK
U 60	0.101	0	0.039	0.096	0.349	0.374	0	0.04	PR4
U 608	0.127	0	0.013	0.076	0.412	0.368	0	0.004	PR3
U 610	0	0	0.022	0.028	0.128	0.813	0	0.009	PR4
U 613	0	0	0	0.086	0.903	0	0	0.012	PR3
U 620	0.172	0	0.114	0.018	0.608	0.055	0	0.034	PR3
U 625	0.022	0	0.001	0.024	0.056	0.873	0.022	0.001	PR4
U 63	0.045	0	0.002	0.033	0.208	0.712	0	0.001	PR4

U 653	0.059	0	0	0	0.854	0.087	0	0	PR3
U 658	0.1	0	0.005	0.529	0.344	0.022	0	0	PR2
U 674	0	0	0	0.004	0.03	0.966	0	0	PR4
U 681	0.76	0	0	0	0.135	0.013	0	0.092	FP
U 738	0.626	0	0	0.161	0.202	0.003	0	0.008	FP
U 783	0.086	0.001	0.094	0.088	0.064	0.315	0.032	0.321	RAK
U 784	0.051	0	0.152	0.054	0.063	0.093	0.037	0.549	RAK
U 8	0.015	0	0.005	0.064	0.135	0.751	0.016	0.014	PR4
U 802	0.453	0	0.004	0.325	0.213	0.005	0	0	FP
U 804	0	0	0.001	0.003	0.034	0.961	0	0	PR4
U 826	0	0	0.032	0.013	0.106	0.838	0	0.012	PR4
U 846	0.509	0	0	0.123	0.27	0.079	0	0.018	FP
U 849	0.725	0	0	0.135	0	0	0	0.139	FP
U 85	0.03	0	0.198	0.109	0.32	0.343	0	0	PR4
U 863	0.069	0	0.065	0.033	0.038	0.445	0.11	0.239	PR4
U 893	0.008	0	0.004	0.008	0.008	0.483	0.463	0.026	PR4
U 901	0.218	0	0	0.117	0.579	0.084	0	0.002	PR3
U 905	0.151	0	0.038	0	0.024	0.332	0.119	0.336	RAK
U 909	0.199	0	0.06	0.093	0.123	0.377	0.017	0.131	PR4
U 924	0.086	0.001	0.094	0.088	0.064	0.315	0.032	0.321	RAK
U 932	0	0	0	0.115	0.649	0.231	0	0.004	PR3
U 94	0.137	0	0.031	0.037	0.01	0.172	0	0.613	RAK
U 942	0.397	0	0	0.24	0.16	0	0	0.202	FP
U 947	0.54	0.004	0.034	0.106	0.172	0.013	0	0.13	FP
U 951	0	0	0	0.419	0.567	0.014	0	0	PR3
U 953	0.064	0	0.032	0.018	0.015	0.215	0.472	0.184	PR5
U 967	0.298	0.002	0.045	0.163	0.094	0.167	0.008	0.223	FP
U 969	0	0	0.047	0.012	0.425	0.513	0	0.003	PR4
U 97	0.168	0.001	0.04	0.146	0.04	0.22	0.031	0.354	RAK
U 975	0.328	0.084	0	0	0.172	0.278	0	0.137	FP
U 986	0	0	0	0.115	0.649	0.231	0	0.004	PR3
U 988	0.198	0	0.16	0.017	0	0.015	0	0.61	RAK
U Fv1953;268	0.402	0	0	0.2	0.379	0.008	0	0.011	FP
U Fv1959;250	0	0	0	0.004	0.03	0.966	0	0	PR4
U Fv1959;256	0.129	0	0.014	0.543	0.309	0.005	0	0	PR2
U Fv1967;262A	0.233	0.001	0.012	0.162	0.384	0.2	0	0.008	PR3
U Fv1968;276	0	0	0.41	0.074	0.346	0	0	0.17	PR1
U Fv1986;84	0	0	0	0.02	0.27	0.709	0	0.001	PR4
U Fv1990;32B	0.159	0	0.129	0.077	0.161	0.148	0.026	0.3	RAK
U Fv1993;231	0.008	0	0.024	0.014	0.034	0.609	0.224	0.087	PR4
U Fv1993;235	0.298	0.004	0.048	0.108	0.268	0.061	0	0.213	FP
Vg 107	0.298	0.002	0.045	0.163	0.094	0.167	0.008	0.223	FP
Vg 159	0.239	0	0.226	0.22	0.093	0	0	0.221	FP
Vg 190	0.467	0	0.121	0.061	0	0	0	0.351	FP
Vg 193	0	0.017	0	0.311	0.015	0.005	0	0.651	RAK
Vg 78	0.102	0	0.077	0.064	0.058	0.311	0.073	0.314	RAK
Vs 3	0.087	0	0	0.025	0.884	0	0	0.003	PR3
Vs 32	0.041	0	0.012	0.07	0.083	0.66	0.03	0.105	PR4

