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The Advent of the Astrolabe in St. Gallen and Notker Teutonicus' Cosmographic Globe (c. 1015)

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Recent findings in Old High German philology have led to the conclusion that a globe mentioned by Notker Teutonicus (c. 950–1022) was not a mere celestial globe, but a combined model of heaven and earth. Based on this conclusion, the first part of this article considers the functionality, purpose and appearance of the lost globe, of which there is only a reference in Notker's text. However, the underlying concept of the globe is described in detail there. Drawing on these considerations, the Abbey Library of St. Gallen initiated a project in 2022 to re-create the early medieval globe with the aid of various experienced artisans. Care was taken to ensure that the reconstruction was carried out using traditional methods, with the resources available a thousand years ago. The individual steps, considerations, learnings, and conclusions from this project will be described in the second part of the article.

Astrolabes, Globes, and a New Drive for Scientific Progress around 1000 CE

The 10th and 11th centuries witnessed a revival in the study and teaching of the ancient scientific subjects that comprised the so-called *quadrivium*. The revival in question has its origins in the Carolingian Renaissance (mid-8th to 9th century).¹ During this period, there emerged a corresponding deepening and specialization of knowledge of the natural sciences and greater communication of the same. To begin with, treatises on individual subjects were written on geometry, arithmetic, music,

¹ Werner Bergmann, *Innovationen im Quadrivium des 10. und 11. Jahrhunderts: Studien zur Einführung von Astrolab und Abakus im lateinischen Mittelalter* (Stuttgart: Steiner, 1985), *jpassim*.

and astronomy, and scholars then progressed onto the study of even more specific matters. Up until that time, the teaching material that comprised the *quadrivium* was limited to the works of a chosen few. Amongst them were Aratos of Soloi (c. 310–245), Boethius (c. 480– c. 525), Isidore of Seville (c. 560–636), Martianus Capella (c. 500), Pliny the Elder (c. 23–79), and the Venerable Bede (c. 672–735). Monastic scholars occupied their time in the transfer of this primarily ancient knowledge. Revival scholars endeavoured to expand their learning and create works of their own. New scientific content was created in the form of commentaries on traditional manuscript contents, but also through the editing or translation of these same works. A prime example of this is Martianus' treatise, *De Nuptiis Philologiae et Mercurii*, which was edited by Remigius of Auxerre (c. 841– c. 908) and commented on and translated by Notker Teutonicus.

Alongside a renewed interest in the writings of the authors of antiquity, the desire to increase knowledge and understanding of natural sciences also manifested itself in a determination to move outside of these established authorities to sources from other traditions or cultures that had, up until the Carolingian Renaissance, been largely neglected, ignored or disregarded. Cosmographic models and instruments such as astrolabes and globes are iconic expressions of this new drive for scientific progress and, to that end, are emblematic of the cross-cultural transfer of knowledge that they represented (**Figure 1**). Based on the original Greek meaning, *cosmography* is the description of the whole world. It deals with the Earth, the heavens and the interrelation between them. In contrast, geography focuses on the Earth. Notker's globe is considered cosmographic because the terrestrial model featured several astronomical attributes, such as the equator, the tropics, the zodiac, an adjustable axis, and a horizon ring. The term "cosmography" was made famous by the identical title of the first Latin translation of Ptolemy's *Geographia* by Jacopo d'Angelo in 1409. (Ptolemy explained his geography via astronomy.) The new title, *Cosmographia*, influenced most of the following copies in the 15th century. However, the term was



Figure 1 Astrolabe (Saragossa, 1079/80) featuring both Arabic and Latin writing. The circles of altitude parallel to the horizon are called *almucantarats*. They relate to a certain latitude. On the astrolabe, these circles are rendered as engravings around the zenith (in the upper half of the disc reproduced above). © Nuremberg, Germanic National Museum, Kat. 155.

also used in the early Middle Ages, e.g. in the 8th century by an author who called himself Aethicus, for his description of Heaven and Earth. Outdated literature assumes Bishop Virgil of Salzburg was behind the pseudonym. But whoever he was, he was not familiar with Ptolemy's *Geographia*. His work did not draw on the corresponding cosmographic concept, nor did Notker's globe. This is important when comparing it with Renaissance globes from the 16th century, which relied

heavily on Ptolemy. Gemma Frisius, for example, explicitly pointed out the importance of including several astronomical components, including a certain number of fixed stars on the terrestrial sphere.²

The Transfer of Learning between Fleury and Lake Constance

Individual personalities rather than groups drove the introduction of instruments such as astrolabes and globes to the early medieval Latin world. When it came to astrolabes, these objects quickly generated a great deal of interest, as evidenced by the large number of surviving manuscripts.³ In reality, only a few of those who dealt with such devices and wrote about them were able to construct them with precision or describe their use with accuracy. Of all the early interpretations that have been handed down to us, only that of Hermann of Reichenau (1013–1054) provides the reader with an accurate and easily understood construction manual.⁴ The presentation of his treatise in Latin, the *lingua franca* of the learned, guaranteed accessibility to audiences across Western and Central Europe. Hermann added still further value to this work with the inclusion of suggestions for further uses for his design, including that of a sundial and guidance on how to calculate the circumference of a spherical earth.

