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Close Mapping of St. Olav's Pilgrimage Path Through Gudbrandsdal Norway: Probabilities of a Designed, Land Surveyed Concept of a Large-Scale Christianised Landscape

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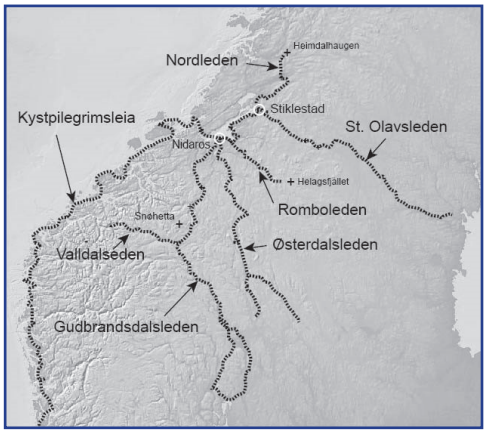
This exercise in Norway *'close-maps'* accurate, existing geometries between thirty-two latitude / longitude points of mostly medieval churches and other sites on the major pilgrimage path through Gudbrandsdal to Trondheimsfjord where the martyr St.Olav was venerated. Site data and basic path routes are taken from the *Pilegrimsleden* website, popular today with religious or recreational tourists. The inclusion of the largest prehistoric monumental mound in Scandinavia as an important early stop on the pilgrimage provides the first clue to the eventual mapping of a large-scale *'system'* of land surveyed patterns. This symbolic anchor in the south, is connected to likely ancient religious sites to the north in Trondheimsfjord where St. Olav was killed in battle. Discovered are several early church sites key to site integration but not included as part of today's pilgrim path. The Gudbrandsdal route appears to have been laid out earlier than the smaller volume, overlapping, Østerdal path immediately to the east.

To distinguish formally designed geometric large-scale patterns from random phenomena, test areas are created where equal numbers of random points replace the existing. Combinations of three-point alignments, cardinal (N-S. E-W) alignments between two points, and right-angle relationships between three points are tested at increasing complexities of combination at accuracies of 0.06° angular deviation or less, mostly around 0.04°. The *'systemic'* map pattern that tests show to be highly probable as designed and land surveyed - occurring about 1 in 100,000 random sets - shows considerable overlap with the *Gudbrandalsleden* map created by the Norwegian website, but variation and omission of important sites occur. The conclusion raises final questions about the value of this real, close-map information to the modern *'pilgrim'*, and to more academic historians and archaeologists. Can today's path experience be heightened by the creation of a more holistic and symbolic concept of modern Norwegian landscape, this is considered together with insights into how historically such a concept may have moderated civil conflict and integrated an imported book-based religion with ancient Norse ritual practice?

Key Words: ritual landscape, medieval churches, land surveying, Norwegian pilgrimage, St. Olav

Figure 1: St. Olav's Medieval Pilgrim Paths
(as represented in the website 'Pilegrimsleden')



The author's dissertation some forty years ago closely mapped the medieval layout of farms and their timber buildings in Norway (Doxtater 1981). While Viking or Norse religious concepts were clearly demonstrated by formal aspects of architecture, *tun* layout (farm cluster of buildings) and ritual practice at this smaller scale, missing was any close mapping of the larger cultural landscape. The study of the locations and orientations of standing medieval *fylke* (parish) churches, however, has recently led to a large-scale hypothesis (Doxtater 2022). While much partial evidence exists of ritual formalisation of the larger landscape during Bronze and Iron-Age periods, a well-integrated systemic (re)modeling did not take place until instigated by pilgrim paths in the 1200's.

One of the first of few written sources depicting a St. Olav pilgrimage comes from Adam von Bremen in the year 1070, about forty years after St. Olav's death and canonisation (for this history see Bagge 2010). Von Bremen describes the Archbishop's visit to the 'Church in the North' including Nidaros and portrays the pilgrimage to Trondheim:

> *The Norwegians' most important city is Trondheim. It is now decorated with churches and visited by many people. There is the very blessed king and martyr Olav's relics. At his tomb the Lord also today works the greatest healing miracles. And people, who believe that they can be helped through this holy man's meritorious deeds, are coming from far away. If you are sailing from Aalborg or Vendesyssel in Denmark, you will arrive in Viken (todays Oslo), which is a city in Norway. From there you turn left and sail along the Norwegian coast, and at the fifth day you reach the city of Trondheim. You could also go another way, coming from the Dane's Skaane, across land to Trondheim. But this route across the mountains takes more time, and as it is dangerous, it is avoided by the travelers* (Pilegrimsleden website accessed 2022).

This website offers a number of different routes for today's tourists, both religious and recreational, however, it disagrees somewhat with Adam of Bremen regarding the widely used and longest route in Norway, *Gudbrandsdalsleden.*

To make the route more accommodating, King Oistein Magnussen in the 1120's built shelters at several places in the higher elevations on Dovre mountain's plateau.

> *The care for the pilgrims was so important that there was a detailed regulation in Norwegian law for the stay in these pilgrim shelters in the Norwegian legislation the 'Gulatingsloven'* (ibid).

From these two sources alone one can speculate about the period between when Olav was canonised, 1031, and the 1200's when paths had become more established and shelters provided, especially for the *Gudbrandsdalsleden*.

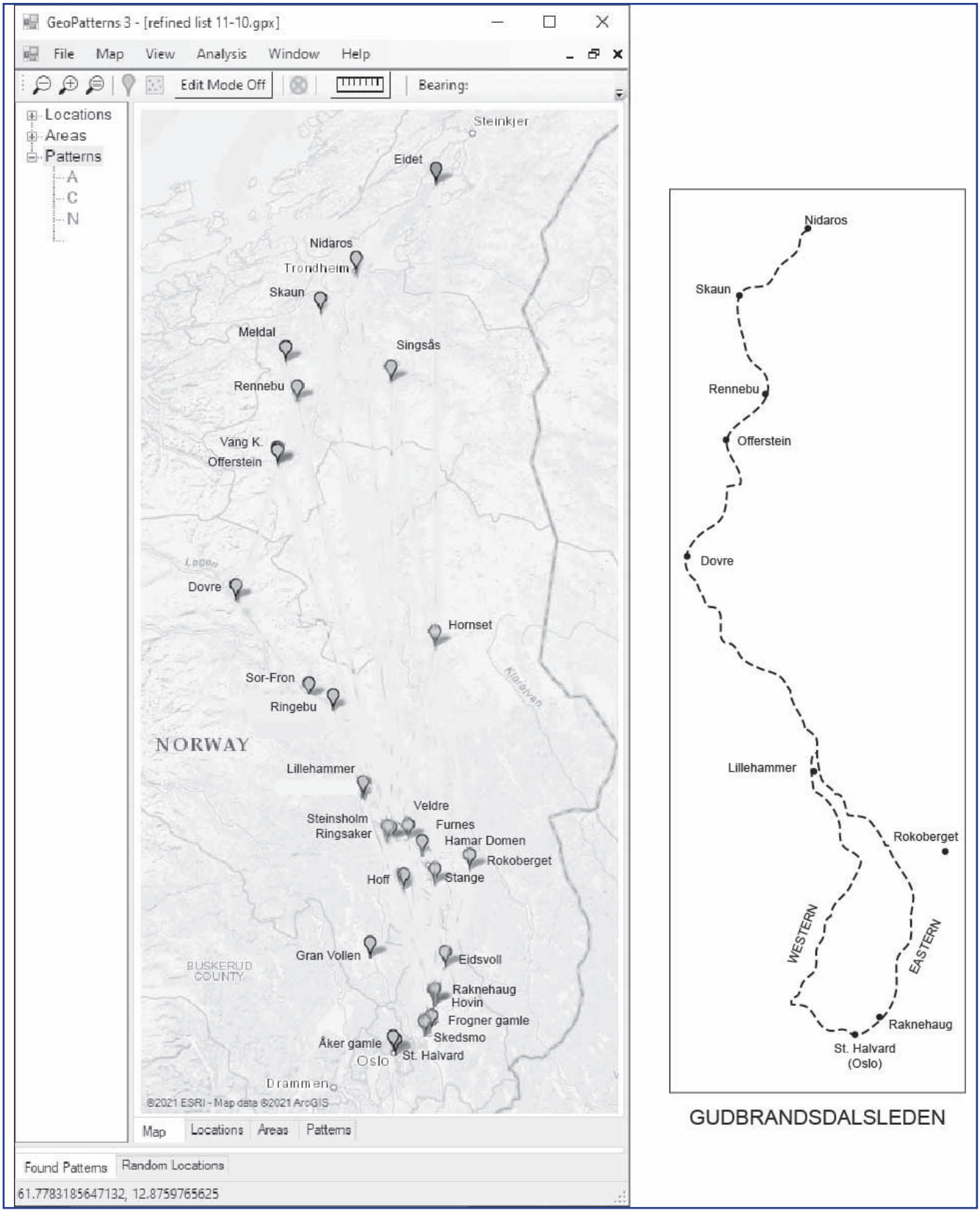
This route (Figures 1&2), has numerous points of contact with histories of the Viking King and martyr, St. Olav (see Bagge 2010 for general background). Many early churches on the path, however, have little association with the saint. According to the pilgrimage website, the central path starts at the ruins of St. Hallvard Cathedral, then divides into a western and eastern route following each side of Miøsa (lake) before uniting at Lillehammer. Taking the western route, one can visit the area where St. Olav grew up, Bønsnes, and the sister churches of Gran Vollen. The eastern route can involve stopping at Skedsmo and the historical Eidsvoll where the Norwegian constitution was drawn up and signed in 1814. The modern pilgrim is left to choose the route whose history and cultural heritage seems most interesting.

Large-scale surveying of any new *Gudbrandsdalen* route up to Trondheimsfjord is understandably not a frequent topic in prominent pilgrimage discourse, e.g. Duda 2016, Øian 2019. The Norwegian valleys were occupied by farming communities long before even Viking times, and communication for trade and social organisation existed, (without shelters however) in some of the high mountain passes. Furthermore, one finds very little evidence of any technically accurate large-scale surveying in the layout of farm property or small kernels of towns at the time. While we know that precise tools and techniques were used by guilds, especially those building large cathedrals at this very time, there is no documentation of larger-scale application of methodology to formally plan the landscape. Some literature on prehistoric land surveying exists, especially for Roman enterprise (see Dilke 1971, Lewis 2001, Gallo 2004) and Ancestral Pueblo in the New World (Lekson 1999).

An exemplar of historical mapping accuracy exists in Germany where they placed twelve watchtowers along a straight 80 km line over hilly terrain (Söderman 1989). The greatest deviation of any particular tower from this line along the Neckar River is two meters (deviation of about 0.016° at an average distance between towers of about 7,000m; the limit of unaided visual acuity is 0.017°). There is no functional, communicational reason why they were interested in such accuracy, well beyond needing to visually signal from every tower to its adjacent neighbours.

Leaving technical issues of medieval surveying aside for investigation by others, here, the focus is on design analysis of the pilgrimage route maps drawn up by

Figure 2: Middle Ages Churches and Two Prehistoric Sites listed in Gudbrandsdalsleden Pilgrimage Route (website) Eidet and Hornset are added, and Singsås is listed as part of Østerdalsleden route (screen shot of software format used in analysis and testing).



website designers. The primary goal is not to criticise what can only have been a relatively quick exercise without precedents. Historical maps of large-scale landscape in the medieval ages do not for the most part exist, beyond relatively independent site histories that are presumed to connect in a real route. Secondly, despite the availability of highly technological digital mapping tools, GIS and other platforms, ready-made tools for quickly evaluating accurate geometries of patterns of points do not exist for a more design than planning analysis of landscape (see Doxtater 2007b).

Archaeologists presently use GIS viewshed applications to discover possible social experiences of territoriality. Viewsheds, however, have been used more extensively by landscape designers / planners to simulate scenic beauty or lack thereof. Neither of these uses are 'cultural', where one begins to map symbolically formal, designed patterns associated with the greater religious effect of organised ritual practice. These designed patterns can be quite accurate, the orientations and alignments of which must be carefully but quickly considered in this 'close mapping' analysis. For a more detailed explanation of five different categories of human spatial experience — way-finding, visual and non-visual aesthetics, task-performance, social territories, and cultural (ritual) space — see Doxtater (2007a).

Churches on *Gudbrandsdalsleden* Dating to the Pilgrimage / Christianisation Period

Numerous points of interest on the website's pilgrimage paths are not from the requisite medieval period, here roughly from 1030 to 1300, nor do they necessarily involve religious motives.

Today's need is to encourage more modern, recreational or educational experiences as part of the route. Originally most important sites were the churches — though with some very notable additions in Gudbrandsdal — along with a lessor number of sacred springs or other natural features. Many of the churches along the routes, however, either do not stand today, or are entirely new from much later periods. Thus, one must first determine as much as possible which are the *locations*, more so than architecture, that may have been positioned in relation to the pilgrim path or paths. Listing all the churches on *Gudbrandsdalsleden*, eliminating any site likely not to have had a church during the pilgrimage period, only two of the twenty-five are part of the western start of the route, Åker *gamle* and the sister churches of Gran Vollen (see Table 1).

Table 1: Churches on *Gudbrandsdalsleden* Dating to the Pilgrimage / Christianisation Period

Site	Comment	Source
Åker gamle	Eleventh century, stylistically related to Ringsaker, Nikolaikirken (one of the two sister churches at Gran Vollen) and the cathedral church (ruins) at Hamar. On the exterior is a *Midgardsormen* (Midgard serpent) showing Pre-Christian cosmology	(*Pilegrimsleden* website).
Gran Vollen	Unusual sister churches from eleventh century; the two stone churches Mariakirken and Nikolaikirken stand wall to wall, said in a saga to have gotten the name from ill will between two sisters, each demanding her own church.	(*Kulturminnesøk*: Gran Vollen various authors).
St. Halvard ruins	This is the starting point for either western or eastern choices to begin the *Gudbrandsdalsleden*. It was Oslo's first '*domkirke*' or Halvardskatedralen, with the integrated Olavskloster and Korskirken, early 11th century; Dominican cloister followed in 1240.	(*Pilegrimsleden* website)
Skredsmo	Stone walls from the medieval structure stand full height in the existing church; St. Olav's figure from the first half of the 1200's.	(*Kulturminnesøk*: documentation by archaeologist Jan Brendalsmo widely known for his encyclopedic recording of church histories, e.g. 2006)
Frogner gamle	Dates from around 1200; lies right on the pilgrim route going via Hamar on to Trondheim.	(*Kulturminnesøk*)
Hovin	Cross shaped existing timber structure built in 1695 to replace a stave church on same site from the 1200's.	(*Kulturminnesøk*)

Table 1 (cont.): Churches on *Gudbrandsdalsleden* Dating to the Pilgrimage / Christianisation Period		
Site	**Comment**	**Source**
Eidsvoll	(continuing on the eastern path) is an important historical place; dedicated to the holy cross (1177-1202), Peter and Paul, said to be the oldest cross formed stone church in the country, a hallmark of the Cistercian order of monks that came to Norway in 1146; archaeological investigation revealed an older church on the same location; may have been associated with the establishment of the *Eidsivatingsamlingene*, (regional law focus) in 1022 by King Olav Haraldsson; in 1814 representatives for the new national constitution (Grunnlovsforsamlingen) met in Eidsvoll to begin this work.	(*Kulturminnesøk*: Christie & Sigrid *Norges kirker*)
Hoff	Standing stone church likely built in the first half of the twelfth century (1100 – 1150).	(*Kulturminnesøk* registration of Middle Ages church places by NIKU with Jan Brendalsmo)
Stange	Probably built in the middle of the 1200's, carries no mention of artefacts or symbolism associated with St. Olav.	(*Kulturminnesøk* source Ekroll, Ø. og Stige, M. *Kirker i Norge)*
Rokoberget	About 28 km off the main (eastern) *Gudbrandsdalsleden*; small stone church mentioned in a Pope's letter (1254), possibly connected to the pilgrim path through Østerdal and Hamar; shortest way between Oslo and Trondheim; site has rich prehistorical use; church dedicated to St. Mikael, portrayed as both victor over evil and angel of grace; still site of several Christian folk celebrations.	(*Pilegrimsleden* and *Kulturminnesøk*)
Hamar Domen	Location of a medieval town and ecclesiastical centre, Hamarkaupangen, on the cathedral promontory; site of Hamar Cathedral, the Bishop's castle (1152), Saint Olav's monastery, a herb garden, hospital and school; in the 16th century the town was abandoned and large parts of the castle and the cathedral were destroyed; Domkirkeodden (the cathedral peninsula) and the Bishop of Hamar - a very powerful centre between Oslo and Nidaros (Cathedral in Trondheim).	(*Pilegrimsleden* website)
Furnes	Medieval timber church located to the right of todays 'new' church (1708) on the same site.	(*Pilegrimsleden* website)
Veldre (gamle)	Medieval location not clear but a tentative site visible in aerial photos; today's church located 'two stone throws' north of where stave church stood; between the standing church and the Flesaker farm are remains of a large prehistoric grave-field	(*Kulturminnesøk*)
Ringsaker	Erected in the second half of the 12th century and expanded in the first half of the 13th.	(*Kulturminnesøk* source Ekroll, Ø. and Stige, M. *Kirker i Norge*)
Lillehammer	Early stave church torn down in 1733 and replaced with a cross-formed timber church erected some 'tens of meters' to the northeast, in the corner of the old churchyard; in 1879-82 a stone walled church replaced the timber church on the spot where the original stave church had stood.	(*Kulturminnesøk: Kildegjennomgang til registrering av middelalder-kirkegårder av NIKU ved* Jan Brendlasmo)
Ringebu	Standing stave church from around 1220 said to be the only stave church in Gudbrandsdal on its original placement	(Kulturminnesøk)
Sør-Frun	Present church location moved in 1787 from its original place on the Listad Øvre farm where the stave church stood; Listad lies about 560m north-northwest from today's church; like many other churches on this list, no pilgrimage related artefacts from the original church are found in today's inventories	(*Kulturminnesøk*)
Dovre (gamle)	An unmarked church site at the Bergseng farm fields, about 1.2 km north of the existing 1740's church (original site is marked in archaeological records); a St-Olav's spring with magical healing properties lies at the north end of the old churchyard at Bergseng.	(*Kulturminnesøk*: *Kildegjennomgang til registrering av middelalderkirkegårder av NIKU ved* Jan Brendalsmo)
Oppdal (Vang K)	Standing church from 1651, the baptism chapel of which has stave church elements from the 1100's	(*Kulturminnesøk*)
Rennebu	Standing timber church from 1669, one of the few 'Y' plan churches in Norway; replaced a stave church, parts of which are reused, together with a crucifix from the 1200's	(*Kulturminnesøk*)
Meldal	Medieval church torn down in 1650, replaced by today's timber structure on the same site	(*Kulturminnesøk*)
Skaun	Scenic stone structure from the 1180's dedicated to St. Olav	(*Pilegrimsleden* website)

Pre-Christian Iron-Age Sites Included in the *Gudbrandsdal* Web Route

Raknehaugen

Known as Norway's and North Europe's largest grave mound, the total diameter of the constructed mound is around 77 meters. The height of the mound is 15 meters. This mound belongs to a unique group of grave monuments from the *Folkevandringstiden* (c.400–c600). Besides being one of Norway's largest individual monuments from prehistory, and North Europe's largest grave mound, Raknehaugen has had a dominating place in Norwegian archaeological thinking. The monumental impression of the gravemound is interpreted as having been built as a demonstration of power. There also is a cart track, which is part of the *pilegrimsleden*. According to *Kulturminnesøk* the diameter of the mound is 90 meters and has not been archaeologically excavated.

