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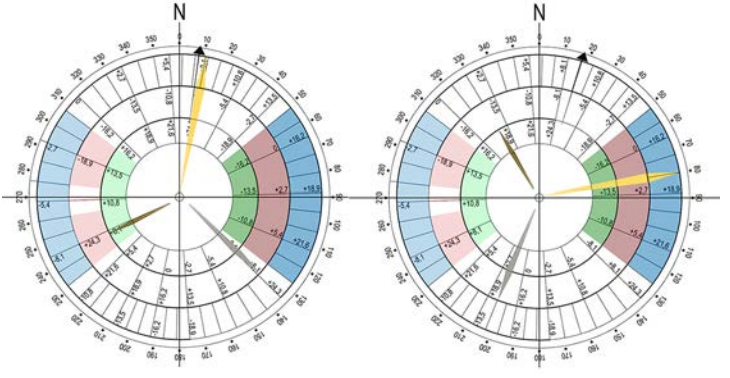

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ABSTRACT

Let us presume that in the ages before the compass was invented and yet, in the context of certain rituals, cultic buildings were sited in the direction of a geomagnetic phenomenon. Directions that could be perceived by the human eye and body were sited, even though their magnetic features were unknown. We will examine the features of the indirect relationship between the axial directions of cultic structures and that of the Magnetic North characteristic at the time of the siting.

An examination of the close interrelation between orientation practices and magnetic phenomena could confirm the hypothesis that humans are capable of sensing certain geomagnetic field directions.

Based on our working hypothesis, at the time of the examined cultic structures' axis siting, performers of cultic rituals sensed certain invisible geomagnetic impulses, even though they did not interpret them as magnetic phenomena. The perceived phenomena were understood as a "World Creator" or as its signs, and this role had a determining significance for cultic orientation directions.

In the last century, other kinds of orientation explanations built on obviously visible astrological references and various ideas connected to them were constructive. Little attention was paid, however, to the invisible, visually unperceivable, self-effacing force behind these cults and rites.

Having observed the axial directions of several hundreds of cultic structures, it appears obvious that the circle of these structures' axial directions is much wider than the zone of Magnetic North's directions. We may exclude as explanation the joint changing of orientation directions and those of Magnetic North. *Only an indirect connection is possible between the orientation data and the still undisclosed features of the geomagnetic field.*

We do not dispute the validity of the geomagnetic field's features as measured by various instruments, but we reinterpret them by articulating a new, spatial network-based on a geomagnetic model built on orientation directions.

In the process we discarded the obviously unstable spatial model of magnetic fields that presume nearly parallel magnetic lines of force.

We can summarize the total geomagnetic field intensity taking effect in one given place by one single direction and intensity value – *as a total field intensity vector*. The geomagnetic North is the horizontal projection of this vector.

The total field intensity direction and intensity of the geomagnetic field is composed of a multitude of such field intensity components and their projections, to which the directions and sizes of the orientation directions of cultic structures refer. Human perception senses and cites only the most powerful field intensity component directions. While we might be able to perceive the field's spatial field intensity components, in the course of cultic orientation we can only site the directions of their horizontal projections. Beside the powerful field intensity components a whole array of weaker components is also present, but our magnetism measuring devices refer only to the latter ones. The powerful and the weak field intensity components are such vectors, whose sum is the total field intensity vector, and its horizontal projection points towards the direction of Magnetic North.

During the analysis of several cultic structures' orientations, we realized that the connection between orientation directions and Magnetic North is astoundingly simple: with a one-degree change of Magnetic North, the siting direction can change between 5 and 8 degrees. Based on those observations, we created a *transmission diagram* modelling the indirect connection between the changing of Magnetic North and that of orientation directions.

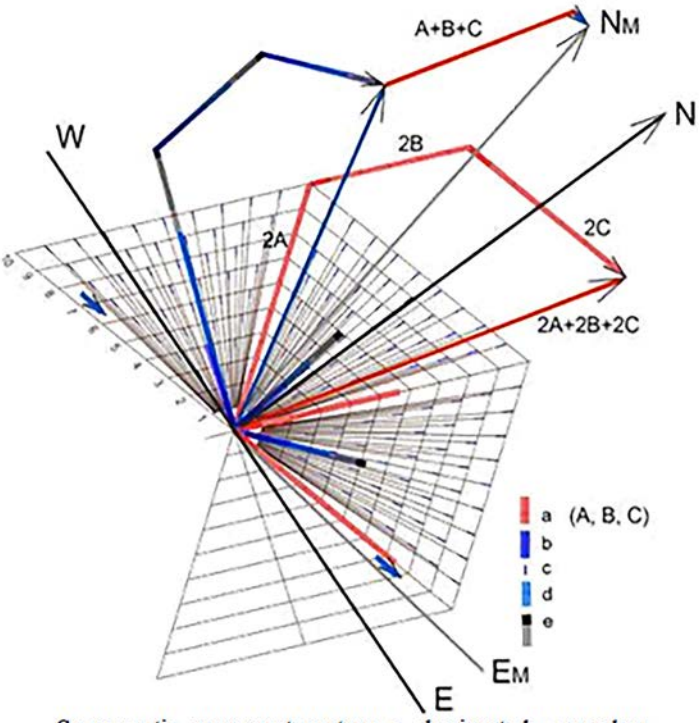
Keywords: cultic orientation, geomagnetic field of a spatial network, magnetic field intensity component vector, Magnetic North component vector, transmission diagram

CULTIC ORIENTATION AND GEOMAGNETICS

The orientation directions of cultic buildings erected before the use of the compass can only show connections with the Magnetic North direction synchronic with human perception of magnetism at the time of the siting. The zone of orientation directions is significantly wider than that of Magnetic North directions. The absence of a mutual changing of the two taking place in the same measure, suggests that there cannot be a direct relationship between them.

During our work of modelling their relationship, *we could only presume an indirect connection based on a geomagnetic spatial network model, articulated on the basis of orientation directions.* According to this model, *the total field intensity direction and the intensity of the geomagnetic field is made up of a multitude of field intensity components, whose horizontal projection directions consist of the cultic buildings' orientation directions.* Humans perceive only the strongest (dominant) field intensity component directions that are observable and may be used for siting purposes. Beside the powerful components, a multitude of weaker components also affects magnetism measuring devices. During the instrumental measuring process the sum of all these influences appears concentrated into one single direction and intensity value, as total geomagnetic field intensity.

The vector has a direction and intensity, and as such is a geomagnetic field intensity identified by magnetism measuring devices. Its *horizontal projection* is *geomagnetic North*, indicated by our compasses that are only capable of measuring on a horizontal plane, and its direction is that which diverges sideways from Geographic North. This diverging sideways is characterized by the angle of deviation from Geographic North, also called declination (meaning: bending). The divergence angle value given in degrees not



Geomagnetic component vectors: a, dominant, b, secondary-dominant, c, weak component vectors, d, the resultant vector of secondary dominant and weak at 10 layers, e, the resultant vector size of secondary dominant and weak vectors at 20 layers

Figure 1: The creation of the Magnetic North vector: the sum of dominant (A, B, C) and the vector sum of the horizontal projections of weak magnetic field intensity component vectors.The interpretation of the layers: Figure 0: on the distance between the observed place and its direct, neighbouring cross-section function the dominant magnetic field intensity projection vectors indicated with the colour red. The dominant vectors in blue and grey appear as the vector sum of the effects in a triangle-like sector of a 20 times as big a distance compared to the neighbouring distance. The sum of these three blue and grey vectors – with a correction indicated by a short blue arrow– represent the effect of the weak components that cannot be sense by humans but which are instrumentally measurable. The vector sum of dominant and weak components results in the Magnetic North vector. The "Magnetic East" is perpendicular to the Magnetic North (E) and it is created by the transposition of the magnetic components separated by a line onto the other side in order to refine the effect of the distant components (indicated by a shot blue arrow).

only refers to an abstract angle, but also indicates the divergence is the lateral direction from the fixed Geographic North, and thus the *direction of magnetic North is always a declinational direction.*

On the other hand, the sign value of the angle between Geographic and Magnetic North becomes only a directional angle without its role as defining the direction of divergence from Geographic North. The divergence of the cultic building's direction from Geographic North is also a directional angle, that is, an azimuth, and nobody thinks that a certain azimuth value is only a shared angle.

Our compasses that allow moving away from the horizontal plane indicate the geomagnetic field intensity vector direction that points obliquely downwards, which, based on *today's physical model,* can be determined by summarizing the *imaginary lines of force* moving in parallel directions.

However, the directions of the component vectors building up the magnetic field intensity vector cannot be imaginary magnetic lines of force as conventionally thought of in today's physics, resulting in an unstable structure. Beside the direction and the intensity of the field intensity vector measured instrumentally, we can construct a new, flexible and stable magnetic field structure with field intensity component vectors that fit the directions of cultic sitings.

We compared and contrasted hundreds of cultic orientation directions and -- based on archaeological findings which are also archaeo-magnetic -- magnetic *declinational directions* synchronic with the setting, that is, the Magnetic North directions. Consequently, it is reasonable to apply the term "declinational direction" also in the case of the Magnetic North and its components. The multitude of components making up the Magnetic North are its declinational components.

Based on the data of a whole array of orientations, we concluded that during the cultic sitings that took place before the age of compass usage, three field intensity

components of the total field intensity were perceptible to human perception. Moving on the horizontal plane, the field intensity components directed obliquely downwards and upwards are perceivable in a point-like but powerful way at their cross-sections one above the other. When not being observed at their cross-sections, an observer receives significantly weaker impulses. It is possible that in the ages before the use of the compass the components were also perceived in the oblique direction. Moving horizontally, a series of nodes could have been perceived, and moving obliquely up and down, continuously functioning impulses could have been experienced.

This might refer to the fact that the past siters of cultic directions chose those directions based on a series of point-like impulses. Those perceived magnetic impulses did not come from the components of Magnetic North, but were rooted in the magnetic effect generated by those components building up the magnetic field intensity in space—their non-touching, superimposed cross-sections.

The instrumentally determined total geomagnetic field intensity vector is a torsional momentum vector in our terminology, where the turning effect can be created on the plane perpendicular to the direction of the field intensity vector. In this way the vector sum of the existing field intensity vector components makes up the total field intensity vector.

The magnetic spatial network can be modelled based on the field intensity component directions retained in the orientation directions of cultic buildings. The interplay of the magnetic field intensity component vectors discloses itself on the basis of the network structure's geometrics.

Beginning with the cultic orientation directions, we established these projectional vector-sizes, beyond the direction of horizontally projected field intensity component vectors. *The component vectors compose triangles in the*

horizontal projectional image between the cross-sections. Based on the differences in the triangles' side lengths, the *relative magnetic field intensity vector sizes* can be calculated.

Year after year, a huge amount of information appears on the active direction and efficacy of magnetic fields. The measured data can be replicated and double-checked. It is difficult to imagine a model radically different from the presumed inner microstructure of the field. It is especially difficult to accept that the magnetic field components deducible from their geometrical construction and function within the spatial network of the magnetic field themselves create –the magnetic field intensity active in a given place and time. *The cross-sections of the network directions receive a significance because in any place the geomagnetic field intensity is provided by the magnetism generated between near and more distant cross-sections. According to our hypothesis the magnetic field with a spatial network and a thread structure is capable of creating magnetic features similar to those instrumentally measured.*

Until we are able to model more precisely the generational place of the magnetic component vectors acting along different orientation directions, we will employ a spatial model reconstructed based on the vector directions. In this model, the generation of magnetism takes place between magnetic component vectors *superimposed on and cross-sectioned by each other* along vertical lines perpendicular to the Earth's horizontal surface.

We have determined the relative size of the horizontally projected field intensity component vectors based on the distance of network intersections, the angles formed between the network threads *and the network lengths.* We have discovered that the sum of the *horizontally projected vectors of the magnetic field*

intensity components leads to Magnetic North as as identified by present-day instruments.[1]

The varying degree of the change in orientation directions and Magnetic North

Observing the axial direction of cultic structures even superficially reveals that the zone of the orientation directions is significantly wider than the zone of Magnetic Northern directions synchronized with the setting. The simultaneous changing of the two to the same degree excludes a direct interconnection. *We may only presume an indirect relationship between them.* We have to find a connection between the exact orientation data and the still undisclosed features of the geomagnetic field.

The geomagnetic field's model articulated with nearly parallel and imaginary lines of force is not stabile and therefore we assumed that *the geomagnetic field being generated around the Earth has a spatial network structure.*[2] *Although still taught today, we discarded the magnetic field model based on imaginary (imagined, that is, not existing in reality) mag-*

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[1] Terminological explanation:
geomagnetic field with a spatial network: the sum of the dominant and weak, mor distant component vectors functioning in a spatial geometrical construction, and building up geomagnetic features measured instrumentally, perceivable with the pro jectional directions of cultic orientation directions
magnetic field intensity component vectors: ingredient vectors functioning between the cross-sections of the geomagnetic instrumentally measurable geomagnetic field intensity vector direction
cultic orientation the result of a setting practice relying on sacred and lithurgically based orientation preferences referring to the transcendent
transmission diagram: a circle diagram representing the relationship between magnetic declination value characteristic at the time of the setting and the magnetic North and between orientation directions
declinational direction: the Magnetic North direction characterizable with the declination's angle value
azimuth: the angle of diverging from the Geographic North direction, a set axial direction in the case of buildings (in connection with our topic: the orientation direction of the cultic building)

[2] Tibor Gánti's Chemoton Theory has called attention to the geometrical features of spatial self-organisation by articulating the geometry of autocatalytic cycles. See: Gánti 2003.
Paul Marrow and Jean-Pierre Mano provide a reliable overview of the topic: "Self-organisation in Natural Systems Inspiring Self-organising Software." In: Marrow 2011: 75-103.

netic lines of force penetrating certain surfaces, articulated by fluxus.

Based on comparing and contrasting the orientations of hundreds of cultic buildings with the synchronic Magnetic North, we discovered that in the cultic orientation's changing direction and that of the changing Magnetic North's, the indirect nature of their relationship can be grasped in the varying degree of the change in direction of the two phenomenon since both are characterized by a direction.

Working out a geomagnetic transmission diagram

Based on our assumptions, the directions sensed by those who performed the siting rites were those directions of the field intensity components of a geomagnetic field with a spatial network structure, projected onto a horizontal plane. *According to our analysis, whose measurements can be replicated and the data double-checked,* the directions of cultic siting had an indirect relationship with Magnetic North characterised by a geomagnetic declination at the time of the setting. *We have modelled* the indirect connection between the aligning of cultic structures with *Magnetic North synchronic with the siting on a transmission circle diagram.*

In the previous century, several researchers tried to establish a connection between the axial directions of cultic structures built between the Later Stone Age and the Late Middle Ages and the characteristic Magnetic North direction at the time of the settings. They were seemingly successful in a few cases – due to an assumption of to-be -discovered ancient compasses and often with significant modification of the ages of archaeological findings. But, the axial directions of the era's cultural buildings do not fit the Magnetic North characteristic of the time of setting. At the time of the Chinese burial pyramid's orientation, the compass was already known, still, the graves are not located in any way to fit theMagnetic North of the day. Instead, the directions follow Feng Shui which also happened in

the siting of roads. That is, the graves were not aligned astrologically but were based upon a human sense of direction. (An exception occurs when the magnetic field intensity component's horizontal projection direction – initiating the siting orientation direction, and diverging from Geographic North by approximately 6 degrees to the East -- *overlaps with Magnetic North.*

According to this hypothesis, the orientation settings from the ages before the use of the compass attributed significance *to the three most powerfully perceivable, and, as such, the dominant field intensity components* that build up the geomagnetic field's intensity vector in a contemporary sense and function within a spatial network structure. *The essentially identical siting procedure was a shared element of the rites and ceremonies of different belief systems. Perceptionoccurred by horizontal movement,* and its source – even if it was not understood as a magnetic phenomenon – could be observed also in vertically perceived movements.

With the wide-spread use of the compass, the siting

Figure 2: Etruscan augurs are perceiving direction

practice of the centuries of spectacular geometrical and mechanical achievements fell into obscurity, along with the experience of perceiving geomagnetics.

The geometrics of a geomagnetic network structure

During the generation of the simplest spatial network system, the interplay of at least three line-like magnetic components that diverge in space must be formed. In order for the spatial structure to exist based on the inner generating and maintaining of energy sources at spatial intersections, and in order to survive with an image capable of changing, the cross-sections of the threads running in space must be superimposed on one another but without touching. *For this to happen, the participation of a fourth "stringing" -- or spacer phenomenon-- is needed, one which is perpendicular to the horizontal surface of the earth.*

We have assumed that through the millennia various people were capable of perceiving the three most powerful ingredients of the field intensity component vector.[3]

The compass, as well as today's instruments, is also influenced by the further weak components represented in Figure 1, which are connected to a more distant network of cross-sections imperceivable to humans. These components which can be characterized with a momentum vector summarized at the site of observation can create a total field intensity vector direction and size identical with the ones measured instrumentally as in the case of the geomagnetic field.

[3] The article entitled "Siting Chronology" (www.koszeghy.hu) has dealt with the question of how for thousands of years what kind of methods and devices lead to the highly precise setting of cultic directions. In: Kőszeghy 2013: 1-40

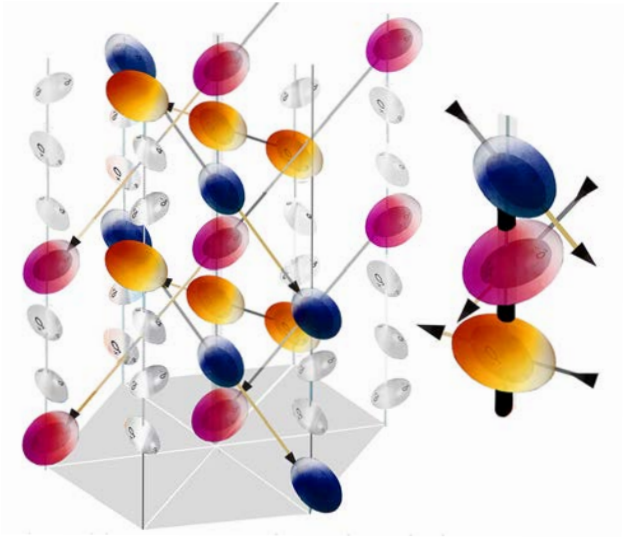

Figure 3: geomagnetic field intensity components. To the right: a triad group

Those determining the siting directions (in a manner similar to birds) might have sensed not the horizontal, oblique divergence characterized by a declination value, but rather its source in the direction of the field intensity vector components, located spatially and characterized by angles of deflection. The performers of the rituals could have reacted to the three magnetic field intensity components exerting the most powerful influence by a horizontal movement, but as human compasses frozen horizontally in space they could observe the projection direction of obliquely moving impulses measured on the horizontal plane.

The intersections of the networks map out a triangle-shape framed by three directions. Based on the differences between the side lengths of these formations, we have determined *relative* field intensity projection *vector sizes*.

As instrumental measurements are available on the

real (total) magnetic field intensity's direction and vector size characterized by an inclinational angle, the real size of field intensity component vectors positioned obliquely in space may be reconstructed. However, for this we first need to work out the conditions of comparability between today's magnetic field intensity measurement data and the data expressed by relative field intensity vectors based on the spatial network model.

We have assumed that the non-touching spatial positions of the field intensity component vectors acting in three directions and the torsional momentum interactions (in a static sense), which, like a whirlpool between the poles, differs at intersections with juxtaposed vertical threads, become the basic sources of the magnet functioning in the magnetic spatial framework. It is, therefore, appropriate to develop measuring instruments and to take new measurements based on the magnetic field's spatial geometry, independent of conventional measuring of electronic magnetism based on a loop.

CULTIC ORIENTATION RESEARCH IN THE PREVIOUS CENTURY

We paid special attention to siting theories and studies processing siting data in connection with a statistically relevant number of cultic structures, such as urban main roads, Neolithic rondels, churches and graves. At least 90% of scholarly analyses attribute a decisive significance to the solar orientation of cultic buildings. In the case of orientation outside the sun's arcing movement, other astrological phenomena, such as the choice of Moon orbits or the times of cultic celebrations, local surface features, building practices and occasionally disturbing factors were also given a directional role. Yet in such cases the presumption of careless siting also emerged.

Missing was any phenomenon collecting the totality of directions and discussing their orientation.

From among the large amount of research and books on sitings based on the movement of the Sun and other sources of celestial light we refer only to those that are important from the perspective of our work on analysing together time and orientation data.[4]

Two experiments in orientation analysis, where in one polar lights (the aura borealis) were given a role influencing siting directions, while at the same time in the other layout diagonals were given a defining significance in the establishing of siting directions.[5]

The analysis of Greek as well as Greco-Roman cultic orientations of an astrological nature contribute directional data of a number of buildings.

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[4] Anthony F. Aveni, A.-Giuliano Romano. "Temple Orientation Magna Graecia and Sicily." In: Aveni 2000: 51-57. Niels Abrahamsen: "Orientation of Medieval Churches in Denmark." In: Abraham-sen 1992: 293-303.
Rainer Bartels, Wolfgang Brestrich, Patrice de Vries, Harald Stäuble. "Ein neolithisches Siedlungsareal mit Kreisgrabenanlagen bei Dresden-Nickern: Eine Übersicht." In: Bartels 2003: 97-133.
Juan Antonio Belmonte, Shaltout, Mosalam: "Keeping Ma'at." In: Belmonte 2010: 532-539.
Efrosini Boutsikas:"Placing Greek Temples: An Archaeoastronomical Study of the Orientation of Ancient Greek Religious Structures." In: Boutsikas 2007-2008: 4-16.
César A. González-Garcia, Juan, Antonio Belmonte: "Sacred Architecture Orientation across the Mediterranean." In: González-Garcia 2014: 95-113.
Tamás Guzsik: "Tájolási rendellenességek a középkori templomépítészetben." [Orientational Disorders in Medieval Church Architecture] In: Guzsik 1975: 91-104.
Peter G Hoare, Caroline S Sweet: "The Orientation of Early Medieval Churches in England." In: Hoare 2000: 162–173.
George Pantazis, Evangelia Lambrou, K.Nikolitas, M. Papathanassiou, A. Iliodromitis: "The Orientation of Delos Monuments." In: Pantazis 2009: 55-68.
Emilia; Pásztor, Judit Barna, Curt Roslund: "The Orientation of Rondels of the Neolithic Lengyel Culture in Central Europe." In: Pasztor 2008: 910-924.
Alun Salt: "The Astronomical Orientation of Ancient Greek Temples." in: Salt 2009: 1-5.
Mosalam Shaltout, Juan Antonio Belmonte: "On the Orientation of Ancient Egyptian Temples I.: Upper Egypt and Lower Nubia." in: Shaltaut 2005: 2-22.
Georg Zotti, Wolfgang Neubauer: "Update on the Simulation of Astronomical Aspects of Middle Neolithic Circular Ditch Systems." In: *Archaeological Prospection. Proceedings of the 10th International Conference*, 2013: 187-189.

[5] Ioannis Liritzis, Helen Vassilioum: "Were Greek Temples Oriented Toward Aurora?" *Astronomy and Geophysics*. Vol. 47 2006 (1): 14-18. Marcello Ranieri: "Digging the Archives: The Orientation of Greek Temples and their Diagonals." *Mediterranean Achaeology and Archaeometry* 14, 2014. 3: 15-27.

But, as a result of the uncertainties of age attribution between the seventh and sixth centuries BC, *there is no Greek cultic building* among our orientation examples. There are, however, promising results due to the improvement of dendralogical and C14 dating, as well as the new dating technique based on differences in the covered and free surfaces of stone findings. The reusing of stones can lead, however, to dubious conclusions in dating 303.

The study of Boutsikas (Figure 4) provides a rough sketch of the features of renovations that took place with a change of direction and that still needs to be interpreted d. Having studied the renovations of 29 Greek churches, he records the changes of direction that have taken place. **He is** important from the perspective of our work on analysing together time and orientation data. His work could not contribute to the establishment of our transmission model's fixed points, hower, because of the incertainty of past Magneit North directions that correspond tu the previus sitings used in the dating of those churches.

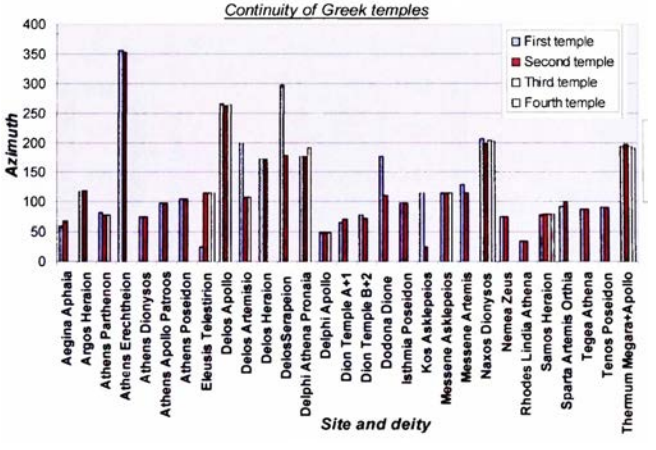

Figure 4: Orientation measurements from 29 cults (72 structures) Efrosini Boutsikas: Placing Greek Temples: An Archaeoastronomical Study of the Orientation of Ancient Greek Religious Structures in: Boutsikas 2007-2008. 4-16.

In Sachsen-Anhalt in Germany there is a Stone Age stone rondel called Goseck, which has its entrances opening to the winter dawn and with a slight slant to sunset as well, and has become today a touristic success story, having been elevated to the level of a solar observatory.