Reichenau is an island on Lake Constance, lying due west of the city of Konstanz. The start of the 11th century saw the ascension of Bern as abbot (1008-1048) of the monastery. It was during his four-decade tenure that the foundations were laid for the intellectual and creative drive that marked out this abbey as one of the most important centres of scientific learning in Western and Central Europe. (Nowadays it is a UNESCO world heritage site together with the convent buildings on the island,

² See Gemma, *De principiis astronomiae & cosmographiae* (Antwerp: Steelsius, 1553), 25-26, described by Elly Dekker, "Globes in Renaissance Europe," in *The History of Cartography* 3, vol. I., ed. David Woodward (Chicago: The University of Chicago Press, 2007): 135-173, 144-145. This refers not only to the globes of Gemma but also to those of his followers Gerhard Mercator and Tilemann Stella. See Jost Schmid-Lanter, *Der St. Galler Globus: Ein kosmographisches Modell des Tilemann Stella* (Basel: Schwabe, 2019), 223-224.

³ See compilation by Paul Kunitzsch, "Glossar der arabischen Fachausdrücke in der mittelalterlichen europäischen Astrolabliteratur," *Nachrichten der Akademie der Wissenschaften in Göttingen, Philologisch-historische Klasse* (1982): 455-571, 475-508.

⁴ Bergmann, *Innovationen im Quadrivium*, 113.

and ten of its manuscripts belong to the Memory of the World). The intellectual creativity and curiosity that he fostered centred, in particular, on the *quadrivium*.⁵ Musicology was an immediate beneficiary of Bern's own dynamic intellect; and, through his own contributions, musical art in the monastery reached new heights. In other subject areas, Bern commissioned his fellow monks to review and further develop traditional knowledge, with a particular emphasis on the fields of mathematics and astronomy. Physical disability proved no obstacle to scientific ability in Bern's monastery: it was upon the paralyzed Hermann of Reichenau (also called Hermann the Lame) that Bern was able to rely for the production of complicated arithmetic tables, revolutionary ideas for the calculation of the Easter date, along with Hermann's important input towards mastery of the alien astrolabe.

A Latin text about Arabic astronomy, containing the oldest astrolabe tradition from Muslim Spain, was copied even earlier in Reichenau, at the turn of the 1st millennium CE.⁶ It was Abbot Bern himself who commissioned such a copy soon after his arrival at Reichenau in 1008. To aid his monks' research, Bern provided reading material. He almost certainly brought with him or ordered books from the great abbey library of Fleury, in France, the abbey from which he came, where he earned his reputation as an astronomer, and where an abundance of translated Arabic manuscripts and ancient cosmographic texts existed.⁷ Only with the aid of these Latin manuscripts, sourced from afar, was Hermann, bound to his stretcher or stool, able to explain both the construction and function of the astrolabe.

⁵ Immo Warntjes, "Bamberger Mönche überliefern die Werke Hermanns des Lahmen und Berns von Reichenau," in *Welterbe des Mittelalters: 1300 Jahre Klosterinsel Reichenau*, ed. Badisches Landesmuseum (Regensburg: Schnell & Steiner, 2024), 470-471.

⁶ Konstanz, Stadtarchiv, Z VIII M1 U8; see Felix Heizer, "Antikes Kulturerbe auf der Klosterinsel," in *Welterbe des Mittelalters: 1300 Jahre Klosterinsel Reichenau*, ed. Badisches Landesmuseum (Regensburg: Schnell & Steiner, 2024), 464.

⁷ Arno Borst, *Astrolab und Klosterreform an der Jahrtausendwende* (Heidelberg: Winter, 1989), 45-71. Further below in this article, figure 7 is featuring such a Fleury manuscript.