Offersteinen: a commemorative stone marker in the gravefield at Vang (Lueget). This gravefield is Norway's and one of North Europe's largest from the Iron-Age with 900 grave mounds. The majority of the burials are from the Viking period, but numerous grave markers are also from the earlier *Folkevandringstid*; this large stone monument is not dated but associated with use by the Oppdal church about a kilometre north; a historic cart track ran adjacent to the Offerstein, and is the route indicated in the *Pilegrimsleden* website, going through the large gravefield and on north to the church (*Kulturminnesøk*).

Raknehaugen as Focus

The search for a formalised large-scale landscape pattern among the *Gudbrandsdalsleden* sites listed above begins with a likely measure of accuracy among three-point alignments. From the investigation of the *Østerdalsleden* (Doxtater 2022), the probability tests were among patterns at or below 0.06 degrees variation or error. One can picture this accuracy by considering a surveyed (medieval) line between two points 100 kilometres apart. At the maximum error of 0.06, an interim point exactly equidistant from the two end points will fall about 52 meters from the line. Most of the patterns in the Østerdalen layout, however, were closer to about 35 meters or less (0.04).

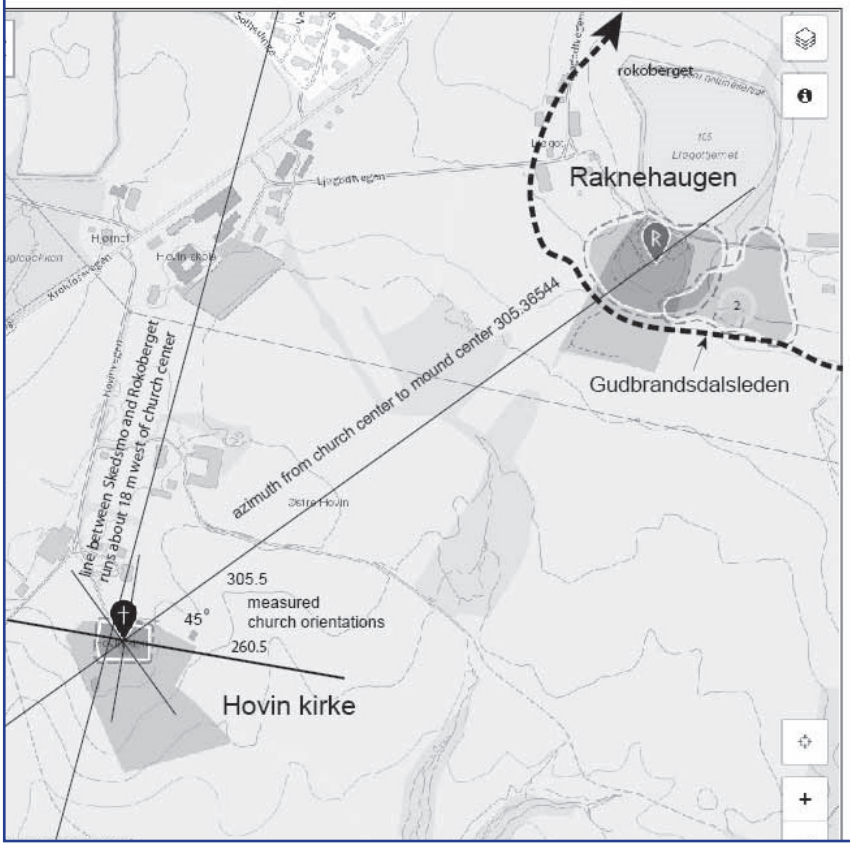
Using the 0.06 figure for the list of Gudbrandsdal sites, seven three-point alignments exist. No cardinal or right-angle patterns exist at these tolerances.

1: set0 ringebu stavekyrka , lillehammer , **raknehaugen** , 199.245786 id=1
2: set0 skedsmo , **hovin** , rokoberget , 344.946113 id=2
3: set0 dovre , sor-fron , furnes , 216.483172 id=3
4: set0 skaun , veldre gamle , **raknehaugen** , 189.142062 id=4
5: set0 skedsmo , **raknehaugen** , eidsvoll , 343.274801 id=5
6: set0 dovre , offerstein , rennebu , 342.619575 id=6
7: set0 ringsaker , hoff , **raknehaugen** , 195.103112 id=7

Most striking here is the frequency of participation of the centre point of the largest memorial mound in the North, Raknehaugen as shown in Figure 3. While any geometric pattern, even at these good accuracies, can be coincidental, considering that five of the seven three-point alignments involve Raknehaugen (including its church 'annex' of Hovin), seems to suggest some design intent giving an important role for this most singular of cultural places.

Having mapped numerous formalised landscapes elsewhere (Doxtater 2021, 2009, 2003, 2002), it is not unusual for the largest of ceremonial sites to be positioned in relation to a cardinal north-south or meridian line at some scale. In the present case, moving the tolerance from 0.06 to 0.07 now picks up a 'vertical' relationship between the centre of Stange Church and the centre point of Raknehaugen. Shown in Figure 4, this still accurate meridian (deviation is 0.06884 compared to the stated limit of 0.06), runs from the mound centre 62.716 km due north to about 75 meters east of the Stange medieval church structure. As seen in the illustration, the western edge of the mound is very close to the exact longitude of the eastern corner of the church. Stange church is such a fine example of a standing medieval structure from about the 1150's that one can accurately measure its orientation from *Norgeskart* (digital land map), to within about one half degree. Stange's axis seems to accurately point to the somewhat enigmatic highly symbolic church of Rokoberget, a site so far east of the main Gudbrandsdal route (19.841km from Stange) that it suggests an alternative path up to Trondheim.

Figure 3: Raknehaugen, Largest Prehistoric Mound in Scandinavia
(Top photo by Øvyind Holmstad from Wikimedia); relation of closest medieval church, Hovin, to mound; dotted line shows today's pilgrimage path.



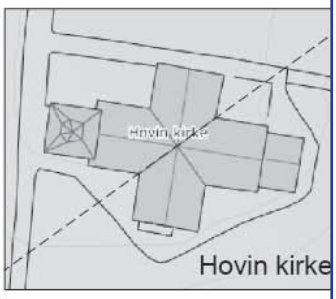


Figure 4: Three-point Alignments at or under 0.06 Accuracy that Terminate South at the Summit point of Raknehaugen, or use it as Midpoint
(photo by Lalla Haugen Trøen)

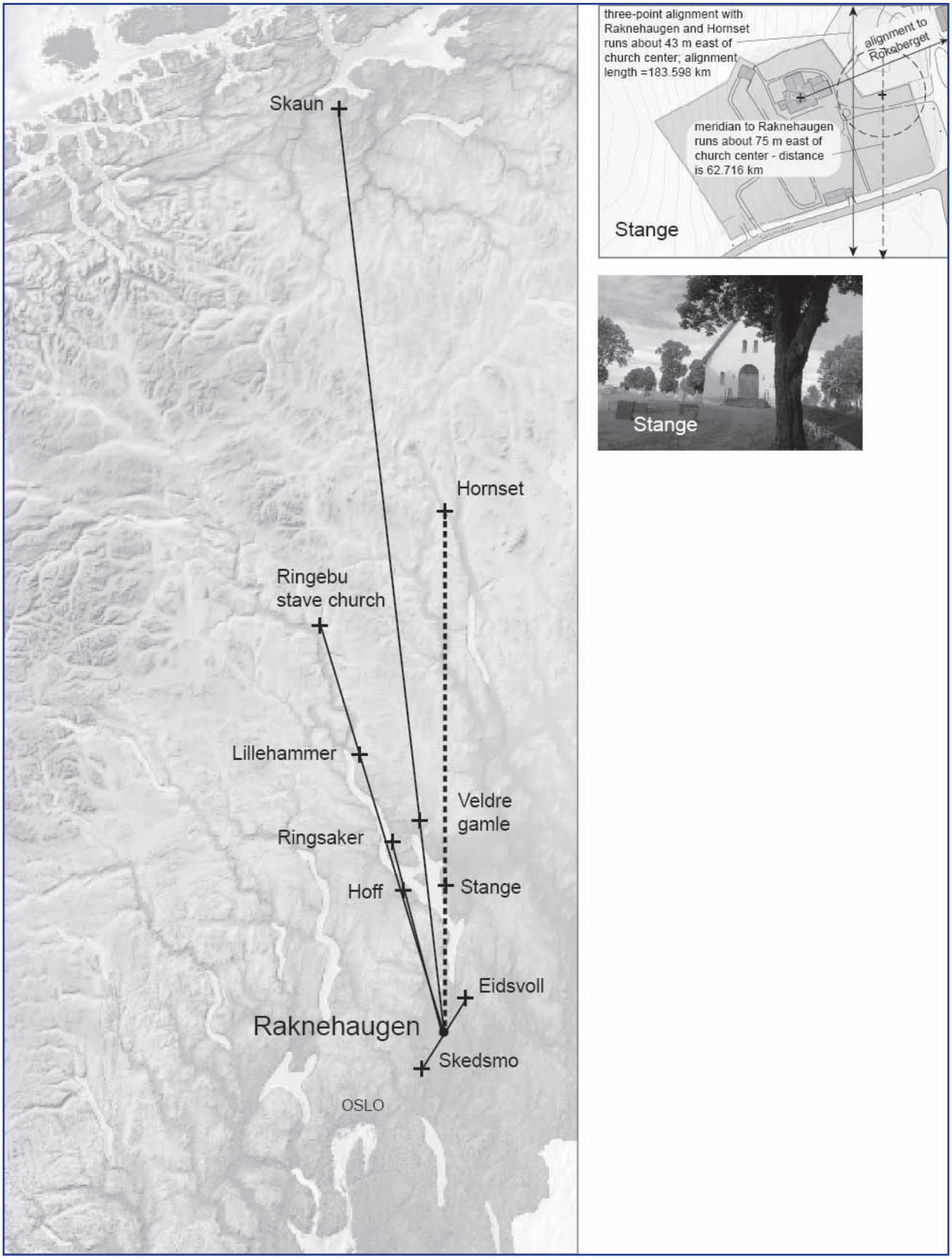
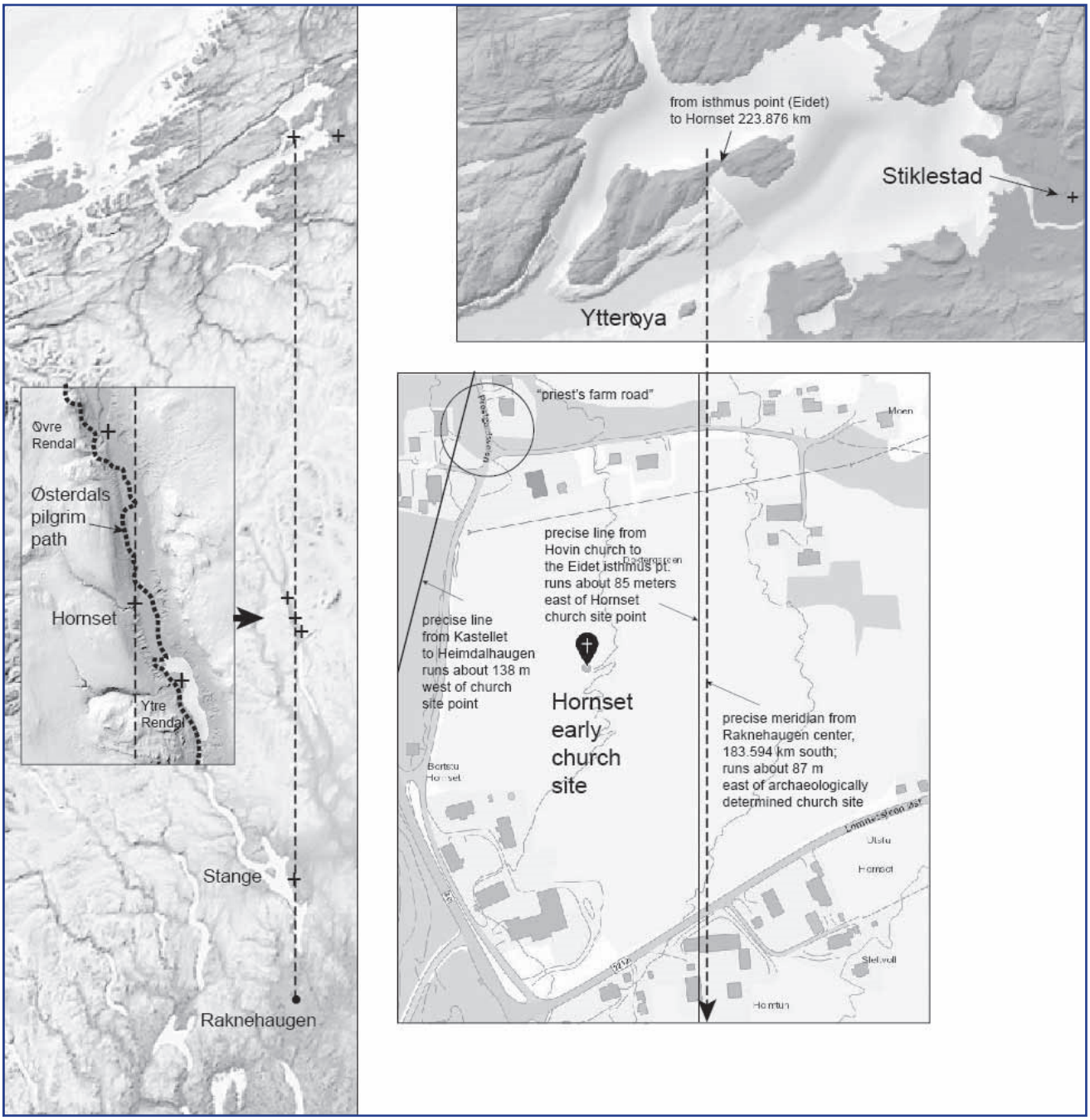


Figure 5: Early Hornset Church Meridian (north-south) Relationship to Three-point Alignment with Raknehaugen and Stange church

To four-point alignment with Hovin, Haltdalen,and the Eidet isthmus point; and to Østerdal pilgrimage route with Øvre and Ytre Rendal churches



Logically one probes the extension of the 'Raknehaugen' meridian north beyond Stange. Curiously enough, this prolongation runs through a gap in the Nidaros – Nesvangen alignment between the Rendal pair, Øvre and Ytre (prominent in the Østerdal formal structure). The meridian does not accurately lie equidistant between the two. But, looking more closely at the land maps of the area — especially for a farm or feature name like '*prestegard*' (priest's farm) — one discovers that an early church existed on an archaeologically defined site called 'Hornset', see Figure 5. This unremarkable place, with no standing remnants or foundation layout, is included in neither Østerdal nor Gudbrandsdal pilgrimage routes.

Hornset's written history begins in 1580 with a record of a bishop's visit and his overnighting. It is reasonable

that S. Peders church in Rendal stood first at Hornset. The existing location is determined by iron nails and skeleton remains found during ploughing. An interesting *kirkeflyttingssagn* (church moving saga) may be related to the building of the Øvre and Ytre Rendal churches:

> *Alt brukbart og innvidd tømmer fra kirken på Hornset [ble] fløtt nedover åa til Lomnessjøen. Det hellige tømmer skulle så få drive dit det ville, men der det tok land, skulle kirken ligge. Det landet ved Otnes, og der ble så kirken lagt* (Solum, 1951:14).