The third, northern entrance has been given an astronomical explanation, which might have strengthened doubts surrounding the buildings' interpretation as a solar observatory.

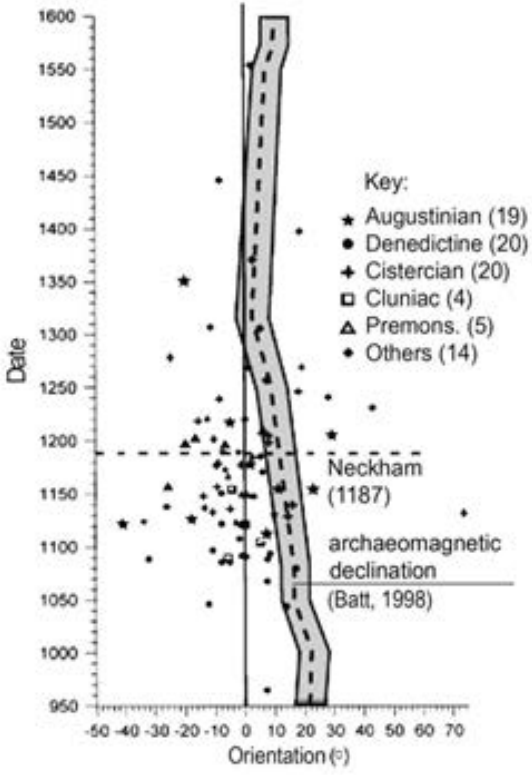

Figure 5. Ali Jason and Peter Munich (2014) assumed the use of a compass during the orientation of medieval churches. They found that their hypothesis was false

Figure 6. Zalaszabar-Borjuállás island, Hungary, Carolingian church and cemetery, changes in the direction of graves (in: Visy 2003). direction of the Church: 82,9° from North, declination: 2,1°. Directions of the tombs: 71° - 112°, changes in declination: 0,8°- 4,2°.

A few studies presupposing a direct interconnection between the axial directions of cultic buildings and Magnetic North

There is more than half a century of research on the direct connection between geomagnetic North and the siting of cultic buildings.[6] Revealing studies have been conducted on the Meso-American pyramids oriented towards a direction near the North, on the Chinese pyramid graves and on the change of direction in the antique palaces of Crete. These studies all presumed that the structures' orientation relied on the compass, even though no device that might function as a compass has been found at these sites.7

The most recent analysis of church orientation in Lower Austria and Northern Germany by R. L. Jason, Ali and Peter Cunich, covers the period between 1100 and 1900 and also presumes the use of a compass in the orientation of these medieval English churches. In Austria and Germany researchers have studied the possibility of the Magnetic North-directed orientation of more than 190 churches and they have concluded that geomagnetic orientation can be excluded.[8] [See the relevant analysis in Figure 32.]

In Sachsen-Anhalt in Germany there is a Stone Age stone rondel called Goseck, which has its entrances open-

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6 Roberth Fuson: "The Orientation of Mayan Ceremonial Centers." In: Fuson 1969. Andreas, Fuls: "Die astronomische Datierung der klassicchen Mayakultur (500-1100 n. Chr.) Implikationen einer um 208 Jahre verschobenen Mayachronologie." Norderstedt, in: Fuls 2007.John Timothy Caroll: Wiew "Ancient Mesoamerican Building Oriented to North?" Manuscript, MIT, Archives 1979.

7 William Samuel Downey: "Orientations of Minoan buildings on Crete may indicate the first recorded use of the magnetic compass." In: Downey 2010. 9-20. Jaroslav Klokočník, Jan Kostelecký, František Vítek: (2009).
"On an Unresolved Orientation of Pyramids and Ceremonial Center in Mesoamerica." In: Klokočník 2009.
Ivanka Charvátova, Jaroslav Klokočník, Josef Kolmas, Jan Kostelecký: "Chinese tomb oriented by compass: Evidence from paleomagnetic changes versus the age of tombs." In: Charvátova 2011: 159-174.

8 Ali Jason R, Cunich Peter: "The Orientation of Churches: Some New Evidence." In: Ali 2001: 155-193.
Patrick Arneitz1; Andrea Draxler 1; Roman Rauch 2; Roman Leonhardt 1: "Orientation of Churches by Magnetic Compasses?" In: Arneitz 2014: 1-7.

ing to the winter dawn and with a slight slant to sunset as well, and has become today a touristic success story, having been elevated to the level of a solar observatory.

The third, northern entrance has been given an astronomical explanation, which might have strengthened doubts surrounding the buildings' interpretation as a solar observatory.[9]

The Polgár-Csőszhalom rondel in Hungary is even earlier than Goseck and also carries the attributes of Lengyel culture. Its initial examination was not followed by any serious excavation and transformation into a tourist attraction, and thus future excavations may even question the widely accepted theories of rondel building. The presumption might gain ground that the wooden directional stilts follow changes in the geomagnetic directions and in the course of relocations the series of pits were formed which later have turned into a pseudo-rondel as a result of continuous restoration.[10]

By relying on C14 dating technique, the study by Stadler and his colleagues offers major support in the analysis of Later Stone Age archeomagnetic features.[11]

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[9] Francois Bertemes, F. Peter Biehl, Andreas Northe, Olaf Schröder: "Die neolithische Kreisgrabenanlage von Goseck." In: Bertemes 2004: 137-145. Rainer Bartels 2003: 97–133.
Ralf Schwarz: "Kreisgrabenanlagen der Stichbandkeramikkultur in Sachsen-Anhalt" [Neolithic Circular Enclosures in Europe.] In: International Workshop in Goseck (Saxony-Anhalt, Germany 2004: 7-9.
Marianna Ridderstad: "Orientation of the Northern Gate of the Goseck Neolithic Rondel." In Ridderstad 2009: 1-6.

[10] Pál Raczky, Arendt Meier, Katalin Walter – Kurucz, Zsigmond Hajdú Ágnes Szikora: "Polgár-Csőszhalom: Researching a Neolithic Site in the Upper Tisza Region and Its Cultural Implications." In: Raczky 1994.
Pál Raczky: "The Complex, Household-based Network Analysis of the Late-neolithic Settlement of Polgár-Csőszhalom." In: OTKA NK 101024 2012-2015.
Emlia Pásztor, Judit P. Barna, Curt Roslund: "The Orientation of Rondels of the Neolithic Lengyel Culture in Central Europe." Antiquity 82 (2008): 910-924

[11] Peter Stadler, Elisabeth Ruttkay, Michael Doneus, Herwig Friesinger, Ernst Lauermann, Walter Kutscheora, Inna Mateiciucová, Wolfgang Neibauer, Christine Neugepauer-Maresch, Gerhard Trnka, Franz Weninger,Eva Maria Wild: "Absolutchronologie der Mährisch-Ostösterreichischen Gruppe (MOG) der bemalten Keramik augfrund von neuen 14C-Datierungen." n: Stadler 2005/2006.

The orientation context of our specific examples and their archeomagnetic backgrounds in certain cases have been enriched by orientation and declinational data from the time of the siting of buildings of about the same age. These provided an opportunity to compare and contrast parallels between orientation directions and their differences as well as specific data on the relationship between declination connections and the transmission diagram's orientation directions.

As a result of this research certain cultic buildings in Rome have come into the picturenear the time of the Pantheon's building and erected in the Roman Empire during the first two centuries AD in connection with the orientation analysis of the basilicas Augustus Treverorum and Sophianea.[12]

Stephan Zink's articledeserves attention for shedding light on the context of the special analysis of the Pantheon.[13] The archeological research materials of cultic buildings from the 9th-11th centuries and the research on the orientation of early Árpád era graves also provide plenty of data.[14]

Péter Márton's works on defining and analysing archeomagnetic data is indispensable for processing the connections of geomagnetic data with Hungarian cultic orientation.[15]

From among the studies analysing the orientation of

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[12] Péter Kiss, Anita Nyerges: "A Járdányi Paulovics István Romkert újabb kutatásai" [Recent Research on the István Paulovics Ruin Garden of Járdány]. In: Kiss 2012.

[13] Stephan Zink: "Reconstructing the Palatine Temple of Apollo: A case Study in Early Augustan Temple Design." In: Zink 2008: 47-63.

[14] Tamás Guzsik: "Orientation Disorders in Medieval Churchb Architecture." 1975: 91-104.;

Bé la Miklós Szőke: "Caroling Era 811-896." In: *Hungarian Archeology at the Millennium*. NKÖM Teleki L. Alapítvány 2013.

[15] Péter Márton, Ferenc Horváth: "Developing an Integrated Research Method for the Examination of Geophysical Environmental Conditions in the Quarternary." 20011. OTKA: TS44765. In: Márton 2011.

Pé ter Márton: "Two thousand years of geomagnetic field direction over central Europe revealed by indirect measurements." 2010: 261-268.

urban high roads in the Roman age -- despite their astrological presumptions – Giulio Magli's study of the siting times and directions of 38 Italian urban roads proved essential. These roads were all decumanus and close to the East, thus offering an opportunity to refute the notion that the possibility of magnetic orientation can be excluded.[16]

It is characteristic of grave orientation that the orientation directions are in an indirect relationship with the archeomagnetic Northern direction typical at the time of the siting (Figure 6)

During the plotting of the transmission diagram, in order to set the declinational values connected to the orientation directions we applied measured archeomagnetic data and approximating graphs previously published. In our analyses those archeomagnetic graphs and measured data were given an important role as they were located on the timeline of the European region between the sixth millennium BC and 1400 AD.[17]

There is a great deal of uncertainty around declinational values from the centuries around the birth of Christ.[18] (Figures 5, 6, 7, 8, 9). The declinational values

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[16] Figure 33. represents the non-Eastern orientation directions of eastern sity roads, following the magnetic declination– with a transposition functioning based on the transmission diagram.
Giulio Magli: "On the orientation of Roman towns in Italy." In: Magli 2008: 63-71.

[17] As a result of the massive amount od data fro the last decades the curves have been refined (with their own decreasing uncertainties have contributed to the determination of the declination data of a transmisison diagram which can be applied in most of the European region We only emphasize a few: Yves, Gallet, Agnes Genevey, Maxime Le Goff: "Three Millennia of Directional Variation of the Earth's Magnetic Field in Western Europe as Revealed by Archaeological Artefacts Dating." *Physics of the Earth and Planetary Interiors.* In: Gallet 2002: 81-89. Sarah-Jane Clelland: "Developing Aarcheomagnetic Dating in the British Iron Age." Phd in: Clelland 2011. Emanuela de Marco, Avdokia Tema, Philippe Lanos, Despina Kondopoulou: "An Updated Catalogue of Greek Aarchaeomagnetic Data for the Last 4500 Years." *Studia Geophysica et Geodaetica*, 58, 2014: 121-147

[18] Sonja Panovska, C.C Fonlay, F. Donaldini, .A.M Hirt: "Spline Analysis of Holocene Sediment Magnetic Records: Uncertainty Estimates for Field Modeling." In: Panovska 2012: 15. Ulrich Hambach, Christian Rolf, Elisabeth Schnepp: "Magnetic Dating of Quternary Sediments, Volcanites and Archaeologic Mterials." In: Hambach 2008: 25-51.

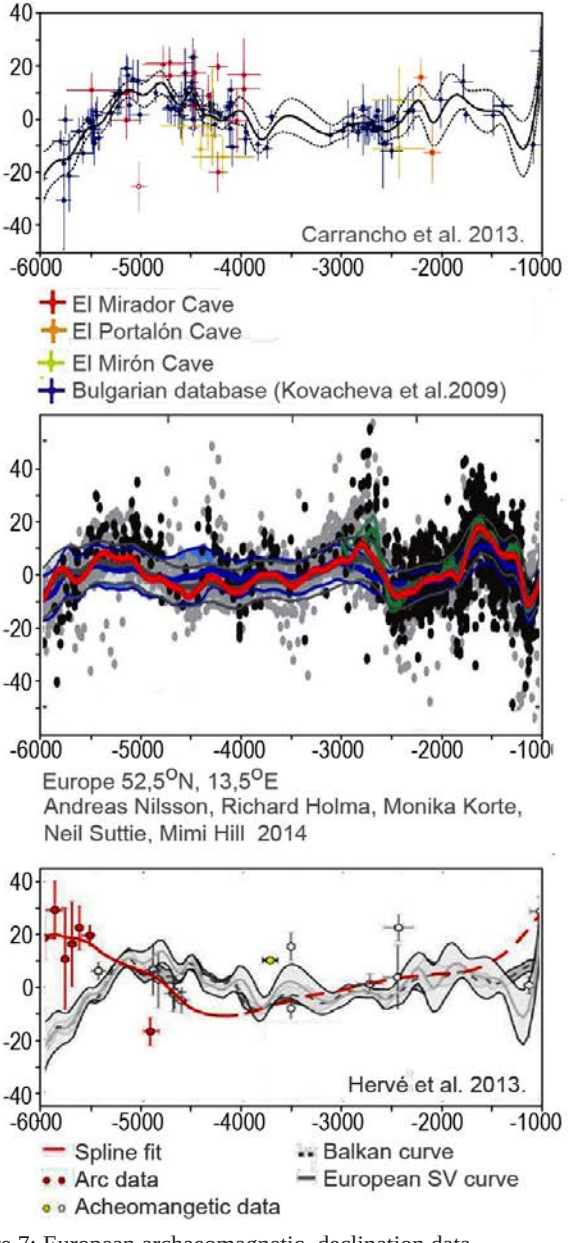


Figure 7: European archaeomagnetic declination data.

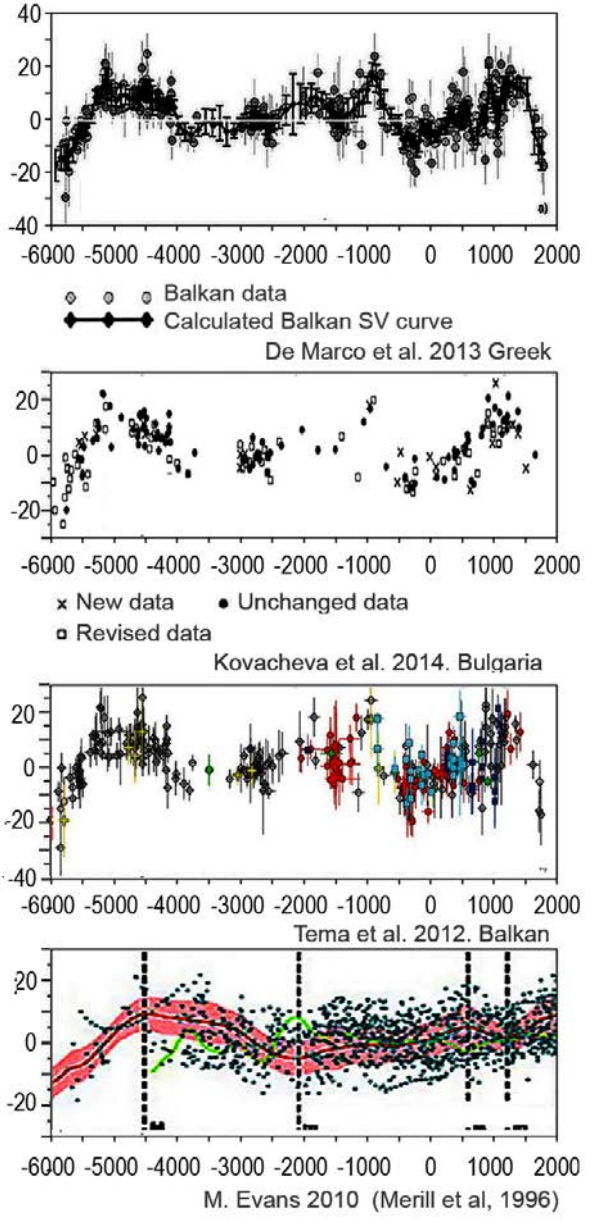


Figure 8. Archaeomagnetic declination data from the Balcan region.

assigned on the basis of sedimentation need to be re-examined as well as the lava flow data that previously appeared as trustworthy.[19]

In the course of selecting geographic regions, ages, settlements and examples to interpret, special attention was

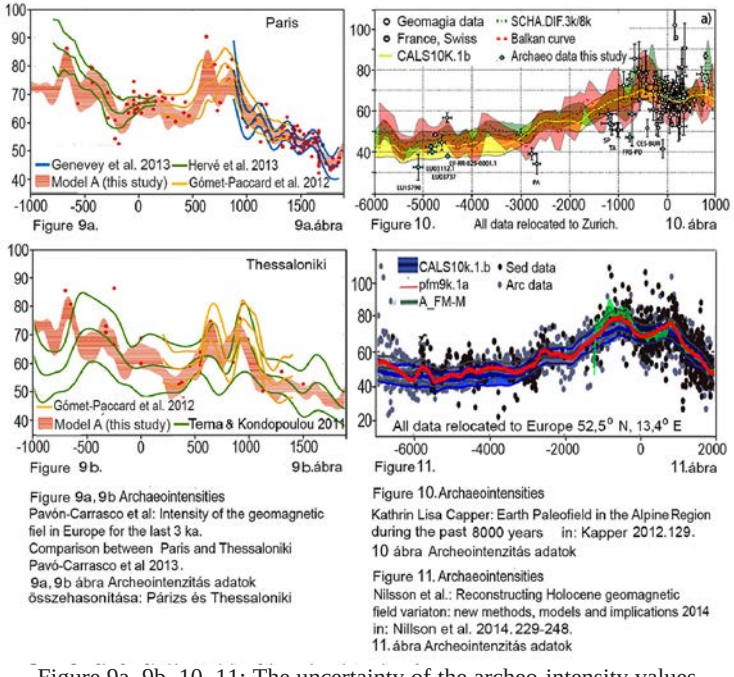


Figure 9a. 9b Archaeointensities
Pavón-Carrasco et al: Intensity of the geomagnetic fiel in Europe for the last 3 ka.
Comparison between Paris and Thessaloniki
Pavó-Carrasco et al 2013.
9a, 9b ábra Archeointenzitás adatok összehasonítása: Párizs és Thessaloniki

Figure 10. Archaeointensities
Kathrin Lisa Capper: Earth Paleofield in the Alpine Region during the past 8000 years in: Kapper 2012.129.
10 ábra Archeointenzitás adatok

Figure 11. Archaeointensities
Nilsson et al.: Reconstructing Holocene geomagnetic field variaton: new methods, models and implications 2014 in: Nillson et al. 2014. 229-248.
11. ábra Archeointenzitás adatok

Figure 9a, 9b, 10, 11: The uncertainty of the archeo-intensity values.

paid to cultic buildings whose datings are archaeologically correct if the archeomagnetic declinational data characteristic of the time of their siting showed little uncertainty (within +-3 degrees), and where it was not necessary

[19] Inclination and intensity are characteristics that have become significant with the interpretation of the values of remanent magnetization. We have assumed that in the Later Stone Age, as a result of a much weaker magnetic intensity than today's, the intensity zone became bigger and impossible to perceive today, than in the case of measuring geomagnetic remanent magnetization with a greater intensity. We have plotted the interplay of relative magnetic declination component vectors functioning in the cultic orientation directions with relative field intensity component sizes.

to deal with a significant distorting effect of magnetic irregularities.

From among the analysed buildings, the Pantheon's orientation, given the significance of the Northern entrance, in the course of repeated renovations the orientation direction from between 20-30 BC did not change. Based on the orientation data (supported by the wall directions of nearby excavations) the basilica Augustus Treverorum from Roman times was built upon a 1st century AD base with a slight change in direction. Constantinus basilica built at the beginning of the 4th century and Sopianae, a basilica from the 4th century, also built in a direction close to a former orientation direction – are of a similar character. However, their orientations are different, which may be interpreted based on the different archeomagnetic declinational values typical of earlier buildings and on the differences in the geographic sites. One can also observe that in the case of the sitings of earlier buildings, Aug. Treveroum, for instance, out of the three potential directions the siting direction was near North (decl. -7°), while in the case of Sopianae it was West (decl.-5°).

In creating the transmission diagram, we relied on the transmission connection between siting and declination, and could only model the nature of this transmission and its directional conditions based on the data of a great number of buildings. In contrast in the analysis of medieval Hungarian cultic buildings we could rely on the precise dating and orientation data of more than a thousand medieval churches.20 In the case of the special analysis of the Hadrianus basilica in Mosaburg/Zalavár, dendrological research has supported the siting time as close to 850AD.

The uncertainty in the Hungarian archeomagnetic graph is especially significant in the time zone between 750AD and 850AD, as here the analysis of the siting

[20] Sándor Keszthelyi– Sragner Márta Keszthelyiné. "Magyarországi középkori templomok tájolása" [The Orientation of Hungary's Medieval Churches]. In: Keszthelyi 2012: 2-40.

offers especially valuable information on potential declinational values. According to archaeological research, in the case of the building that preceded the Roman basilica of Sopiane, built around 190 AD at the earliest, with a declination structure based on the siting of around +10°.

These values correspond to the archeomagnetic data measured by Márton, yet its plotted graph does not follow this local increase in value, which is not typical of other regions of Central Eastern Europe. During the renovations of the Pantheon the siting direction from about 20-30 BC did not change. Based on the orientation data (and supported by the wall directions of nearby excavations) the Roman basilica of Trier was erected on earlier, 1st century AD bases with but a slight change in direction.

PROCESSING THE ORIENTATION RAW MATERIAL —THE TRANSMISSION DIAGRAM

The transmission clockwork

Compasses react to the magnetism of the Earth in different ways than do the direction sensors of animals or humans. To use a clockwork metaphor: as in the clockwork of traditional clocks, the direction of the hour-hand barely changes in comparison with the turning of the minute-hand; similarly, the direction of Magnetic North hardly changes in comparison with changes of direction in the impulses generated by magnetic field intensity components sensed by humans (and many other living beings). The transmission diagram articulating the relationship between the geomagnetic field and the triads of cultic directions is a specific kind of clockwork: its hour-hand moves along the values of the instrumentally determined magnetic declination angle's values characteristic of Magnetic North's direction. In the region of Central Europe the minute-hands, that is, the branches of the triads, move along the thickening and attenuating divisions of the circular diagram. The angles of the orientation directions of the

magnetic field intensity components between the minute-hands (projected into the horizontal plane) fit the thickenings and attenuations which are characteristic in the north-eastern and south-westerns zone.

The divisions of the transmission diagram in the case of any orientation direction signify a possible Magnetic North direction in such an orientation direction by providing the declination values. The values beyond the signified positive and negative declination values are also possible to read by moving beyond the given maximal (28-29) declination values.[21] The declination values indicated by the orientation directions are possible to read until +-16,2°, in the case of further declination values, for instance at +20°, one needs to proceed by adding the restarted positive declination values.

Within the peculiar clockwork of the earth's magnetic field, the compass is the hour-hand pointing to the direction changes in Magnetic North. When the direction of Magnetic North changes by one degree, the direction of the dominant magnetic field intensity component projections sensed by human direction sensors, and the components of building up geomagnetic North – in our clockwork the three co-moving magnetic minute-hands – turns by at least five degrees, and near the East by more than eight degrees.

[21] The fixed points of the diagram are made up of those data complexes where beside the time of the building's siting the direction of Geographic North (indicated by a declination value) is also known. In such a position, for instance, the Roman Pantheon's orientation direction is outstanding, as are such Árpád-era grave complexes where successive monarchs' coins have been discovered and where the changing graves' directions follow changes in Geomagnetic North typical at the time of the coins' minting. The orientation direction change interconnected with the change of declination is kept within strict boundaries by the thickening and rarefying of the divisions created by the circle connected to the consistently changing declination value. The orientation directions between the dominant, near-northern component threads of the north-eastern spatial network of the magnetic the angle value in the past millennia has not decreased to less than 108 degrees. Even in the case of an asymmetrical arrangement it is not typical that the value of the other two angles exceeds 138 degrees.

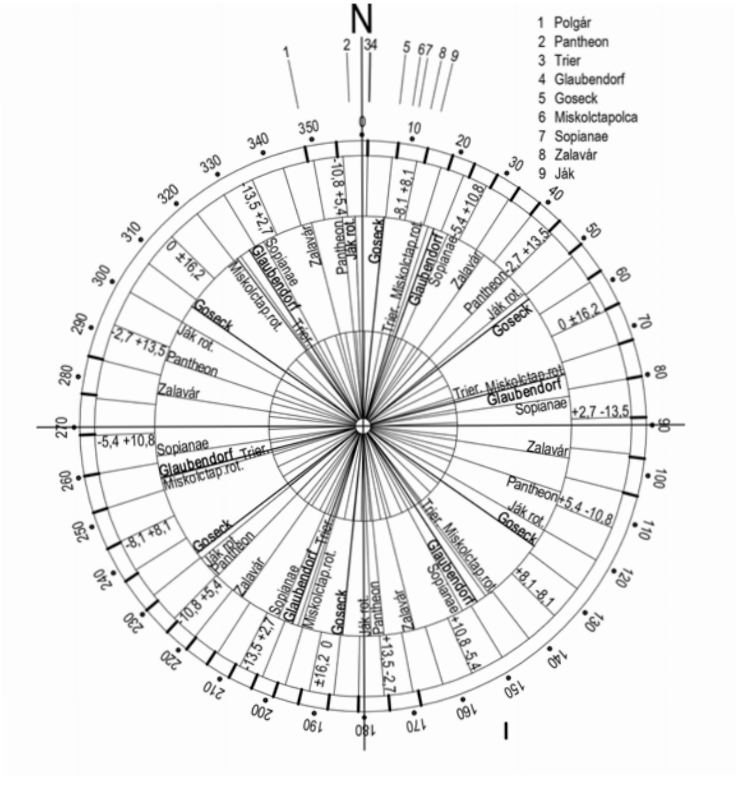


Figure 9: Transmission diagram: the orientation of the analyzed buildings' gates and that of the earthworks appear as dominant component directions building up the Magnetic North.