Understanding the Universe

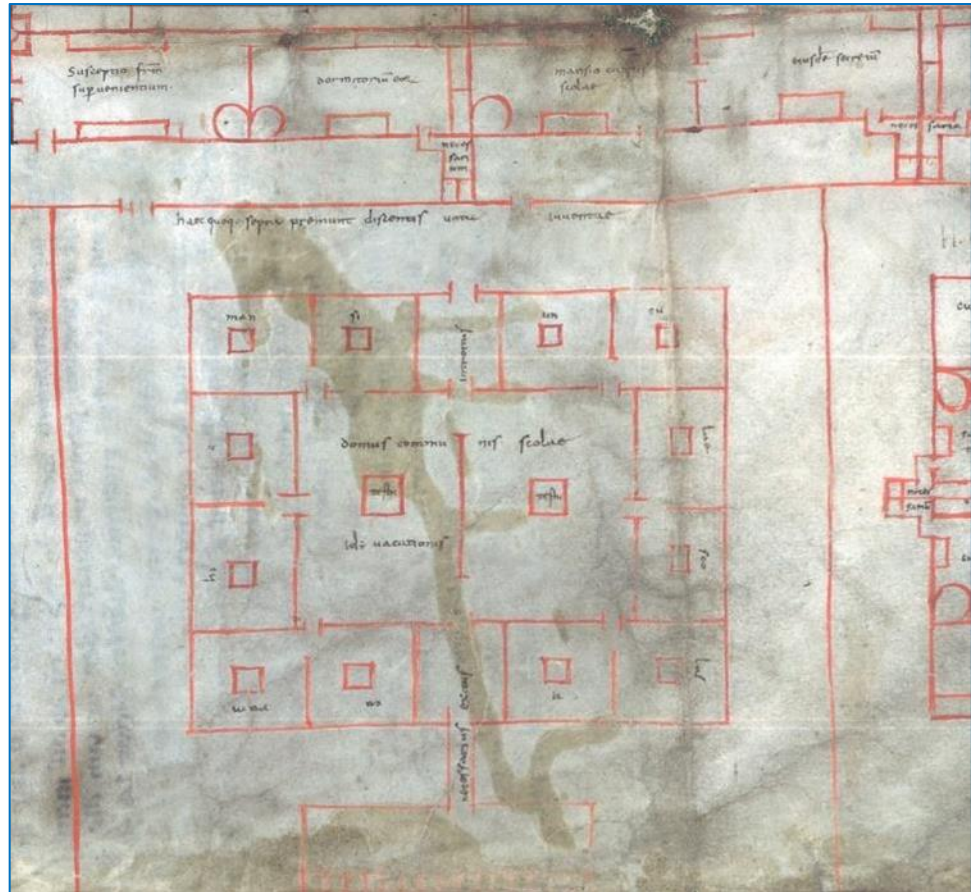
Whereas Reichenau rests in the midst of Lake Constance's waters, the abbey of St. Gallen is located on its southern shore. In the early medieval period, both monasteries were of great importance and maintained close ties. This close partnership has been recognised with the fine sobriquet "*eremus et insula*" ("solitude and island").⁸ Reichenau was a cosmopolitan spot benefitting from its location on an important long-distance trade route. St. Gallen, on the other hand, had a location more conducive to introspection. Nevertheless, a special contract between the two monastic sites, dating from 800 CE, obliged them to communicate regularly. This open channel inevitably led to an intensive exchange of ideas.⁹ The most famous example is a Carolingian monastery plan, made at Reichenau for St. Gallen (**Figure 2**). A new example proposed here concerns texts and ideas about the astrolabe that Bern brought with him from Fleury to Lake Constance. Notker Teutonicus, head of the monastery school in St. Gallen at this time, probably learned of and had access to these texts when the new Abbot arrived on Reichenau in 1008 or shortly thereafter. To truly appreciate the astrolabe, one required a deep understanding of the fact that the height of the celestial north pole or the sun above the horizon correlates with geographical latitude. Notker grasped this relationship—one to which scant attention had been paid in the Latin West—and proceeded to incorporate it into his teachings. As this relationship concerns a phenomenon in the multidimensional space-time continuum, visualising it by means of a globe had clear pedagogical advantages. It allowed one to clearly present the positions of the sun at various degrees of latitude over the course of the year. Surely, this was why such a globe was built in St. Gallen around 1015.¹⁰

⁸ Walter Berschin, *Eremus und Insula: St. Gallen und die Reichenau im Mittelalter* (Wiesbaden: Reichert, 2005), *passim*.

⁹ Cornel Dora, "Fischfang trifft Morchelzucht: Die Reichenau und das Kloster St. Gallen," in *Welterbe des Mittelalters: 1300 Jahre Klosterinsel Reichenau*, ed. Badisches Landesmuseum (Regensburg: Schnell & Steiner, 2024), 186-195.

¹⁰ Jost Schmid-Lanter, "Notker der Deutsche als Kosmograph: Ein Erd- und Himmelsglobus um 1015," *Medialität: Historische Perspektiven* 25 (2022): 3-11; Jost Schmid-Lanter, "The Construction of a Terrestrial and Celestial Globe under Abbot Purchart II of St. Gallen around 1015," *Globe Studies* 67 (2023): 138-150; Jost Schmid-Lanter, "Der Notker-Globus von um 1015," in *Sterne: Das Firmament in St. Galler Handschriften*, ed.

Figure 2 School on the Carolingian Monastery Plan (Reichenau, 825/26). Photo: St. Gallen, Abbey Library, Cod. Sang. 1092 (detail).



Notker embedded an unusually extensive cosmographic excursion in his edition of Boethius' *Consolatio Philosophiae*. The importance of this treatise to him is demonstrated by the fact that it is the most extensively integrated digression on the *quadrivium* in an edition of the *Consolatio* bearing commentary.¹¹ Notker had a particular affinity for the quadrivium, and this was especially true when it came to astronomy. His writings on this subject regularly exceed the usual scope of textual commentaries. In theory, these writings could be compiled into a textbook from which the entire basic astronomical knowledge available in the early Middle Ages could be found. In addition, while head of the St. Gallen school, he conducted

Cornel Dora (Basel: Schwabe, 2023): 83-91; Jost Schmid-Lanter, "Eine Geschichte von Notker dem Deutschen bis Jost Bürgi," in *Schlüssel zum Kosmos: Jost Bürgi 1552–1632*, ed. Kulturmuseum St. Gallen (Schwellbrunn: FormatOst, 2023): 40-47; Jost Schmid-Lanter, "Notker Teutonicus' Cosmographic Globe: A Re-Creation Experiment," *Globe Studies* 69 (2025): 213-224; Jost Schmid-Lanter, "Notker der Deutsche als Kosmograph: Ein St. Galler Erd- und Himmelsglobus um 1015," in *Notker der Deutsche: Proceedings of the International Symposium, St. Gallen 2022: Lingua Historica Germanica 29*, ed. Stephan Müller (Berlin: De Gruyter Brill, 2025, in press).

¹¹ Christine Hehle, *Boethius in St. Gallen: die Bearbeitung der "Consolatio philosophiae" durch Notker Teutonicus zwischen Tradition und Innovation* (Tübingen: Niemeyer, 2002), 199.

observations of the sky with his pupils.¹² A drawing made around the year 1000 in St. Gallen shows him perhaps performing such an activity with the aid of a tube blocking out stray light (Figure 3).