> *all usable timber from the Hornset church was placed in the river flowing to the large lake. The holy timber was left to go as it would, but when it landed on a shore, there should a church be built. That land was Otnes, and thus the church is there (Ytre Rendal).*

> *Kulturminnesøk____(Kildegjennomgang til registrering av middelalderkirkesteder av NIKU ved Jan Brendalsmo, RA).*

While few of the widely varied and numerous folk sagas about building or placement of the first Christian churches have been shown to be topographically or historically accurate — they are usually included as a 'local' addendum to archaeological site information — in this case of the two early Rendal churches, both from the medieval period, they may have been something of a replacement for an early Hornset church. Indulging the folklore for the moment, what, one may ask, was so holy about timbers from this *location*? Is this an earlier Gudbrandsdal framework spiritually based on the meridian from Raknehaugen to Stang, extended to a second church to the north? The azimuth from Raknehaugen's centre point to Stange is again 0.06884 at its distance, and to the archaeological point of the Hornset site is more accurate, 0.02914 at its distance of 183.594 km from the great mound.

With this cognitive map in mind, it remains to extend the meridian to some farthest north feature, given the pervasive symbolism of 'North' in Norse cosmology and folklore. The most interesting possibility here is the ritual-like natural feature of the isthmus of Ytterøya (island) in Trondheimsfjord, as seen also in Figure 5. The actual topographic isthmus 'bridge' is called Eidet, and lies less accurately in relation to the Raknehaugen meridian, i.e. 359.91764 at a distance of 407.239 km. The second early church on the isthmus is more accurate at 359.96018, or about 0.04 off the meridian, giving a total of three Christian churches accurately on a cardinally oriented Raknehaugen meridian.

The possible symbolic meridian 'climax' at the natural isthmus may be more typical in pilgrimages farther north in Europe then those farther south. In Ireland, Nolan (1983) contrasts pilgrimage as 'place' rather than 'object' (sacred bones and artefacts) oriented. In Ireland, these places — mountains, caves and especially springs — often took precedence over architectural settings, particularly churches, where pilgrims could worship sacred remains. Though in many cases chapels may have been built secondarily to natural landscape foci. While the Raknehaugen meridian has three Christian churches accurately aligned with it, the great mound may well have been subordinate in spiritual power to some more ancient ritual meaning of the highly topographically unique natural place called 'Eidet'[1].

We will return to the possible meaning of this natural feature with a topographical predisposition for liminality, perhaps at the scale of the entire fjord. But one clear element is the common latitude of the isthmus 268.89558 due east 20.579 km to the medieval church that celebrates the martyrdom of St. Olav, Stiklestad (1180) — said to be 'at' an actual battle site not precisely determined (Kolberg 2011). Some question exists in the pilgrimage website about where pilgrims coming from across the mountains and the Baltic — *St. Olavsleden* and the route of his 'army' — go after visiting Stiklestad. Uncommented on are several routes possible down to Nidaros in Trondheim, presumably also including the possibility of taking boats out to the Eidet.

If Hornset were part of a *Gudbrandsdal* set of sites that preceded the formal pattern eventually laid out

1 **Eid (Ytterøy)** is the name of a priest's farm and apparently three churches built within virtually the same site, a second in 1651, and a third in 1890 which stands today about 70 meters to the northeast of the first two, though the exact location of the very first has not been archaeologically determined. Numerous prehistoric features exist at or adjacent to the isthmus. *Kulturminnesøk* (*Kildegjennomgang til registrering av middelalderkirkegårder av NIKU ved* Jan Brendalsmo)

as *Østerdalsleden,* then it would have required a second surveyed long line to create its latitude on the Raknehaugen meridian, to be discussed shortly. One can now include the Hornset and Eidet churches to the computer list, seeking additional three-point and cardinal alignments:

A (9)
1: set0 ringebu stavekyrka , lillehammer , raknehaugen , 199.245786 id=1
2: set0 hornset k , stang , raknehaugen , 180.039895 id=2
3: set0 skedsmo , hovin , rokoberget , 344.946113 id=3
4: set0 dovre , sor-fron , furnes , 216.483172 id=4
5: set0 skaun , veldre gamle , raknehaugen , 189.142062 id=5
6: set0 skedsmo , raknehaugen , eidsvoll , 343.274801 id=6
7: set0 dovre , offerstein , rennebu , 342.619575 id=7
8: set0 ringsaker , hoff , raknehaugen , 195.103112 id=8
9: set0 hovin , hornset k , eidet k , 359.867789 id=9

C (3)
1: set0 stang , hornset k , 0.009905 id=10
2: set0 raknehaugen , hornset k , 0.029856 id=11
3: set0 eidet k , raknehaugen , 179.959062 id=12
N (0)

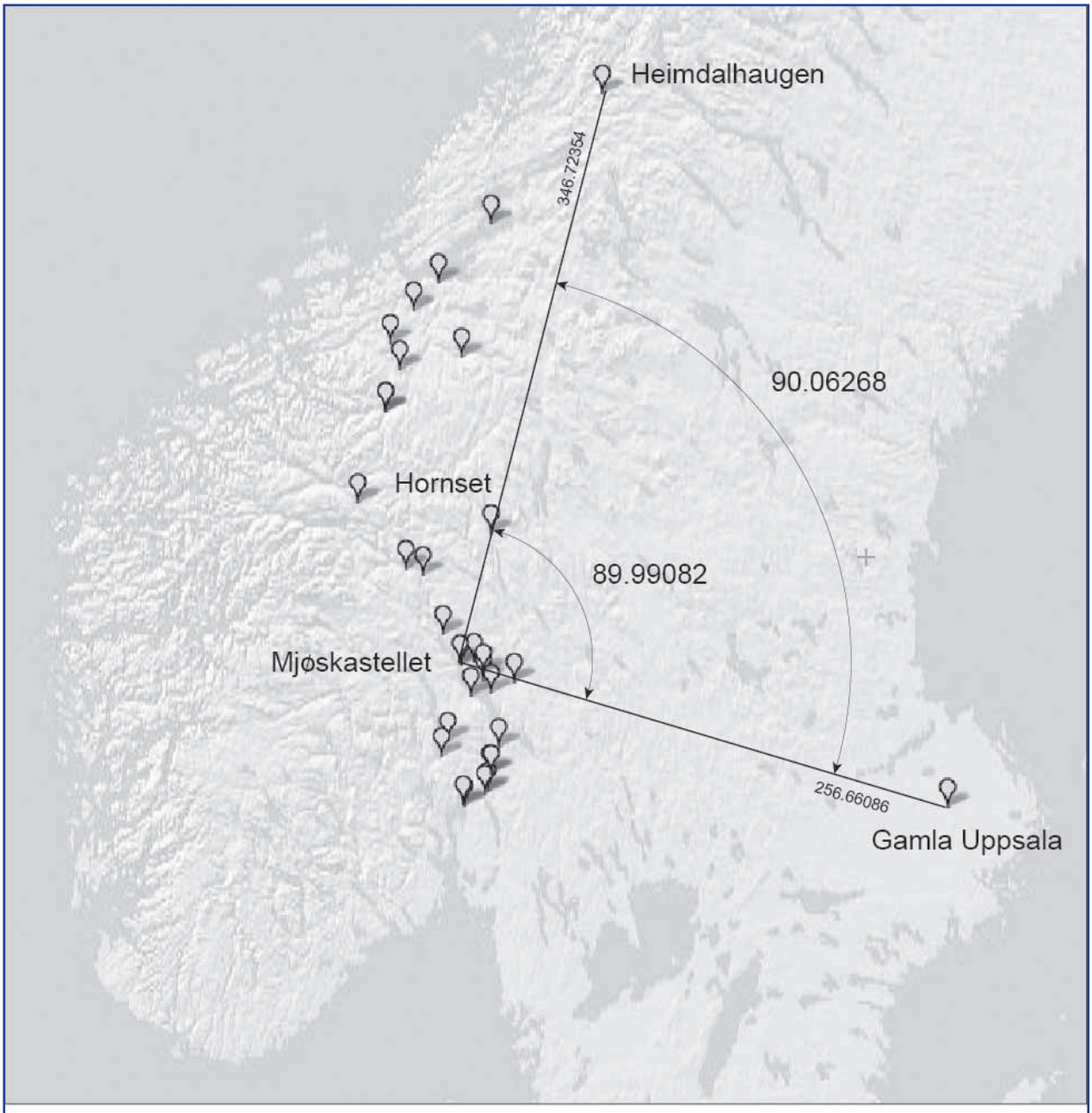
One can assume that once Gudbrandsdal pilgrims have chosen the eastern leg at the start, they pass directly around much of Raknehaugen (again Figure 3). Do they go out to Rokoberget and then continue on the eastern shortest route alignment to Hornset and to Singsås and on up to Nidaros? If so, they would have missed one of the densest cultural landscapes, both Iron-Age and Christian, along the largest lake in the country, Mjøsa. In today's website maps, it is assumed that most Gudbrandsdal pilgrims take a route that follows the eastern shore of the lake rather than divert to the Rokoberget alternative. Those taking the initial western branch out of the Oslo area travel up the western side of the lake only joining the 'main' path at Lillihammer, over 27 km north of the lake. They too would have missed the two important churches at Hamar and Ringsaker, but more importantly in terms of a possible integrated formalised landscape scheme, a vital 'benchmark'.

Mjøskastellet: Right Angle To Heimdalhaugen And Uppsala

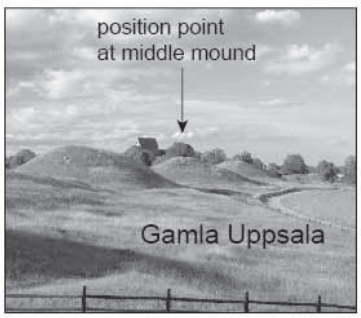
In this 'close' mapping design analysis one finds two very accurate right-angle patterns at large scale in relation to the *Gudbrandsdal* path. The first is a 90.00755 angle from the early Åker church as vertex in present day Oslo — with its *Midgardsormen* (Midgard serpent) sculpture — and side rays running no less than to Nidaros in the north and Uppsala to the east. This accuracy (89.99382) and scale is matched by another right-angle vertex point along lake Mjøsa and the major pilgrimage route along the east shore, to Mjøskastellet; its two rays aligning with the church site of Hornset and Uppsala (Figure 6). Both patterns are cartographically real and either or both might have been created by chance. In the case of Åker, its direct relation, especially to Nidaros, would require no further pattern integration (to a pilgrimage path) to connect with St. Olav's remains at the cathedral in Trondheim, thus not providing any additional evidence of possible design. At Hornset, however, its integrated patterns relating to an *axis mundi* concept involving Raknehaugen and the Eidet area are beginning to suggest ritual intent in the pattern itself, not just the church location.

It is not just the accuracy of the Hornset right-angle, but the orientation of the pattern itself that may reveal an additional design intent. Included in the illustration of Figure 6 is this author's combination of two 'systems' of orientation found by Lindström (1997 & 2005) primarily among patterns of grave orientations that relate not to local landscapes, as archaeologists have surmised, but to large scale spatial concepts across parts of Scandinavia. His off-cardinal 'systems' are apparently created by broad cultural adherence to two specific times, the Fall Fest after equinox, and the Winter Solstice sunrise. A third orientation is added at Easter after Christianisation (roughly around the turn of the first millennium). Significantly all three 'systems' exhibit *two* grave orientations perpendicular to each other, creating a cross cardinal pattern. Although few researchers have commented on the implications of Lindström's ideas, the same symbolic evidence of off cardinal systems of paired perpendicular directions can easily be found in prehistoric Migration Period farm dwellings on Gotland (Stenberger, 1955 and diagrammed in Doxtater, 1981:58), and in folk valleys such as Setesdal in Norway

Figure 6: Possible Example of Lindström's 'Vinkelrätt' Expression in 'right-angle' Pattern from the Mjøskastellet as Vertex with Rays to Heimdalhaugen (plus Hornset) and Uppsala



Arkitek P. Blix' 1897 artistic reconstruction of Mjoskastellet



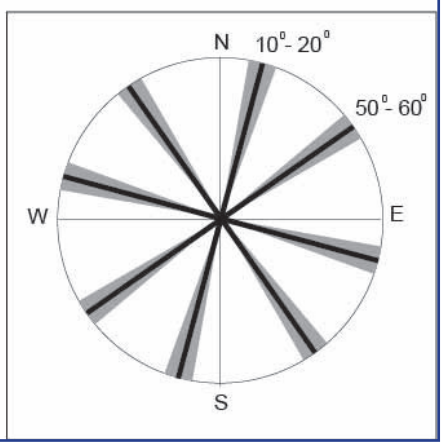
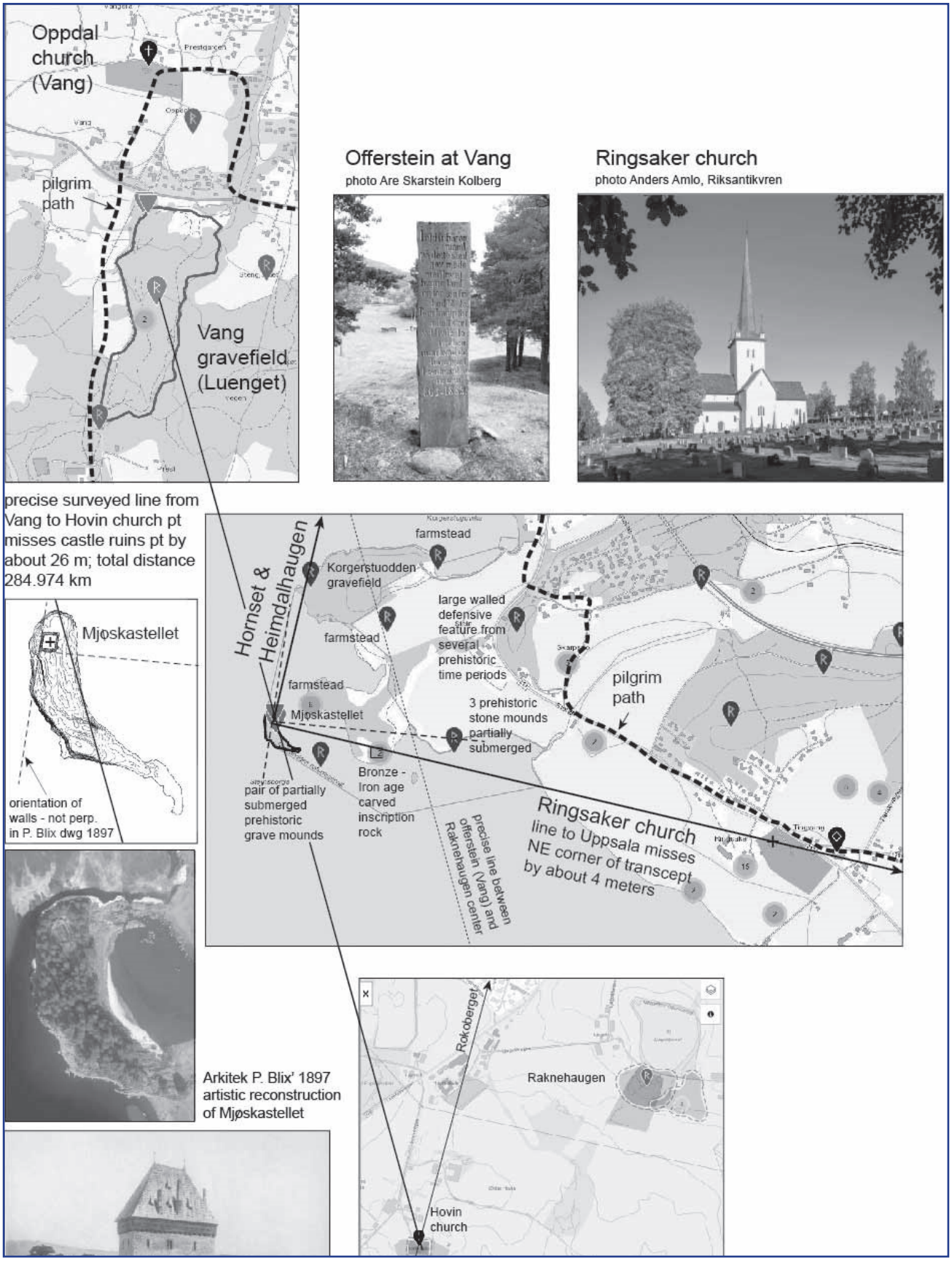


Figure 7: Possible Surveyed Relationship Between the Kastellet as Interim Aligned Point Between the Largest Gravefield and most Adjacent Church (Hovin) to Raknehaugen, the Largest Singular Mound in Scandinavia
Tower as Vertex to Right-angle to Heimdalhaugen and Uppsala



(ibid 61). The orientation of the Hornset right-angle, falling within Lindström's 10-20 degree most northernly pointing direction, could be another symbolic example of a 'system', beyond the simple association of the points in the Åker right-angle to Nidaros. The azimuth from Åker to Nidaros is 2.56465 degrees west of being true north.

More interesting than Hornset's right-angle orientation *per se*, is the feature along lake Mjøsa than serves as vertex to this pattern. Located in one of the most culturally rich landscapes of central Norway, as seen in Figure 7, the point that works best is probably the largest architectural structure in the area, the tower-castle called *Mjøskastellet.* Near Ringsaker church, prehistoric gravefields and a large '*borg*' or circular fort of earthen embankments, one finds today its massive foundation right at the lake's edge. This was one of two military towers built in the first decades of the 1200's. Three earlier ones had been built and torn down at Trondheim, Bergen and near the border at Konghelle (Arstad 2015). The second castle built at this time lies south of Oslo at Valdisholm on the Gomma River.