Orientation directions and declinations on the transmission diagram

We have indicated the axial direction of the cultic buildings with the azimuth degree value increasing from Geographic North towards the East. Along the orientation direction, we have also noted the declination value characteristic of the time of the siting (determined on the basis of the archeomagnetic graph). Aarcheomagnetic studies offered declination values of 3-5 degrees uncertainty in the case of individual directions.

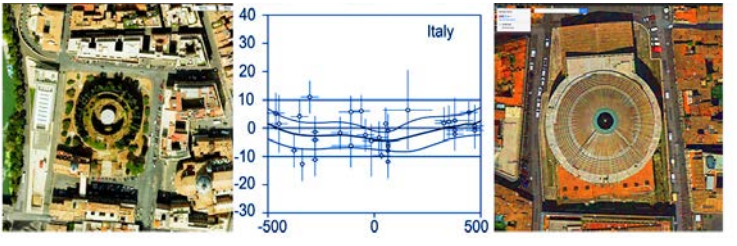
We have interpreted the archeomagnetic declination data burdened with uncertainties which are synchronic with the time of the siting, based on the precise orientation data of hundreds of cultic structures. The siting times chronologically close to each other have delineated the magnitude of the declination changes.

In comparison with the declination changes, the orientation changes are of a greater extent, and thus several significantly different declination values may be connected to the same orientation direction. Every orientation axial direction has been articulated by magnetic declination values of opposing directions (their arrows) connecting to and complementing each other.

In the case of Stone Age rondels with three or six entrances, occupying all three directions, there were only three different cultic structures that offered these directions and the value of synchronic Magnetic North characterized by declination.

The features of dominant and weak geomagnetic component vectors

We have established a connection between the orientation axial directions and the geomagnetic vector phenomenon of direction and size, which do intersect in space.



.Figure 10.-11.-12: Directional European Bayesian SVCs declination directions; the thick line represents the main geomagnetic field declination, the thinner lines represent a 95% reliability level. In: Pavón-Carrasco, et al. 2011: 411.

We also assumed that between the vectors functioning in the geometrical network image there are interactions at play among the distances *between network cross-sections*.

The strongest magnetic interactions are active in the connections functioning over the shortest distances. The linear dimensions till the cross-sections are different, and so the projections of the vectors of the geomagnetic field intensity components, that is, the vectors appearing as the components of the Magnetic North that make up Magnetic North, participate in the power game taking place in the network as vectors of different directions and sizes. *We call the vectors that are organised till the next cross-section and function in three directions "dominant magnetic component vectors," and the ones further away "weak component vectors." By adding up the vectors we have built up a mechanical model concerning the transmission diagram.*

On the transmission diagram we have connected every declination value characterizing Magnetic North to three orientation directions, and thus three "declination *zero point places";, that is, the direction of Magnetic North components building up Magnetic North as well as the place of Magnetic North's zero declination have been outlined.*

Within a circle around Budapest with a 500 km radius, 16,2 degrees have given a declination value which offered declination values for a number of buildings that change in a logical way in comparison to one another. Compared to the past three thousand years' thickening zone's characteristics in the Later Stone Age the thickening zones of declination change were slightly different, as we have indicated on the margins of the transmission diagram.[22]

[22] Insofar as measurements directed toward the inclination become possible, we will be able to distinguish the field intensity components overlapping at the declinational directions, which differ from each other from the perspective of inclination. The perception of dominant components is made easier by the fact that they are isolated from the zones of the weak magnetic components with an "empty" zone of more than one degree, since in these zones only very distant impulses are working which do not reach the sensitivity of instrumental measuring.

EXAMPLES REPRESENTING THE FUNCTIONING OF THE TRANSMISSION DIAGRAM

The selected buildings:

From the Late Stone Age time-zone: Goseck, Glaubendorf, Polgár rondel

From the time-zone of Antiquity and the Middle Ages: Rome, Pantheon; Trier/Augusta Treverorum, Constantinus basilica; Pécs/ Sophianae late-Roman basilica;

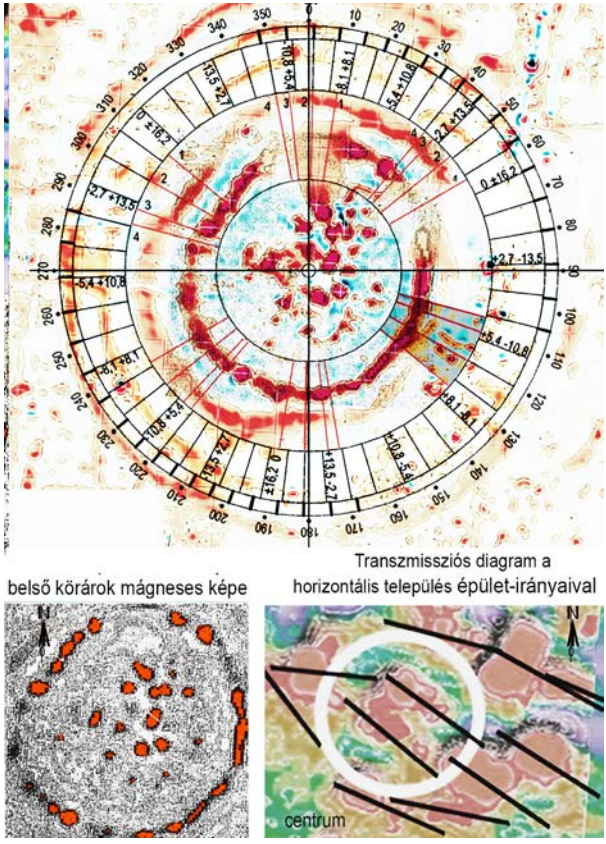
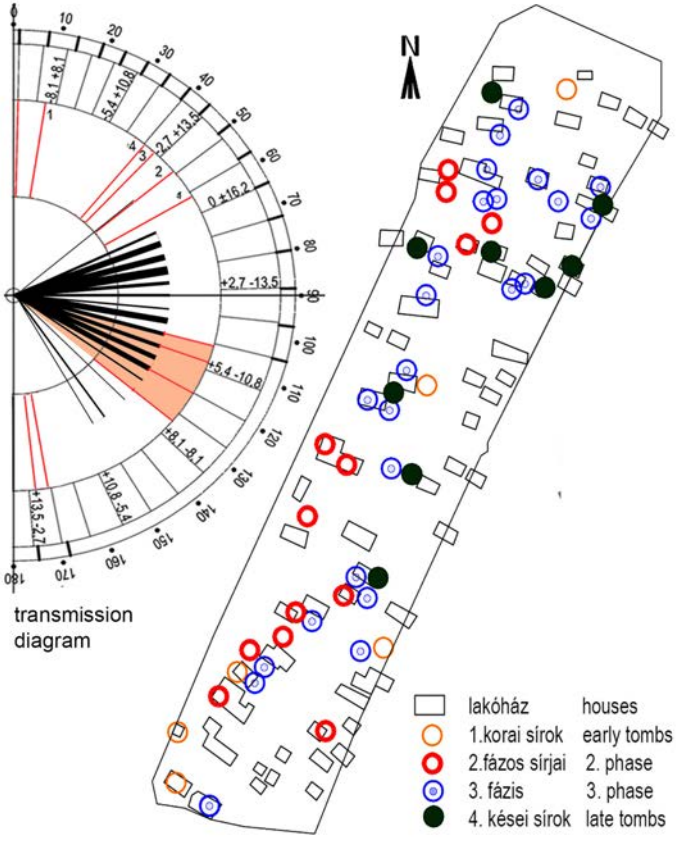


Figure 13.-14: Polgár-Csőszhalom, Hungary, the same directional changes in the gates of rondels and the tombs of the horizontal settlement



Gate direction of 64 known roundels, Culture Lengyeli (black)
Polgar-Csöszhalom, orientation of tombs and houses (red) in: Raczky, 2015

64 ismert Lengyeli kultúrához köthető késő-neolit körárok keleti kapu-irányai (fekete,mennyiségi arányokat jelző vastagságokkal), vörös felülettel Polgár-Csőszhalom horizontális település sírjainak iránya

Figure 15. Polgár-csőszhalom, houses and tombs (Raczky et al. 2014).

From medieval Europe: *Zalavár/Mosaburg, Hadrianus basilica; Ják, early rotunda; Miskolctapolca, early rotunda.*[23]

We have linked the declination values indicating

[23] Tamás Pusztai describe the excavation of the latest early rotunda: "The Architectural History of Tapolca's Benedictine Monastery." In: *Hermann Ottó Múzeum Évkönyve LII*. 2013: 149-170.

figure 16. Polgár-Csőszhalom, painted dishes. The oblique lines and recurring points might refer to the spatial magnetic network structure.

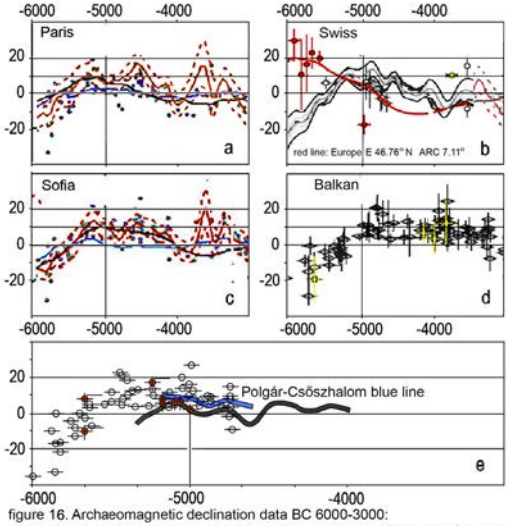


figure 16. Archaeomagnetic declination data BC 6000-3000:
a,c: P.-Carrasco 2014; b: Capper 2012; d: Tema 2011; e: Márton-Horváth 2011
Polgár-Csőszhalom: BC5200-4600 declination: transmission diagram blue line
16.ábra: Archeomágneses deklináció adatok ie. 6000-3000
a,c: P.-Carrasco 2014; b: Capper 2012; d:Tema 2011; e: Márton-Horváth 2011
Polgár-Csőszhalom: BC 5200-4600 deklináció: transzmissziós diagram kék vonal

Figure 17. Archaeo-magnetic declination data: BC 6000-3000: a, c: P.-Carrasco 2014, b: Kapper 2012,d: Tema 2011, Márton-Horváth 2011.

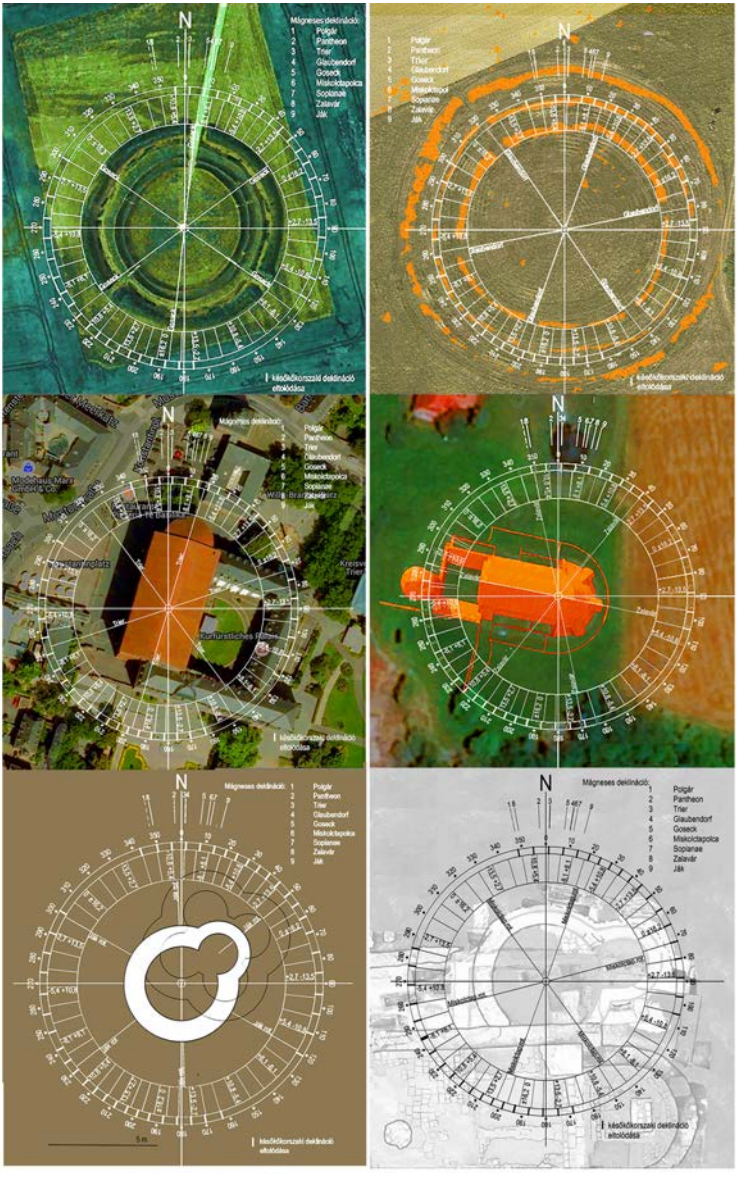


Figure 18. The buildings of Goseck, Glaubendorf, Augusta Treverorum/ Trier, Mosaburg/Zalavár, Ják, Miskolctapolca structures placed under the transmission diagram.

Magnetic North characteristic at the time of siting to the orientation directions.

The data given in the diagram are valid for the Central and Southern European region between the eras of Antiquity and the Middle Ages, with a declination value uncertainty below one degree. The size of the dominant vectors functioning in the direction of the geomagnetic triad branches depends on the cross-sectional distance of the spatial network, which decreases with the increasing of the distance squared.

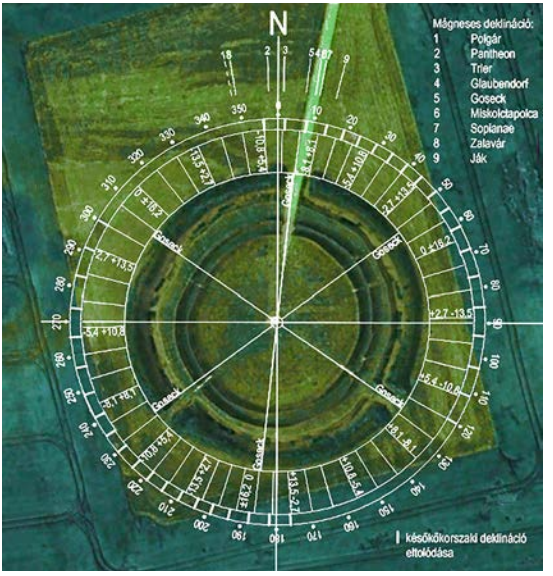


Figure 19. The Goseck rondel (Google 2016 and A. Kőszeghy. 2013-2015).

Some of the Stone Age structures have retained all three triad branch directions of the magnetic spatial network. Cultic church buildings have offered only one axial direction for the building of our model, but in the case of hundreds of similar buildings, further magnetic triad directions have appeared which are comparable to the ones measured in the case studies.

In the case of Later Stone Age structures, the three emphasised directions are the three directions of the triad which represent the basic geometrical structure.

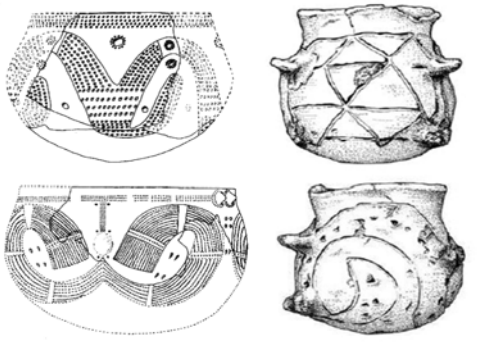


figure 20.Goseck surrounding Late Neolithic pots

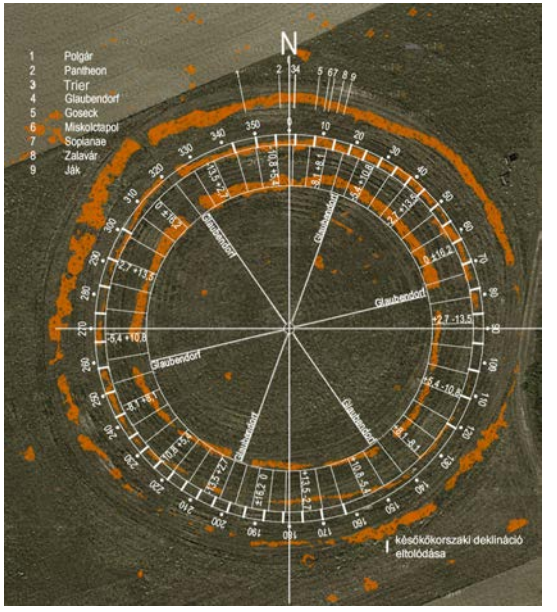


Figure 21: Glaubendorf, a Figure of magnetic measurements.

Figure 22: the magnetic m. of the Glaubendorf rondel.

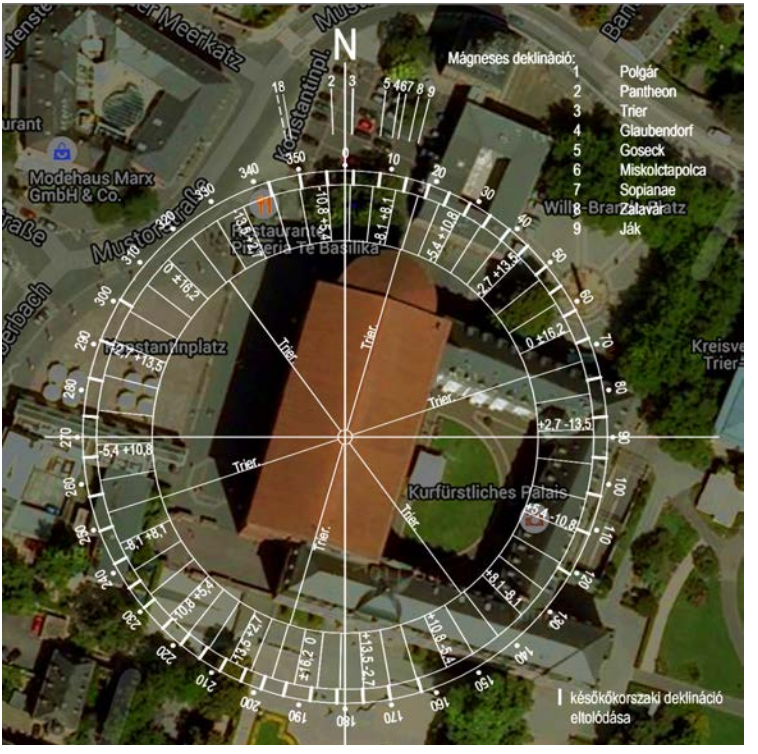


Figure 23: Augusta Treverorum/Trier, Bas. Constantinus Kőszeghy 2015).)

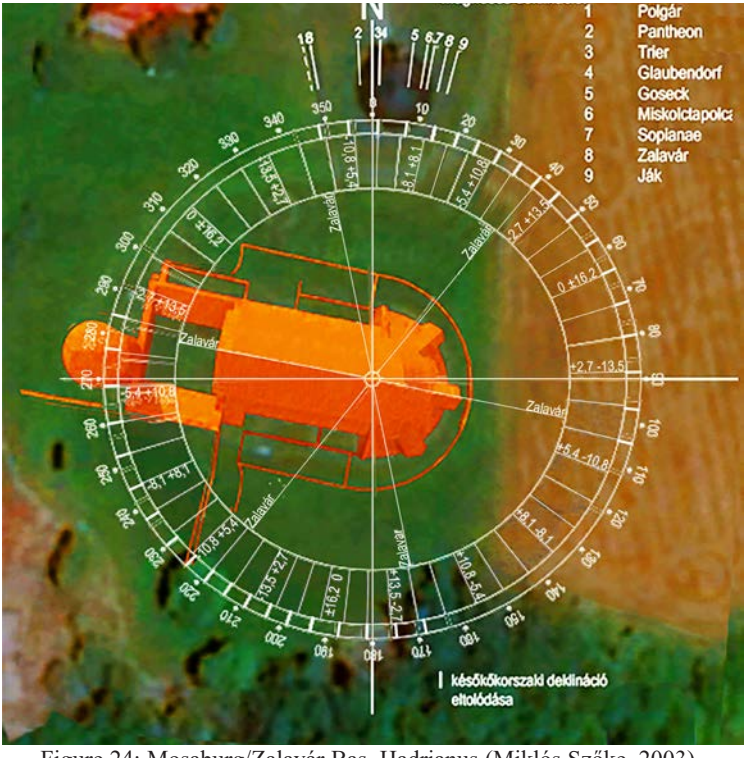


Figure 24: Mosaburg/Zalavár Bas. Hadrianus (Miklós Szőke, 2003).

We have contextualized a few buildings of the same age from Antiquity and the Middle Ages along with case studies. Such context-creating examples include the Pantheon, for instance, and the mausoleum of Augustus [Figure 13].

Orientation examples from the Later Stone Age

A well-known example of European rondels constructed after the end of the sixth millennium BC and before the middle of the fifth millennium may be found in Hungary at Polgár-Csőszhalom where a multiple roundel structure includes dwelling places and nearby graves. During the excavation of the rondel, archaeologists presumed the existence of several settlement layers, and more or less visible

entrances.24 The directions drawn along the deepest excavations of Polgár-Csőszhalom's inner rondel as well as the axial directions of the nearby horizontally arranged settlement's dwelling houses and graves correspond to the multiple directions close to East which characterise the entrances to the 64 rondels from the Late Stone Age named after Lengyel village that have been discovered before 2014.

The potential process of rondel -formation as seen in the case study of Polgár-Csőszhalom.

The orientation directions of the settlement's horizontally arranged houses and nearby graves shed light on the origins of the rondel's axial directions, which appear in the image of the rondel's magnetic excavated layer. Based on the marks indicatingto the changing of the co-orientation, one can presume that the directions measured from the rondel's centre had been marked by deeply dug-in wooden columns which were replaced multiple times. Based on such assumptions, one may conclude that *no interconnected rondel -bank arches* previously *existed* [Figures 14, 15].

[24] Pál Raczky, Walter Meier -Arendt, Katalin Kurucz, Zsigmond Hajdú, Ágnes Szikora: "A Late Neolithic Settlement in the Upper Tisza Region and Its Cultural Connections (Preliminary report)." In: Raczky 1994: 231-240; Pál Raczky, Alexandra Anders, Norbert Faragó, Gábor Márkus in: Raczky 2014: 363-376.; Emilia Pásztor, Judit Barna, Curt Roslund: "The Orientation of Rondels of the Neolithic Lengyel Culture in Central Europe." In: Pasztor 2008: 910-924.; "The Aarcheomagnetic Curve of Hungary Between 6000 and 1000 BC." Péter Márton, Ferenc Horváth: "Developing an Integrated Research Method for the Examination of Geophysical Environmental Conditions in the Quarternary. 20011. OTKA: TS44765. In: Márton 2011.

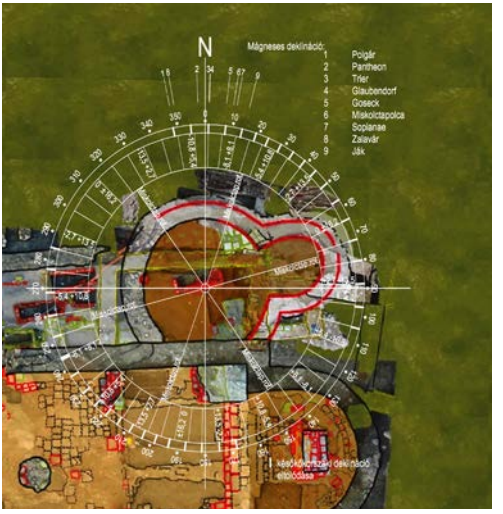


Figure 25: Rotunda, Miskolctapolca, Hungary (drawing: Tamas Pusztai PhD 2013).

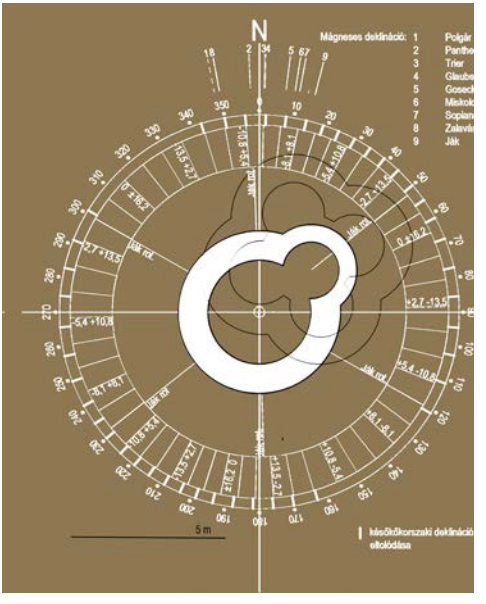


Figure 26: Ják, Hungary, Early rotunda (A. Kőszeghy 2015).