APPENDIX H - PREDICTIONS FROM PART 1 TEST 2

Rune-Stone	E	M1	M2	L	Predicted Class
G 116	0.779	0.218	0.003	0	E
Gs 18	0.394	0.035	0	0.572	L
Hs 9	0.187	0.239	0.047	0.527	L
M 3	0.848	0.132	0.003	0.017	E
M 7	0.345	0.356	0.039	0.26	M1
M 8	0.589	0.213	0.01	0.188	E
Ög 108	0	0.718	0.282	0	M1
Ög 109	0.051	0.88	0.067	0.002	M1
Ög 110	0.886	0.07	0	0.045	E
Ög 125	0.023	0.721	0.251	0.005	M1
Ög 130	0.302	0.262	0.056	0.38	L
Ög 135	0.021	0.84	0.125	0.015	M1
Ög 138	0.364	0.107	0.007	0.522	L
Ög 144	0.377	0.52	0.055	0.049	M1
Ög 145	0.29	0.508	0.095	0.106	M1
Ög 150	0.187	0.239	0.047	0.527	L
Ög 152	0.847	0.083	0.034	0.036	E
Ög 163	0.266	0.69	0.044	0	M1
Ög 180	0.466	0.402	0.086	0.046	E
Ög 181	0.707	0.293	0	0	E
Ög 19	0.35	0.413	0.073	0.163	M1
Ög 206	0	0.421	0.083	0.496	L
Ög 209	0.021	0.84	0.125	0.015	M1
Ög 210	0	0.3	0.478	0.222	M2
Ög 226	0.036	0.506	0.449	0.009	M1
Ög 26	0.562	0.31	0.031	0.097	E
Ög 46	0	0.209	0.331	0.46	L
Ög 48	0.187	0.239	0.047	0.527	L
Ög 62	0.008	0.809	0.163	0.02	M1
Ög 77	0.228	0.772	0	0	M1
Ög 95	0.266	0.69	0.044	0	M1
Ög Fv1959;241	0.256	0.342	0.065	0.337	M1
Ög Fv1970;310	0.083	0.187	0.058	0.672	L
Öl 36	0.022	0.352	0.603	0.023	M2
Sm 100	0.187	0.239	0.047	0.527	L
Sm 107	0.848	0.132	0.003	0.017	E
Sm 113	0.431	0.569	0	0	M1
Sm 122	0.417	0.544	0.039	0	M1
Sm 127	0.67	0.251	0.036	0.044	E
Sm 128	0.075	0.135	0.088	0.702	L
Sm 135	0.886	0.07	0	0.045	E
Sm 136	0.047	0.377	0.406	0.17	M2
Sm 140	0.187	0.239	0.047	0.527	L
Sm 142	0.187	0.239	0.047	0.527	L