Figure 3 Possibly Notker Teutonicus himself looking up to the sky with an observation tube (St. Gallen, c. 1000). Photo: St. Gallen, Abbey Library, Cod. Sang. 18, pag. 45.

The basis of Notker’s approach is the cosmographic principle, according to which the precise location of geographical features draws upon astronomical supports. The celestial sphere therefore becomes the reference point upon which geography can be deduced. Notker provides many examples using islands, cities,

¹² Ernst Hellgardt, “Geographie und Astronomie im Werk Notkers des Deutschen,” in Dietrich Huschenbett and John Margetts (eds.), *Reisen und Welterfahrung in der deutschen Literatur des Mittelalters* (Würzburg: Königshausen & Neumann, 1991) (Würzburger Beiträge zur Deutschen Philologie 7): 54-68, 57.

and shores that have different solar altitudes at particular times of day and year.¹³ To visualize this for his pupils, he refers to the globe as quoted in the Boethius commentary: “You can track this on the globe that had recently been constructed under the aegis of Abbot Purchart II” (1001–1022); “it shows the geographic positions of all peoples and countries.”¹⁴

The construction of the globe to which Notker refers is the result of a development that began with the Carolingian Renaissance. The three-dimensional depiction of a terrestrial sphere emerged in manuscripts of the 9th century with the earth (or a globe) seen from a bird’s eye view (**Figure 4**).¹⁵ It contains various great circles. However, if one assumes that such a depiction represents a three-dimensional globe, it would be a pale likeness. For example, apart from the Rhiphaean Mountains,¹⁶ only a few topographical features are indicated. Better representations of a spherical instrument are to be found in early medieval images of celestial globes linked to the work of Hellenistic court poet Aratos. He composed a didactic poem “Phaenomena” (“celestial phenomena”) in the 3rd century BCE. As we shall see, these pictures can give us an idea of the appearance of the Notker globe (**Figure 8**).

The Cosmographic Globe as Didactic Aid

Thanks to interdisciplinary collaborations, the improved reading of the cosmographic excursion in the Boethius commentary led to important new insights into the construction of an early medieval terrestrial and celestial globe, insights that were conceived by Notker himself.¹⁷ His reference to the fact that the globe axis could be adjusted should be recalled as an example. By contrast, the globes of Gerbert

¹³ Schmid-Lanter, “The Construction of a Terrestrial and Celestial Globe,” 144.

¹⁴ Quote translated from Old High German Cod. Sang. 825, pag. 96-97 (“Taz mag man uuola séhen án déro spera díu in cella SANCTI GALLI nouiter gemáchôt ist sub PUCHARDO ABBATE. Sî hábet allero gentium gestelle.”) “Gestelle” means a terrestrial position. See also Hellgardt, “Geographie und Astronomie,” 91.

¹⁵ Barbara Obrist, *La cosmologie médiévale: Textes et images I, Les fondements antiques* (Florence: Sismel, 2004), 110.

¹⁶ See picture in the lower, i.e. northern, part of the circular ecumene, which is the known inhabited part of the world. The Rhiphaean Mountains were already mentioned by Pliny the Elder and were passed on in the Middle Ages. Bishop Adam of Bremen localised it in Sweden (between 1073 and 1076); see Edward Brooke-Hitching, *The Phantom Atlas: The greatest myths, lies and blunders on maps* (London: Simon & Schuster, 2016), 198-199.

¹⁷ Schmid-Lanter, “The Construction of a Terrestrial and Celestial Globe,” 137-140 and 144-145.