CULTIC STRUCTURES SELECTED FOR ANALYSIS USING THE TRANSMISSION DIAGRAM

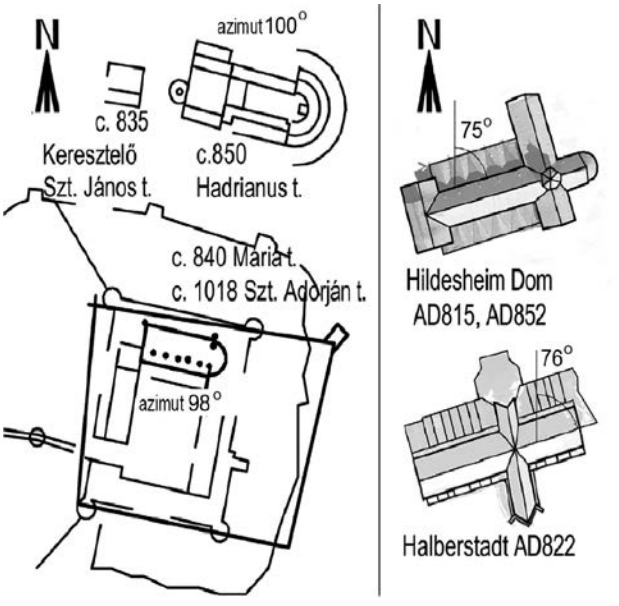
We apply the transmission diagram onto either the top view of cultic buildings or on the ruin image of the given building's layout, and in the case of rondels we place the transmission diagram on the top view of the rondel.

From among the cultic buildings of the Hungarian Carolingian-era, the consecration time of the St. Mary church at Mosaburg (Zalavár) is 23 January 850 AD, and its siting time is between 845 and 87 AD. The presumed time of the Hadrian church's siting is between 850 and 855 AD (Szőke, 2003). The siting of the nearly Carolingian-era church of Zalaszabar-Borjuállás could have taken place between 815 and 820AD at the earliest. In 815AD a church that still stands today was built at Hildesheim and in 822 another one at Halbertad. [Figures 27, 28.]Two early one-apse rotundas have received special attention with regard to the heavily disputed time of building in the case of round churches. The siting directions of the basilicas of Sopianae (Pécs) and Augusta Treverorum (Trier) might have been influenced by the foundations of earlier buildings as well, but it is also possible that *timed reconsecrations* took place. When renovating towards a different direction, the difference in siting is often slight, suggesting that the concept of waiting for the return of the magnetic declination value remains a possibility.

The siting direction of the presumably cultic building preceding the Sopianae basilica may be compared with the siting direction of the greater sanctuary space in Savaria (Tóth 2010, Kiss 2012)25. Both were constructed in the 2nd century AD was erected on earlier, 1st century AD bases with but a slight change in direction, while Sopianae was built at the end of the century

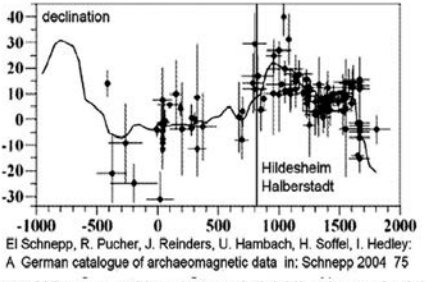
.

[25] Péter Kiss – Anita Nyerges: "Recent Research on the Paulovics István Ruin Garden of Járdány". In: Kiss 2012. ; Zsolt Tóth: "The Three-dimensional Reconstruction of the Basilica of the Roman Town of Sopianae." In: Tóth 2010.



27..ábra. balra: Mosaburg/Zalavár, Hadianus bazilika jobbra: hildeshemi és halberstadti dóm (rajz: É. Kőszeghy)

	Setting time AD...	Azimut	Archeom.decl
Mosaburg Hadrianus t.	850-855	100°	-4,0°
Mosaburg Mária t.	842-845	98°	-4,2°
Zalaszabar t.	815-830	82,9°	-5,9°
Hildesheim t.	815	75°	+9,4°
Halberstadt t.	822	76°	+9,5°



28. ábra. Kitűzési idő és nyugati impulzus szerinti deklináció a preferált keleti tájolás

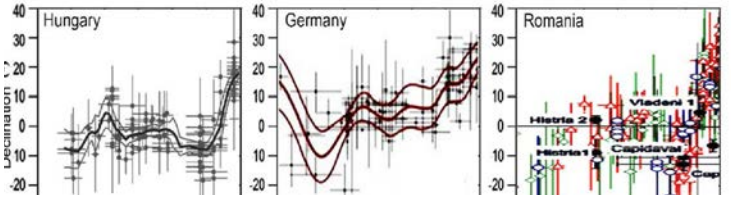


Figure 29. Archaeo-magnetic data BC 500 – AD 1000, Hungary: Márton 2010 116, Germany: P.-Carrasco 2011, Romania AARC Calin-lib-re 1997.

PREFERENCES IN CHOOSING THE ORIENTATION DIRECTION

The direction preferences of any cult – such as the North-South direction on Crete or the eastern direction in the Christian Middle Ages -- has led to a siting direction in the majority of declinational directions resulting from "applying" magnetic impulses functioning in the opposite direction. *The condition of siting to the East in one-third of the siting spectrum forces us to apply the directions of the impulses functioning on the opposite side as siting directions.* Figure 31 represents the three phases we have indicated; that is, those three direction zones of which one is given a role if the other two are not yet or not any longer near the East and in spite of the position of the zone opposing the eastern side (see Figure 31).

A study published in 2014 examined the siting of churches built after 1100AD in Lower Austria and North Germany. The authors focused on the era *before the Synod of Trent* that invalidated the dogma of easting (1545-63) and as a result, the set of churches could be narrowed down to buildings built before 1400 AD, when the use of the compass was probably still quite rare.

North delineated this way is characterized by the fact that the whole process of examinations defining the different archeomagnetic declinations has resulted in positive declination values. The values exceeding 20 degrees around 1000AD decreased unevenly but only until the dec-

lination value of 4°-5°. Consequently, the transmission diagram graphically illustrates when, from among the dominant magnetic components, the Western side components linked to the declination value received a special role.[26]

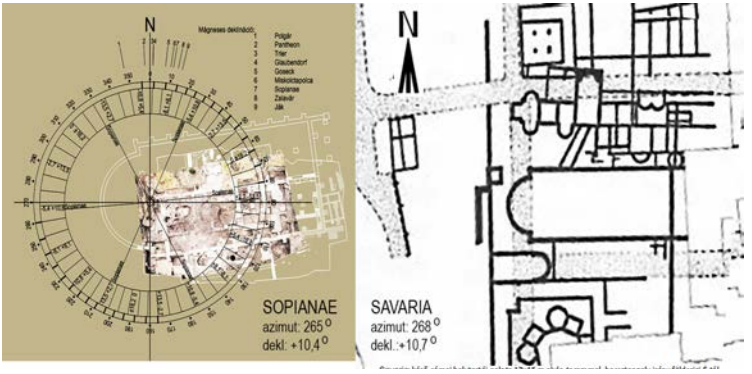


Figure 30. Sopianae and Savaria (Hungary) cultic structures (Kiss 2012) Sopianae azimuth: 2650, decl.: 10,250, Savaria azimuth: 2680, decl.: 10,70 .

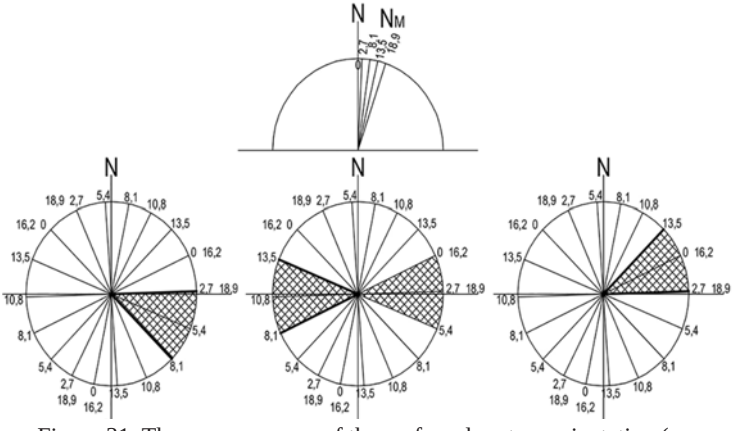


Figure 31. The consequences of the preferred eastern orientation (example): The orientations of the churches which were built in the 11th to14th centuries (Arneitz 2014), can be determined with Western declination components (drawing: É. Kőszeghy).

[26] Patrick Arneitz1, Andrea Draxler1, Roman Rauch 2, Roman Leonhardt 1: "Orientation of Churches by Magnetic Compasses." In: Arneitz 2014.

The decrease in the declination value, the impulses sensed on the eastern side indicate a decreasing declination from the near 20 degree value – down to 13,5°, that can still be roughly labeled called of an eastern nature. However, on the eastern side there is no impulse indicating a decrease continuing down to 8,1°, and thus during the siting ceremonies such impulses could have been received only from the West; or, by giving up the principle of easting, they could have experimented with siting towards the near-North. The latter idea, however, did not become characteristic for another 150 years.

DEVIATION AND DECLINATION

The authors of this study attempt to analyse the siting of churches in Austria and in Germany whose siting took place between 1100-1400AD and which differs from the East partly by siting to dawn (usually chosen for unclear reasons) and other influencing factors that do not show astrological references. The article presents the more flexible siting of churches built after the end of church regulations on easting and thus dilutes the database on siting. The authors excluded the possibility that geomagnetic north might have played a role in determining siting.[27]

In Figure 32 we have indicated with a larger rhombus the siting directions measured from the East, and we have used a smaller rhombus to illustrate the value of the direction belonging to such sitings that correspond to the declination that can be read from the transmission diagram. The granular gray strip indicates the directional zone that corresponds to the declination, where due to the eastern zone's "emptiness", the dominant field intensity components functioning in the western zone become the sources of sensed impulses.

The Decumanus roads of sities founded in the pre-Roman and Roman ages often diverge greatly from the East-

[27] Arneitz 2014. 1-7.

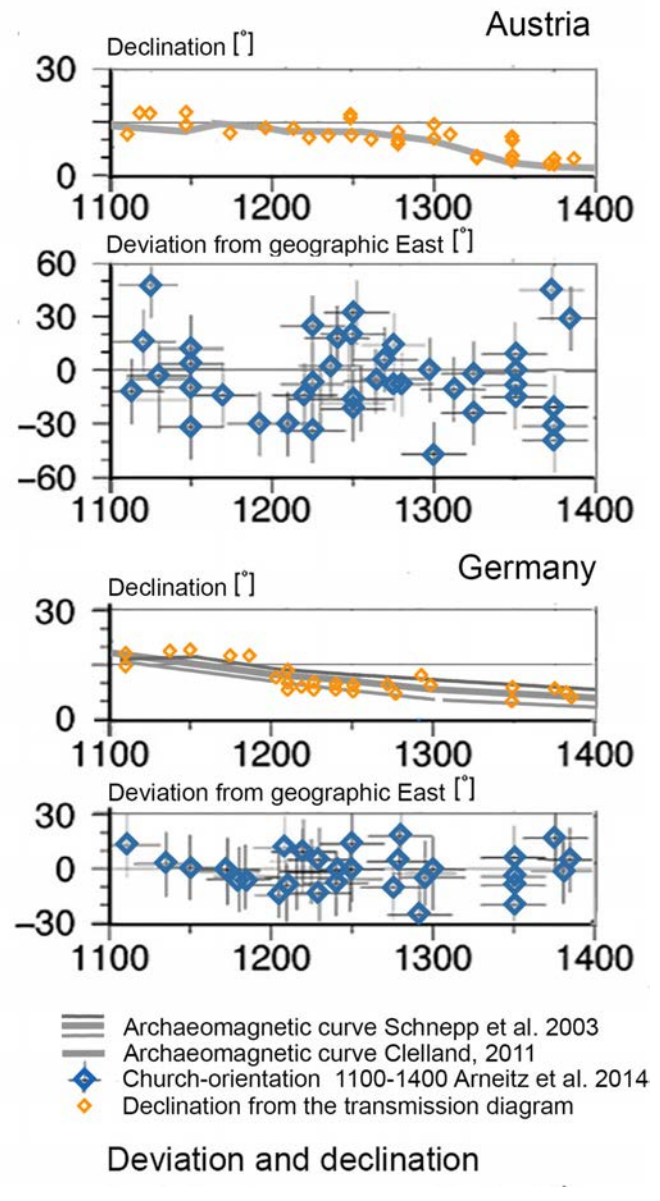


Figure 32. Deviation and declination; Austrian and German churches (drawing: É. Kőszeghy).

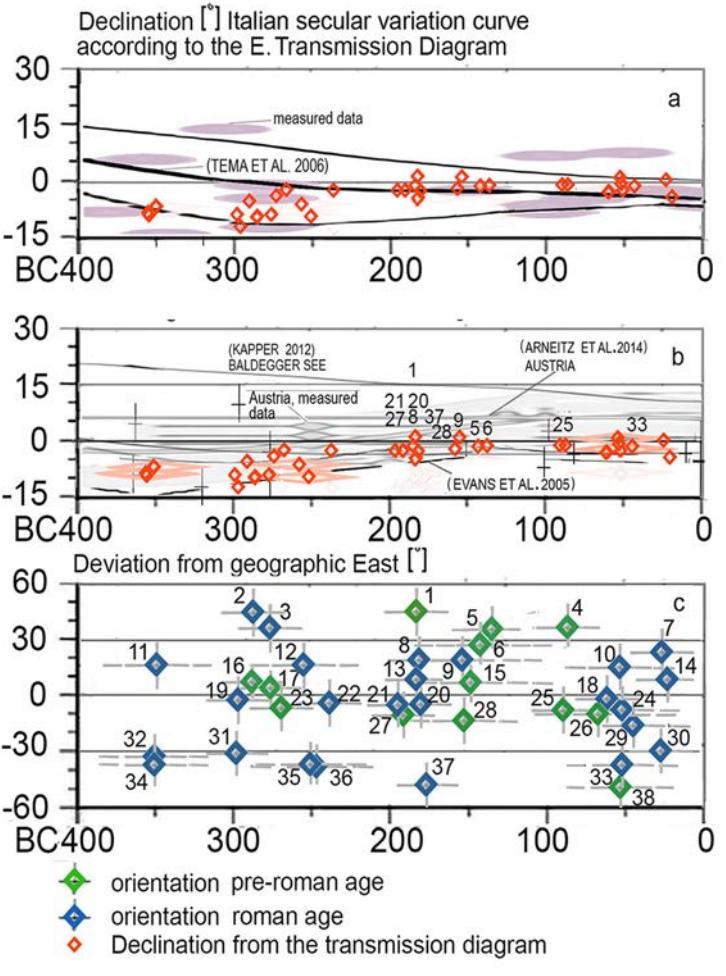


Figure 33. The deviations of decumanus roads of Italian sites from Geographic East and the value of Magnetic North synchronic with the siting based on the European Transmission Diagram (drawing: É. Kőszeghy).

West direction.[28] The siting direction of the Cardo roads at the same time corresponds to the median of the two component directions close to Geographic North.

THE ENTRANCE DIRECTIONS OF BIAXIAL ROTUNDAS

A recently published analysis presupposes that from among the Later Stone Age circular shaped earth works (rondels) of Central and Northern Europe almost fifty buildings are sited to dawn.29 In the majority of these rondels close to Lengyel culture, archaeologists have found an entrance with two axes that function as four entrances. For an analysis see Figure 35.

In studies analysing siting, the entrances oriented to three main axes have appeared as special cases, and the arrangement of two main axes of the entrance has re-

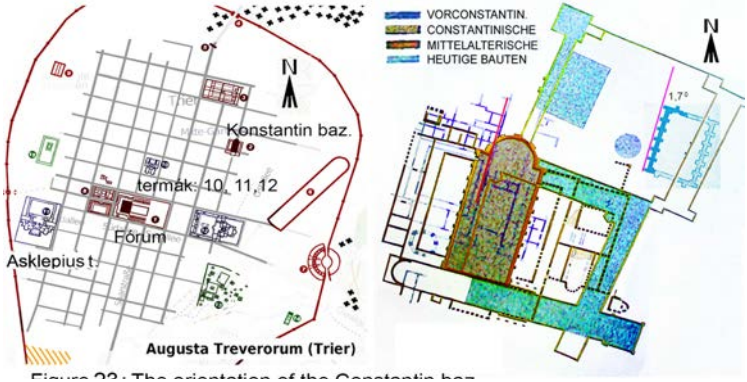


Figure 34. The siting of the Constantine basilica corresponds to the direction of the cardo road built in the first century following the direction of magnetic declination.

[28] Giulio Magli, (2007):" On the orientation of Roman towns in Italy." in: Magli 2007. 1-11.

[29] Emilia Pásztor, Judit P. Barna: "The Astronomical Characteristics of Late Neolithic Circular Enclosures in Light of the Most Recent Research from the Transdanubian Region." 2015: 465-502.

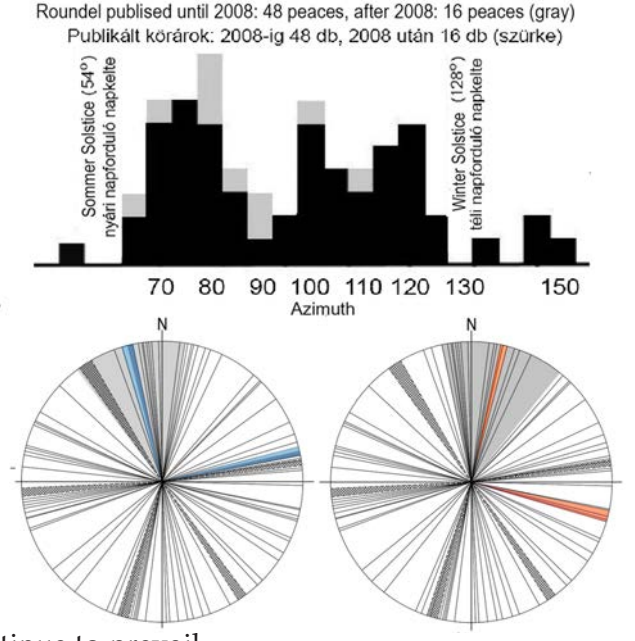
mained in the context of supposed astrologically based sitings. If, according to our hypothesis, the entrance axes of the earth works were set to the highest, invisible, creative trinity, then the tangible direction of the triad, which by today's standards means one of the directions of the geomagnetic field's dominant components sensed by human perception, two from among the three directions could have featured as "co-represented" near the direction of Geographic North-South. In the case of the other two, the bisectrix could have appeared with a weaker impulse than the third. For the direction-sensing ritual performers all three impulses came from one source, from one axis. From the two more perceptible ones the weaker impulse is the least touchable, but could have referred to the transcendent being, the creating character staying the farthest away from earthly existence [like Neith and Amon in Egypt, or Zeus or Jupiter in the Greek-Roman era].

The axis indicated by the entrances is mainly not p erpendicular, but diverges from the perpendicular with at most 8-10 degrees. In the case of solar siting, to choose the diverging directions quite a few arguments have been given to account for such a direction composition.

In the Decumanus directions the marginal positions of the Sun's movement do not warrant any role, while the direction of the equinox was indicative of the direction in only a very few cases [Figure 35].

During the planned arrangement of buildings and settlement-like formations and grave complexes, the nearly right-angled grider structure became increasingly important.30 The perceivable-invisible magnetic component triplets have a direction-setting role and could, however,

[30] Cardo plays a crucial role in Etruscan siting. The lack of knowledge about the changing direction of Magnetic North, refers not to the changes of Magnetic North around Geographical North, but to the more powerful, more spectacular changes in direction in the East-West zone. Typically, while the magnetic declination changed by 6 degrees in 40 years, the direction of the impulse sensed by the performer of the ritual near the eastern direction could have changed by as much as 50 degrees.



continue to prevail

Figure 35. Entrance directions of the Central European rondel. Top: eastward orientation of the entrances, bottom: reducing three declination components to two axes

THE MECHANICS MODEL APPROACHING MAGNETIC NORTH

BY THE SYNOPSIS OF COMPONENT VECTORS

The top and side view images of the geomagnetic network structure

We defined the shortest network length based on the network geometrical data, as shortening and lengthening when? compared to the length unit. Accordingly, we calculated the sizes of the relative field intensity components changed along with the square of the distance. Thus,

the strongest effects occurred in the relationships forming within the shortest network cross-section lengths closest to the observed position; that is, in the triads of the dominant magnetic component vectors (or, in short: dominant vectors). We articulated the structural shape of the network structure providing the stability of the magnetic component vectors while considering the distant effects as well. We assumed that there needs to be a balance between the place of equalization of the vertical "distance keeping" significant twisting momentums, "stringing" the components".

Since the power pairs of the torsional momentums generated by the cross-sections of the torsional momentum functioning in the vertical thread and the dominant magnetic components "anchored" in space need to be in balance.

We unified the weak Magnetic North component vectors (in short: weak vectors) functioning in the various more distant cross-sections making up the three dominant component vectors and the spatial network arranged in layers of grids, *and so brought it closer to a Magnetic North direction, characterized by a declinational angle* [Figure 36].

The sketchy image of the grid layers and their division into segments is shown by Figure made up of the layers of weak components.[31]

The delineation of the weak vectors' zone takes place in two steps: firstly, place into one vector those vectors functioning in the triangular fields between the dominant vectors and the weak vectors. Second, separate those weak components with a line drawn perpendicularly to Magnetic North determined instrumentally, and those components

[31] We have indicated the perception boundary of the leftover magnetism in the horizontal projection of Later Stone Age's weak magnetic field intensity at a 14-15 mesh grid layer distance from the place of observation. In the case of buildings before the 10th century AD we have assumed the limits of instrumental perception at 19-20 mesh grid layers with an almost twice as strong??big leftover field intensity. More precise data can be given by knowing the actual field intensity component vectors' projections connected to actual field intensity values.

could not have a role in the formation the instrumental declinational value but were absent on the other side because of the value calculated based on the segments and thus they could influence the formation of the approaching to magnetic North.[32] By a straight line perpendicular to Magnetic North that can be defined by the declination value according to the transmission graph, we extract the weak components from under the straight line and add them to the other side.

Adding the dominant and weak component vectors yields a direction nearing the instrumentally measured Magnetic North.

The border sensitivity of instrumental measuring is not dependent on direction. For example, we cut out the weakest zone of the weak components functioning in the oval field that sensitively follow the distances from the place of observation, delineated by triangles.

These procedures are demonstrated in the case study of the Pantheon. [Figure 36]

THE SIGNIFICANCE OF THE NETWORK STRUCTURED GEOMAGNETIC MODEL

Beyond a new approach to the siting direction of cultic buildings, these research results might give new impetus to creating fresh models of a wide range of Magnetic North phenomena and also open up new ways to study magnetic perception of living beings.