Returning to the issue of Hornset's location on a Raknehaugen meridian, most likely the meridian came first, and then the vertex was positioned by some trial-and-error process that considered both the orientation of the right-angle and its two rays out to important end points such as Uppsala and a point to the north — before Hornset existed. Surveyors would have had to lay out a line to the northern point and Uppsala adjusting their vertex in the Mjøsa area such that the right angle is precise. Once the Kastellet site was chosen as requisite — in addition to its surveillance possibilities along the lake — then the point where the northern ray crosses the Raknehaugen meridian became Hornset. The best northern point may have been the most prominent mountain in the Trondheimsfjord region, Heimdalhaugen. The precise line from the Kastellet tower to the benchmark on the summit of Heimdalhaugen, some 424.755 km, runs about 138 meters west of the Hornset church point, see again Figure 5.

Heimdalhaugen: curiously enough this site has no archaeologically recorded features on its top (aside from several Sami field sites, a few hundred meters down from the summit point). This mountain has been historically part of the cultural threshold between the Sami and Norse. Even though the northernmost pilgrim path '*Nordleden*' is shown on the website to begin at a small remote church - Gloshaugen - no mention is made of this large (1159 m) mountain looming just over an immediate ridge, less than seventeen kilometres to the northeast of the church. When queried about the church, the county administrator in the area added that she had climbed Heimdalhaugen both in summer and winter. The mound shaped feature ('*haugen*' is 'mound') is highly visible from the sea and historically used as a way-finding marker. Heimdalhaugen is clearly the most prominent mountain on Trondheimsfjord, in addition to being at its *northern* end.

Mythologically, North was the land of the dead; the god Loki went north to Jotunheimen (land of the dead) to get the goddess Idunn (Birkeli 1943:209). In *Snorri's Edda,* fear is usually associated with the north and a more positive meaning with the south (ibid). Spiritual and spatial oppositions abound between the gods and between Asir / Vanir axes. Thor, without an opposite in Dumezil's description, is placed in the centre (1973:61). In the *Grimnismal*, Thor goes to the Ting meeting at the location of the world tree Yggdrasill (Birkeli 1943:223). An Eliadian centre axis is most evident in the position of Heimdall; Dumezil calls Heimdall the 'frame' god (ibid); his residence is interpreted by Jan De Vries as a:

> *Palace above the skies in Himinbjorg ... The rainbow is the path that joins the limit of the horizon to the center of the sky; it is from above the sky at the top of the central axis, that the watch-god watches the whole circumference of the world* (from Dumezil 1973:130).

The farthest north point so far discussed as possibly used with a pilgrimage route is the Eidet, natural isthmus feature on Ytterøya. The precise meridian north of Raknehaugen, besides being quite accurately cardinal to both Stange and Hornset, again also runs within this range of tolerance (here 0.045) to the earlier Eidet church. Given the older age of the Raknehaugen, it seems unlikely that the Eidet was ritually significant because of its location due west of the Stiklestad, where King Olav died in battle.

One reason behind its importance may have been its participation in the alignment between the Ting site at *Frostating* on the central peninsula of Frosta in

Figure 8: Four-point Alignment Between Logtun Church (Frostating), Eidet Church and Isthmus Point, Maere Church, and Summit Marker on Heimdalhaugen

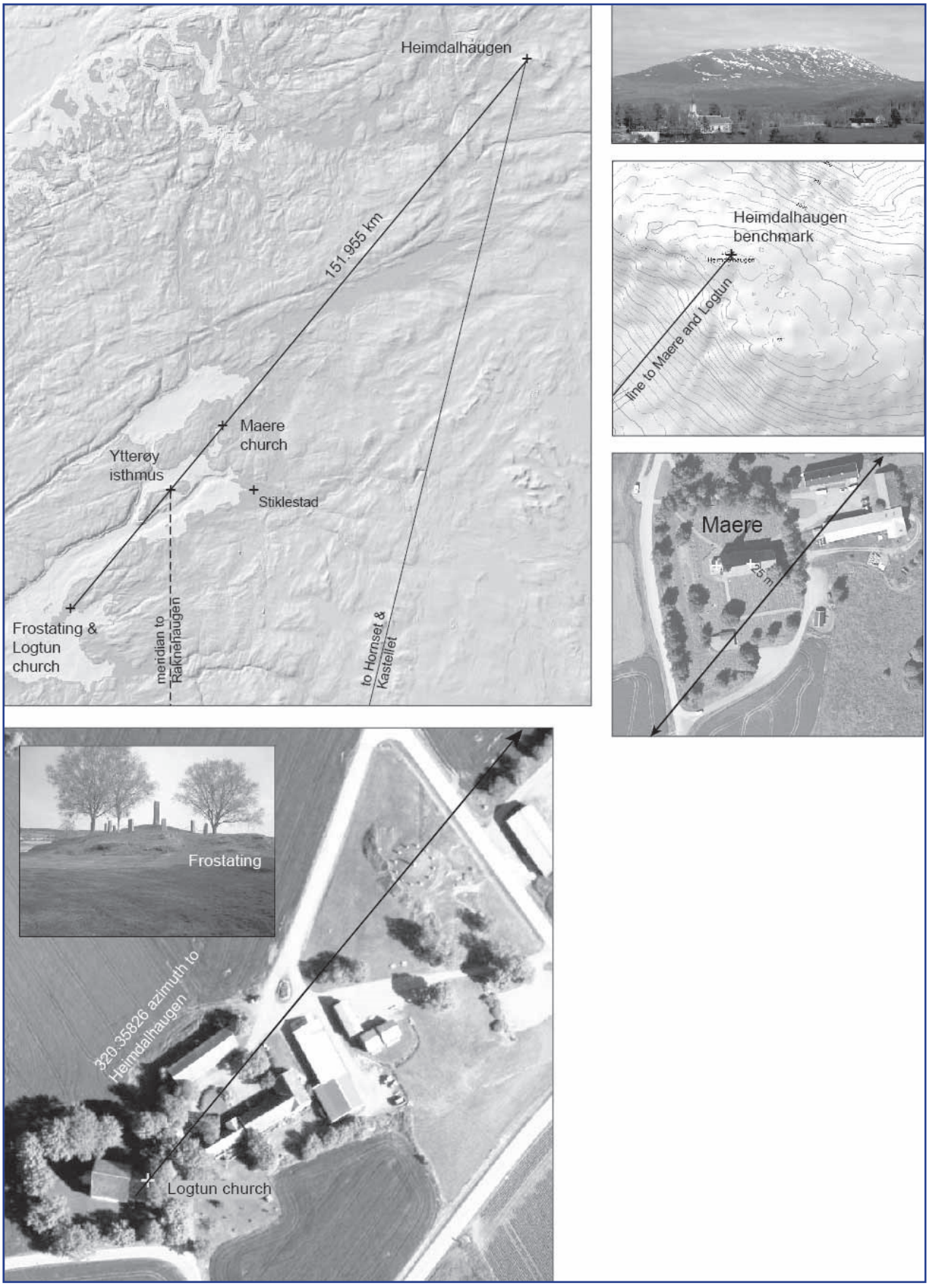
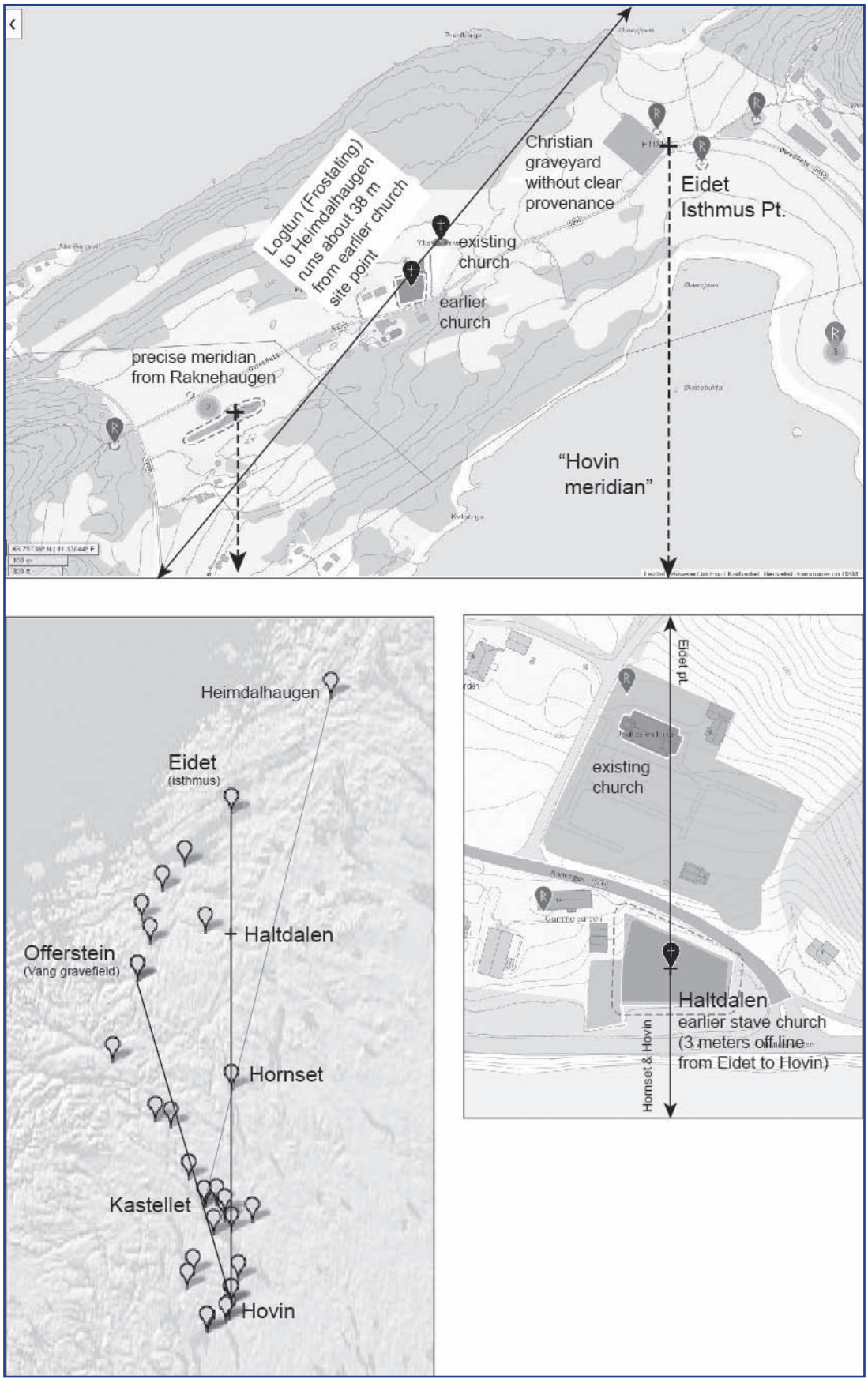


Figure 9: Relation of Eidet Sites to Large-scale Lines

Logtun (Frostating) – Heimdalhaugen and meridians from Hovin (Raknehaugen); position of early Haltdalen church on meridian.



Trondheimsfjord — and its adjacent medieval stone church Logtun — and the early stone church of Maere with the summit marker of Heimdalhaugen (Figure 8). This seemingly prehistoric line also runs quite directly through the Ytterøy isthmus as seen in Figure 9. The line runs about 38 meters north of the earlier Eidet church site. It misses the centre point of Maere church by about 25 meters to the east. Maere is the only early church in the region excavated in the search for site continuity with Viking times (Lidén 1968). Some evidence in this regard was found in the form of small religious scenes in gold called 'plaquettes' and related to some form of palisaded first structure on the site. The existing medieval parish church still standing today is one of the largest in Trondheimsfjord, built around an existing wooden stave church.

It is not illogical to think about the Ytterøy isthmus as a more important ritual site than the perhaps later *Alting* yearly meeting site near Frosta's southern tip. The Frostating marker seen in figure 8 is not prehistoric, even though the yearly function of the site is documented as having been continuous from Viking to Christian Middle Ages. The *Alting* event was large, attracting hundreds of people and involving many farms in the immediate area (Stamnes 2017); archaeological investigation has not established any well-defined ritual center like that at Thingvellir in Iceland. What may have made the Ytterøy isthmus more religiously important was its natural oppositional form, perhaps the most unique natural feature in Trondheimsjord. Ritually it makes sense for Heimdalhaugen to be the otherworld repository of the spirits In the North. The isthmus in turn forms the ultimate liminal threshold articulating with the largest symbol of organizational life, the collective Ting assembly in the South.

Haltdalen: stave church possibly on a more Christian *axis mundi* from Hovin to the topographically defined isthmus point Eidet (rather than the early church). Given Hovin's close adjacency to Raknehaugen, such a surveyed line from this 'king's church' will have a cant, pivoting slightly as it were at Hornset. Design evidence that this was a replacement of the more prehistorically influenced Raknehaugen – Stange – Hornset – Eidet church meridian might be seen in the location of the stave church at Haltdalen also shown in figure 9. Persuasive is the accuracy of the four-point alignment Hovin – Hornset – Haltdalen – Eidet point. Although all patterns on the list below are at or under a tolerance of 0.06, five three-point alignments of this 'Hovin' meridian (including one involving Stange) are at or below 0.04. The Eidet point used here is almost identical to the enigmatic church-less Christian graveyard.

Haltdalen is not yet associated with either Østerdal or Gudbrandsdal pilgrim website routes. Portions of the stave church at this location, about 100 meters south of the standing church, were moved to a folk museum near Trondheim. These elements dated to the 1100's (*Kulturminnesok: registrering av middelalderkirkegårder av NIKU ved* Jan Brendalsmo).

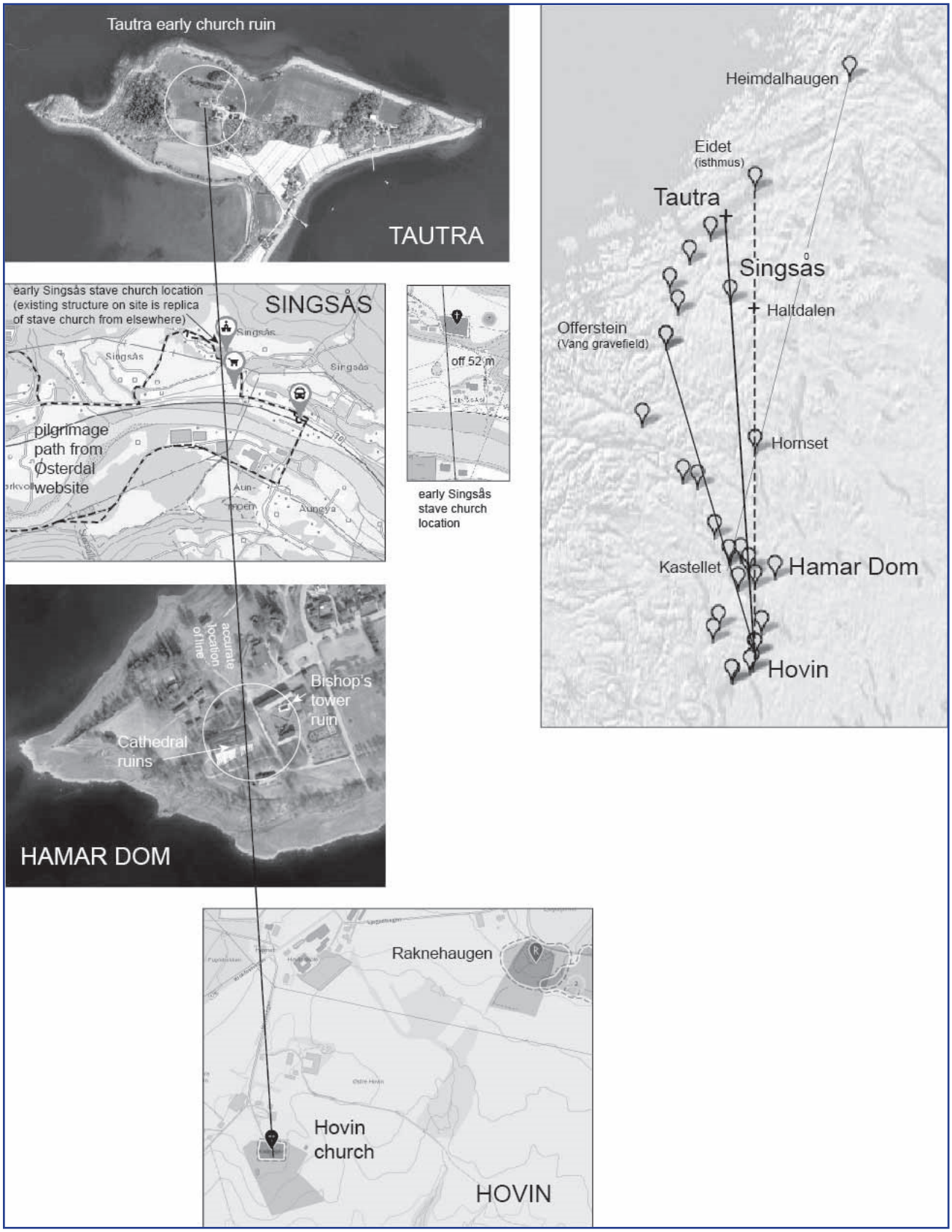
One can now add Heimdalhaugen, the Eidet topographic point, Haltdalen, Kastellet (steinsholmen tower) and Uppsala to the list of possible route related sites. The list of found patterns:

A (17)
1: set0 ringebu stavekyrka , lillehammer , raknehaugen , 199.245786 id=1
2: set0 hornset k , stang , raknehaugen , 180.039895 id=2
3: set0 skedsmo , hovin , rokoberget , 344.946113 id=3
4: set0 dovre , sor-fron , furnes , 216.483172 id=4
5: set0 skaun , veldre gamle , raknehaugen , 189.142062 id=5
6: set0 skedsmo , raknehaugen , eidsvoll , 343.274801 id=6
7: set0 dovre , offerstein , rennebu , 342.619575 id=7
8: set0 vang , steinsholmen tower , hovin , 195.819630 id=8
9: set0 offerstein , steinsholmen tower , hovin , 195.873867 id=9
10: set0 ringsaker , hoff , raknehaugen , 195.103112 id=10
11: set0 steinsholmen tower , hornset k , heimdalhaugen , 346.304158 id=11
12: set0 hovin , hornset k , haltdalen , 359.795508 id=12
13: set0 hovin , hornset k , eidet , 359.804521 id=13
14: set0 hornset k , haltdalen , eidet , 359.774296 id=14
15: set0 hovin , haltdalen , eidet , 359.793728 id=15
16: set0 stang , haltdalen , eidet , 359.834848 id=16
17: set0 raknehaugen , haltdalen , eidet , 359.853748 id=17

C (2)
1: set0 stang , hornset k , 0.009905 id=18
2: set0 raknehaugen , hornset k , 0.029856 id=19

N (4)
1: set0 aker , nidaros , uppsala , 90.007553 id=20
2: set0 veldre gamle , steinsholmen tower , nidaros , 90.056170 id=21
3: set0 steinsholmen tower , hornset k , uppsala , 89.993829 id=22
4: set0 hornset k , steinsholmen tower , dovre , 90.010274 id=23

Figure 10: Four-point Alignment Tautra – Singsås – Hamar Dom – Hovin
Other Two Large-scale Lines to Hovin from the Vang Gravefield and the Eidet.