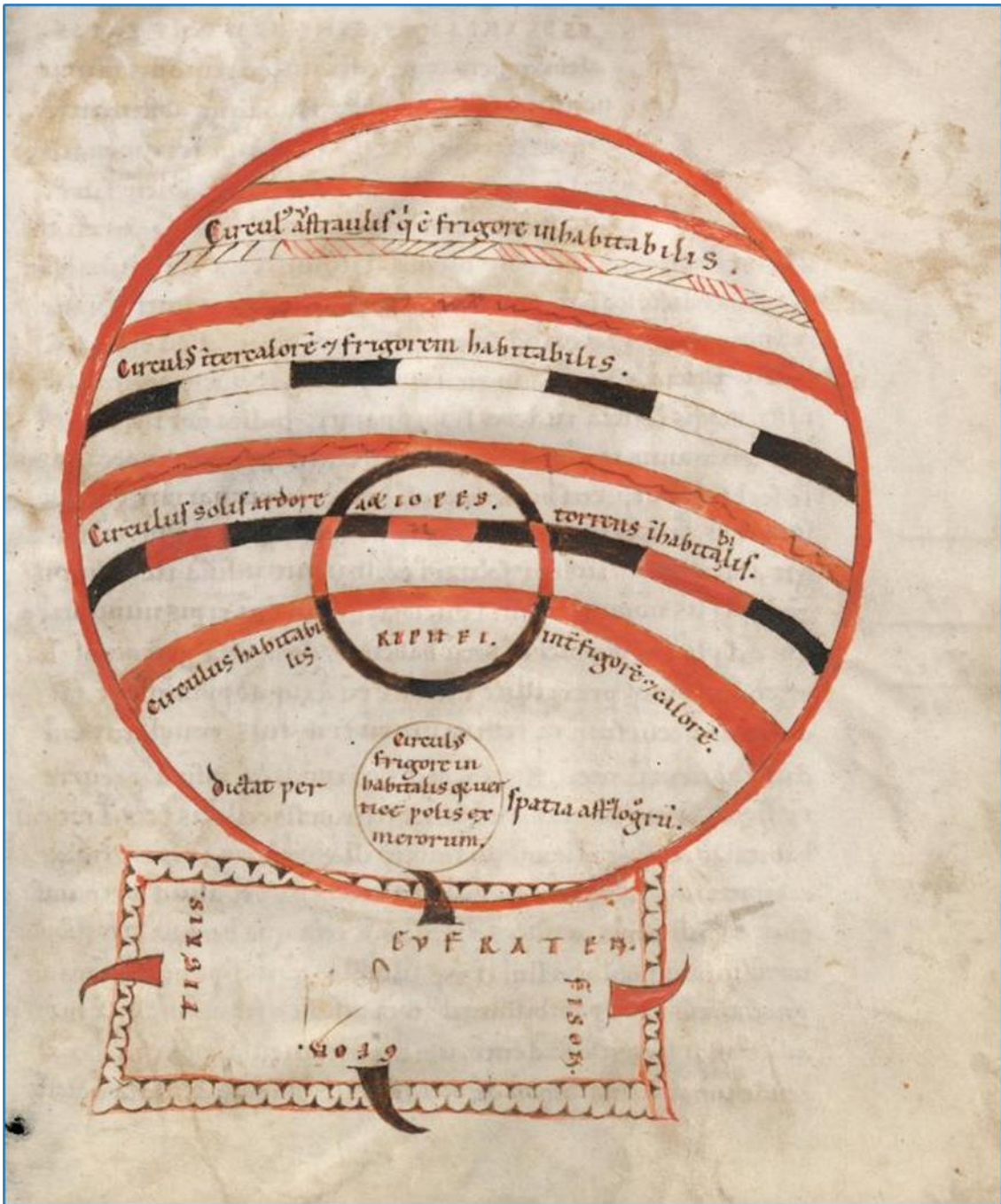


Figure 4 The “Brendan map” (South on top) in the Albert Knoepfli collection shows the known inhabited part of the world, the ecumene, which is indicated by a full circle and the naming of “Etiopes” and “Riphei.” Grand circles of latitude distinguish different climes on the spherical earth (Southern Germany, 1175/1200). Photo: Frauenfeld, Thurgau State Archives, AKS 3 OMB 110a.

d’ Aurillac (c. 950–1003), only a few years older than those of Notker, had axes that were still fixed with regard to their inclination. Gerbert, later Pope Sylvester II, adopted Aratos’ idea, which was true for the Cilician degree of latitude at 36° instead of the Reims degree of latitude at 49°. ¹⁸ Obviously, he had yet to take into account that the height of the celestial north pole or the sun above the horizon correlates with geographical latitude. Since this relationship became known in the Latin West around the turn of the millennium, thanks to the introduction of the astrolabe, we can conclude that Gerbert was not among the first to fully understand this novel astronomical instrument and its functions. ¹⁹

Notker’s comment about the limited visibility of the zodiac and the signs associated with it makes it possible for us to infer that his globe had a zodiacal band that was partially concealed behind a horizon ring. ²⁰ In the literature of modern times, it was quite new to suggest that early medieval scholars were, using their full cosmographic knowledge, able to combine in a single didactic terrestrial globe astronomical components such as a zodiacal band with star signs, the great circles, an adjustable axis and a horizon ring, thus creating a cosmographic globe. Until now, the advent of such combined celestial and terrestrial globes has been corroborated only for the late 15th century. That is because early medieval sources are sparse. The few relevant documents of the period that survive combine the zonal concept of Macrobius (c. 385– c. 430) and a *mappa mundi* approach to feature a corresponding world map with the zodiac (**Figure 5**), or they draw more heavily on Macrobius and present the earth with closely-related terrestrial and celestial zones (**Figure 6**). This relationship was understood to be of such close proximity that a similar approach

¹⁸ See Elly Dekker, “The Celestial Globe of Gerbert d’ Aurillac: Its Place in the History of Celestial Cartography,” *Cartes & Géomatique* 243/244 (2021): 61-73, 64.

¹⁹ Whether Gerbert was familiar with the astrolabe or not is very controversial. Gerbert already constructed an armillary sphere in the 990s CE, but reliable knowledge of an astrolabe was not handed down by him. See Dekker, “The Celestial Globe of Gerbert d’ Aurillac,” 64; Oscar Darlington, “Gerbert, the Teacher,” *The American Historical Review* 52 (1947): 456-476, 468; Borst, *Astrolab und Klosterreform*, 48.

²⁰ On the novel adjustable globe axis and on the existence of a horizon ring on Notker’s globe, see Schmid-Lanter, “The Construction of a Terrestrial and Celestial Globe,” 142-143.