The modelling of the structural system of this under-

[32] We have delineated the weak component vectors outside of the triangle-like zones by an oval zone touching dominant component vectors, including surplus vectors located there. The instrumental measuring independent of direction (with its own identical perception limit value) excludes the vectors outside of the nearly semi-circular-shaped zone. The boundary zones of the vectors added in the oval shape and those vectors eliminated by the semi-circular boundary remain uncertain. As the vector summary shows, the instrumental declination direction – even in the case of applying a less sensitive device -- is influenced by less than one degree declination by the correction stemming from the creation of the oval model and the instrumental measuring independent of direction. The cultic buildings and rituals thus could have been part of the horizontal projected directions of these threads of the tapestry, special transformors of these spiritual-mental relationships.

lying phenomenon existing in the Earth's underground and aboveground spaces, which is intangible, invisible, barely perceivable, but still observable everywhere, hasbeen a significant intellectual achievement of human culture known and retained for thousands of years. These perceived phenomenon are part of one single, all-pervasive, omnipresent efficacy tapestry based on sensual ex-

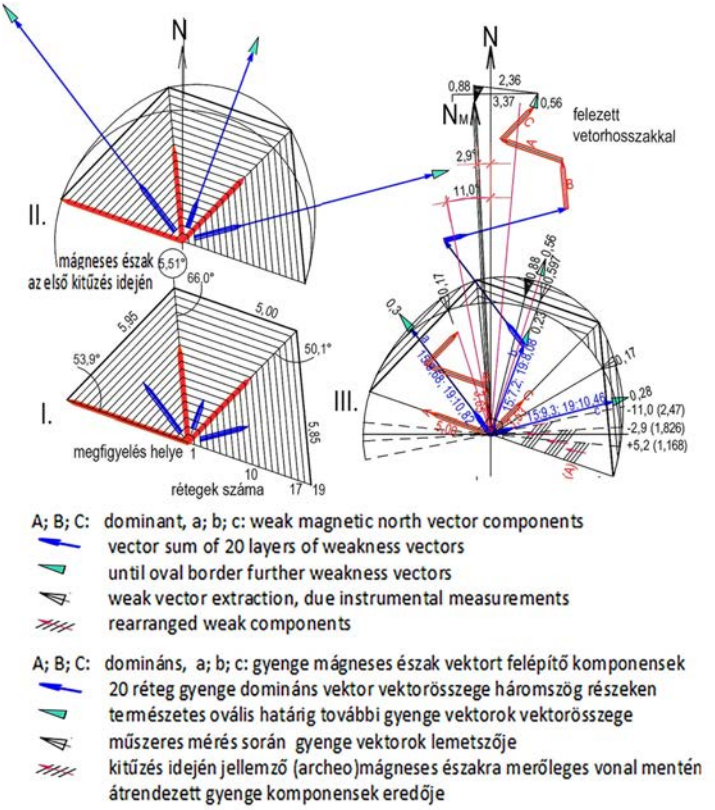


Figure 36: The route from the orientation direction to the direction of Magnetic North. (Rome, Pantheon)

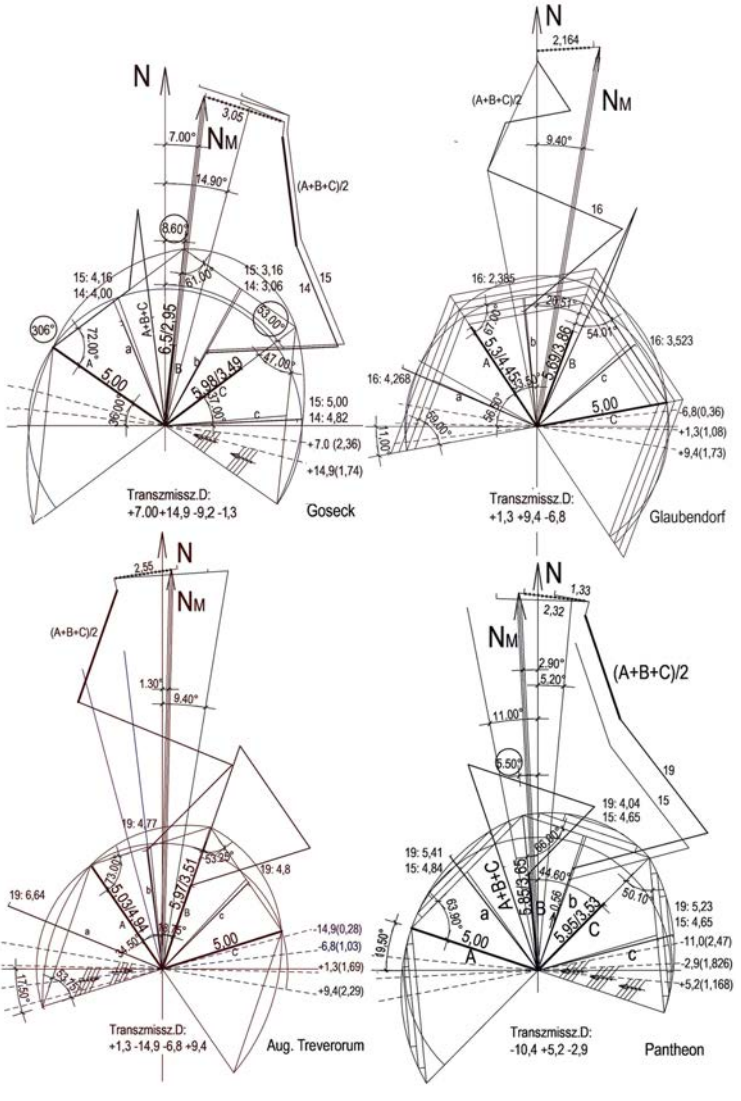


Figure 37. Summary of the vectors

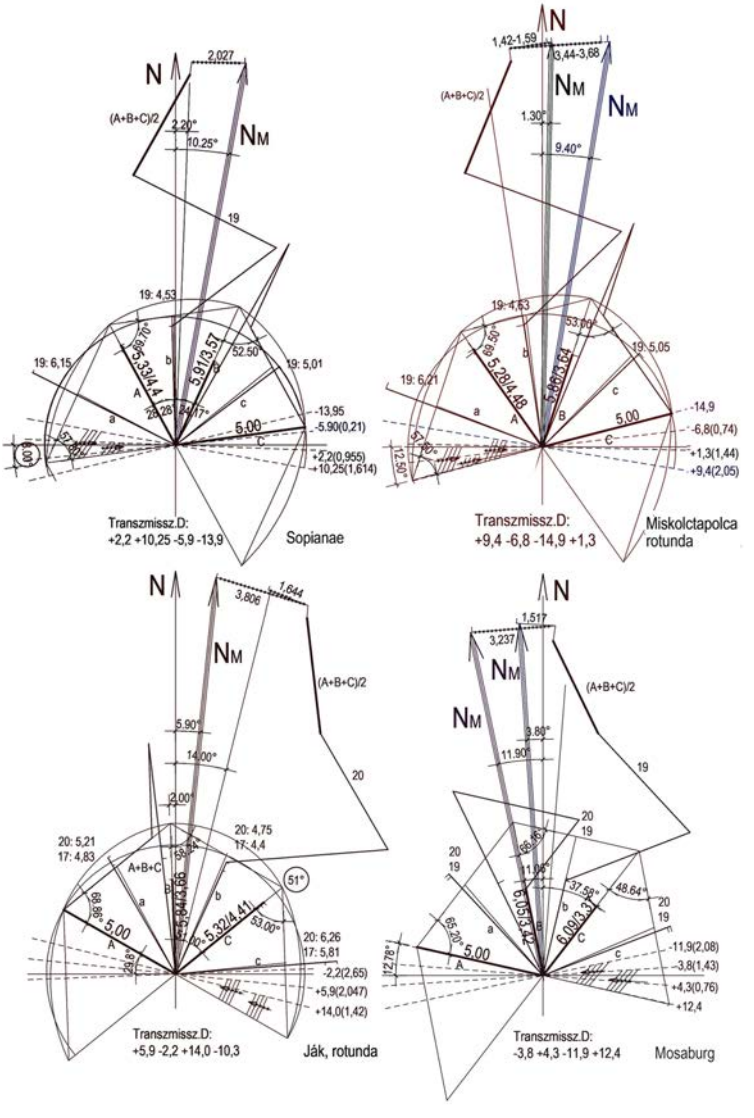
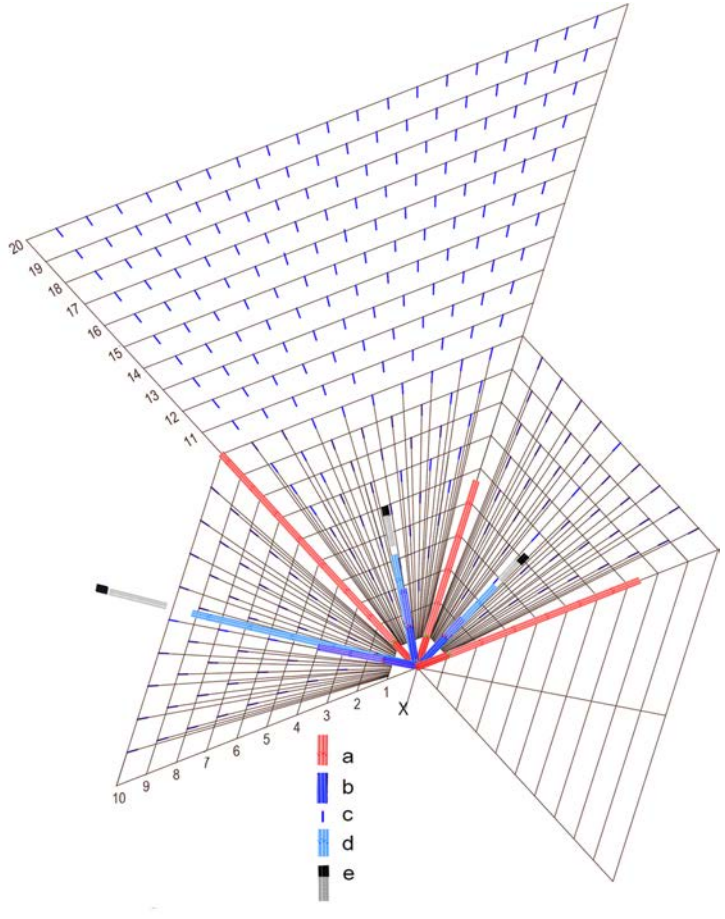


Figure 38. Summary of the vectors



Geomágneses deklináció komponens vektorok: a: domináns, b: másod-domináns, c: gyenge komponens vektorok; d: másod- domináns és gyenge vektorok eredő vektora 10 rétegnél; másod-domináns és gyenge vektorok eredő vektor mérete 20 rétegnél; x: a mérés helye

Figure 39. Dominant and weak geomagnetic field intensity components - horizontal projection directions

a: dominant, b: secondary-dominant, c: weak component vectors, d: root of 10 layers, e: root of 20 layers.

periences.

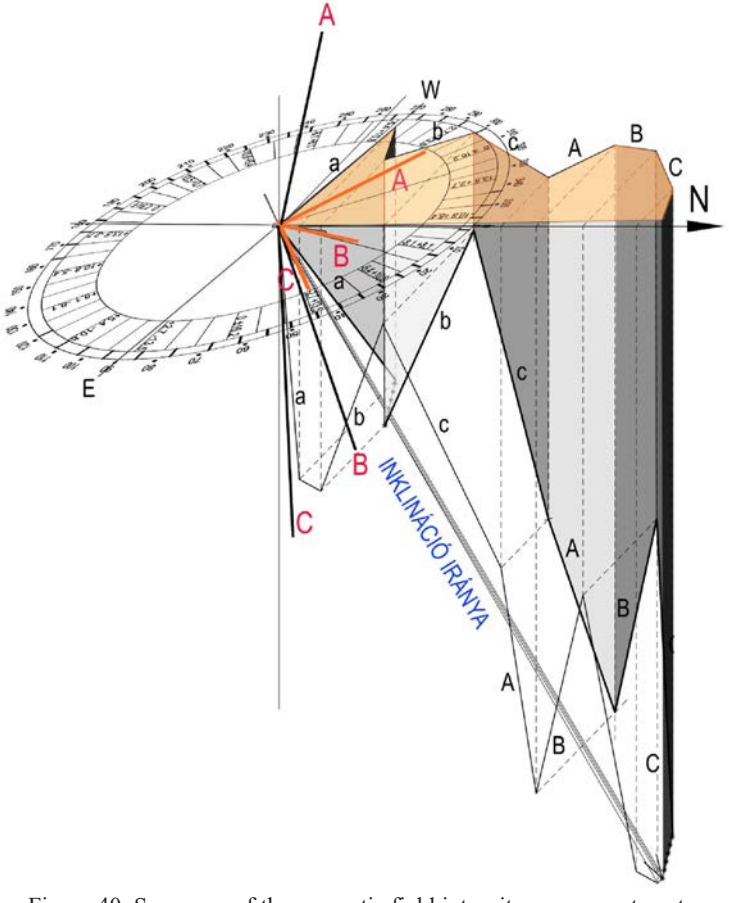


Figure 40. Summary of the magnetic field intensity component vectors

The future of the transmission model

We have remodelled the physical phenomenon which from the Stone Age until the Middle Ages used to suggest directions for the siting of cultic buildings. The magnetism which is without visible surfaces, *but exists in an infinitude of directions, on the level of the directions as oscillating interactions, organising itself on a cosmic scale (autopoietic), its spatial geometrical structure may be analogous to the activity field of human consciousness.* The remodelling of the magnetic field structure, the articulation of the old cultic buildings' siting as well as the relationship between instrumentally measured magnetic field features could contribute to the improvement of cultivation forms in tune with actual physical structures and the regeneration of a multitude of atrophied spiritual-mental connections that had been neglected in their interactions.[33]

[33] Once the magnetic components making up the spatial structure of the geomagnetic field become perceivable by instruments as threads,s fibers or a thread of the magnetic field, then components of a dominant magnetic field intensity could provide more precise information-recording sign, it could become possible to strengthen or weaken the vectors functioning in the individual thread-directions, and the whirlpool-like phenomena appearing around atomic accelerators could also be weakened or prevented in the course of the increasing magnetic field intensity.

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APPENDIX I.

THE GEOMAGNETIC ORIENTATION OF A FEW EARLY ROTUNDAS IN THE CARPATIAN BASIN

Figure 0. Algyógy/Geoagiu/Gergesdorf, rotunda
(Photo: Ardelean 2012.)

The myth of magnetic lines of force – possible reinterpretations

The term "magnetic line of force" was first used by Petrus Peregrinus (Pierre de Maricourt) in the middle of the thirteenth century. He sprinkled iron raspings onto a piece of magnet iron ore which was carved into a spherical shape and the filings arranged themselves into lines between the magnetic poles. It seemed obvious that the phenomenon was caused by forces acting along the direction of the lines formed. It did not even occur to him that the magnetic field between the two poles of the magnet could have a spatial network structure and that the linear elements of the figure are built up by the multitude of oblique magnetic components that have a direction strongly divergent from the poles. *Even though the iron filingss could only arrange themselves in distinct threads because of the sideways repelling effect of the spatial force components which resulted in a lined surface.*

After half a millennium – in the course of scientific study of electromagnetic lines of force –ideas about the lines of force found a new location. The arrangement of the lines of force of the electric space was not surprising given the image of the iron filings' lines around a bar magnet which had been known for centuries. Similarly to the representation of the linear image of the magnetic field of force, the forms divided into strands considered to be electronic force field lines may also to represented by a visual image. The lines around what are called the positive and the negative charges are similar to the arrangement of iron filings on a bar magnet. The radial formation around a solitary electronic charge is also known. The radial formation will also occur on a horizontal sheet of paper placed above one of the ends of the bar magnet.

The moving electric charges create a magnetic field which can interact with the magnetic fields of magnet-

ic bodies. Thus, the magnetic field affects moving electric charges. We can identify the field intensity of the magnetic field at any observed point based on its effect of creating magnetic induction or turning a leading loop permeated with electrisity. Since Maxwell's electromagnetism theory, the phenomena of the electric field is not often interpreted from a perspective of magnetic phenomena but rather the other way round: the vectors of magnetic induction are represented similarly to the linear figures of the electric space from point to point, and thus end up with *magnetic induction* lines – bound up with electrisity. The size of the single total magnetic field intensity vector functioning on an electrical basis and measured instrumentally is also connected to the electronic features of the measuring instrument. When we talk about magnetic fluxus or induction fluxus, or in short, simply fluxus we mean the induction line number passing perpendicularly through the plane of a delineated surface, on the territory of the electronic leading loop. *The existence and number of induction lines are imaginary, postulated and to fit conventional measurement systems.* The word "fluxus" applied as a name for electrostatic space might have suggested an analogous solution to the articulation of the magnetic space's fluxus. The fact that the lines of force of the electrostatic force field start out from charges and end in charges has become part of basic material knowledge. And in this sense this force field involves a source.

It is not disputed that there is no magnetic charge in the magnetic force field, there are no places *where the induction lines start or end, and as such the magnetic force field is source-free. We put together the induction lines* – the field intensity vectors characterising the magnetic torsional momentums–from a series of tiny vectors defined point by point. However, the torsional momentums themselves function in a plane perpendicular to the vectors! The agent in which this twisting functions cannot be to the direction of the induction lines.

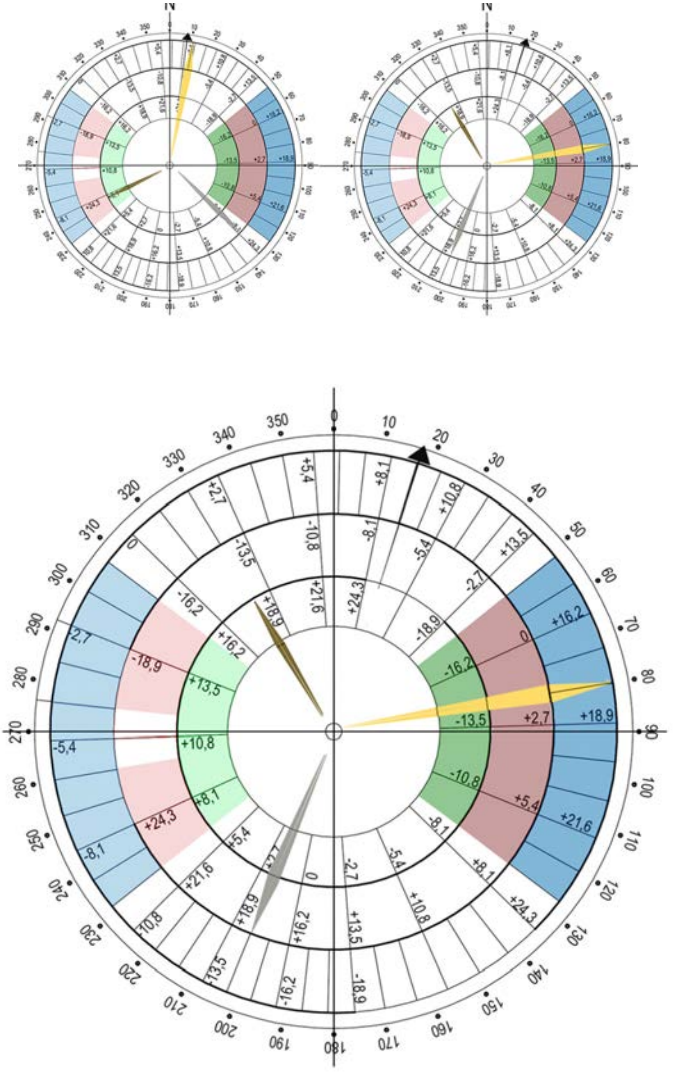


Figure 1. perceived direction around East
Based on the transmission chart
(Kőszeghy É. 2016.)

The imaginary models of induction combined with Maxwell's theory of electrisity and magnetism appear ufficient to describe and measure the features of magnetic fields. The builders of the total field intensity vectors remain hidden *cross-sections of the more distant, weak field intensity components and the dominant ones closer to the place of measuring*.

Based on our assumptions the magnetic force field was *arranged into a spatial network, and as such is divided, and as a result, of source, with a basic bipolar structure similar to electricity. These points are network cross-sections. In a spatial network in the absence of a magnetic charge similar to electricity, there can still be magnetism generating starting points and endpoints formed. The magnetic field intensity component fibers, threads cross-secting or intersecting above each other without touching* generate torsional momentums on the axis perpendicular to the horizontal plane. Beyond the cross-sections that are the closest to the places of measuring, the multitude of more distant cross-sections also appears with a special emphasis at the places of measuring.

The disclosing discovery of the magnetic force field's structure that is quasi-sourceful or it could be called a pseudo-source makes it possible to describein a new way the features characterising the magnetic field.

The sources of the magnetic field intensity component vectors are those torsional impulses which are generated at the pseudo-cross-section points of the spatial network as pseudo-charges. Thus, those field intensity vector components, which are presented in the Figures summarising the vectors are formed at such a network of thread cross-sections where the network thread's direction cannot fit the directions of the component vector. The plane of the force pair of the torsional momentum is not arranged in a known spatial network thread direction *but it is arranged according to the pole direction difference forming at the cross*

sections **over each other.** The pole direction is presumably created by the twisting momentums appearing at superimposed cross-sections in different planes of different sizes.

The relationship of cultic orientations and geomagnetics: the eastward orientation

Christian easting, which was influential for more than a thousand years, settled the axial direction of churches by the dogma of eastward orientation. *The multitude of orientations near the East has encouraged us to* look for indirect connections between the orientation practice and Geomagnetic North direction synchronic with the orientation – despite the obvious lack of a direct interrelation between the two.

Before the use of the compass, in a great number of cults something called "the One which is Three" played a crucial role, as a notion of an invisible creating triad characterized merely by this number. Sacred triads, those cultic directions founded on human perception that dominated siting practices through thousands of years, sunk into oblivion with the appearance of the compass. The compass only indicated one single direction, or, if it was formed in such a way that it could also move obliquely, then it registered the total magnetic field intensity, while on the horizontal plane it registered the direction of Magnetic North. But on the issue of eastward orientation it could have been more accurate than siting by rotating a bishop's crosier, which was part of the comedy-like context of sixteenth-century indulgences.[34]

[34] Three decades after the beginning of the Reformation the major document of the Counter-Reformation, the edict closing the Synod of Trident (Trento) between 1542-1564 did not make the eastern orientation of Catholic churches compulsory. This sped up the forgetting of orientation without a compass to directional triads also in the circle of non-Catholic cultic buildings.

In the framework of present-day physics, it is an established fact that magnetic space is built up out of a multitude of non-intersecting, imaginary magnetic lines.

The geomagnetic field intensity vector defined on this basis, however, is a theoretical construction. The vector measured by an instrument is in reality not present at its assumed place. Rather, the effect of the component vectors is summarized into one single direction by our measuring instrument, *regardless of the way we conceptualize the component vectors.*

Among the figures referring to the cults in the millennia before the use of the compass are references to a network, whose magnetic nature has gone unrecognized in the case of new Assyrian reliefs, and the tree of life drawings visible on seals. The oblique network-threads of the network structure are emphatic, superimposed repetitions and intersections suggesting further connections are also visible These refer to important features of the geomagnetic field's network model. Similarly detailed representations did not appear during the following centuries.

Cultic orientation directions change to a much larger extent than that of Magnetic North. Between the changing of Magnetic North and the changing of the cultic orientation directions covering all points of the compass no direct relationship can be established.

The medieval Christian easting of cultic buildings providesa key to uncovering how the declinational values and the corresponding changes in the direction of Magnetic North are connected to the changing of the orientation directions which were five to eight times larger.

The direction diverging approximately 25° from the East might have been regarded as near to the East, which in the case of a Magnetic North being very close to Geographic North (referred to a declinational direction of about 0°). The magnetic component perceived here shifted towards the East with an angle of about 65°, while Magnetic North diverged towards the East by only eight

degrees. If Magnetic North moved another degree further, the direction signifying component perceived, thus ran far beyond the zone near East. A new component needed to be found. Such a component appeared in the other branch of the cultic triad at yet another 8°-9° turn, a third branch appeared as well. One of them is the extension towards the East of the component located in the West.

This is possible because in the case of cultic axis sitings not one but three co-moving, invisible, but perceivable phenomena have been offering siting directions for thousands of years. The practice of easting – similarly to the direction-perception limited to the northern zone of Cretian culture – gives an opportunity to reveal cultic phenomenon from the past, which, according to our present-day knowledge, is the location of the triad-like spatial network

Khasekshem fáraó kora Keselyű-mindenségisten hármas "szerkezettel"; kettő letalpal, egy buborékformában talp nélkül. A két oldalsó Iven elágazások.

Figure 2. Engraved figure with a Trinity shape, granite vessel of Khasekshem pharaoh, Egypt. [Exact figure: A. Kőszeghy 2013] Goddess Nekhbet in the form of a vulture on the Shen ring of eternity with a trinity shape [Discovered by: Hierakonpolis (Kom el-Ahmar) Quibell in 1898]

system of the magnetic field's field intensity component.

The sum of the field intensity components vectors is the total field intensity vector

The total geomagnetic field intensity vector is based on three dominant vectors (previously discussed) *and much outer, weaker vectors.* The horizontal projection-direction

of the total geomagnetic field intensity vector is the directions of Magnetic North, near to Geographic North.[35]

In the course of a series of failures we realized that one of the three dominant vectors emerges upward above the horizontal plane – even though its horizontal projection did not so indicate this – and it remains hidden when viewed from above. The directions of the three vectors close to a near 120 degree with each other in the widely known triskell, triskelion shapes. All three vectors point towards Geographic North zones. The triskell formula only figures the three legs with nearly 120 degree difference from one another because on the horizontal cut the vector pointing upwards was cut along with the ones pointing downwards.

The three-legged *mskt Figure* of the Egyptian Khasekshem pharaoh refers to the fact that there is a different third direction between the two "footing downwards" directions. On the vessel older than 2600BCE the carved Figure "tells" that the formula of *One-which-is-Three* is held by *the uncreated creator* represented in the image of a vulture.

Uncertainties stemming from interval data

We presume that a few dominant components of the total geomagnetic field intensity can be perceived by the human eye and body and we interpret their direction on the horizontal plane. The existence of a cultic siting prac-

[35] The horizontal field intensity component projections are located nearly 120 degrees from each other, turning towards Magnetic North on the northern hemisphere to varying degrees. If the three field intensity component vectors and the weaker, more distant ones build up the magnetic field intensity vector together, then in the case of a field intensity different from zero, an inclination of 90 degrees cannot be achieved. The compass becomes useless near magnetic poles, if H – horizontal field intensity – is between 3000 and 6000 nT, where H is less than 3000 nT. Where H is less than 2000 nT, the daily change of the declination can easily be greater than 10 degrees. (SCANsat [v16.1]* The Scientific Committee on Advanced Navigation. 2014.05.06)

tice based on perceiving the directions of magnetic field intensity components can also be supported by a graph which describes the interconnections between the orientation directions and the direction changes of Magnetic North characteristic at the time of the setting.

The graph needs presents a systematic connection between the orientation directions fitting Geographic North and the changing of Geomagnetic North measured by instruments. If the three geomagnetic field intensity component vectors' vector sum points towards the direction of Geomagnetic North, then the presentation of an indirect relationship would become quickly successful. However, today's magnetism measuring devices also measure the three dominant magnetic field intensity component vectors and summarize them with a multitude of further, weaker component vectors which explains howthe measuring device ends up with a horizontal projection of the total magnetic field intensity, that is, the direction of Magnetic North.

The three dominant components based on the magnetic spatial network's geometrical structure registers the size of the field intensity component vector taking into account the distance from the network cross-sections which are losest to the examined place. Based on the same principle, further component vectors can also be formulated. Without doubt, there will be further vectors which will be sensed by the measuring devices. The examination and the application of the magnetic field and the total field intensity direction measured by instruments need to be identical with the vector summaries based on the spatial network magnetic field model. By applying the loop with electricity (with the addition of measuring devices) defined field intensity vector sizes and the size of the relative field intensity vector sizes in the spatial network model being harmonized can be realized after the accepting of the spatial network model.