In addition to Hovin's possible importance as the new meridian base to the Eidet, it also serves as southern base to another symbolically important line up through the Kastellet to the marker called Offerstein in the Vang gravefield, average tolerance of 0.03.

Tautra: a third major line to Hovin. The most important Christian site on or near the central *Alting* on Frosta may have been the Cistercian Monastery on the island of Tautra. Given the possible integration of Gudbrandsdal lines to the Frosta 'axis', missing might be a clearly Christian site in the vicinity of the Frostating. The very early Cistercian monastery Munkeby, up near Stiklestad, was burned sometime in the late 1100's, and a replacement Cistercian monastery and church was built at Tautra (begun in the 1170's and consecrated in 1207). Thus, the early Gudbrandsdal pilgrimage route may have had an important Christian north point at a time when the cathedral in Nidaros was under construction (1070 – 1300), and St. Olav's remains were still being kept in St. Clements church in Trondheim. Also, in the early 1200's the stave church site of Singsås, included in the northern area of the websites' Østerdal route, seems to suggest linkage to Trondheimsfjord.

Singsås: No church still stands on this site that is one of the oldest religious places in Gauldalen. A church stood here until 1884, which was then torn down and replaced by one over four km downriver. The site was in danger of becoming obscure fields when a reproduction of a very small stave church from elsewhere in Norway was purchased for the site in 2011, reminding people that the first church here must have been something similar (*Pilegrimsleden* website).

As for the early Singsås' stave church location, just twenty kilometres west along the Gaula River from the Haltdalen stave church on the Hovin meridian, it relates as well to this foundational church point next to Raknehaugen, see Figure 10. Not only do Tautra, Singsås and Hovin align, but the perhaps the second most massive architectural point in the Mjøsa region, the Hamar Cathedral and bishop's fortification, do so as well, an overlapping of four three-point alignments all within a tolerance of 0.03 degrees.

Closing the System: Integrating the Vang Gravefield, Dover and Rennebu

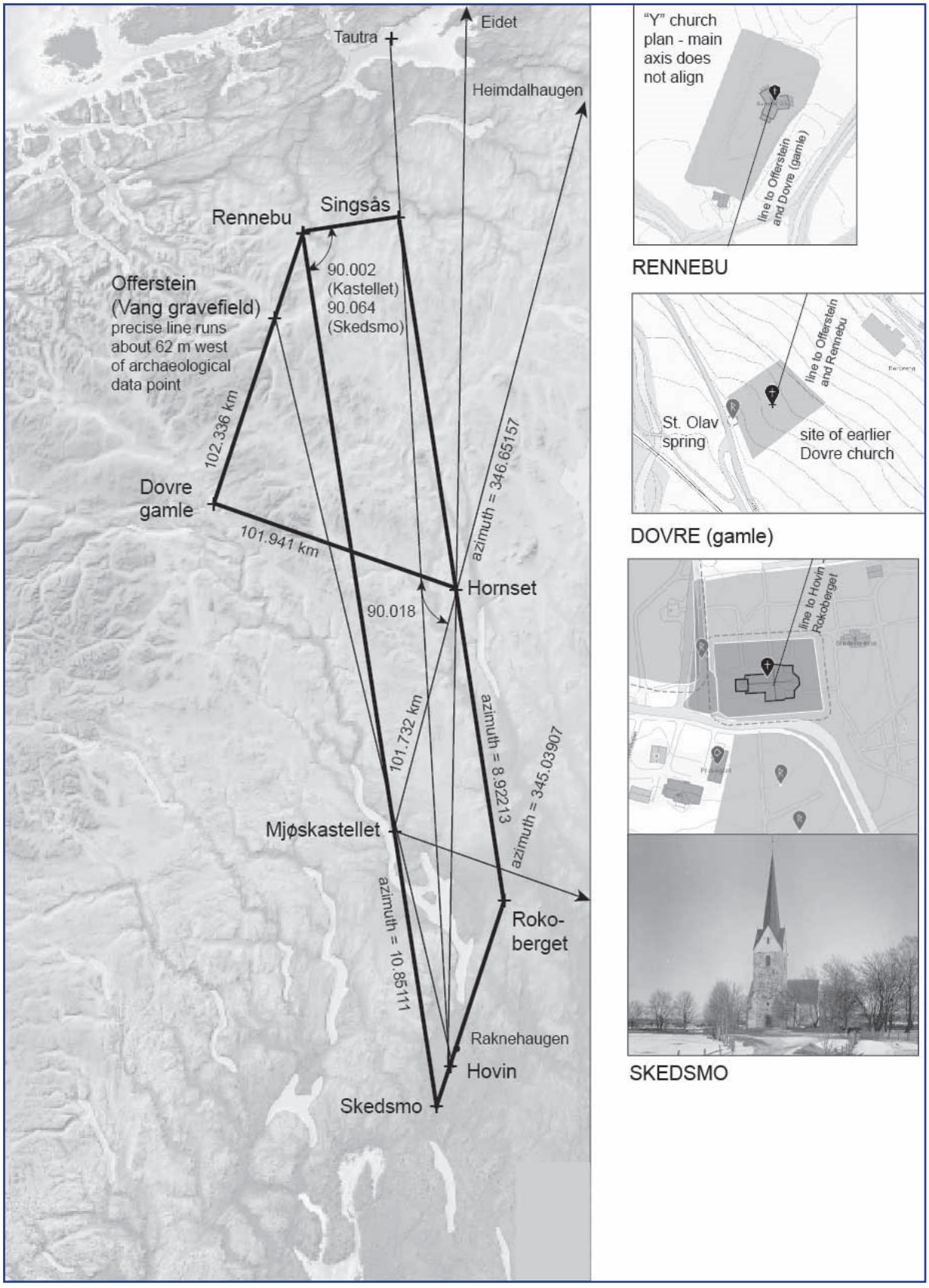
The Offerstein marker at Vang forms an accurate three-point alignment with the Kastellet and Hovin, one of multiple lines radiating out from this Raknehaugen 'annex'. Surveyors may have felt a need to formalise the route from Mjøsa to Vang, providing a designed closure to the emerging overall pattern. Difficult as the passage was — testified by Adam of Bremen — this was undoubtedly already a major route up across Dovrefjell and down to Trondheimsfjord. It is also true that a pilgrim route through this area provides dramatic views of what was considered until the 1800's to be Norway's highest mountain, Snøhetta, (see image in Figure 18).

The first design move could have been to chain (measure) the distance from Hornset to the Kastellet, 101.732 km. Then, wishing to create a 'right-angle' symbolic relationship, the same distance could have been marked off perpendicularly to the west from Kastellet. This angle is 90.018 and the distance to the end of this line is 101.941, where the early church of Dovre was positioned, (see Figure 11). About 25 meters west of the archaeological point is a St. Olav spring, said to have been good medicine for children. While this and other presently suggested surveying efforts await field evaluation, the accuracy of the two rays of the right angle from Hornset — note that this position on the Hovin / Raknehaugen meridian is symbolically logical to create additional formalisation of the 'system' — can be considered by dividing the difference in length of the two lines by two, i.e. 209/2 meters or 104.5 meters. The error here is about one meter for every 1000 meters measured.

Next, a line could have been prolonged from Dover through Offerstein (best point available) north to some aligned tentative Rennebu point. There the construct would turn east to integrate with Singsås, perhaps established by the Tautra-Hovin line intersection with a Rokoberget-Hornset- Singsås alignment, creating closure on the eastern portion of the overall scheme. A point on the line from Dover, about 40 km from Singsås would have been estimated for its 90 degree relation to two rays, one to the Kastellet, the other to Singsås. Two initial surveys to the prospective Rennebu 90 degree point would be needed. Crews would have to be active in both lines

Figure 11: Closure of the 'System'

Vinklerätt from Hornset as vertex to Kastellet and equal length to Dovre; vinklerätt from Rennebu as vertex to Kastellet and Singsås; alignment Dovre – Offerstein- Rennebu; alignment Singsås – Hornset – Rokoberget; alignment Skedsmo – Hovin – Rokoberget.



simultaneously as it is moved by trial-and-error north or south along the Dover-Offerstein line. The existing right-angle at Rennebu is 90.002 degrees.

The new line from Rennebu to Kastellet and slightly less accurately on down to Skedsmo has a roughly parallel azimuth in the mentioned closure line Singsås – Hornset-Rokoberget.

These two possibly conceptual parallel lines at their southern ends make a final statement about Hovin's foundational role in the system. Skedsmo and Rokoberget align very accurately with the Hovin church in between. (See again image in Figure 3).

Testing the Apparent Closure of The 'System'

Again, the main goal of this work is not any final proof that early medieval people in Norway designed and land-surveyed formal patterns. Rather this is a first step in evaluating large-scale patterns as possible cultural artefacts. Thus, major work has been dedicated primarily to using custom software to document accurate formal relationships among sites. In conventional professional landscape architecture this is an accurate 'site analysis', though at larger scales than customary. The patterns thus far described and measured do *exist*, though now including other sites not part of the *Gudbrandsdal* route(s) as described in the website. One begins to question whether the complex pattern has a logical relationship not only to this pilgrimage route, but to some earlier cultural concept.

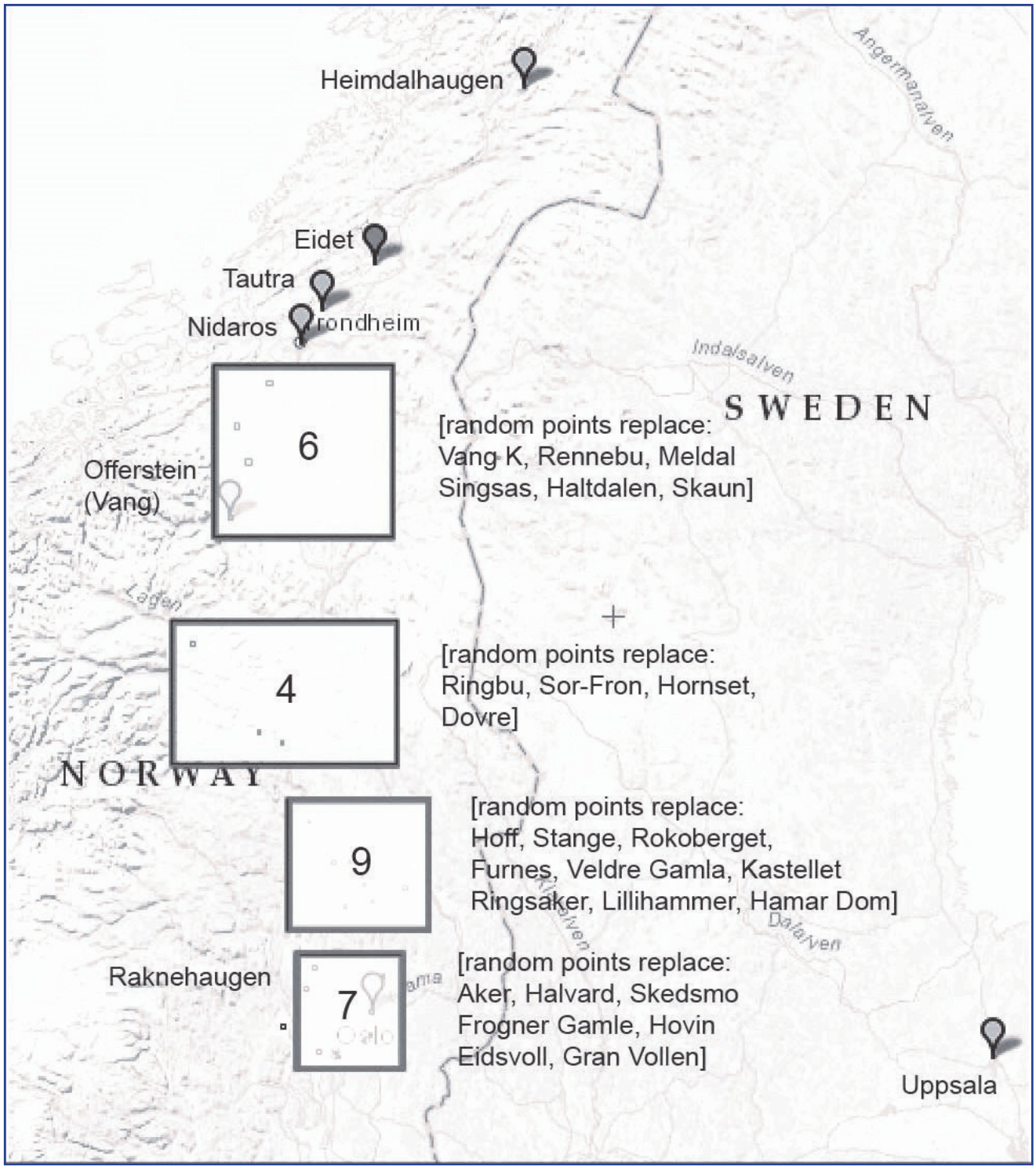
In the absence of a team of Norwegian historians and archaeologists one can presently at least test the existing formal 'scheme' against random phenomena to see if it warrants further consideration. The following exercises compare arrays of patterns produced by random points that replace existing points in logical test areas as shown in Figure 12; one begins with simple patterns like three-point alignments, cardinals and right-angles, and then combine them into increasingly complex 'molecules'. The number of existing sites has been expanded from the original *Gudbrandsdalen* list to include Heimdalhaugen, the Eidet point, Tautra and Uppsala; these together with Nidaros, Offerstein and Raknehaugen are 'fixed' points in each test set and are free to combine with random points to create patterns. The original list of churches has been expanded with the addition of Hornset, Haltdalen, and Singsås (part of the Østerdalen route list). The Kastellet site is also included to be replaced by one random point in each set.

The issue of whether the terrain on which a random point lands is suitable for construction has been addressed in previous publications by the author (2022, 2021, 2009, 2007a). Essentially the location of churches at large scales for purely symbolic reasons is independent of local functional site conditions. While large scale sites like Hornset might have to be adjusted slightly because of topography, no existing natural feature in the site itself is likely to cause an alignment to a site or sites many kilometres away. If a random point lands on a lake or river, one can further assume that for a particular set of random points, some different, accommodating but independent watercourse could have been possible.

The simplest exercise is to set the computer to generate 100 sets where each has the seven fixed points and 26 random ones to replace the existing. Within each set, the application looks only for three-point alignments at or under an accuracy of 0.06 (limit of patterns found in the Østerdal route). Results are shown in Figure 13, where the average number of alignments per random set is 8.04; the highest number of random three-pointers in any set is 18; and the number of alignments in the existing set is 22. Thus, the likelihood that all three-point alignments in the existing are random is considerably less than 1 in 100.