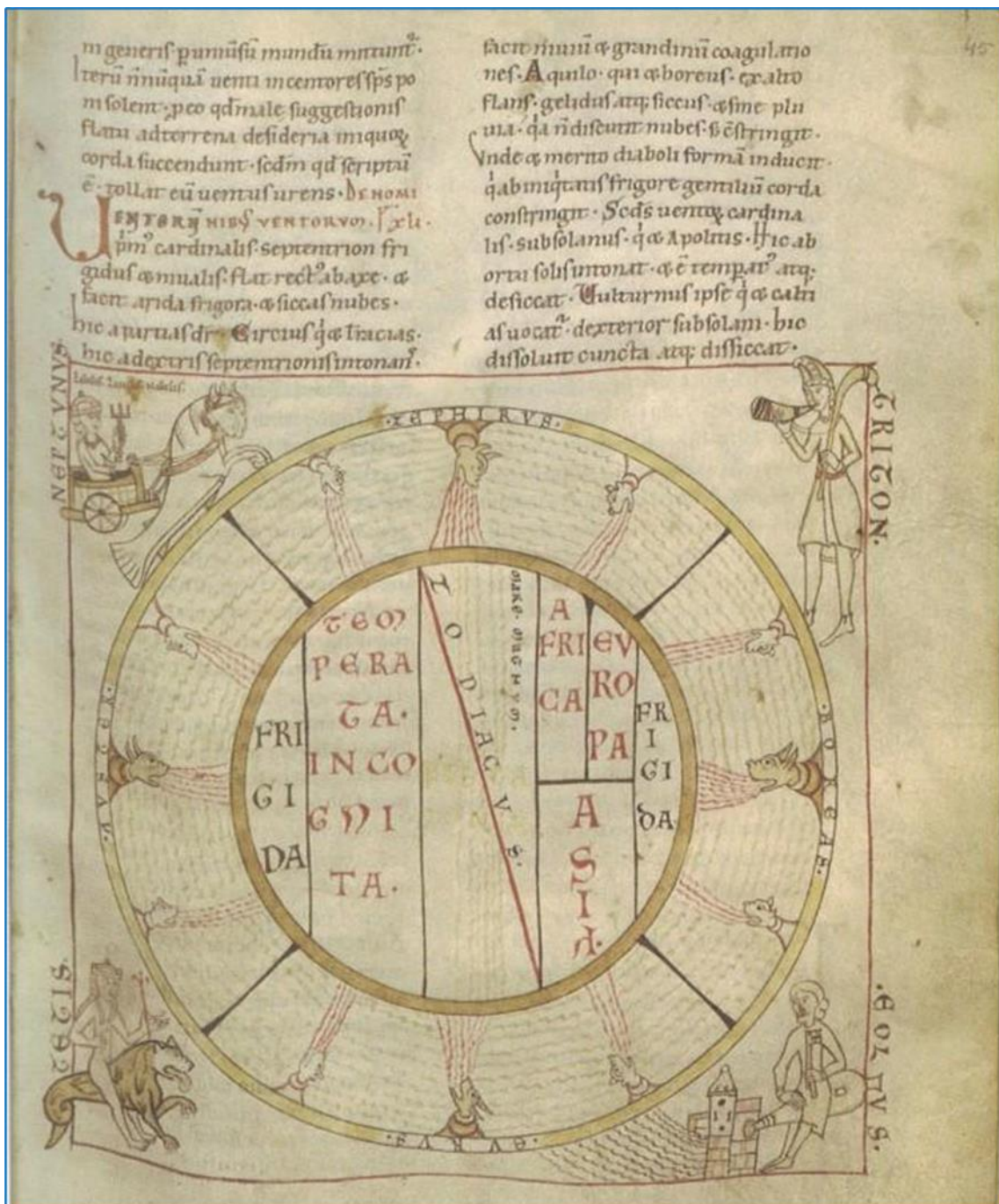


Figure 5 West-orientated mappa mundi with the zodiac after Isidore of Seville, *De natura rerum* (13th century). Photo: Leiden, University Library, PER F 2, fol. 45^r.

could be used to combine the terrestrial and celestial zones with the zodiacal band on the same sphere (Figure 7).

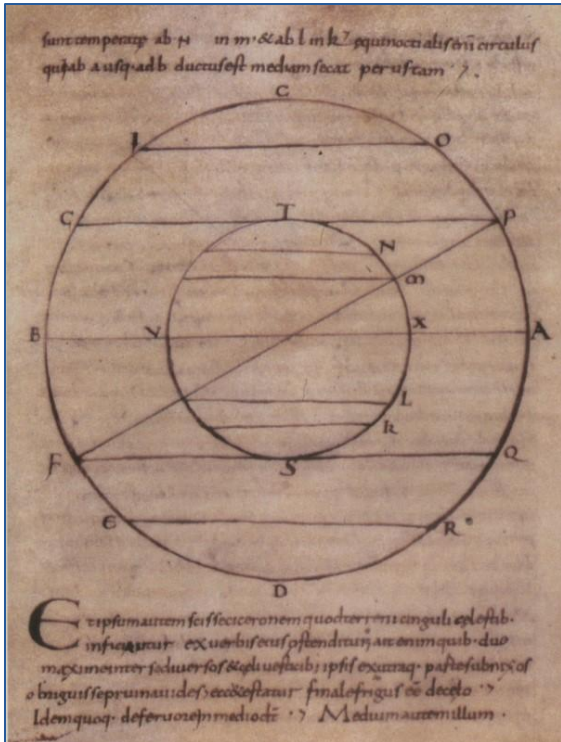


Figure 6 Combined terrestrial and celestial zonal map after Macrobius with one zodiac fitting for both Heaven and Earth, Commentary on *Somnium Scipionis* II.7 (Corbie, 9th century). Photo: Paris, Bibliothèque Nationale de France, ms. nouv. acq. Lat. 454, fol. 66r.