Sm 148	0.394	0.271	0.018	0.317	E
Sm 152	0.299	0.34	0.045	0.316	M1
Sm 157	0.016	0.88	0.098	0.005	M1
Sm 163	0.011	0.195	0.158	0.637	L
Sm 169	0.464	0.51	0.025	0	M1
Sm 31	0.187	0.239	0.047	0.527	L
Sm 55	0	1	0	0	M1
Sm 73	0.848	0.132	0.003	0.017	E
Sm 78	0.744	0.207	0.024	0.026	E
Sm 89	0	0.692	0.308	0	M1
Sm 90	0.423	0.273	0.061	0.243	E
Sm 92	0.888	0.112	0	0	E
Sm 99	0	0.663	0.337	0	M1
SÖ 103	0.014	0.345	0.478	0.163	M2
SÖ 114	0.51	0.482	0.008	0	E
SÖ 126	0.555	0.242	0.064	0.14	E
SÖ 129	0	1	0	0	M1
SÖ 13	0.015	0.117	0.112	0.756	L
SÖ 132	0.865	0.094	0.033	0.009	E
SÖ 143	0	0.245	0.738	0.017	M2
SÖ 145	0.904	0.096	0	0	E
SÖ 148	0.934	0.066	0	0	E
SÖ 149	0	0.299	0.621	0.08	M2
SÖ 15	0.764	0.236	0	0	E
SÖ 150	0.219	0.514	0.092	0.176	M1
SÖ 152	0	0.506	0.457	0.037	M1
SÖ 153	0.157	0.238	0.154	0.45	L
SÖ 157	0.219	0.514	0.092	0.176	M1
SÖ 160	0	0.965	0	0.035	M1
SÖ 168	0.239	0.303	0.009	0.449	L
SÖ 17	0.35	0.413	0.073	0.163	M1
SÖ 172	0	0.587	0.29	0.123	M1
SÖ 177	0.035	0.163	0.801	0.002	M2
SÖ 182	0.35	0.413	0.073	0.163	M1
SÖ 184	0	0.573	0	0.427	M1
SÖ 189	0.763	0.165	0.017	0.055	E
SÖ 215	0.672	0.191	0.021	0.116	E
SÖ 22	0.002	0.035	0.233	0.731	L
SÖ 23	0.004	0.237	0.429	0.33	M2
SÖ 232	0	1	0	0	M1
SÖ 238	0.019	0.128	0.064	0.788	L
SÖ 242	0	1	0	0	M1
SÖ 245	0.274	0.574	0.069	0.083	M1
SÖ 247	0.377	0.52	0.055	0.049	M1
SÖ 249	0.359	0.443	0.045	0.153	M1
SÖ 25	0	0.951	0	0.049	M1
SÖ 260	0.187	0.239	0.047	0.527	L
SÖ 264	0	0.797	0	0.203	M1