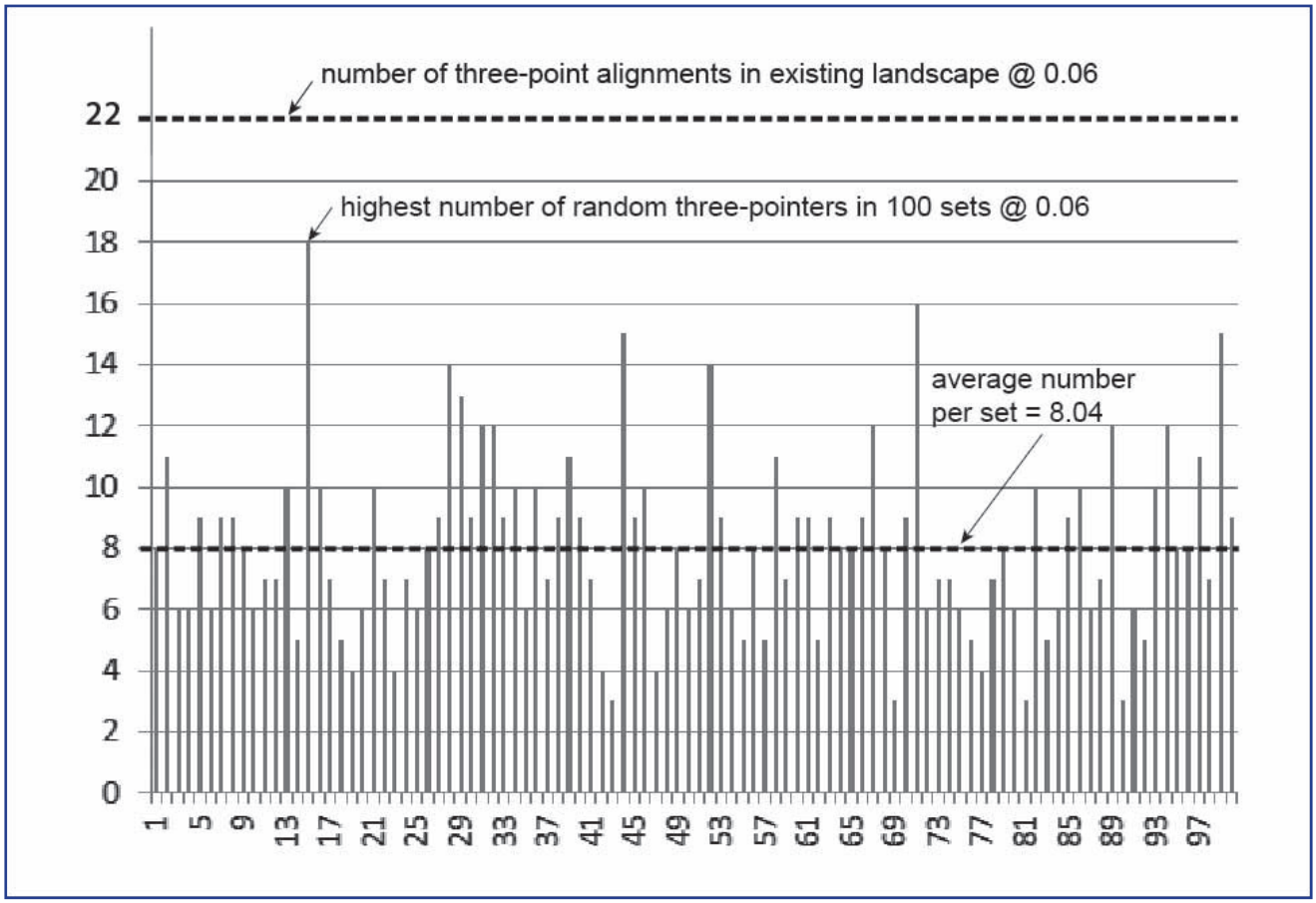
The caveat here is that fifteen three-pointers of the existing twenty-two involve the five sites added by the author (not included in either of the two pilgrimage routes mapped in the website), i.e. Heimdalhaugen, Tautra, Kastellet, Hornset, and Haltdalen (Uppsala has no three-point alignment). One might well question the process by which particularly Hornset and the Kastellet were 'found'. Was this just part of a larger trial and error search for points that would expand the number of existing three-pointers or was there a formalised spatial role that these points particularly played in an evolving overall 'system' concept?

Figure 12. Test Areas in Which Numbers of Random Points Equal to the Number of Existing Sites are Distributed for Each Set;
seven sites are not replaced and are 'fixed' in their locations for each set of random points.



To speak more directly to this question, one can begin to combine three-point alignments with cardinal relationships between two points (either north-south or east-west) and 90 degree or right-angle patterns among a vertex point and two points on the two legs. The first combined pattern thus far discussed is the Hovin 'meridian' among the six points diagrammed in Figure 14. To set up this test, combinations of 'A', 'C' and 'N' are inputted in varied sequences and number until the more complex pattern is found among the total set of existing.

Figure 13. Comparison of Simple Numbers of Random Three-point Alignments in 100 Sets at or less than 0.06 Accuracy; existing is 22.



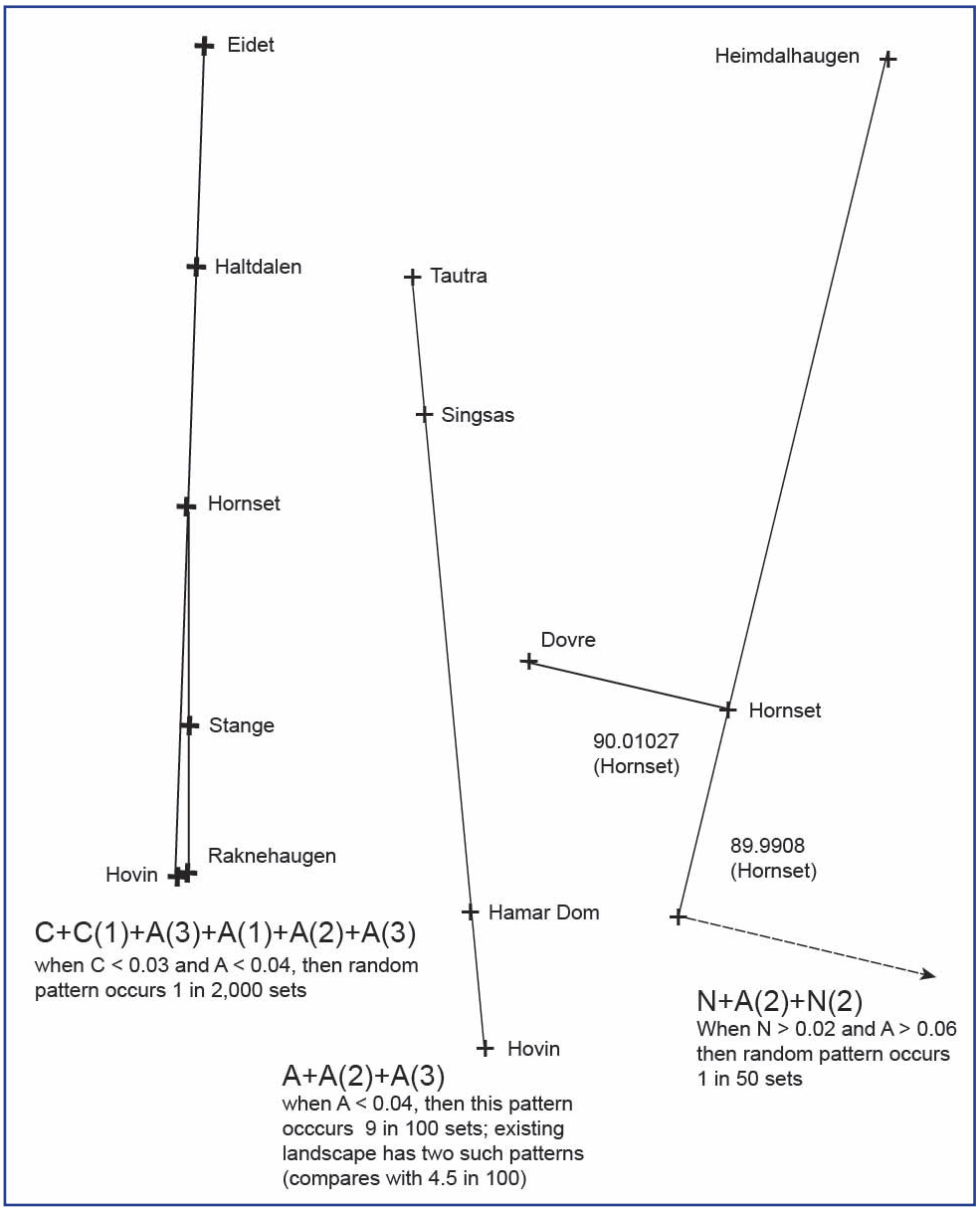
For the Hovin meridian molecule, a first pattern of two cardinally (N-S) related points (Raknehaugen – Stange) is inputted as the first [C]. Then a second (N-S) cardinally related pair overlapping the first with one point can be added (Hornset – Stange), [C+C(1)]. Since the four–point alignment that runs from Hovin to the Eidet point is slightly off true north-south, no further cardinal patterns can be added. Instead one can add the pattern of Raknehaugen – Stange – Hornset as a three-point alignment independent of their cardinal relationships (though if designed, the two are likely to have been combined), [C+C(1)+A(3)]. One can now add the four-point alignment from Hovin to the Eidet that overlaps at Hornset, [C+C(1)+A(3)+A(1)+A(2)+A(3)]. If the computer search now picks up this string without finding variations, one can look for the identical string in numbers of random sets. The tolerance for each kind of pattern can be set more precisely like the existing for the comparison, here A = 0.04 or less and C = 0.03 or less.

Among random sets, a pattern identical to the' Hovin Meridian' occurs 1 in 2,000 sets. This random set does not use Raknehaugen, but Eidet alone as the only fixed site.

A second and third Hovin molecule can be isolated, each as [A+A(2)+A(3)]; this finds the four-point alignment between Tautra – Singsås – Hamar Domen – Hovin, and the Hovin – Hornset – Haltdalen – Eidet four-pointer. Among the random sets one therefore looks for two four-point alignments. When A is 0.04 or less, nine four-point alignments occur in 100 random sets. Thus the odds of any set having one such pattern are about 1 in 11. It is true, however, that the existing sites create two four-point patterns which for a single random set to duplicate would be odds of one pattern times itself, or about 1 in 123.

The third molecule one can test is the combination of two right angles and an alignment also shown in Figure 14. Inputting the first ninety at 0.02, picks up that between the Kastellet, Uppsala and Hornset; then an A(2) finds the

Figure 14. Existing 'Molecules' (combinations of single patterns) Tested Against Sets of Randomly Generated Points



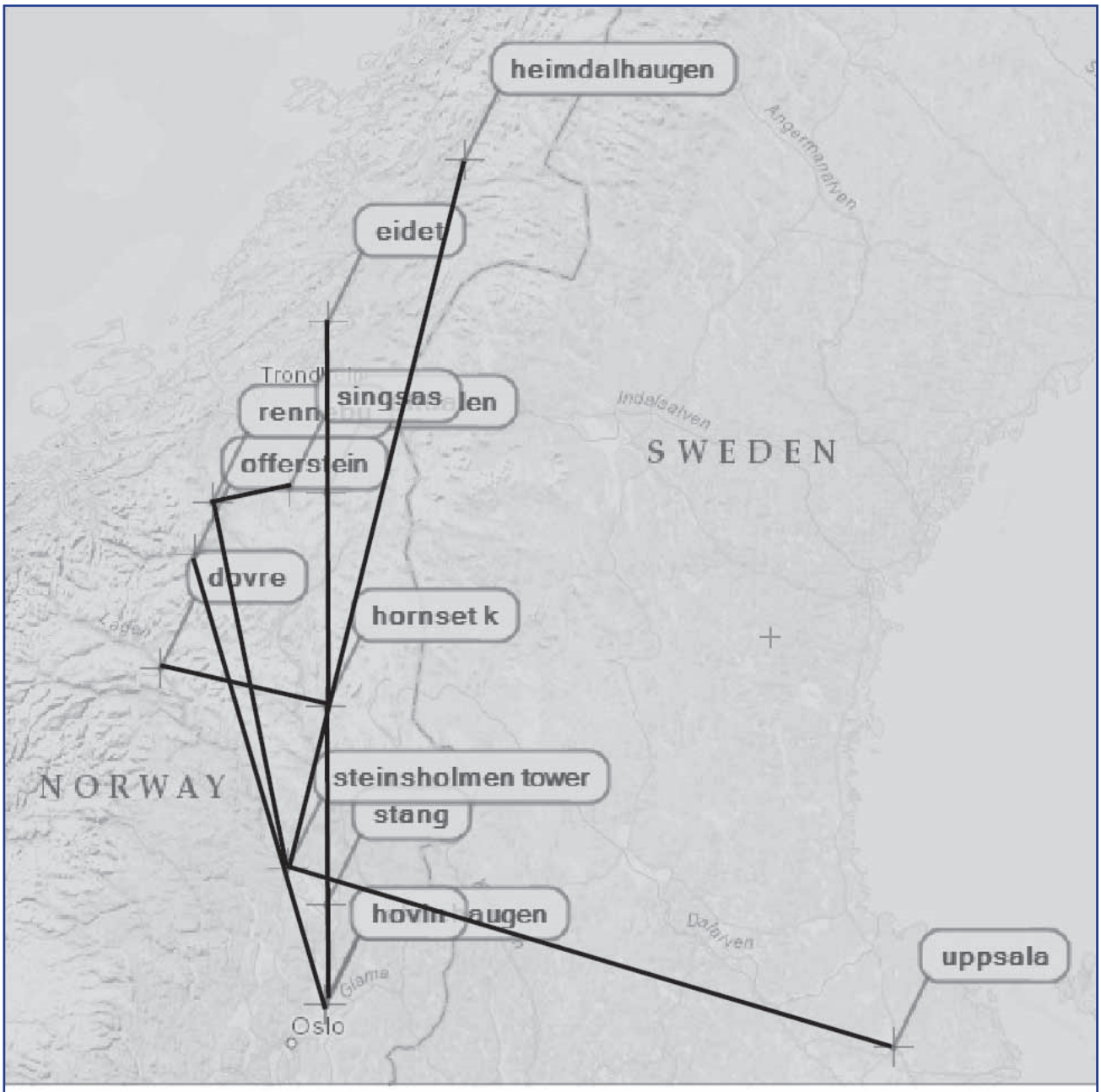
three-point alignment at or under 0.06 between Kastellet – Hornset – Heimdalhaugen; and finally the second ninety again at or under 0.02 is that from Hornset to Kastellet and Dovre. This search string is N+A(2)+N(2). Running 100 random sets, again, this pattern appears two times, or 2 in 100.

Testing a Maximum Molecule

By now the reader may begin to sense how likely a single set of sites, existing or random, is to contain all three of the molecules tested separately above. Using the simple rule of calculating multiple odds, one can multiply 1:2000 (0.05) times 1:123 (0.81) times 2:100 (2.0) for a total odds of 0.00081 or **1 in 1,234**.

These three sub-patterns, however, do not map what seems to be the total closed or most integrated pattern. However, present software has limitations as to how complex a search string one can create. What can be done at present is to map the greatest integration that exists in the existing landscape pattern, up to where less integrated pieces start connecting in less formal ways. This is mostly the three sub-patterns already tested with some variation of sequence and 11 elements rather than 12 total; this configuration of points is shown in Figure 15 along with each of the individual patterns that are picked up in the search. Again, among the existing sites, this string only finds this composite pattern.

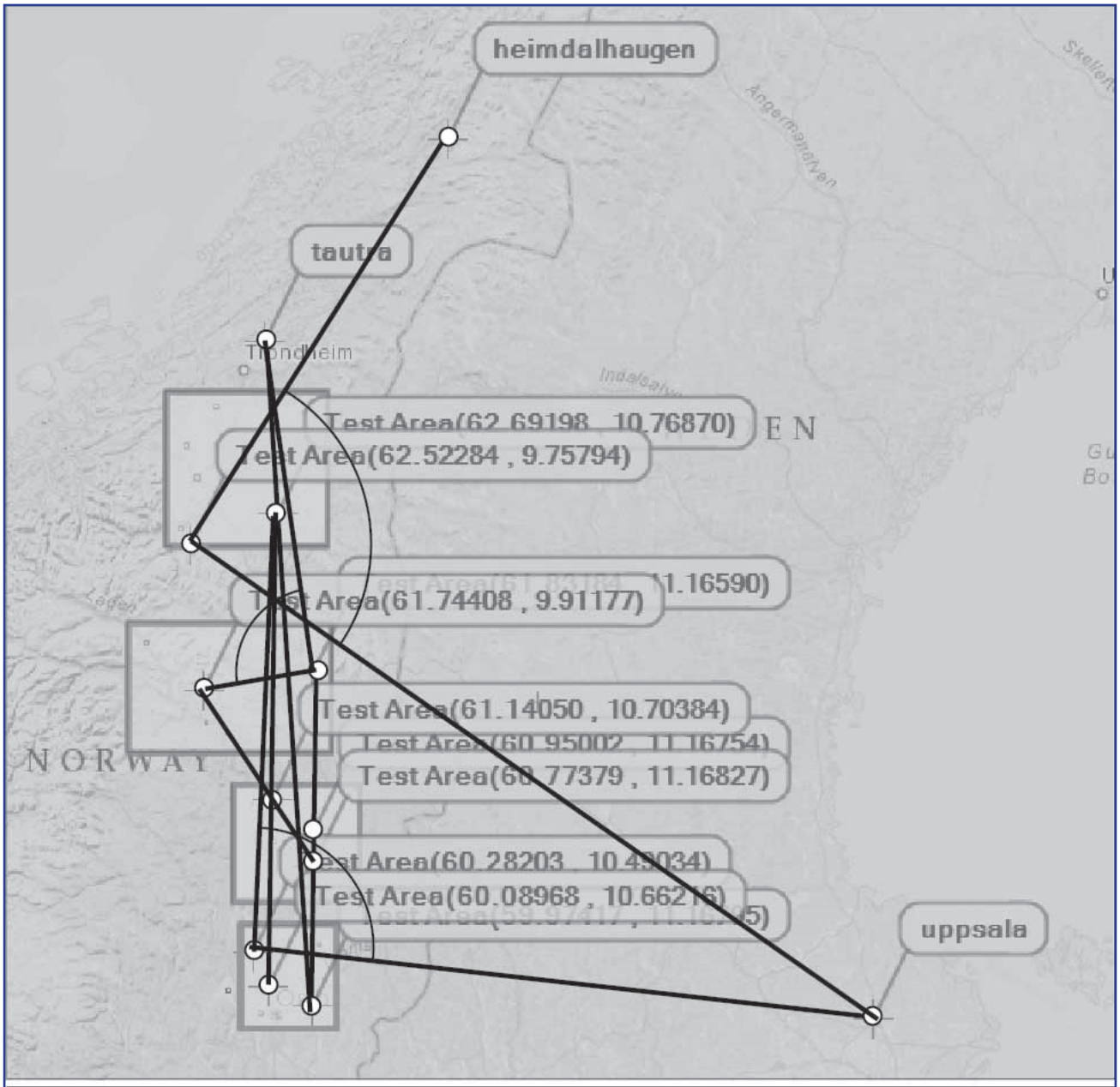
Figure 15: Maximum Molecule Search String that Finds Integrated Existing Patterns Listed in Printout.