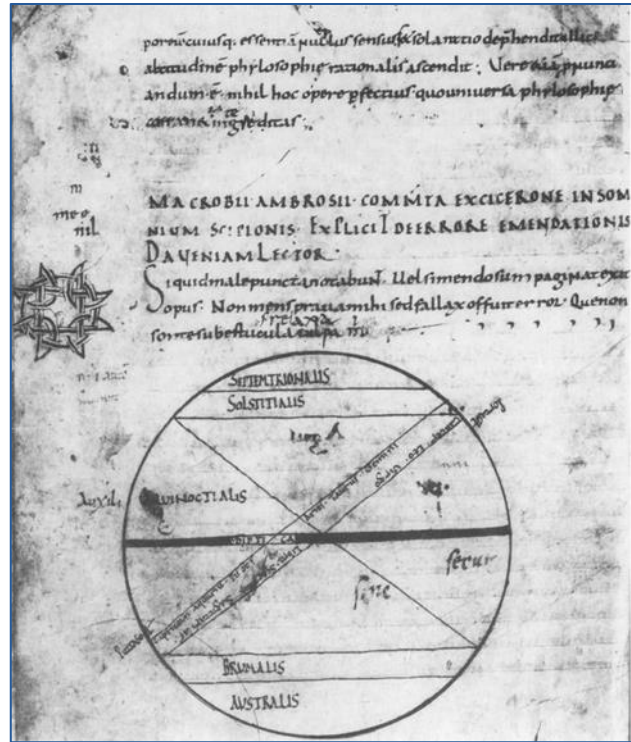


Figure 7 Terrestrial zones after Macrobius on a sphere with the zodiacal band, Commentary on *Somnium Scipionis* II.9 (Fleury, 9th century). Photo: Paris, Bibliothèque Nationale de France, ms. lat. 16677.

Dating Notker's Globe

Gerbert is unlikely to have been the source of expertise relating to the astrolabe, because, as mentioned above, it is highly questionable as to whether he knew or understood the astrolabe at all. Furthermore, Hermann of Reichenau would probably not have judged Gerbert so harshly in his chronicle if he had been able to rely on him as a source for his own work on the astrolabe.²¹ Gerbert is sometimes mentioned as a key figure in the transmission of Arabic science from Spain to the Latin West. However, he can be deprived of such credit in this particular instance.²²

²¹ Borst, *Astrolab und Klosterreform*, 56.

²² For supportive explanations in a similar case see Elly Dekker, *Illustrating the Phaenomena: Celestial Cartography in Antiquity and the Middle Ages* (Oxford: Oxford University Press, 2013), 206.

On the other hand, the St. Gallen expertise in globe construction may have been influenced by Gerbert.²³ Such an influence presumably occurred through mediators such as Bishop Notker of Liège (d. 1008), who had close relationships with both Gerbert of Reims and the abbey of St. Gallen.²⁴ Notker of Liège died in the same year that Abbot Bern arrived in Reichenau. Therefore, it is likely to be around the year 1008, when the knowledge of both globe construction and the astrolabe came to St. Gallen, presumably by different routes. Notker probably began his extensive cosmographic writings soon after he had learnt about the astrolabe and the correlation between the height of the sun above the horizon and the geographical latitude. We can imagine how, brimming with enthusiasm, he wanted to share this eureka moment about a still largely unknown piece of cosmographic knowledge and therefore conceived his treatise and his novel globe, both of which he intended to be used for didactic purposes.

We estimate that Notker's globe dates from around 1015. This assumption is based on the fact that it was built only a few years prior to his writing of a particular letter to the Bishop of Sion. In this letter, dated 1019 or 1020, he mentions the Boethius edition (and thus implicitly the cosmographic excursion and the globe).²⁵ It took Notker two decades to edit the Boethius text in a process that involved numerous adaptations and supplements. He began as early as the first decade of the new millennium.²⁶ It is therefore possible that the cosmographic descriptions, and thus the globe, date from 1008 at the earliest. This is consistent with the source in the Boethius edition, which dates the construction of the globe to the aegis of Abbot Purbach (1001-1022).²⁷

²³ *Ibid.*

²⁴ Ingeborg Schröbler, "Die St. Galler Wissenschaft um die Jahrtausendwende und Gerbert von Reims," *Zeitschrift für deutsches Altertum und deutsche Literatur* 81 (1944): 32-43, 40.

²⁵ Andreas Nievergelt, "Leben und Werk Notkers des Deutschen," in *Zeitenwende: Notker der Deutsche: Sommerausstellung*, ed. Andreas Nievergelt (Basel: Schwabe, 2022): 18-23, 19.

²⁶ Cornel Dora, "Troost der Philosophie," in *Zeitenwende: Notker der Deutsche: Sommerausstellung*, ed. Andreas Nievergelt (Basel: Schwabe, 2022): 47-65, 59.

²⁷ "Das kann man gut an der Kugel sehen, die jüngsthin im Kloster St. Gallen unter Abt Purbach geschaffen wurde." (This can easily be seen on the sphere that has recently been created in the Abbey of St. Gallen under Abbot Purbach); My translation after Schmuki, "Mittelalterliche Weltkarten (*Mappae mundi*)," in *Karten und Atlanten: Handschriften und Drucke vom 8. bis zum 18. Jahrhundert*, ed. Stiftsbibliothek St. Gallen (St. Gallen: Verlag am Klosterhof, 2007): 19-39, 36.