The indirect relationship between the orientation and

the geomagnetic declination was articulated on the basis of such spatial magnetic field intensity components whose existence is unknown to today's physics. According to our model, the orientation directions can only be systematically connected to Geomagnetic North's direction. As today's measuring devices according to our present knowledge are unfit for sensing the presumed spatial magnetic field intensity components, a magnetism measuring device needs to be developed that can sense geomagnetic field intensity components separately. *Without such a device,* we can provide a network geometrical description articulated on the basis of the cultic orientation directions and then based on theoretical considerations we might offer a method to determine the direction of the summarized vector of the many field intensity components.

It would be easy to present the indirect connection of the cultic orientation directions and Magnetic North if we knew the past *before the age of the compass* -- Magnetic North synchronic with the time of the cultic sitings; for instance, the angles of Geographic North and Magnetic North, based on the angle of the geomagnetic declination. The measured values of the archeomagnetic declination known today can be characterized with wide value-intervals. Even after narrowing down with statistical practices and fitting them to certain archeological approximations, there are still 8-10 degree differences in the declination values visible in the intervals containing the declination data of a given century. Within the century-long time-span, the unrealistically quick declination changes can thus be filtered out. The various researchers' graph data are close to one another, the applications of iterations within a hundred-year time span and the careful calculation of the extreme values give us an opportunity to make them fit for determinining the orientation directions and the connection between declinational data. Renovations and buildings having a precise dating related to certain decades, built before the age of the compass provide the opportu-

nity to articulate the interconnection of orientation being built on relative declinational differences and declinations.

The uncertainty of the "steepness of declinational-changes" might need a bridging of the data-lackingaps different from linear changes.[36] In the field of archeomagnetic examinations connected to cultic orientation *it is elemental that the near hundred-year dating time-span should be replaced with dating time-spans of only 20-25 year*.[37]

Early round churches with one apse where there are no ruins of earlier cultic structures

The early rotundas of Gyulafehérvár, Veszprém, Miskolctapolca, and Algyógy give us an especially au-

[36] I.Zananiri, C.M. Batt, Ph. Lanos, D.H. Tarling, P. Linford: "Archaeo-magnetic Secular Variation in the UK During the Past 4000 Years and Its Application to Archaeo-magnetic dating." In: Zananiri et al. 2007.

[37] The uncertainties barely influencing the identification of interconnections are also worthy of attention: The uncertainty of the buildings' axial directions (for example non-parallel longitudinal walls in churches) are less disturbing in comparison with declination determination. For instance, a 3-degree directional difference of two longitudinal church walls influences the relevant declination value with half a degree. For the determination of the geographical North one needs to know the date of the satellite images oriented to the Magnetic North, the same is true for visual direction determination as well, this is how the converting of the Magnetic North to the Geographic North can take place. When converting the measured directional data to the geographic North a one-degree measuring mistake might leas to a declination difference of about 0,2 degrees. In geodetical surveys the superficial determination of certain elements' directional data might lead to serious directional data mistakes in the highly precise extension database. For example, if a 8-10 degree directional mistake happens when putting the measurements of rotund of Algyógy/Geoagiu on a geodetical map, the axial direction identical with that of the Gyulafehérvár rotund this way might refer to a building time decades before the actual date. It is characteristic with the setting time of a building that the time of foundation often means the time of ordainment or rarely the putting down of the foundation-stone, and thus the setting time often needs to be estimated, and the time of the first setting is uncertain with renovated sites. The re-buildings occasionally provide points of reference. The data of the coins from cemeteries around the cultic buildings can be misleading, however, written documents referring to the starting time of coined burials can give us a chance to estimate the time-lane of the pre-coin burials.

Figure 3. Gyulafehérvár/Alba Iulia, Google picture from May 2016, vertical Magnetic North. Axes are adjusted to Geographic North. Based on Geomag Declination data (May 2016 decl. 5,18 degrees +-0,33'), the axial directions were set to Geographic North.

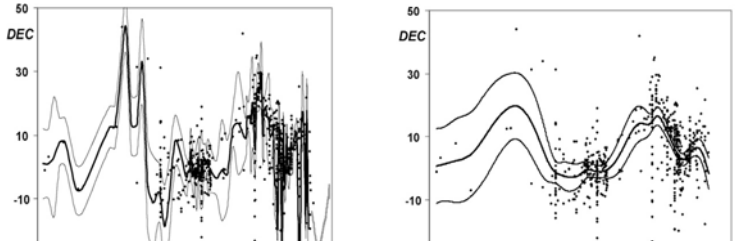


Figure 4. Archaeo-magnetic modelling based on the measured data: various techniques were employed in order to use the data to construct a secular variation (SV) record: moving window with averaging and median, as well as Bayesian statistical modelling. Based on hundreds of directly measured data (indicated with a rhomb sign) about the archeomagnetic calibration graphs of the United Kingdom spanning 4000 years, statistical models have been created with the data of centurial differences with moving window averaging and meridian formation (to the left), also, with a Bayesian statistical model (to the right). For the articulation of the interconnections between orientation directions and magnetic declination values, declination values arranged onto graphs with statistical methods prove useless. The leap-like differences between measured data leads to the presumption of directional changes of an unrealistic extent. Figures: I. Zananiri et al., 2007.

thentic picture of the time of their construction as well

as potential declinations at that time, since there are no older buildings with certain direction suggestions underneath them.

There are several known rotundas that are nearly of the same age but we only refer here to those where the orientation direction is well-reconstructed based on data of the known Magnetic North direction and the cultic buildings built onto it or almost onto it confirm their primariness, too. To determine the age of rotundas of similar orientation but located elsewhere a "time bridge" is employed with approximate declination.

The transmission diagram gives an opportunity to determine the orientation directions and the declination approaches and thus a Magnetic North synchronic with the siting's orientation directions.

We have attempted to coordinate two data groups: the group of Hungarian archaeomagnetic declination values and uncertainties based on Péter Márton's 2006 study, corrected in 2010 and the series of data from the magnetic transmission diagram modelling the relationship of orientation directions and declination values. The transmission diagram is based on a series of cultic buildings with a known construction date and synchronic magnetic declination. The date having been refined through several iterations and the data of hundreds of cultic structures with precise orientation data and well-approximated times of origin. The archaeomagnetic values and the uncertainty of the related dating make it more difficult to formulate a more precise model on the relationship between orientation and declination.

Constructed and sited between the construction of the early rotundas and the beginning of compass usage.

Table I. and table Ia represents the suggested and to-be-accepted siting data of the cultic buildings. A few early round churches have more than one suggested siting time.

Table I, : Relationship of temple axes with archeomagnetic declination Carpathian Basin 800-1200

Hungarian Settlement and church	Founding time	azimuth	declination transmission chart West	declination transmission chart East	correction of the Central Hungary dekl.
Kaposszentjakab ch.	820-850	93 °	25,7 9,5	19,4 3,2	+0,4
Kaposszentjakab benedict.	1050-1070	91 °	25,7 9,5	19,4 3,2	+0,4
Tarnaszentmária ch.	970-990	78,2 °	25,5 9,3	17,6 1,4	-0,5
Veszprém I. hypothetic	920-940	49,8 °	22.0 5,8	14,1 -2,1	+0,5
Veszprém I. cath.	1015-30	49,8 °	22.0 5,8	14,1 -2,1	+0,5
Kalocsa I. hypothetic	930-950	51,7 °	22,5 6,3	14,6 -1,6	-0,1
Kalocsa I. ch.	1015-30	51,7 °	22,5 6,3	14,6 -1,6	-0,1
Kalocsa II. ch.	1170-1190	72,3 °	25,2 9,0	17,1 1,1	-
Alba I. Gyula hypothetic..	850-870	96,5 °	-4,5 11,7	19,8 3,6	-1,0
Alba I. Gyula ch.	900-930	96,5 °	-4,5 11,7	19,8 3,6	-1,0
Alba I. I. István ch.	1000-15	98 °	-4,3 11,9	20,2 4,0	-1,0
Somogyvár I. István ch.	1020-40	61,3 °	23,8 7,6	15,7 -0,5	+0,5
Somogyvár benedict.ch.	1085-1095	68,9 °	24,5 8,3	16,6 0,4	+0,5
Győr Szt Lázár cath.	970-1000	77,0°	25,6 9,4	17,6 1,4	+0,6
Győr Székesegyh.	1060-1090	68,8 °	24,7 8,5	16,9 0,7	+0,6
Tihany Bazilita t.	1050-1070	81 °	25,6 9,4	18,2 2,0	+0,3
Tihany early t. hypothetic	940-970	68,1	24,7 8,5	16,5 0,3	+0,3
Tihany benedict.ch.	1060-1090	68,1 °	24,7 8,5	16,5 0,3	+0,3
Pannonhalma cript	970-1000	75 °	25,5 9,3	17,5 1,3	+0,5
Vésztő-Csolt I ch.	1080-1090	78,6 °	25,9 9,6	17,8 1,6	-0,4
Vésztő-Csolt III ch.	1160-1180	76	25,4 9,2	17,4 1,2	-
Pétermonostora ch.	1150	54 °	23,2 7,0	14,8 -1,4	-
Miskolctapolca benedict ch.	1030-1080	84 °	26,7 10,5	18,6 2,3	-

After 1140, the differences between the part of the cauntry disappeared

The changing of Magnetic North in Central Europe

An attempt to outline the relationship of declination changes and orientation while fitting it to the declination data of the Central European magnetic transmission diagram encounter the archaeomagnetic declination data of the centuries around the millennium that offer *an opportunity to articulate only a rough sketch.*

Hungarian, German and Roman intervals of magnetic declination values for 900s and 1000s that are also available from European magnetic declination isogons appear-with slightly decreasing declination values in the direction of East and South—East (for instance, the declination value in Central Romania is 9°-11°, in Germany it is 14°).

When analysing the siting axial directions of Hungarian, Transylvania, Polish and Czech rotundas we have to employ declination differences with reference to synchronic siting times with Hungarian ones [see figure 8.]

The churches of Gyulafehérvár / Alba Iulia at the first millennium

The axis of the nave of the Catholic cathedral of Gyulafehérvár and the direction of its longitudinal walls still retain today the direction at the time of siting around1070, during the age of Saint Laszlo. Later renovations only made a few degrees change in direction on the part of the apse. After 900, this non-Western Christian church was erected during the reign of the Transylvanian monarch Gyula or his predecessor, currently it is a covered ruin and its orientation direction is 104,2°. Its new longitudinal wall indicates that the nave is not from the Roman Age.

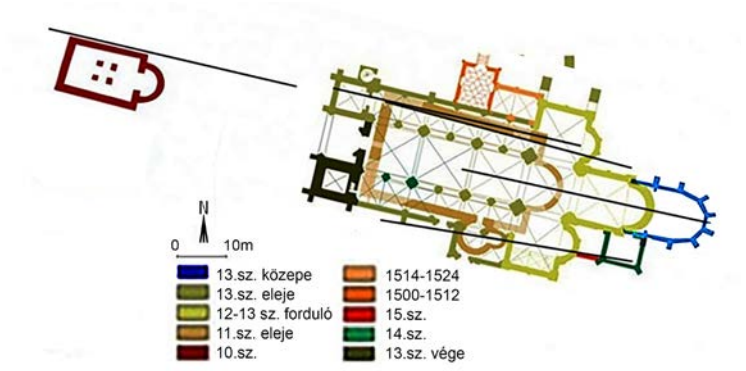


Figure 5. Estimated construction time for the Alba Iulia church from the early rotunda until the 16th century. Búzás Gergely – Kovács Olivér, Mátyás Király Múzeum, Visegrád

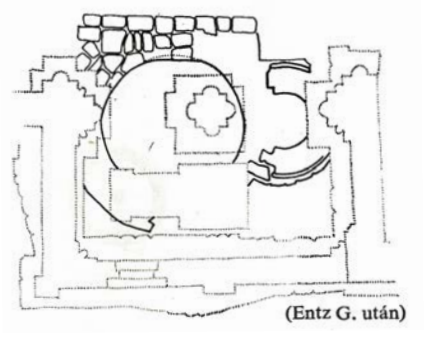
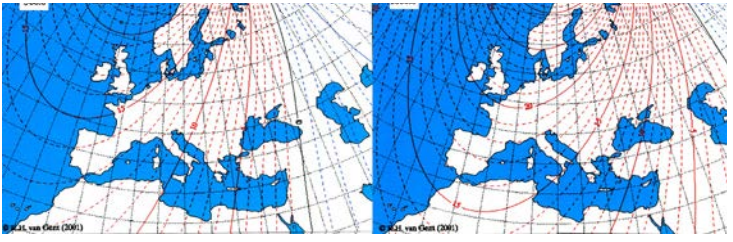


Figure 6. The wall of the rotunda under the structure of the St Stephan Basilica – Drawing: A. Szilagyi foter G.Entz 2003)

The church of István I sit about 1006 diverges from Geographic North by 106,7° degrees. Before the church of István I was constructed there are two dates when the start of the building of rotundas diverging from Geographic North by 100° is possible, in the years 830-840 and 920-930. In 920-930 the construction could have occurred almost at the same time as that of Gyula's church. The early rotunda of Vesprem suggests a siting time between 830 and 840.

Table Ia: Orientation and declination values
Assumed construction time for the earliest rotundas

Cultic structures	Orientation, azimuth east side	Orientation, azimuth west side	beginning of construction time bar AD 600-1200	archaeeomag. declination at Budapest according to Márton 2010	Declination in eastern Romania	Declination according to the transmission chart	Declination according to the transmission chart	Based on Márton 2010 declination corrected
Ják, rotunda	+51 °		820 -840	(-8) **-1,5** (+16)		-9,7 +6,5	**-1,7** +14,5	**+0,7**
Przemsl rot.	+60,2 °		820 -840	(-8) -1,5 (+16)		-8,7 +7,5	**- 0,6** +15,6	**+0,7**
Ducó/Ducové rot	+66,5		830 -850	(-18)-8 0 (+16)		-7,9 +8,3	**-0,2** +16,0	**0**
Miskolctap.rot.	+77,0		840 -860	(-8) **-3/+2,5**(+15)		-6,8 +9,4	**+1,5** -14,7	**+0,6**
Veszprém rot.	+89,6 °		850 -870	(-8) **-3/+2,5** (+15)		-5,4 +10,8	**+2,7** -13,5	**+0,3**
Alba Iulia rot.	+92,3 °		850- 870	(-8) **-4/+4** (+16)	-17 +2	-5,0 +11,2	**+3,1** -13,1	**-1**
Algyógy rot	+93,3°		850 - 870	(-8) **-4/+4** (+16)	-8 **+3** +16	-4,9 +11,3	**+3,2** -13,0	**-1**
Ják, rot.	+51 °	+231 °	860 - 880	1 **+4/+6**(+15)		-9,8 **+ 6,4**	-1,7 +14,5	**+0,7**
Przemsl rot.	+60,2 °	240,2	860 -890	0 **+5,5** (+15)		-8,7 **+7,5**	- 0,6 +15,6	**+0.7**
Ducó/Ducové rot	+66,5	243,5°	870 -880	0 **+7** (+22)		-8,2 **+8,0**	-0,4 +15,8	**0**
Öskü rot.	+73,9 °	+253,9°	870- 890	(-8)+5/**+ 9** +(17)		-7,1 **+9,1**	+1,1 -15,1	**+0,3**
Miskolctap. rot.	+77,0°	+257 °	870 -890	(-8)+5/**+ 9** +(17)		-6.8 **+9,4**	+1,5 -14,7	**-0,6**
Szalonna rot.	+89,3 °	269,3 °	900	(+5) **+11** (+15)		-5,4 **+10,8**	+2,8 -13,4	**0**
Veszprém rot.	+89,6 °	269,6 °	900	(+5) **+11** (+15)		-5,4 **+10,8**	+2,7 -13,5	**+0,3**
Alba Iulia rot.	+92,3 °	+272,3 °	900 - 920	+9 **+13** +16(+22)	+6 +24	-5,0 **+11,2**	+3,1 -13,1	**-1**
Algyógy rot.	+93,3°	+273,3°	900 -920	+9 **+13** +16(+22)	-	-4,9 **+11,3**	+3,2- 13,0	**-1**
Ják, rot.	+51 °		910 -930	+9 **+13** +16(+22)		-9,7 + 6,5	-1,7 **+14,5**	**+0,7**



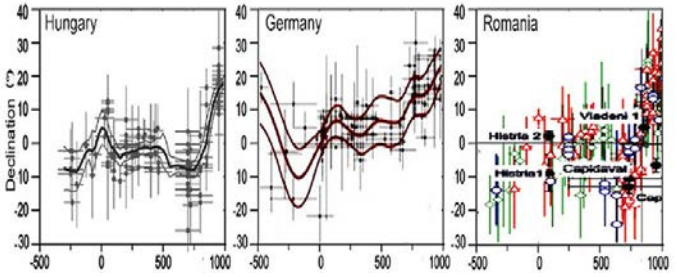


Table 1b. the esatward decreasing declination values in tabular form

Ország mai neve	magnetic dekl. 900	magnetic dekl. 1000
Németo.	14	19-21
Lengyelo.	13	18-20
Cseho.	13	18-20
Magyarország (csonka)	10-12	17-19
Közép-Románia	9-11	15-17
Bulgária	8-10	13-15

Figure 7.Europe decnlination value isogons i R.H. van Gent (2001) Ut recht University

Figure 8. Archaeo-magnetic data between BC 500-AD 1000 Romania (AARC Ca-lin-libre, 1997) Hungary (Marton 2010), Germany (P.Carrasco 2011).

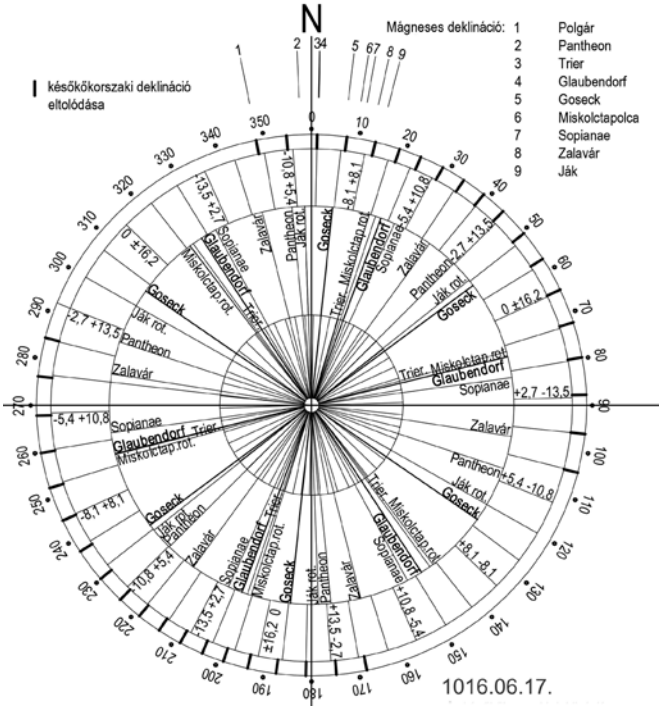


Figure 9. Central-European magnetic transmission diagram with orientation examples (Koszeghy, 2013).

The oldest round churches have mostly survived in ruins and are to be found next to significant sacred buildings. It is improbable that these round churches were built at the same time as those other buildings. Both in the case of palaces and Catholic church buildings, the practical recycling of these rotundas might have occurred when they were given a new role as non-dangerous housing for a cult or another such usage probably abandoned earlier. In the light of all this, we can assume that the time of construction was earlier than 830-860. In the case of the cultic, longnaved buildings of Zalavár, we can also time lane of 810-850. The old indicator that the rotunda of Veszprém dates

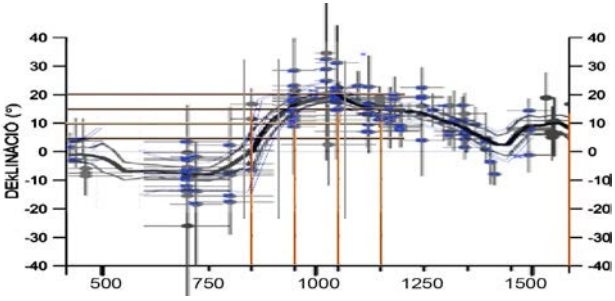


Figure 10. Hungary, archeomagnetic declination curve between AD 500-1750 .(Márton, 2010)

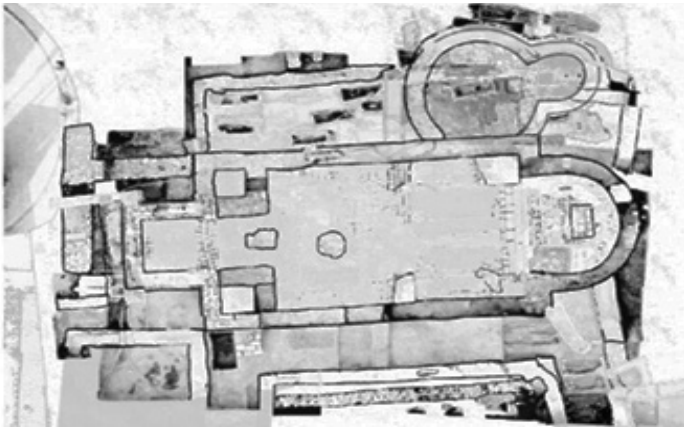


Figure 11. Miskolctapolca, The relationship of the Benedictine church and the rotunda, (Drawing: Pusztai, 2013.)

from the age of István I – which would qualify as extremely old elsewhere – might not refer to a building barely 50 years old but rather to a building of 150-160 years old.

The graphs representing the nature of all European declinational changes – in the European region the declination isogons of 900AD and 1000AD – provide information on how in the years around 900 in the region of Alba Iulia a declination of + 7° / +8° was typical, at the Black Sea +3° / +4° is the synchronic declination and earlier

around +850 the declination value not referring to the extent of uncertainties is 0°.

Gyulafehérvár/Alba Iulia is located halfway between Budapest and the Black Sea. Since the Romanian data were primarily based on the Eastern region, the European declinational "slope" between 900 and 1200 considered from Budapest also tried to formulate data by limiting the Romanian data to the Central region of Transylvania. In analyzing the Hungarian rotundas we modified the given data for the region of the capital with a declination value of 0,3 and 0,7 degrees when considering the European declination value slope (decreasing towards the East).

There is a subtle refinement to be made in the changing declination value in the Márton data : a correction of that part of the country: from Budapest to West and East: +0,3° until 80-130 km, + 0,7° beyond 130 km, to the East: -0,3° until 80-130km, - 0,6° beyond 130 km at the same time, until Alba I: -2 °. Aarcheomagnetic data from Romania near the Back Sea at Alba I. +1° declination value increase in the case of newly measured data. At the Polish Przemsl rotunda: +0.7°.

We need to realize that the building of the oldest round churches might have happened in the era called, Late Avar Period. The more extended research of the still standing rotunda of Algyógy and its surroundings might provide points of reference concerning the connections between rotundas and Avar Christian liturgy characteristic in this early time lane. Not forgetting that in the case of such approaches there are strong arguments for the cessation of construction of the earliest rotundas at about 860.

Similar suggestions – even though without Avar references – might be derived from articulated during the research intoof the oldest Polish rotundas.

The direction of the longitudinal wall of the currently visible cathedral is 104,2 degrees from Geographic North (with a geomagnetic declination of 5,18° added to the measured data of Google from May 2016). Only the 13th-cen-

tury apse-renovation part is slightly smaller, with a 103,2° value characteristic. According to the Hungarian transmission diagram its declination value belonging to the axial direction set at the time of Saint László is 14,5°.

Based on the archeomagnetic graph data of Márton, +18,4° can be emphasized from the data interval between +15° and +22° around 1050.

The +20,7° degree value of magnetic declination in the region of Alba Iulia is only typical between 1080-1100 based on the Romanian archaeomagnetic data, in the best case at the time of Saint László. Then, the declination value at the time of King István might have been significantly smaller but even smaller at the time of the rotunda's and the Gyula church's construction. In the European region declinational values decreasing from the West to the East were characteristic between 850-1000.

The transmission diagram gives such values independent of the changes in declination value occurring in the Central-European region. The declination values of archeomagnetic graphs, however, need to sensitively follow the declination values changing in the European region. Currently we could only consider changes in Hungarian assumed that in the relationship of orientation and declination value and in connection with both positive and negative declination values until the millennium of the Later Stone Age only a declination value change within one degree had occurred, which could be primarily attributed to the movement of Magnetic North and South poles

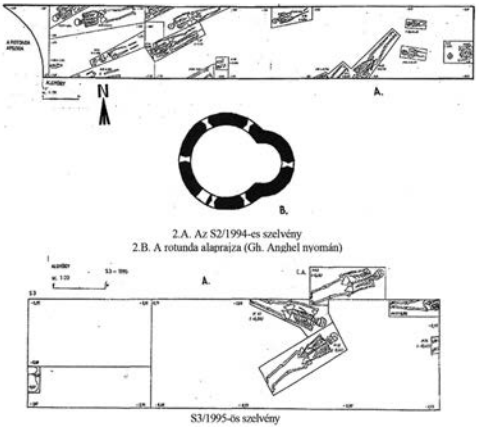
When plotting out the transmission diagram, we have assumed that in the relationship of orientation and declination value and in connection with both positive and negative declination values until the millennium of the Later Stone Age only a declination value change within one degree had occurred, which could be primarily attributed to the movement of Magnetic North and South poles.