C+C(1)+A(3)+A(1)+A(2)+A(3)+N(1)+N(2)+A(2)+A(2)+N(1) (1)

Cardinal: stang , hornset k , 0.009905
Cardinal: raknehaugen , hornset k , 0.029856
Alignment: hornset k , stang , raknehaugen , 180.039895
Alignment: hovin , hornset k , haltdalen , 359.795508
Alignment: hovin , hornset k , eidet , 359.804521
Alignment: hornset k , haltdalen , eidet , 359.774296
Ninety: steinsholmen tower , hornset k , uppsala , 89.993829
Ninety: hornset k , steinsholmen tower , dovre , 90.010274
Alignment: offerstein , steinsholmen tower , hovin , 195.873867
Alignment: steinsholmen tower , hornset k , heimdalhaugen , 346.304158
Ninety: rennebu , singsas , steinsholmen tower , 89.997716 id=1

Figure 16a: Search String for Existing Molecule Finds Related but Different Molecule
(random set #156,162)

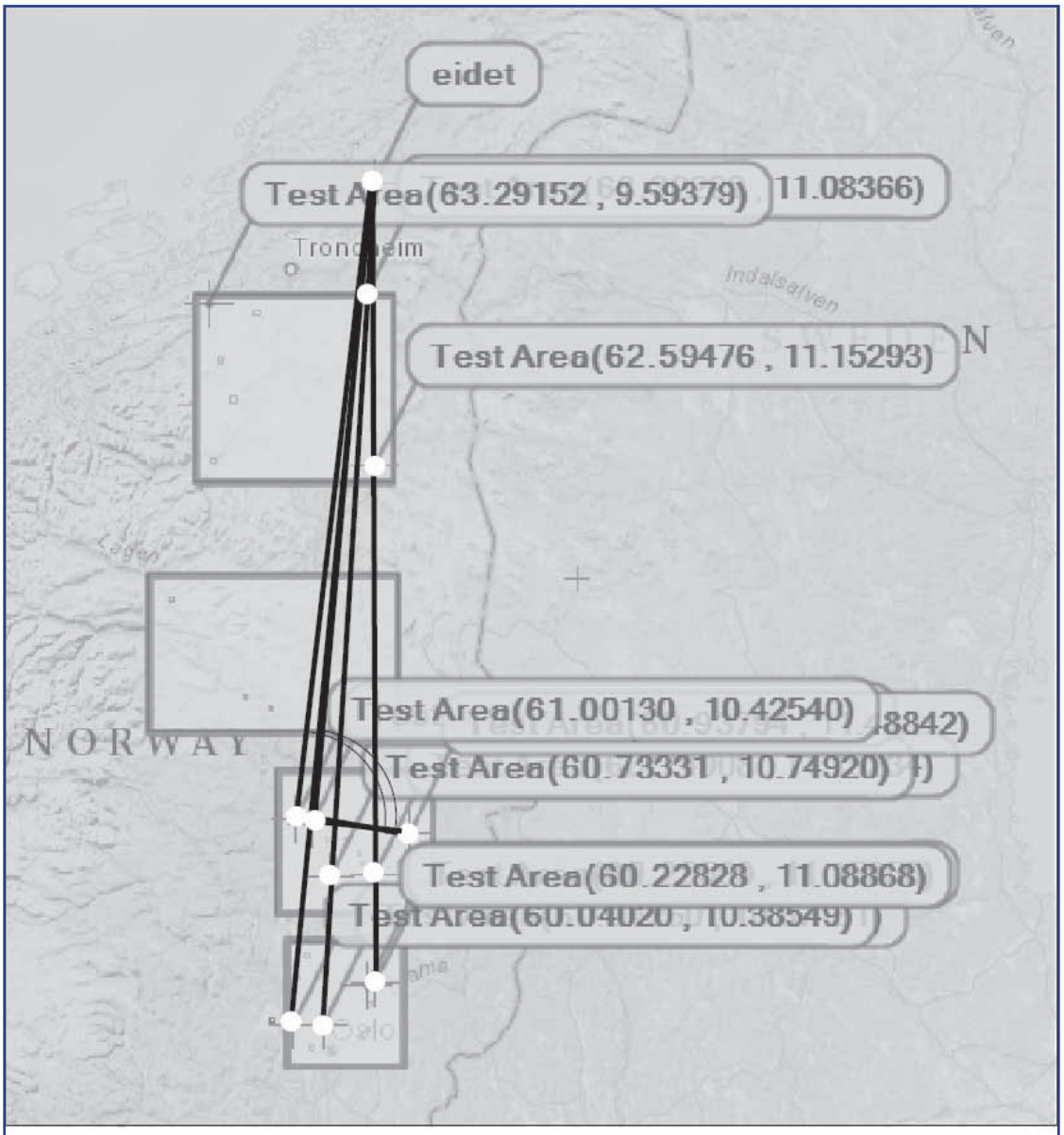


Patterns Investigated (1):

C+C(1)+A(3)+A(1)+A(2)+A(3)+N(1)+N(2)+A(2)+A(2)+N(1) (11)

set56162
Cardinal: Test Area(59.97417 , 11.16795) , Test Area(60.95002 , 11.16754) , 0.011961
Cardinal: Test Area(59.97417 , 11.16795) , Test Area(61.83184 , 11.16590) , 0.030800
Alignment: Test Area(61.83184 , 11.16590) , Test Area(60.95002 , 11.16754) , Test Area(59.97417 , 11.16795) , 180.031291
Alignment: tautra , Test Area(62.69198 , 10.76870) , Test Area(59.97417 , 11.16795) , 184.199523
Alignment: Test Area(61.83184 , 11.16590) , Test Area(60.77379 , 11.16827) , Test Area(59.97417 , 11.16795) , 180.024686
Alignment: Test Area(61.83184 , 11.16590) , Test Area(60.95002 , 11.16754) , Test Area(60.77379 , 11.16827) , 180.083004
Ninety: Test Area(60.28203 , 10.49034) , Test Area(62.69198 , 10.76870) , uppsala , 90.001182
Ninety: Test Area(61.83184 , 11.16590) , Test Area(61.74408 , 9.91177) , tautra , 89.986502
Alignment: Test Area(61.74408 , 9.91177) , Test Area(61.14050 , 10.70384) , Test Area(60.77379 , 11.16827) , 211.810907
Alignment: Test Area(60.08968 , 10.66216) , Test Area(61.14050 , 10.70384) , Test Area(62.69198 , 10.76870) , 358.882212
Ninety: Test Area(62.52284 , 9.75794) , heimdalhaugen , uppsala , 90.012539 id=1

Figure 16b. Search String for Existing Molecule Finds Related but Different Molecule
(random set #164,139)



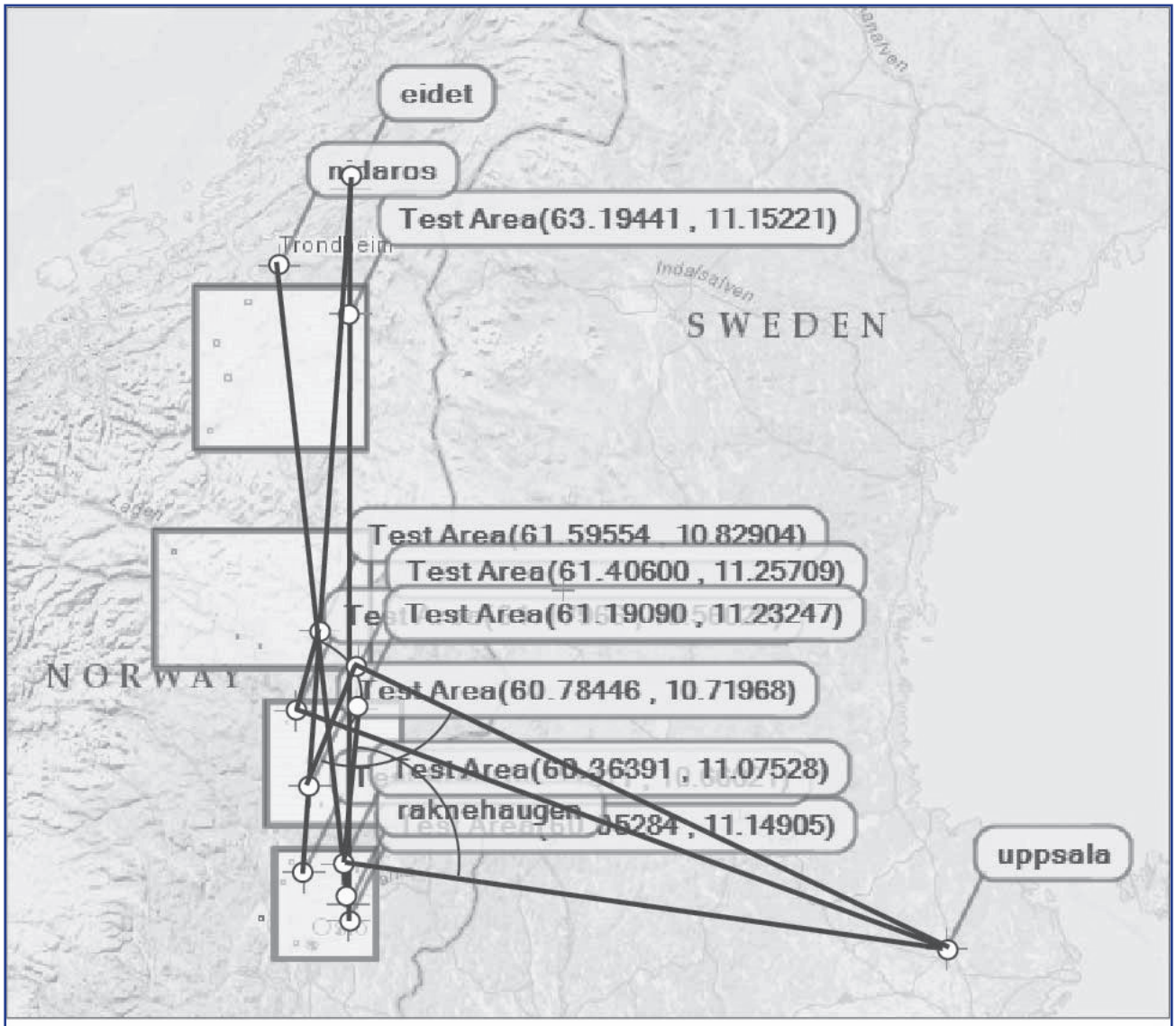
Random Sets: 100000

C+C(1)+A(3)+A(1)+A(2)+A(3)+N(1)+N(2)+A(2)+A(2)+N(1)

set 64139
Cardinal: eidet , Test Area(60.74908 , 11.15234) , 179.995631
Cardinal: eidet , Test Area(62.59476 , 11.15293) , 180.001831
Alignment: eidet , Test Area(62.59476 , 11.15293) , Test Area(60.74908 , 11.15234) , 179.996438
Alignment: Test Area(60.04260 , 10.67161) , Test Area(60.73331 , 10.74920) , eidet , 356.728262
Alignment: Test Area(60.04260 , 10.67161) , Test Area(60.73331 , 10.74920) , Test Area(63.32229 , 11.08366)
Alignment: Test Area(60.73331 , 10.74920) , Test Area(63.32229 , 11.08366) , eidet , 356.371304
Ninety: Test Area(60.98326 , 10.55887) , eidet , Test Area(60.93794 , 11.48842) , 90.000528
Ninety: Test Area(61.00130 , 10.42540) , eidet , Test Area(60.93794 , 11.48842) , 89.980388
Alignment: Test Area(60.04020 , 10.38549) , Test Area(60.98326 , 10.55887) , eidet , 354.712741
Alignment: eidet , Test Area(62.59476 , 11.15293) , Test Area(60.23569 , 11.15355) , 180.004670
Ninety: Test Area(60.23569 , 11.15355) , Test Area(60.22828 , 11.08868) , Test Area(63.29152 , 9.59379)

AlignmentTolerance = 0.06
NinetyTolerance = 0.02
CardinalTolerance = 0.03

Figure 16c: Search String for Existing Molecule Finds Related but Different Molecule
(random set #189,554)



Random Sets: 100000

C+C(1)+A(3)+A(1)+A(2)+A(3)+N(1)+N(2)+A(2)+A(2)+N(1)

set 89554
Cardinal: eidet , Test Area(60.05284 , 11.14905) , 179.972790
Cardinal: eidet , Test Area(63.19441 , 11.15221) , 179.973670
Alignment: Test Area(60.05284 , 11.14905) , Test Area(63.19441 , 11.15221) , eidet , 359.972518
Alignment: Test Area(60.31211 , 10.66021) , Test Area(60.78446 , 10.71968) , eidet , 356.397437
Alignment: Test Area(60.31211 , 10.66021) , Test Area(60.78446 , 10.71968) , Test Area(61.59554 , 10.82904) , 356.374985
Alignment: Test Area(60.78446 , 10.71968) , Test Area(61.59554 , 10.82904) , eidet , 356.259322
Ninety: Test Area(61.17966 , 10.56029) , Test Area(61.59554 , 10.82904) , uppsala , 89.996326
Ninety: Test Area(61.40600 , 11.25709) , uppsala , Test Area(60.78446 , 10.71968) , 90.017465
Alignment: nidaros , Test Area(61.59554 , 10.82904) , Test Area(60.05284 , 11.14905) , 185.977836
Alignment: nidaros , Test Area(61.59554 , 10.82904) , raknehaugen , 186.044532
Ninety: Test Area(60.36391 , 11.07528) , Test Area(61.19090 , 11.23247) , uppsala , 90.012799 id=1

AlignmentTolerance = 0.06
NinetyTolerance = 0.02
CardinalTolerance = 0.03

In this most complex of tests, tolerances of A = 0.06, C = 0.03, and N = 0.02 are used, setting the first batch of random sets at 100. No hits. Then at 1,000; still no hits. Then at 10,000 still no hits. Setting the program then for 100,000, the first produces nothing. But the second (200,000) finds a requisite layout in sets number 156,162; 164,139; and 189,554. The next run (300,000) sees no patterns, but the following (400,000) finds numbers 300,732 and 345,365. The final run (500,000) is without a find. Thus a combined pattern occurs 1 in 100,000 sets.

Looking at the three patterns occurring in the second one hundred thousand set (typical of the other two), figures 16a, 16b, and 16c make it immediately clear that these patterns are different than the existing. Nevertheless, the molecules may be quite similar, especially the combination of north-south meridian and alignments. Yet even though the search pattern picks up only pieces that seem to unify sites in the existing, this same search pattern can find other ways to combine sub-patterns randomly. Even if one meticulously compared each of the random patterns found to the existing, this would be an illogical use of one's time. Whether looking at either the existing or a random result with the same string components, **such complex patterns are extremely rare phenomena**. All are highly unlikely to have been produced by multiple social groups locating their churches — once each — for only clearly independent reasons such as who donated property or having to find an appropriately level construction site.

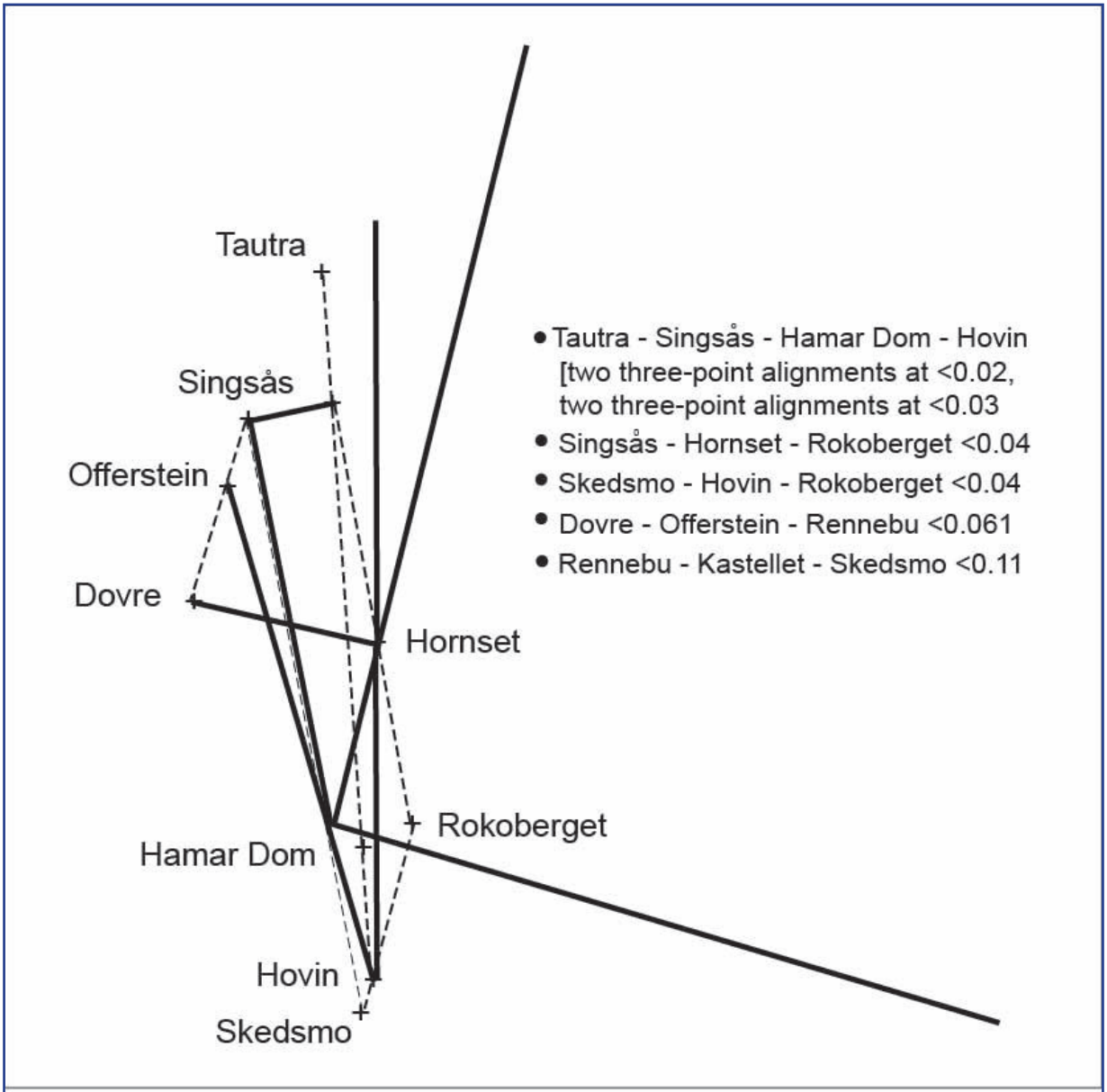
Figure 17 summarises the way additional individual patterns seem to complete the core molecule tested. Again, these patterns cannot neatly be added to the search string used in the test. While all six additional three-point alignments can be picked up by additional elements to the string, one cannot predict the order in which the algorithm finds them. It is also true that because some only overlap by a single site, one would expect to also pick up less integrated individual patterns. A greater likelihood exists that, while they exist in the real landscape, they may tend to be random phenomena.