SÖ 270	0.012	0.95	0.036	0.001	M1
SÖ 276	0.532	0.314	0.06	0.095	E
SÖ 287	0	0.926	0	0.074	M1
SÖ 300	0.162	0.132	0.01	0.696	L
SÖ 34	0	0.138	0.861	0.001	M2
SÖ 343	0	0.639	0.277	0.084	M1
SÖ 349	0.004	0.237	0.429	0.33	M2
SÖ 351	0.764	0.236	0	0	E
SÖ 36	0	0.5	0.5	0	M2
SÖ 362	0	0.045	0.955	0	M2
SÖ 363	0	0.084	0.916	0	M2
SÖ 374	0.55	0.119	0.035	0.296	E
SÖ 42	0.656	0.304	0.022	0.018	E
SÖ 43	0.345	0.356	0.039	0.26	M1
SÖ 44	0.544	0.445	0.011	0	E
SÖ 47	0.762	0.238	0	0	E
SÖ 60	0	1	0	0	M1
SÖ 7	0.033	0.61	0.335	0.021	M1
SÖ 70	0.403	0.304	0.124	0.17	E
SÖ 85	0	0.045	0.955	0	M2
SÖ 95	0.084	0.247	0.669	0	M2
SÖ 97	0.327	0.278	0.058	0.337	L
SÖ ATA6163/61	0.824	0.176	0	0	E
SÖ Fv1948;282	0	0.245	0.738	0.017	M2
SÖ Fv1954;22	0.187	0.239	0.047	0.527	L
SÖ Fv1958;242	0	0.207	0.776	0.016	M2
SÖ Fv1969;298	0.186	0.209	0.522	0.084	M2
SÖ Fv1979;240	0.377	0.52	0.055	0.049	M1
SÖ Fv1982;235	0	0.362	0.503	0.135	M2
SÖ Fv1993;229	0	0.487	0.498	0.014	M2
U 1000	0.2	0.394	0.138	0.268	M1
U 1012	0.38	0.122	0.03	0.467	L
U 1017	0.127	0.371	0.12	0.382	L
U 1031	0.029	0.213	0.338	0.42	L
U 1041	0.001	0.103	0.34	0.556	L
U 1043	0.002	0.296	0.629	0.072	M2
U 1049	0.106	0.225	0.119	0.549	L
U 1054	0.003	0.041	0.223	0.733	L
U 106	0.002	0.045	0.267	0.685	L
U 1061	0.351	0.488	0.029	0.132	M1
U 1064	0.014	0.116	0.058	0.812	L
U 107	0.072	0.168	0.029	0.731	L
U 1077	0.001	0.005	0.02	0.974	L
U 108	0.023	0.068	0.021	0.888	L
U 1126	0.021	0.18	0.299	0.5	L
U 1142	0.013	0.541	0.417	0.029	M1
U 1145	0.303	0.262	0.061	0.374	L

U 129	0.036	0.108	0.073	0.783	L
U 149	0.001	0.023	0.119	0.857	L
U 151	0.003	0.019	0.978	0	M2
U 157	0.008	0.402	0.405	0.186	M2
U 16	0	0.357	0.636	0.007	M2
U 164	0.016	0.3	0.684	0	M2
U 183	0.023	0.068	0.021	0.888	L
U 212	0	1	0	0	M1
U 25	0.103	0.163	0.009	0.726	L
U 255	0.001	0.023	0.119	0.857	L
U 26	0.078	0.583	0.218	0.12	M1
U 261	0.016	0.3	0.684	0	M2
U 268	0.001	0.023	0.119	0.857	L
U 27	0.185	0.815	0	0	M1
U 293	0.055	0.139	0.779	0.026	M2
U 294	0.004	0.11	0.223	0.663	L
U 296	0.002	0.03	0.123	0.845	L
U 316	0.023	0.077	0.479	0.421	M2
U 322	0.007	0.412	0.564	0.017	M2
U 339	0.037	0.35	0.437	0.176	M2
U 342	0.057	0.093	0.056	0.795	L
U 345	0	0.796	0	0.204	M1
U 346	0.004	0.237	0.429	0.33	M2
U 367	0.009	0.024	0.112	0.855	L
U 379	0	0.619	0.153	0.227	M1
U 381	0	0.281	0.718	0	M2
U 385	0	0	0.151	0.849	L
U 387	0.437	0.245	0.031	0.287	E
U 39	0	0.408	0.588	0.004	M2
U 393	0.562	0.31	0.031	0.097	E
U 394	0	0.409	0.463	0.127	M2
U 397	0.019	0.489	0.473	0.02	M1
U 420	0.002	0.041	0.138	0.818	L
U 443	0.043	0.434	0.212	0.311	M1
U 452	0.043	0.434	0.212	0.311	M1
U 46	0.102	0.14	0.08	0.678	L
U 462	0.001	0.023	0.119	0.857	L
U 464	0.2	0.37	0.201	0.229	M1
U 467	0.051	0.692	0.235	0.022	M1
U 470	0.045	0.442	0.319	0.194	M1
U 472	0.001	0.023	0.119	0.857	L
U 488	0.004	0.237	0.429	0.33	M2
U 493	0.011	0.751	0.191	0.048	M1
U 498	0.266	0.284	0.171	0.28	M1
U 50	0.105	0.183	0.041	0.67	L
U 520	0.002	0.02	0.075	0.903	L
U 531	0.206	0.649	0.063	0.083	M1
U 542	0.155	0.293	0.086	0.467	L