Despite this permanence in the transmission diagram's data, such data could not be decisive in approximating

I.Table: Gyulafehérvár/Alba Iulia, rotunda and other rotundas

Location of construction	Difference from middle-hungarian declination	Google Maps asimuth East	GoogleMaps asimuth W.	estimated construction time	Middle-hungarian declination°from-to values	Declination° near the Black Sea	Declination transmission chart west	Declination transmission chart east	Declination after duplication filtering
Ják, rotunda	0,7	+51°		820 -840	(-8) **-1,5** (+16)		-6,3 + 9,9	**-1,8** +14,4	**-2,0°**
Przemsl rot.	0,7	+60,2°		820 -840	(-8) **-1,5** (+16)		-8,7 +7,5	**- 0,6** +15,6	**-0,7**
Ducové rot.	0	+66.5°		820 -840	(-18)-8 **0** (+16)		-8,3 +8,2	**-0,4** 15,8	**- 0,2°**
Miskolctap. r.	- 0,6	+77,5		840 -870	(-18) 0**+2** (+15)		-6,8 +9,4	**+1,5** -14,7	**+1,5°**
Veszprém r.	0,3	+89,6°		840 -870	(-18) 0**+2,2**(+15)		-5,4 **+10,8**	**+2,7** -13,5	**+2,7°**
Alba Iulia r.	- 1,8	+100°		840- 860	(-18)-8 **+ 3**(+16)		- 4,1 +12,2	**+4,1** -12,5	**+4,0**
Alba I.Gyula t.	- 1,8	+104,2°		850 - 870	(-18) 0 **+5,5** (+15)	-8 **+3** +16	+12,7 -3,5	**+4,3** -11,7	**+4,0°**
Algyógy rot.	- 1,8	+105,4°		850 - 870	(-18) 0**+5,5** (+15)	-8 **+3** +16	+12,8 -3,4	**+4,5** -11,7	**+4,0°**
Ják, rot.	0,7	+51°	(+231°)	860 - 880	(-18) 1 **+6** (+15)		-9,8 + **6,4**	-3,5 +14,3	**+6,5°**
Przemsl rot.	0,7	+60,2°	(+240,2)	850 -870	(-18) 0 **+6** (+15)		-8,7 **+7,5**	- 0,6 +15,6	**+7°**
Ducové rot.	0	+66.5°	(+246,5°)	870 -880	(+8) **+7** (+22)		-8,0 **+8,2**	-0,4 +15,8	**+8°**
Öskü rot.	0,3	+73,9°	(+253,9°)	870- 890	(-8) **+ 9** +(22)		-6,7 **+9,5**	+1,2 -15	**+9.5°**
Szalonna rot.	0	+89,3°	(+269,3°)	890 -900	(+8) **+11** (+22)		-5,4 **+10,8**	+2,7 -13,5	**+11,0°**
Veszprém r.	0,3	+89,6°	(+269,6°)	890- 900	(+8) **+11** (+22)		-5,4 **+10,8**	+2,7 -13,5	**+11,0°**
Alba Iulia rot.	- 1,8	+100°	(+280°)	910 - 920	+9 **+13**+16(+22)	+6 +24	-4 **+12,2**	+4,2 -12	**+12,0°**
Algyógy rot	- 1,8	+105,4°	(+285,4°)	910-920	+9 **+14** +16(+22)	+6 +24	-3,4 **+12,8**	+4,5-11,7	**+12,5°**
Alba I.Gyula	- 1,8	+104,4°	(+284°)	920 - 940	+9 **+13** +16(+22)	+6 +24	-3,4 **+12,8**	+4,4 -11,6	**+12,0°**
Ják, rot.	0,7	+51°		910 -920	+9 **+13** +16(+22)		-9,8 + 6,4	-1,5 **+14,7**	**+14,5°**

Between 800 and 1100 declination decreased to East, grown to Westward at the same time (compared to Central Hungary).



2.A. Az S2/1994-es szelvény
2.B. A rotunda alaprajza (Gh. Anghel nyomán)

S3/1995-ös szelvény

Figure 12. Algyógy, four graves with coins excavated near the apsis at the rotunda (G. Petrov, 1998). The features of the graves with obuluses in front of the apsis of the Algyógy rotunda according to the transmission diagram:

Fugure 13:Algyógy, rotunda Google Maps 2016

buildings' siting times. From the interval data of the archeomagnetic declination data, based on the presumption of several siting times, we had to select the most probable time lane. As becomes visible from our analysis the choice of source of the past orientation impulse significantly influences our decision. Based on the transmission diagram those 50-60-year-long periods are outlined,in which the settings took place die to the Eastern or the Western impulses.

In the central region of Europe, to the East, in the circle of the rotunda buildings declination values connect-

ing to the precise datings of Mosaburg (Zalavár) of about 850 did not provide an obvious point of reference from which to date the rotunda buildings. Connecting the age of the rotundas to the age of the Hungarian Settlement, Christianization and certain castle-building traditions, Christening and burial functions are just as unfounded as ideas referring to orientation based on astrological phenomena. Therefore, we suggest taking a step back in time, and identify the traditions of the Christian trends' ceremonial space that vanished during the forced converting practices in the Eastern-and Southern-European region.

At least the obvious facts need to be properly evaluated: the rotunda of Gyulafehérvár is undoubtedly significantly earlier than the church of St. István. Beside the wall mortar mixed with brick powder, the axis of the building has an obviously geomagnetic direction setting and its directional difference stemming from this might be significant. According to Vera G. Molnár, the basilica and the rotunda were not built at the same time, but the rotunda is about half a century younger. The mortar of the rotunda is mixed with brick powder in a Byzantine fashion, while that of the István church is pure lime mortar. Did the rotundas excavated at the episcopates founded by István in Eger, Veszprém and perhaps even Csanád mean more for the bishoprics than standing walls of side buildings?

The rotunda of Algyógy /Gergesdorf/Geoagiu [38]

The round church of Algyógy is a relic in today's Romania, in Hunyad county. In the inventory of Romanian relics it is recorded as HD-II-m-A-03316.

The axial direction of the Algyógy rotunda from

[38] George Petrov (1993-1995). In: Petrov, 1998 (Preliminary report on the archeological research of the medieval building complex at Algyógy).

St. László 41 graves (110 °)1085	+- 5 buried ° in	decl.:	21,3 °
Kálmán 42 graves (68 °)1110	+- 5 buried ° in	decl.:	16,7 °
Kálmán 40 graves (65 °)1115	+- 5 buried ° in	decl.:	16,4 °

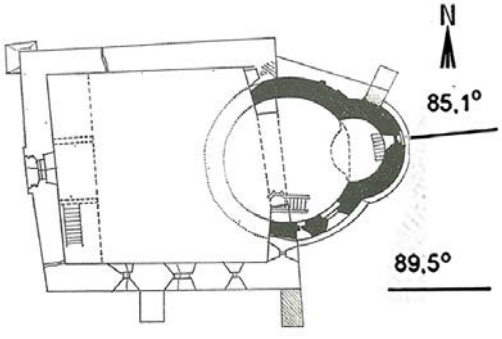


Figure 14: Szalonna, rotunda (drawing: Sarkadi, 2007)

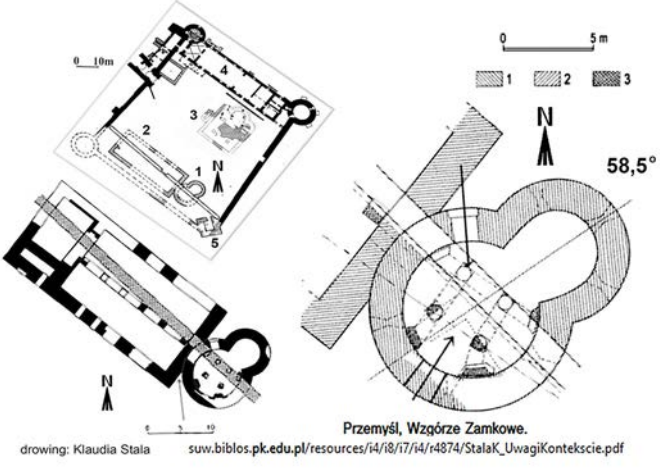


Figure 15: Przemysl rotunda and early romanesque monastery
(Drawing: Klaudia Stala, 2002)
1 - preromańska rotunda z IX wieku, 2 - preromańskie monasterium z IX wieku, 3 - romańska bazylika trzynawowa z X wieku, 4 - Teatr „Fredreum" - pozostałości gotyckiego zamku z XIV wieku, 5 - relikty kwadratowej wieży - rysunek według J.T.Frazik.

Geographic North is 105,4° .

The declination is at a setting of about 1090: 20,7°. However, as an analogue of the rotunda direction under István: at a setting between 910-920 the declination is +12,4°- +12,8° , with a setting of 850-870 the declinationmight be +4,5°. There were partial archeological excavations in 1965 and 1985, and in the case of the graves in 1994-1995. According to their most recent excavator "

The graves were found in various layers based on the coins of (St.) László I and Kálmán, the church might have been built around 1077. The inner diameter of the nave is 5,5 m, the radius of the sanctuary is 1,55m…"

There are no data on repopulation on the previous graves, only on burying around them.

Szalonna, rotunda

Szalonna was the quarters of one of the branches of the Örsúr clan of the Hungarian Settlement. Szalonna features in certificates from the 1200s. The drawing is ten years old, at its creation Magnetic North was 3° 51" from Geographic North. At the time of the siting, it stood 60 from Geographic North.

Przemysl rotunda, 9th century

The rotunda and the building added to it are both dated by the Polish archeologists for the 9th century, but the latter could also be from the early 10th century as its cultic role is uncertain [Figure 15]

The rotunda of Ducó/Ducové

Ducó /Ducové is located above Pozsony, on the way to Nyitra, it is a ruined rotunda surrounded by graves containing coins from St. István and St. László.

At Ducó at the time of the graves' excavation the declination was 3,2° in comparison with North as set by a compass. Here the Google image from 2016 – with a 4,5° declination – shows an axial direction of 62° from Magnetic

North. That is, the axial direction from Geographic North is 66,5°, the declination 0,4° (3° direction difference) with uncertainty: between a *63,5° and 69,5° orientation direction a divergence measured from Geographic North at that time is possible.*

Öskü, rotunda

Its axial direction is 73,9° from Geographic North.[39] (Keszthelyi, 2012). Its archaeomagnetic declination values can be:

In the East +1,2° +17,4 ° and - 15° in the West: -7,5° +8,7°.

Veszprém rotunda

The analysis of the Veszprém rotunda includes points of view for determining the siting times of the earliest rotundas. During the reign of Géza the nave-and-aisles church of Veszprém was already functioning, the Saint Mihály Catholic Church, consecrated by Adalvin, the Archbishop of Salzburg in 866, and its building according to the archeological findings used to stand where the current cathedral. The siting of this church could have taken place between 855-890 at a declination value of +5,7 ° and the validity of the church direction for the reconsecration could have been determined between *+920-950 during the reign of Géza*.

The typical +13,6° declination at the current axial direction might have changed until +18° during the 1001 refounding, but the time of the refoundings could have been connected to finishing the renovations and modifications.

In Veszprém, the St. György rotunda was built before

[39] Keszthelyi Sándor – Keszthelyiné Stragner Márta: "Magyarországi középkori templomok tájolása." [The Orientation of Medieval Hungarian Cruches]. In: Keszthelyi, 2012.

Árpád's Settlement of the Magyars in Hungary, with an axial direction of 89,6° from Geographic North. In the case of such a direction according to the transmission diagram the declination is +2,9° or (on the Western side) the declination could have been +13,5° but a geomagnetic declination of -5,2° is also possible.

In Márton's archaeomagnetic declination graph, observing the typical declination slope of the era, and taking into consideration the location different from Budapest we work with the dating belonging to the +2,5° degree declination – with quite soft boundaries. (The +13,5° degrees were only characteristic of the 10th century.)

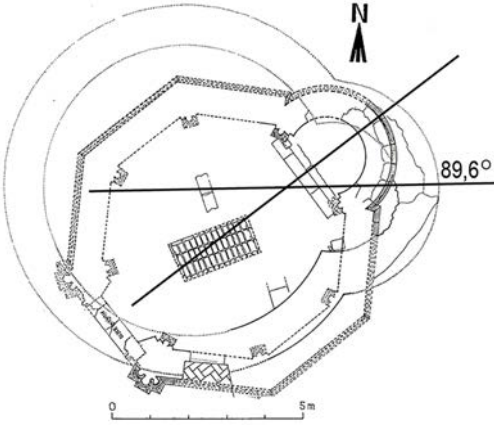


Figure 16: Veszprém, St. George rotunda I. II.
Drawing: Katalin Gyürky,1963.

The siting time plane preceding the siting time of the Saint Mihály church in the case of +2,9° declination in Márton's graph we consider +2,5° declination value, and so the siting time is 820-840-860. In the case of -5,2° declination the potential siting time is 740-760-820.

The the most realistic time for the active period of the

fort at Zalavár would be around 840 when precisely at that time the constructing of long-house churches was typical. There is no sign of a Byzantine influence. Presuming the setting of a non-Catholic Christian Avar-era rotunda, the consecration of the rotunda might have happened at the beginning of the 9th century.

In the case of the building of all early, thick-walled one-apse rotundas, there is a possibility of an 8th century siting. For instance, the rotunda of Gyulafehérvár could have been sited a quarter of a century before Gyula's church. The octagonal building (Veszprém) from the late 15th century could also have been sited without a compass.

The Veszprém cathedral next to it: could have been sited about *985, with an 46,8° axial direction, corresponding to Márton's (2010) archaeomagnetic declination graph.*

Miskolctapolca, rotunda and Benedictine church

The original inner floor level of the rotunda was found a meter beneath the pavement level typical of the 11th century which is the estimated era. Based on the orientation direction, a siting time from the 9th century is postulated, corresponding to the floor level of that era. [Figure 11]

Axial direction: 73,5° from Geographic North. Based on the transmission diagram two declination values indicate the age options: in the case of +1.3° declination: setting 845-855 AD, in the case of +9,4° declination the setting is between 900-910 AD.

We plotted out the field intensity vector horizontal projection components' summary possible at the time of the rotunda's setting.40 Based on the setting direction of the rotunda in the transmission diagram with two directions set to the same declination, the triad of the vector com-

[40] Pusztai Tamás: "A tapolcai bencés apátság építéstörténete" [The architectural history of the Benedictine monastery of Tapolca.]. 2013. In: Pusztai 2013.

ponent projections is determined. The vector direction of these and the distant weak components' vector summary. We have represented the vector summarizing in a figure at the end of this section.

The orientation of Hungarian graves from the 9th and 11th centuries

The relationship of cultic directions with archeomagnetic data

The established grave orientations could provide a comparative framework forresearch into the relationship between the orientation of rotundas and their age, and further specify the Hungarian archaeomagnetic declination data between 1000 AD and 1100AD.

Ebes-Templomdűlő, based on the orientation data of Árpád-era graves, compared to similar graves containing coins from Hajdúszoboszló .

Locality, grave and finding descriptions: M. Nepper Ibolya: "Hajdú-Bihar County 10th-11th century grave findings part I" pp. 43-45 (locality 29) appendix: localities on the county map, Déri M. Régészeti Adattára 256-290. Finding saving excavation 1989 (M.Nepper – Sz. Máthé 1993, pp. 126-128).

Geomagnetic declination for Debrecen in 1989 (the sign "North" established by compass needs to be corrected to Geographic North): 2,8°.

The Árpád-era village has been located North of the church hill and towards the East. 600-800 meters North-East from the church hill on the right bank of the river Kösely a 10th century cemetery and an ancient settlement have been found. Ebus (Ebes) is a personal name known since 1138. First written mention is found in a 1134 papal

tithe record. (Módy 1997-98, 237).

Data of five graves described: from the head: 1: 126,60; 2:126,60; 3:900; 4:132,20; 5: 129,40 one on table (12). The cemetery is a communal cemetery from the end of the 10th century, the middle of the 11th century, its borders have been excavated.

In comparison: Hajdúszoboszló-Árkoshalom pp. 158-159, pp. 165-168. Excavation in 2000-2001 during a preventive excavation before construction of route 4 highway bypass. We have only considered the directions of the graves whose coins date themd for from the 10th to the 11th century.

Geomagnetic declination for the indication of the Magnetic North of drawings from 2000: one needs to calculate with 3,4 ° declination, were oriented to magnetic North

The grave directions of the archaeological excavations at Ebes and Hajdúszoboszló and the magnetic declination determined on the basis of the transmission diagram

Excavation data at Ebes and Hajdúszoboszló.[41] Ebes graves: 1: 126,6°; 2:126,6°; 3:90°; 4:132,2°; 5: 129,4°, Hajdúszoboszló graves with Solomon and Peter coins.

Study of the relationship between 9th century West-Transdanubial grave directions and the time of their siting:

Based on Miklós Szőke's archaeological excavations of grave axis directions at the Garabonc-Ófalu I-II, we have determined siting time lanes by applying a transmission diagram drawn up for the region and a graph created for the time lane of the siting with a structure based on measured archeomagnetic declination values. Also indicated

[41] M. Nepper Ibolya: Hajdú-Bihar megye 10.-11. századi sírleletei I. Ebes-Templomdűlő 6.4. Sír- és leletleírások 44.; Hajdúszoboszló-Árkoshalom 9.5. Sír és leletleírások]Grave findings from Hajdú-Bihar county from the 10th-11th centuries]. Numismatics: Kovács László. Budapest-Debrecen, 2002. All studies should be within quotes and any translations within brackets [ ].

are lanes of uncertainty.[42]

Cultic building Hungerian data (Márton P.) +- dekl.°	Archeol. orientation reducing to Geogr. North, azimuth	Transmiss declination western	Transmiss declination eastern	Potential age AD870-1200 3 decades at the most	Budapest archeo-magn. declination acc to Marton2010 +Marton 2006 betwen 950 and 1100	P.Marton declination data correction in the Ebes region	Based on archeo-magnetic declination and trans-mission diagram
grave -0,6 1	126,6+2,8 =129,4	+15,5	+23,6	1060-1090	1000-1100	15;**19,6**;28; -0,6	**+23 °**
grave -0,6 2	126,6+2,8 =129,4	+15,5	+23,6	1060-1090	1000-1100	15;**19,6**;28; -0,6	**+23 °**
grave -0,6 3	90+2,8 =92,8	+11,3	+19,4	980-1020	950 -1050	9;**18**;28 -0,6	**+19 °**
grave -0,6 4	132,2+2,8 =135,0	+16,2	+24,3	1020-1090	1000-1100	15;**19,6**;28; -0,6	**+24 °**
grave -0,6 5	129,4+2,8 =132,2	+15,8	+24	1000-1090	1000-1100	15;**19,6**;28; -0,6	**+24 °**
HSz 47. grave -0,6 Péter dénár	133+3,4	+16,5	+24,5	1040-1070	1000-1100	15;**19,6**;28; -0,6	**+24 °**
Hsz. 73. grave -0,6 Salamon dénár	102+3,4	+12,6	+20,7	1065-1090	1000-1100	9;**18**;28 -0,6	**+20 °**
HSz.109. -0,6 VII. Konszt.II. Romanosz 945-959	66+3,4	+8,6	+15,6	950-990	900-1000	9;**17**;28 -0,6	**+16,0 °**
HSz. 247. grave -0,6 Salamon dánár	120+3,4	+14,7	+22,9	1065-1090	1000-1100	9;**18**;28 -0,6	**+22 °**

Table II/1

[42] Szőke Miklós: "Karoling kori szolgáló népi temetkezések Mosaburg/Zalavár vonzáskörzetében" [Carolin-era servant burials near Mosaburg/Zalavár. Garabonc-Ófalu I-II. Zalai Múzeum 5. 1994: 290-295.

Table II/2

Geographical North	of Graves	Decl. degree	Decl. degree	Decl. degree +0,6°
83	1	2,2; ny-5,9	830-**840**-850	835-**845**-855
84	2	2,32; ny -5,78		
86	2	2,45; ny-5,65	830-**840**-850	835-**850**-860
87	2	2,57; ny-5,53		
88	3	2,7; ny-5,4	830-**845**-855	845-**860**-870
89	17	2,8; ny -5,3		
90	14	2,9; ny -5,2	835-**850**-860	855-**865**-885
91	34	3,0; ny: -5,1		
92	18	3,15; ny -4,95	845-**860**-870	860-**870**-890
93	22	3,22; ny -4,88		
94	6	3,3; ny - 4,8	850-**865**-880	865-**875**-895
96	1	3,55; ny -4,55	855-**870**-890	875-**885**-900

The axial directions of the graves are indicated together with modifying directions to Geographic North determined at the time of the 1981-84 excavations.

The axial directions of the graves from 840-890 AD, according to the relevant transmission diagram can be characterized by the magnetic declination synchronic with the setting. Márton's (2010) dating set to the Hungarian archeomagnetic declination graph taking into consideration the declinational slope within the country at that time. The dating data is indicated on the thick line of Márton's archeomagnetic graph in bold, the zones of uncertainty are indicated by dating data in normal font.

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APENDIX II

TRIADS REDUCED TO TWO MAIN AXES BETWEEN THE LATER STONE AGE AND THE MIDDLE AGES

Idols with a reclining facial plane appeared in the Cycladic culture around 2600 BC, and also appeared more than a thousand years earlier along the Tisza, in the area of Szegvár-Tűzköves.

According to our hypothesis, in the reclining plane of the face and by the direction of the protruding edge of the nose, by today's standards the ritual performers understood geomagnetic impulses. They considered this phenomenon a mysterious creative force, although they did not know about its geomagnetic nature. The direction of the nose protruding in the middle of the face signifies a direction that is almost perpendicular to the East-West component direction. This direction in the case of Etruscan-Roman Age sitings would later be the direction of cardo roads.

In discussing geomagnetic orientation we assume that one single, invisible, phenomenon provided a basis for the appointment of cultic siting directions, and that this phenomenon also functioned as a sacred trinity, which could be perceived by the human nervous system in three directions (also called a triad). Cults from Antiquity gave the names triskell, trinascia, trifus and then during Christianity, trinitas to these figures branching out in three directions, which from a top view are almost 120 degrees apart? from each other, when seen sideways they are positioned obliquely as an invisible, "elementary trinity".

We assume that in the background of cultic orientations to the two major directions we also find these cultic, or, in other words, sacred trinities. The geometrical elements from the sixth millennium BC signify a strengthening of the modelling view but the *models with two major axes* appeared only in the Late Neolithic era.

Not breaking away from the primary direction sensing experiences, they created a new biaxial construction answering the need to have the simplest, orthogonal arrangements' cultic foundation, based on the directly mapped out triad arrangement with the unification of two triad branches.[43]

The headless figure considered to be the invisible creator can be seen with a sickle-shaped device that helped in sensing the phenomenon, which we today recognize as a magnet and on its shoulder we observe the direction-sensing axe-like tool for cultic direction siting in Figure 2 (Szentes, Koszta Museum). Their estimated time of creation is the 5th millennium BC. The cultic figures are also characteristic of an almost natural representation from 7000-10000 BC in the region of Catal Hüyük. There are no signs as yet of the ritual practices founding with a sensing procedure of the invisible creator and the geometrical forms referring to this phenomenon. Currently the idols of Szegvár-Tűzköves are the earliest representations of these cultic devices and the geometric signs of a barely observable invisible phenomenon that appear on the idols' faces.

[43] The more than ten thousand year-old drawings, carvings emphasising the character traits of animal and human figures after the last Ice Age in the course of turnings and marching during audio-visual rituals arranged onto the triad experiences of invisible phenomena the forms serving as spatial boundaries while creating artificial living spaces. Beside the three-directional signs appearing as rondels the column-shape of dwelling places and graves only emphasise one triad-direction. The practicality of this construction affected in turn the formation of cultic spaces. The observation of geometrical traits, not limited to concrete building activities, also influenced the spatial modelling of the experiences of ritual practices. The triad-directions observed in the building of cultic spaces might have given a place for the new triads known today as god-triad in already biaxial spaces.

Late Neolithic events

Figure 1. Cyclaic idols. National Archeologic Museum, Naxos

Neolithic Lengyeli I-II eras we have emphasized the ones which aid in reconstructing the entrance directions that once "sublimated" into final. Instead of a static picture retaining the final condition, we modelled a functioning building sited to changing directions with multiple relocated direction signifiers. It is easily imaginable that the rondel buildings assumed today might not have ever existed.

By focussing on the same central lines or edges of earth bridges or entrance lanes measurable today we can also consistently interpret the entrance directions of similar buildings.

This procedure becomes impossible when, for instance, seemingly innocent modifications in direction take place to increase tourist attraction value.

We have already given special attention to Stone Age rondels with three main axes and 3 or 6 that are tuned to the phenomenon of the geomagnetic field in the most subtle way in discussing the rondels of Goseck and Glaubendorf. However, in the case of rondels that are mainly biaxial, and, moreover, have axes that are almost perpendicular to one another, and also in the case of the orientation of Etruscan and then Roman urban main roads

along with a multitude of military structures that are visibly set to two main axes, we argue that in the background of these biaxial orientations we find the same dominant magnetic field intensity vector trinity, and that the triads observed for thousands of years received a crucial role. It is not an accident that at the siting of cities with two main axes and cultic buildings with one main axis the same Etruscan rituals and performers were present.

Wands and cultic statues used during the rituals tell us about similar features of Stone Age rituals.