The likely most important sub-pattern not included in the test, is the four-point alignment Tautra – Singsås – Hamar Dom – Hovin (see again Figure 10). The two alignments Singsås – Hornset – Rokoberget and Rokoberget – Hovin — Skedsmo seem related as perhaps some expression of southeastern boundary. Not dissimilarly to the northwest, the alignment of Dover and Rennebu with the Vang gravefield (Offerstein point) may have provided closure in that direction while defining the pilgrim route over the mountains and by the huge prehistoric burial ground. Finally the less accurate (0.11) line from Singsås down through the Kastellet and to Skedsmo might nonetheless have defined the final piece of the total construct.

The final list of individual patterns using the website list of pilgrimage attractions plus seven additional points (five churches, a castle, and a prominent mountain) is provided below. At a tolerance of 0.061 four of the twenty-two three-pointers, along with one right-angle at 0.02 'deviate' from the 'system'. Though as seen in Figure 4, three of the four deviants run to the great mound, Raknehaugen — as does much in the ultimate system via Hovin. Patterns in bold type seem less 'systemic':

A (22)
1: set0 **ringebu stavekyrka , lillehammer , raknehaugen** , 199.245786 id=1
2: set0 singsas stav , hamar domen , hovin , 183.811250 id=2
3: set0 tautra **,** hamar domen , hovin , 183.818448 id=3
4: set0 hornset k , stang , raknehaugen , 180.039895 id=4
5: set0 skedsmo , hovin , rokoberget , 344.946113 id=5
6: set0 **dovre , sor-fron , furnes** , 216.483172 id=6
7: set0 **skaun , veldre gamle , raknehaugen** , 189.142062 id=7
8: set0 skedsmo , raknehaugen , eidsvoll , 343.274801 id=8
9: set0 vang , steinsholmen tower , hovin , 195.824185 id=9
10: set0 offerstein , steinsholmen tower , hovin , 195.857236 id=10
11: set0 **ringsaker , hoff , raknehaugen** , 195.103112 id=11
12: set0 singsas stav , hornset k , rokoberget , 189.184942 id=12
13: set0 steinsholmen tower , hornset k , heimdalhaugen , 346.308169 id=13
14: set0 hovin , hornset k , haltdalen , 359.796202 id=14
15: set0 hovin , hornset k , eidet graveyard , 359.820210 id=15
16: set0 tautra , singsas stav , hamar domen , 184.097168 id=16
17: set0 tautra , singsas stav , hovin , 184.102723 id=17
18: set0 tautra , singsas stav , raknehaugen , 184.164624 id=18
19: set0 hornset k , haltdalen , eidet graveyard , 359.810042 id=19
20: set0 hovin , haltdalen , eidet graveyard , 359.829062 id=20
21: set0 stang , haltdalen , eidet graveyard , 359.870255 id=21
22: set0 raknehaugen , haltdalen , eidet graveyard , 359.889083 id=22

Figure 17: Accuracies of Additional Patterns Necessary for 'Closure' of Possible System
(not included in search string of test molecule).



C (3)
1: set0 **ringsaker , singsas stav** , 0.020178 id=23
2: set0 stang , hornset k , 0.009905 id=24
3: set0 raknehaugen , hornset k , 0.029856 id=25
N (4)
1: set0 **aker , nidaros , uppsala** , 90.007553 id=26
2: set0 rennebu , singsas stav , steinsholmen tower , 90.009940 id=27
3: set0 steinsholmen tower , hornset k , uppsala , 89.990817 id=28
4: set0 hornset k , steinsholmen tower , dovre , 90.018296 id=29

Future Work by Others?

This work undertakes a close mapping exercise of the landscape in design analysis of large-scale formal patterns that technically could have been surveyed in the early Middle Ages. This focus includes the problem of distinguishing formal design from a background of accurate individual patterns that random points on the landscape can generate. While this report may seem to achieve proof of patterns as artefacts', such is not intended. The following are ideas about these patterns that might now become interesting to researchers from various fields, that perhaps eventually would lead to some shared disciplinary understanding of such phenomena.

Investigation of Particular Sites

For an archaeologist or medieval historian, the location of Hornset Church and related other meanings — no built elements remain on the surface — should now be interesting. It seems impossible that all of the large-scale pattern revolving around this point is simply coincidental, it is:

1) on the accurate meridian and four-point alignment from Raknehaugen with Stange and the early church at Eidet,
2) on the four-point alignment from Hovin with Haltdalen to the Eidet isthmus point,
3) the vertex of two ninety-degree angles that work with the alignment from the Kastellet to Heimdalhaugen, with the perpendicular to Dover,
4) the right-angle with the Kastellet vertex to Uppsala,
5) the interim point on the alignment with Singsås and Rokoberget [all at or under an accuracy of 0.04 degrees].

In spite of the fact that neither of the earlier churches at Øvre Rendal or Ytre Rendal still stand in the two existing churchyards, what might be gained from an analysis of their present day church inventories? Why was Hornset apparently built first and then decommissioned as it were to build this Rendal pair? Might one somehow find hypothetical orientations of the two early Rendal churches based on patterns with the Hornset point together with elements of the standing churches?

Surely the second least coincidental seeming pattern is the Hovin church complex, adjacent to Raknehaugen. Its elements are:

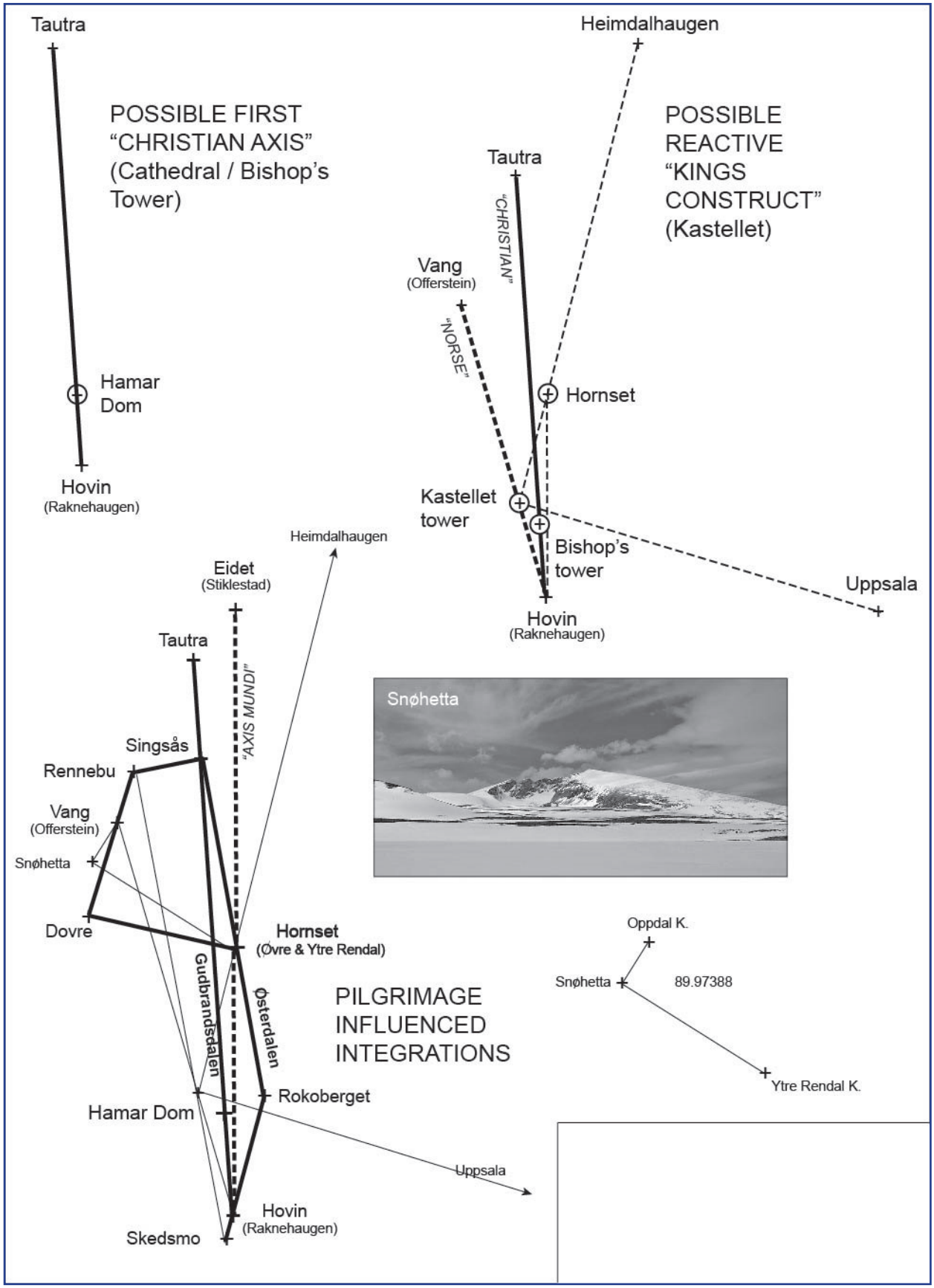
1) a likely 'base' symbolism similar to Raknehaugen's meridian to Stang, Hornset and the early church at Eidet; Hovin is the foundation point for three sites very nearly meridian in orientation, Hornset, Haltdalen and the precise topographical isthmus point Eidet under an accuracy of 0.04;
2) a second four-point alignment at this accuracy includes Hamar Cathedral, Singsås and the Tautra monastery;
3) the power of the Vang gravefield (Offerstein) is connected to Hovin by the aligned interim Kastellet structure at or under 0.04; and
4) Hovin as an interim position between Skedsmo and Rokoberget at or under 0.04. What is the 'king's farm' history of Hovin, whose stave church was on the same site and said to be built in the 1200's. Is there anything in the standing Hovin church that speaks to any of these patterns aside from its intercardinal (45°) alignment to Raknehaugen (figure 3)?

The Eidet itself is a historical and archaeological mystery, particularly where the very earliest stave church was located. Also intriguing is the Christian graveyard right at the topographic Eidet isthmus, which somehow had no church associated with it.

Expression of Civil Wars of the Period

The most datable aspect of the *Gudbrandsdalen* route as now closely mapped might be the area around Mjøsa because of the political history of this important area. In 1184 King Sverre declared that the king should rule over the church. The strife that followed was most

Figure 18: Speculative Evolution of System Elements
1) Christian axis, 2) Kings construct, and 3) Pilgrimage influence; view of Snøhetta from pilgrim route, held to be highest mountain in Norway at that time



architecturally expressed by the opposition between the Kastellet tower, and the tower built by the bishop at Hamar Cathedral i.e., 'two towers tight against each other' (Reinfjord 2018). About 23 kilometres separate the two. Part of the conflict between King Håkon Håkonsson and bishop Pål concerned rights to the island of Helgøya. By building the Kastellet around 1230, the King attempted to control several important inland roads that led to Trondheimsfjord over Dovrefjell. While the competing tower that Reinfjord writes about was built circa 1250, it was an addition to the bishop's compound located just behind the cathedral. How then can this competition relate to the design and surveying of symbolic lines in the landscape by the two political groups?

One scenario might have begun with a move from the power centre of the region at Aker Farm to the Domkirkeodden, the site where the cathedral was completed around 1150. Since the much smaller church at Tautra was completed only about twenty years after Dom Church, it is not impossible that the alignment of the two points with a perhaps contemporary new church at Hovin took place in this time period. Thus, the first political entity to associate a landscape axis with its church might have been the Papal group at Hamar along with the Cistercians up at Tautra. This large-scale association of Tautra to the Frostating area and Raknehaugen could have been seen as a highly symbolic advantage in the competition with the king and his men (see figure 18).

When the Christianity fuelled civil strife began to reach boiling point in the early 1200's, it became necessary to make a larger presence known at Mjøsa. In describing the largest castle in Norway at the time, the Kastellet, Arstad concludes that:

> *Despite the fact that, in terms of size and location, the castle at Steinsholmen was a very impressive castle, it becomes obvious that none of the military leaders in Eastern Norway in 1240 considered this stronghold to hold any vital strategic significance in or for the presence of the kingdom in the inner Eastern Norway region during the campaign. The war between the Vårbelger and Birkebeiner show us that Mjøs Castle neither dominated the surrounding landscape nor had control over the lines of communication. Naturally, the garrison could keep an eye on traffic, but not, on the water and, to an even less degree, prevent what took place on land. Besides, both sides knew that the Mjøs Castle's fate would be decided in the course of the season somewhere other than in Mjøsa. Norway would be won on the battlefield* (Arstad 2015:30).

The purpose of the Kastellet — given its lack of real territorial power — could have been to create a large-scale pattern that would symbolically oppose the new religion, expressing a 'georitual' past in Scandinavia by which large scale social power was integrated. Now opposed to the Tautra-Hovin alignment of the cathedral and bishop's tower, is the largely Norse alignment of Vang gravefield with Kkastellet down to the new Hovin Church. The ancient power of this line comes at the largest scale from the Heimdalhaugen and Uppsala right angle pattern.

Pilgrimage Incentivises Final Closure of System?

In pilgrimage planning — such as it was in a still contested political geography — the main question may well have been, not so much who 'owns' the holy Christian shrine with St.Olav's bones, but where in the landscape did the spirt transform to the other world. The important actors in this transitional culture may have realised that the formal landscape that opposed the Tautra and Kastellet elements based at Hovin had no integrating common axis between the two patterns. Since this may have been an ancient role of Raknehaugen and its meridian to the Eidet, it may have been logical to refine this meridian creating the four-point alignment from the topographic isthmus on the Heimdalhaugen / Frosta axis down to Hovin.

Even though St. Olav's remains were apparently not interred at the isthmus — again quite accurately west of the Stiklestad church where he died — a more symbolically fitting pilgrimage destination than Nideros might well have been the combination of death location together with the point where his spirit would have gone to Valhalla. After all, the new cathedral in Trondheim was not completed until the 1300's and not dedicated to St. Olav. It is interesting in this regard to look more closely at — according the *pilegrimleden* website — where the pilgrims coming from the east through Storsjøn (St.

Olavsleden) went after visiting Stiklestad. They are assumed to have gone as well to Nidaros, though the website is not specific as to the route. One can find no documentation that pilgrims logically went down the Frosta peninsula stopping at important churches like Alstadhaug and the *Alting* site itself (along with Logtun Church), and eventually took boats over to Tautra, before continuing by boat to Nidaros.

The combination of a more symbolically logical pilgrimage destination with the building of additional churches to create closure to the pilgrimage map would have facilitated the social and political benefits of more pilgrims from abroad and more important locally, a means of continuing Norse practices in a ritual landscape, while discursively doing so as 'Christians'.

Conclusion: Formal Cognitive Maps and New Discourse in the Contemporary 'Pilgrim' Experience

Aside from some future recognition by historians and archaeologists of the 'artificiality' of such patterns and their cultural association with medieval pilgrim experience, would contemporary users benefit from more immediately understanding a closely mapped site analysis as part of their travel experience? First, there is nothing anti-academic about creating digital maps of patterns that exist, and need not be presented as any kind of hypothesis about history. A lay person could use this information as he or she wished, perhaps participating in blogs creating contemporary meanings associated with spatial aspects of the 'system'.

Perhaps a newer concept of Norwegian landscape could evolve serving two purposes, first as a model for contemporary conceptions of more holistic landscapes generally, and second, as provocation about ideas of cultural landscape as Christianity fused with Norse belief. This might radically change the way historians and archaeologists interpret the process by which an imported book-based culture ultimately appropriated an ancient prehistoric means of structuring a non-discursive ritual landscape.

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