U 550	0.219	0.514	0.092	0.176	M1
U 555	0.071	0.344	0.099	0.487	L
U 576	0.075	0.598	0.24	0.087	M1
U 587	0.191	0.55	0.237	0.022	M1
U 598	0.394	0.271	0.018	0.317	E
U 60	0.037	0.27	0.322	0.371	L
U 608	0.004	0.237	0.429	0.33	M2
U 610	0.01	0.067	0.138	0.785	L
U 613	0.011	0.115	0.873	0	M2
U 615	0	0.61	0.39	0	M1
U 625	0.001	0.046	0.058	0.895	L
U 63	0.001	0.082	0.232	0.685	L
U 653	0	0.187	0.76	0.053	M2
U 658	0	0.495	0.482	0.023	M1
U 674	0	0.004	0.035	0.961	L
U 681	0.114	0.702	0.166	0.018	M1
U 738	0.011	0.7	0.285	0.004	M1
U 741	0	0.472	0.528	0	M2
U 783	0.303	0.262	0.061	0.374	L
U 784	0.555	0.242	0.064	0.14	E
U 8	0.013	0.078	0.131	0.778	L
U 804	0	0.006	0.034	0.959	L
U 826	0.012	0.044	0.107	0.837	L
U 846	0.026	0.5	0.393	0.081	M1
U 849	0.136	0.864	0	0	M1
U 85	0	0.323	0.315	0.363	L
U 863	0.232	0.162	0.037	0.57	L
U 893	0.033	0.029	0.01	0.928	L
U 901	0.002	0.296	0.629	0.072	M2
U 905	0.306	0.204	0.022	0.468	L
U 909	0.127	0.371	0.12	0.382	L
U 912	0	0.537	0.4	0.063	M1
U 916	0	0.22	0.693	0.086	M2
U 920	0	1	0	0	M1
U 924	0.303	0.262	0.061	0.374	L
U 932	0.004	0.166	0.648	0.182	M2
U 94	0.589	0.213	0.01	0.188	E
U 946	0	0.626	0.281	0.092	M1
U 953	0.256	0.145	0.021	0.578	L
U 967	0.219	0.514	0.092	0.176	M1
U 969	0.003	0.038	0.476	0.483	L
U 97	0.345	0.356	0.039	0.26	M1
U 975	0.162	0.27	0.203	0.365	L
U 986	0.004	0.166	0.648	0.182	M2
U 988	0.601	0.382	0	0.017	E
U Fv1953;268	0.012	0.557	0.423	0.008	M1
U Fv1959;250	0	0.004	0.035	0.961	L
U Fv1959;256	0.001	0.612	0.383	0.005	M1

U Fv1967;262A	0.008	0.402	0.405	0.186	M2
U Fv1968;276	0.182	0.448	0.37	0	M1
U Fv1986;84	0.001	0.037	0.272	0.689	L
U Fv1990;32B	0.276	0.406	0.148	0.169	M1
U Fv1993;231	0.086	0.049	0.034	0.831	L
U Fv1993;235	0.19	0.515	0.239	0.056	M1
Vg 107	0.219	0.514	0.092	0.176	M1
Vg 159	0.165	0.766	0.069	0	M1
Vg 190	0.373	0.627	0	0	M1
Vg 193	0.868	0.106	0.021	0.006	E
Vg 78	0.302	0.262	0.056	0.38	L
Vs 3	0.003	0.176	0.822	0	M2
Vs 32	0.102	0.14	0.08	0.678	L