However, they are silent about one phenomenon: *what kind of perceptions caused our ancestors, who were capable of sensing magnetic impulses in three axial directions (even though they did not recognize them as magnets), to emphasize not one of the triad branches closer to the northern direction in the northern hemisphere but the one between the two, an almost bisecting direction? One answer could be that* only in this way could earth-work structures be formed with entrances sited to a single nearly perpendicular axial pair despite sensing of three component directions which is how urban structures sited to nearly perpendicular directions could be built.

Synchronic with the phenomenon sensed in a nearly East-West direction, the triad was also present in two further directions. The latter also formed the "basis" for building the geomagnetic declination, but summarized into one direction, halfway between the other two (directions). We do not know today the exact procedure for determining this halfway direction. In a well-structured relational formula that essentially extends to half of Europe, the East-West direction (readable from the transmission diagram) declination value can be referred to the hidden, single direction, the phenomena pair appearing in the bisecting direction.

On the transmission diagram the two directions can be located here the declination noted value with a direction close to East-West is typical. The cardo axial direction has

to appear halfway between the two.[44]

It is obvious from the above that based only on the observation of the nearly East-West decumanus axial direction the direction of the cardo axis can be constructed. Based on the siting of hundreds of rondels with their entrance direction reduced to a biaxial form, a set of cardo directions can be derived which are nearly perpendicular to the East-West direction, where one can see together the divergence from the East-West direction and the nature as well as approximate extent of the divergence from Geographic North. The process of the cultic siting based on primary observation and not on conclusions is the determination of the direction near East-West. So, where only one axis appears at the rondels, we can see cultic buildings that function even without the elaboration of the nearly Northern direction. Especially when the axes of the graves nearby are nearly synchronic with the entrances of the rondels almost coincides with the direction offered by this two-entrance arrangement.

A subject for thorough future research could be whether beside the surviving gate directions what earlier entrance traces might be found with significantly different direction indicators. Because of the magnetic field intensity component's uneven change accompanying the ever changing of Magnetic North, the summarizing of the components close to North led to the possible formation of a cardo-decumanus road pair different from the orthogonal directions.

In such a case the stronger of the two magnetic field intensity vectors close to North can be the pointer of the cardo axial direction or – as in the case of Goseck – all three axial directions appear. *Moreover, the different number of furrows and entrances cannot be accounted for this way.*

The table I. determines the cardo direction near the

[44] Source of basic data: Pásztor-Barna-Roslund, 2008. Table 1. And Plath 2011 Phd dissertation Tables 2-4, Kőszeghy transmission diagram 2016.

In such a case the stronger of the two magnetic field intensity vectors close to North can be the pointer of the cardo axial direction or – as in the case of Goseck – all three axial directions appear.

A quarter of a century ago, beside the uncertainties of the functional determination of rondel systems, Gerhard Trnka called researchers' attention to the fact that the "paleo-astronomical considerations" concerning entrance orientations "*are barely useful, since coincidences with the directions of heavenly bodies can also be totally accidental.*

The role of the triads in the biaxial orientation background, on the basis of the rondel data of the Lengyeli culture

Table I.

rondels with two main axes	near N °	near E °	to the East °	to the West	from SW to NE	North branch	from north to links °	from north to rechts °
Würnitz-Hornsburg	~~353~~	~~86~~	~~+2,7 -13,8~~	~~-5,8 +10,4~~	28	332	~~21~~	~~35~~
	353+3,2	**81+3,2** ext.	+2,1 -14,1	-6,1 +10,1	24	330	**26,2**	**27,8**
	355+3,2	***82,5+3,2*** int.	+2,3 -13,9	-5,9 +10,3	26	333	25,2	27,8
Friebritz	~~10~~	~~91~~	~~+4,0 – 12,2~~	~~-4,3 +11,9~~	~~37,5~~	~~345~~	~~25,6~~	~~21,9~~
	10+2,6	***95,5+2,6***	+4,0 -12,2	-4,2 +12,0	36,7	346,5	**24,1**	**26,1**
Immendorf	~~14~~	~~101~~	+4,05 -12,15	-4,15 +12,05	36	346,5	~~22~~	~~27,5~~
	~~***15,3+2,6***~~	~~***101,5+2,6***~~	~~+4,4 -11,8~~	~~-3,8 +12.4~~	39	348,5	~~20,9~~	~~29,1~~
o	*Plath 2011*	/O:+13,5 W:+9mean/						
	13+2,6 early: *13*	***103,5+2,6*** O:+13,5	+4,65 -11,55	-3,75 +12,45	40,4	349	**24,8**	**26,6**
Gnadendorf	~~c10~~	~~105~~	+4,2 -12	-4 +12,2	38	347,5	~~22,5~~	~~26,5~~
	15+2,6	**105+2,6**	+4,8 -11,4	-3,4 +12,8	42	352	**25,6**	**24,4**
	Mért, KA.							
Kleinrötz	**25+2,6**	**115+2,6**	+6,2 -10	-2,0 +14,2	***52***	-1	**24,4**	**26,6**
	27+2,6	**118+2,6**	+6,6 -9,6	-1,6 +14,6	***55***	+3	**27,6**	**26,6**
Rasovice	~~350+2,6~~	~~70+2,6~~	+1,0 -15,2	-7,2 +9,0	18	324	~~30,6~~	~~25,4~~
	~~343,5+2,6~~	~~72,5+2,6~~	+1,35 -14,85	-6,75 +9,45	19	325	~~21,1~~	~~34,5~~
	349+2,6	**70+2,6**	+1,0 -15, 2	-7,2 +9,0	18	324	**27,6**	**25,9**
Vedrovice	**354+2,6**	**80+2,6**	+2,1 -14,1	-6 +10,2	24,5	328,6	**28,0**	**27,5**
	356+2,6	**87+2,6**	+2,7 -13,5	-5,4 +10,8	28	334	**24,6**	**28,8**
Tesetice-Kyjovice	**355+2,6**	**82+2,6**	+2,3 -13,9	-5,8 +10,4	26	331	**26,6**	**28,4**
	350+2,6	**80+2,6**	+2,1 -14,1	-6,1 +10,1	24,5	328	~~24,6~~	~~32~~
Bucany	**20+1,5**	**115+1,5**	+5,9 -10,3	-2,2 +14	47,5	356	**25,5**	**26**
	22+1,5	**116+1,5**	+6,0 -10,2	-2,1 +13,9	48,5	357	**26,5**	**25**
Bylany	**350+1,5**	~~**80+1,5**~~	+1,95 -14,25	-14,3 +1,9	22	326	~~25,5~~	~~30,5~~
		76+1,5	+1,5 -14,7	-14,7 +1,5	19,5	326,5	**25**	**28**
Goseck (1993)	**6,0+1,6**	**125+1,6**	+6,9 -9,3	-1,2 +15	55	**6,5**	~~61,5~~	~~48,5~~
Polgár 1-2	**34,5**	**128**	+7,5 **ie5000**		60	9	25,5	25,5
	18,5	**110**	+5,2 **ie4900**		43	354	24,5	24,5
Polgár 3-4	**27**	**120**	+6,3 **ie4800**		52	2	25	25
	16	**106**	+4,6 **ie4700**		41	351	25	25

bisecting direction (for legibility's sake arranged on two sides). *Cardo directions are the siting directions appearing as the bisectors of two magnetic field intensity components near North-South*. (The source of the basic data: Pásztor-Barna-Roslund 2008 Table 1.; Plath 2011 Phd dissertation Table 2-4 and Kőszeghy 2016 transmission diagram).

The changing of directions initiating the orientation directions, but still unrecognised as magnets, has been known since the Stone Age. between the two.[45]Similarly to changes in axial direction in the case of church renovations, the direction indicators of Later Stone Age rondels might have also followed the changes of directions, but presumably the same happened during the building of Bronze Age ones as well. With this approach, the rondels are not the products of a particular major building project, but the results of gradual relocations of wooden columns signifying directions.

Figure 2. Sickle and Axe God, Tisza culture, Szegvár-Tűzköves archeologic excavation, Cycladic head-shape, which a thousand years later appears in the Mediterranean. [Photo: Kőszeghy A. 2016[

[45] Sources: Würnitz Figure: FWF Project ASTROSIM, P 21208-G19 DE a strosim.7host. at; Fribritz-Dél summary with the years of the excavations: Bundesamt Abteilung für Baudenkmale.

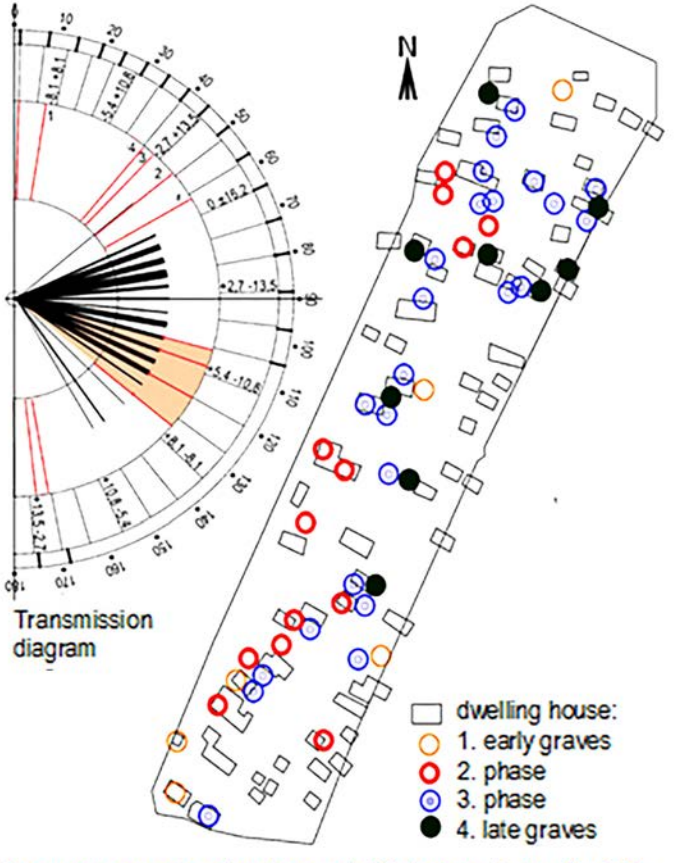
See, for example, the strikingly point-like changing depth of the innermost circle-shape of Polgár-Csőszárok. The axial directions of buildings erected in the middle of the rondels correspond to the directions of the buildings and graves of the horizontal settlement that was gradually formed nearby. According to the transmission diagram, there is also a correspondence between the declinational features connected to the directions and the direction change of building-burying projects taking place almost every hundred years.

The rondel of Polgár-Csőszhalom and the graves, houses of the horizontal settlement nearby do not only represent a case study of the orientation to magnetic field intensity components fitting the Geomagnetic North direction, but also the possibility of entrance direction changes indicating the changing of orientation and also the fluctuation of the related magnetic declination values fitting the order of orientation changes.

The geomagnetic declination values referred to the axis near East-West according to the transmission diagram when referred to the two further triad branches as well, also define the directions of those. The bisector of these two directions is very close to the entrance directions of the rondels that are close to North-South. The same is typical in the case of various other rondels.

The arrangement of the entrances in one direction refers to a perennial entrance direction, and the arrangements of the bones referring to cultic sacrifices as well as the changes in the depth of the furrow, however, suggest the possibility of several entrances.

If the rondel ceased to function in the centuries 4700-4600 BC, then the remaining entrance direction refers to the Magnetic North direction of a characteristic magnetic declination value typical in this era.



The eastern gate directions of 64 known Late Neolithic rondels connected to Lengyel culture (black, the thickness of the line indicates proportions of quantity),
In red: the grave directions of Polgár-Csőszhalom's horizontal settlement

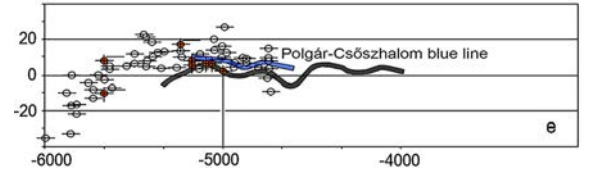


Figure 3: Polgár-Csőszhalom houses and tombs [Raczky et al. 2014] Márton Hungary declinations BC5200-4600, with transmission cyrcle dating

APPENDIX III

THE GEOMAGNETIC ORIENTATION OF LATE-ROMAN FORTRESSES IN THE CARPATHIAN BASIN

To see the significance of cultic orientations based on essentially identical rituals through the millennia it is helpful to realize that the field of their application beyond narrowly defined sacred buildings also extended not only to dwelling houses and the directions of graves, but also to military and economic structures that attributed major significance to rationality. We have demonstrated that the direction of an invisible phenomenon that had not been recognized as a magnet that can be described as having a triadic direction perceivable by our bodies and which can be observed in the case of several Stone Age rondels. In the case of later sacred buildings and graves, based on the knowledge of one of the three directions the other two can be reconstructed, moreover, knowing these directions the network of further effects can also be deduced. On such a basis the vector sum of magnetic field intensity components leads us to the measurable field intensity vecor direction of the magnetic field.

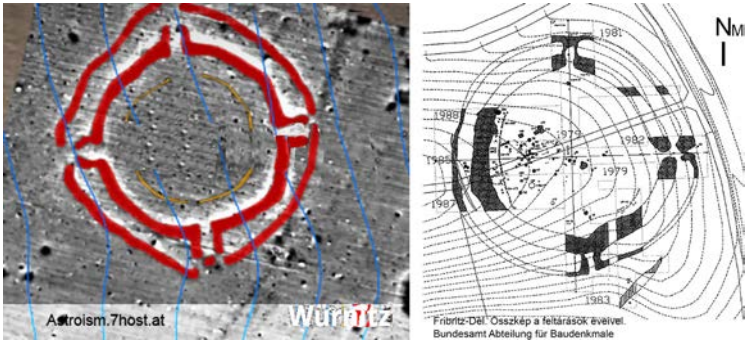


Figure 4. Würnitz (left) and Fibrits (right) rondel characteristics.

After observing the orientation practices of thousands of years we conclude that in the majority of Late Stone Age Central European rondels not three but only two dominant siting directions are visible. Figure 14. Szalonna, rotunda (drawing: Sarkadi, 2007)

It is also characteristic of Roman cities and military fortresses that they were built had been arranged along two main directions, on the cardo and decumanus main roads. The seemingly universal siting practice –observing three magnetic components characteristically with the angle of the given magnetic declination and building up the Magnetic North component –in the case of these buildings does not appear valid.

We have assumed that the bisecting direction between the two geomagnetic components near Geographic North somewhat represented the two branches of the geomagnetic triad. We have further interpreted the road direction approximately East-West -- the direction of the Roman decumanus road -- as the axial direction of the third triad branch and based on our transmission diagram we supplied it with definite declination values. In the transmission diagram the bisector of the two axial directions that remain hidden should coincide with the direction obtained by the examination of the buildings. One only needs to pay attention to the past siting times of the roads and convert theMagnetic North of our current measurements to Geographical North.

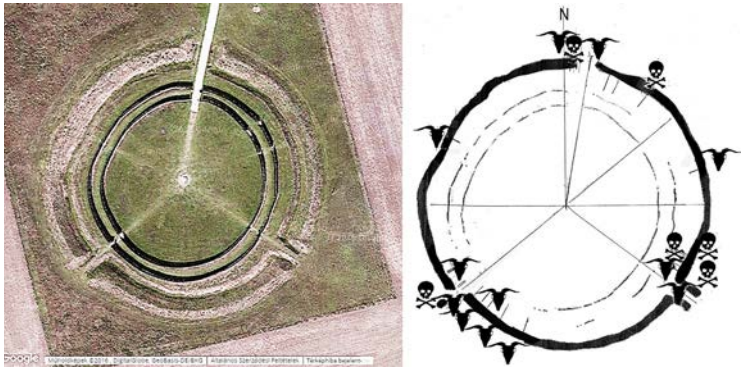


Figure 5. Goseck as a hypothetical Solar Observatory, tourist attraction, Goseck rondel BC 4900-4700 [Google maps 2106,drawing: Kőszeghy E. 2014]

Figure 6. Goseck Rondel: perhaps it never has been, but tourism could benefit from the show.

Four Late-Roman fortresses

Table II

The application of magnetic declination values corresponding to geomagnetic field intensity components perceived in a direction near East-West to two other components

Table II. Biaxial orientation with triads in the background

Place of fortress	Cardo direction with regard to Geogr. North°	Azimuth to the East°	North-East declination°	South-West declination°	Triad from the South to the North°	South-West triad branch, asimuth°
Fenékpuszta/Valcum Castellum	352,5	84,5	2,5	5,7	26,5	333
Tokod-Dargellaca	312	43	-2,9	5,2	287	346
Környe/Vincentia*	**331** (358 a felező)	**82** /78/68	**2,1** /2,5/0,4	**-6,1**/-4,7/-6,8	**22**/30/15	**328**/332/316
Alsóhetény/Iovia	2	92	3.1	-5.1	30	337

From the multitude of Roman military buildings we have selected a few well-documented buildings to demonstrate this discovery. The Roman fortresses -- buildings built in in the 4th century, the last century of Pannonia -- the station places of *cohors trubunuses* became known from the middle of the previous century based on the archeological findings at Környe-Vincentia, Ságvár-Quadriburgium, Alsóhetény-Iovia and Fenékpuszta-Valcum.[46] Among the building antecedents from centuries earlier, the cardo and decumanus roads of the military camps and the siting times of the early basilica buildings erected there have received little attention. We attempt to demonstrate that beside a minimal amount of building activity in the first century the siting of main roads had already taken place and that these directions might have served a crucial function when siting the axial directions of the walls of not-yet-Christian basilicas.

Bibliography of Appendices II and III

[46] Tóth 2010Tóth Endre: Pannonia régészete. 1 September 2010.

Figure 7. Keszthely-Fenékpuszta fortress [Tamáska et al. 2012]
14: the inner buildins of the fortress, 15: granary, 3:princioal building, A25:main building of the fortress, 23:heating chanel, 22: triumphal arch
https//size.hu/file/13e/archivun/KenezArpad.ertekezes.pdf

Figure 8. Keszthely-Fenékpuszta fortress [Google.com]

Figure 9. Dargellaca satellite images [google maps 2016]

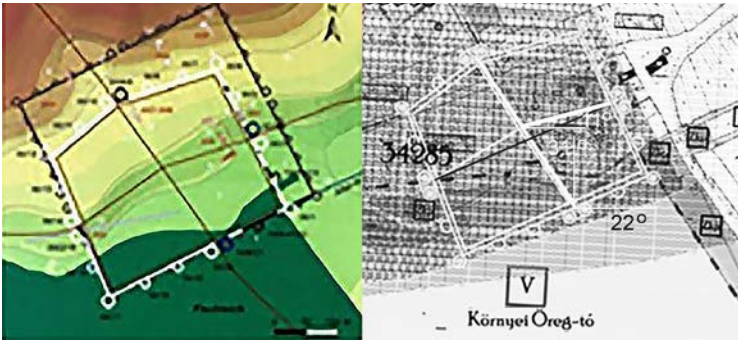


Figure 10. Környe/Vincentia fortress

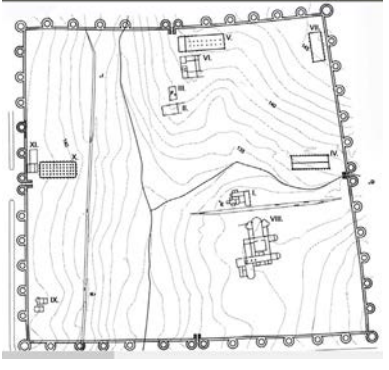


Figure 11.Alsóhetény – Iovia fortress. [Citing: Tóth, 2010]

Similarly to the procedure applied with the orientation of Lengyeli Late-Neolithic and Early Bronze Age rondels, in the case of the orientation features of Roman fortresses, we have based our analysis on the magnetic declination interconnections articulated in the geomagnetic transmission diagram worked out for the Central-European region as well as Péter Márton's archeo-magnetic declinational data based on Budapest but extended to include a region with a 350-400 km radius, but also consideration "declinational slopes"

.

The orientation of cardo roads of the Roman fortress Keszthely-Fenékpuszta - Valcum Castellum The region of Fenékpuszta was conquered by the Romans in 15 BC. Its thick fortress walls were built in the 4th century and, based on the citing of the major road axes already outlined in the first half of that century. The cardo road is oriented from the direction of Geographic North towards the West with a divergence of about 7,5 °. The decumanus road diverges with 92° from this cardo direction, and with 84,5° from Geographic North. The axial direction of the basilica diverges with 86 ° from Geographic North. The direction of the decumanus road is of primary importance being also the direction between the entrances). At an 87,5° azimuth the declination in the East according to the transmission diagram +2,5°, on the Western side – 13,7° According to the D +2,50 that can be projected upwards from Southwest to Northeast +206° azimuth, and thus in the North-East the azimuth is +26° which is the direction of the top right triad branch. In the North-West the triad's left-side branch can be observed in +332° azimuth direction. According to Márton's Hungarian archeo-magnetic declination graph the declination value zones from the first to the fourth centuries AD only the +2,5° the declination observable or, on the very same axis, -5,6° might be decisive when it comes to the triad's direction.

At +2,5 ° (according to Márton 2010 from +50 to 100AD) and on the opposite side: at -5,6 ° (in Márton 2010 almost the entirety of the third century) the siting time lane of the cardo road. The cardo direction located at geographical North is the direction that bisects the two triad branches (here with a 1,5° divergence from the bisecting direction, because of the effect of weak components).

The axis of the basilica stands 86 degrees East from Geographic North. The Eastern declination is +2,6° (Márton: 60-90AD) and the Western declination is -5,5° (Márton 100-200 AD). The earliest siting time of the basilica's axis is between 70 AD and 100 AD.

It still needs to be clarified whether – by differing from our assumptions– two triad branch field intensity component vectors in closr proximity to one another can, along with a few, slightly more distant component vectors (but without perceiving more distant, weak components) cause a slight resemblance of the functioning of a compass.

This effect in the direction of the vector summary strongly perceivable both by human and animal bodies? In the lack of such a summary it is realistic to assume

that halfway between two powerful effects, a slightly weaker effect -- an effect generated at a lightly more distant cross-section -- receives a quasi-decisive, "judging" role, and the place of the triad next to the circle is taken over by the Northern triad in the biaxial arrangement, instead of the undistinguishable triad branch image in the previous millennia The triad images being differentiated in the zone close to the North. It is worthwhile comparing the information above with the orientations of a few Roman camps' cardo and decumanus roads.

The positions of two fortresses– Tokod and Környe – compared to geographical North is possible to determine in a relatively precise way.

P. The positions of two fortresses– Tokod and Környe – compared to geographical North is possible to determine a relatively precise way.

Tokod - Dargellaca fortress

The cardo direction is 312°, the axial direction of the decumanus roadis 43° East from Geographic North. For this axial direction according to the transmission diagram the realistic declinational values are -2,9° and +5,3° declinations. The -2,9° declination as typical of the appointment of the direction of the bisector at Tokod.The potential time of the siting is between 100 and 250AD.

Környe - Vincentia fortress

A dominant element of this only partly researched early fortress based on the excavated entrance traces is the outline of the cardo road and the Eastern side of the decumanus road. The decumanus road's direction diverging from North by 82° to the East according to the transmission diagram indicates +2,1° declination, in the direction projected from the southern side to the North and from North to the East 24° is the direction of the triad. In the Northwestern direction from North to West 31° corresponds to a +2,1° declination. The angle between the two directions near North is 55°. Had we chosen the direction of the bisector as a cardo direction, then this direction would be around 332,5°. The cardo road leading to the Northern entrance – an entrance still waiting to be excavated -- actually indicates precisely this direction. Thus, in the case of this fortress the cardo direction was not sited in the bisector between the two near-northern triad branches, but instead the near North triad branch.

Alsóhetény - Iovia fortress

The archaeologist Endre Tóth has provided a picture of the series of fortresses within the Roman limes in con-

nection with the fortress of Iovia, especially about the fortress of Alsóhetény-Iovia The fortress's layout is arranged to Magnetic North,and if we turn it towards Geographic North, we have assumed -- considering the time lane of excavation -- that during the excavation process around 1995 they used a current map, and thus the diagram of the fortress could be set to North with the declination angle of that time, 3,7° by turning it to Geographic North. The cardo axial direction is thus describable with a 2° azimuth. The Eastern direction is 92° from Geographical North. The declination on the Eastern side is +3,1°, while on the Western side it is -5,0°. Accordingly, the Southern declination is +3,1° and -5° projected to the North: in the case of +3,1°declination it is at +30°, in the case of -5° declination it is at 340 dgrees. In the Northwestern zone at +3,1° declination the direction is 337°, at -5,0° declination it is typically 266°. Incomparison with the +2° cardo orientation direction at a +3.1° declination on the Western side 25°, and in the East 28° distance can be determined. If the cardo direction is 3° then the angle diversion from it on the Western side is 26°, in the East it would be 27°. The hypothesis can be confirmed that here the direction of the bisector of the two triad branches from the North is the cardo direction. The bisector directions are slightly dragged towards the left exactly as can be seen at the vector plots.[47] . The transferring of the magnetic declination values corresponding to the geomagnetic field intensity components perceived in the East-West direction to two other components and determining the bisector direction close to the cardo direction. We call cardo direction the siting direction appear ing as the bisector of the two magnetic field intensity components near the North-South. The declination references of the axial direction near the East characterized as the De-

[47] Kőszeghy 2013.

cumanus direction are indicated by the transmission diagram. It also gives the two other triad directions whose bisector has to be the cardo direction already known in the circle of the fortresses. The sources of the basic data are provided at the descriptions of the fortresses.

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