APPENDIX I – STATISTICAL SIMILARITIES IN FINDSPOTS

PROVINCES

	G.G	G.OG	G.O	G.SM	G.VG	S.N	S.SO	S.U	S.VS	S.VA	N.G	N.HS	N.M
G.G	100%	100	20	100	100	80	100	100	100	20	60	40	100
G.OG	62.5	100%	37.5	100	87.5	62.5	87.5	100	87.5	37.5	37.5	25	87.5
G.O	33.3	100	100%	100	100	66.7	100	100	100	0	33.3	33.3	100
G.SM	62.5	100	37.5	100%	87.5	62.5	87.5	100	87.5	12.5	37.5	25	87.5
G.VG	71.4	100	42.9	100	100%	71.4	100	100	100	42.9	42.9	28.6	100
S.N	66.7	83.3	33.3	83.3	83.3	100%	100	100	83.3	16.7	50	33.3	83.3
S.SO	62.5	87.5	37.5	87.5	87.5	75	100%	100	87.5	37.5	37.5	25	87.5
S.U	50	80	30	80	70	60	80	100%	70	30	30	20	70
S.VS	71.4	100	42.9	100	100	71.4	100	100	100%	14.3	42.9	28.6	100
S.VA	100	100	0	100	100	100	100	100	100	100%	100	0	100
N.G	100	100	33.3	100	100	100	100	100	100	33.4	100%	66.6	100
N.HS	100	100	50	100	100	100	100	100	100	50	100	100%	100
N.M	71.4	100	42.9	100	100	71.4	100	100	100	42.9	42.8	28.6	100%

REGIONS

	G	S	N
G	100	100	87.5
S	80	100	70
N	100	100	100

APPENDIX J – STATISTICAL SIMILARITIES IN CROSS FEATURES

PROVINCES

	G.G	G.OG	G.O	G.SM	G.VG	S.N	S.SO	S.U	S.VS	N.G	N.HS	N.J	N.M
G.G	100%	85	45	85	80	50	95	100	50	70	65	30	40
G.OG	44.7	100%	39.5	86.8	71.1	26.3	94.7	95.7	26.3	60.5	42.1	18.4	28.9
G.O	56.3	93.8	100%	81.3	75	37.5	100	100	37.5	62.5	56.3	18.8	25
G.SM	48.6	94.3	37.1	100%	74.3	25.7	100	97.1	25.7	65.7	45.7	71.1	31.4
G.VG	51.6	87.1	38.7	83.9	100%	32.3	96.8	96.8	32.3	64.5	48.4	22.6	35.5
S.N	100	100	60	90	100	100%	100	100	100	80	70	50	50
S.SO	41.3	78.3	34.8	76.1	65.2	21.7	100%	95.7	21.7	52.2	37	15.2	26.1
S.U	39.2	70.6	31.4	66.7	58.8	19.6	86.3	100%	19.6	47.1	35.3	13.7	23.5
S.VS	47.6	85.7	57.1	85.7	71.4	28.6	100	100	100%	71.4	61.9	28.6	42.9
N.G	58.3	95.8	41.7	95.8	83.3	33.3	100	100	33.3	100%	54.2	25	41.7
N.HS	72.2	88.9	50	88.9	83.3	38.9	95.5	100	38.9	72.2	100%	33.3	50
N.J	85.7	100	42.9	85.7	100	71.4	100	100	71.4	85.7	85.7	100%	71.4
N.M	66.7	91.7	33.3	91.7	91.7	41.7	100	100	41.7	83.36	75	41.7	100%

REGIONS

	G	S	N
G	100	100	68.9
S	84.9	100	60.4
N	96.9	100	100