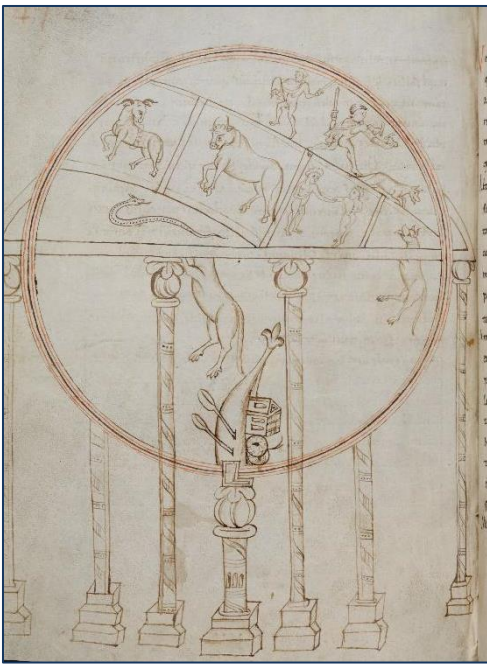


Figure 8 Celestial globe in an Aratos manuscript (St. Gallen, 9th century). Photo: St. Gallen, Abbey Library, Cod. Sang. 250, pag. 472.

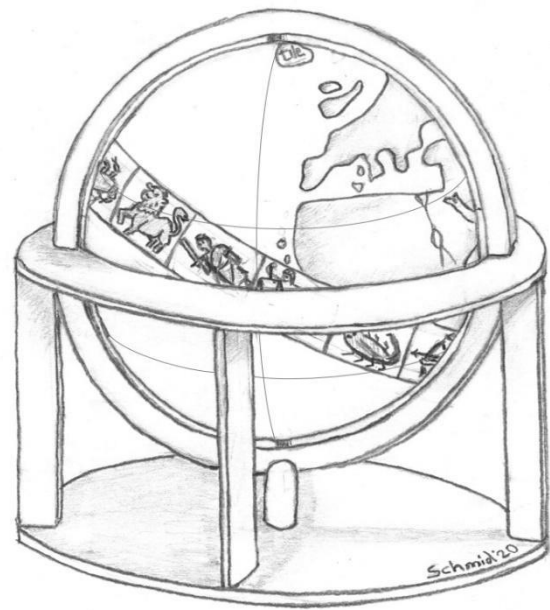


Figure 9 Drawing of the Notker Globe as a model for its re-creation. Photo: Jost Schmid-Lanter.

The extraordinarily long cosmographic digression in this otherwise philosophical text was probably elaborated over several steps, the mentioning of the globe being a product of a later stage of editing. The source that supports this—the only surviving copy of Notker’s Boethius edition²⁸—was finally put down in writing posthumously and represents a revised version in which the description was smoothly integrated into the text. This makes it possible to narrow down the previously suggested dating of this earliest known cosmographic globe, i.e., from the aegis of Abbot Purchart (1001-1022) to a date of around 1015—give or take seven years at the very most.

Transition of Astronomical Approaches in the 11th Century

Notker’s prompt reaction to the transfer of cosmographic expertise from the monastery at Reichenau gives the impression of an immediate shift in emphasis from

²⁸ Cod. Sang. 825.

the descriptive procedure handed down from Aratos to a mathematical approach imported from Islamic cultures. In general, however, there was a transitional period in Europe during which scholars and interested students combined elements from both sides.²⁹ Around the turn of the millennium, several editions of Aratean manuscripts were kept and studied intensively within the St. Gallen monastery school.³⁰ The corresponding illustrations contained within the codices most likely had an influence on the construction of Notker's globe—even if only in terms of its aesthetic design (**Figure 8**).

Alongside our novel globe, there might exist another early example of the inclusion of Islamic astronomy in St. Gallen, namely, in the treatise *De circulis sphaerae et polo* (about the pole and the grand circles on a sphere) by an anonymous author, a work dated to the 11th century. In it is to be found a section dealing with the construction of a globe or spherical astrolabe together with an explanation of the concept underlying the *almucantarats*, the typical features of an astrolabe: "*Inventis in sphaera rotunda coluris, et ipsa sphaera in sexaginta divisa, ad inveniendum nostri almucantaratus, haec est ratio ...*"³¹ Later in this work, the author indicates the north pole to be at 48° above the horizon. Thus, the origin of the manuscript has hitherto been narrowed down to the few monasteries on that latitude, above all that of St. Gallen ($\varphi = 47^\circ 25'$).³² This has been corroborated by the fact that the corresponding text was to be found, according to the source editor, Jacques-Paul Migne (1800-1875), in the manuscript collection of the Zentralbibliothek in Zurich (Ms. Car. C 176).³³ The Zentralbibliothek holds many St. Gallen codices, so this is a likely source location. The first part of the manuscript published by Migne is a *De Astronomia* edition, i.e.

²⁹ Elly Dekker, *Illustrating the Phaenomena*, 206.

³⁰ Manuscripts from the period preserved in the Abbey Library in St. Gallen are Cod. Sang. 902 and Cod. Sang. 250. See also Karl Schmuki (ed.), *Das Kloster St. Gallen und seine Schulen: zum 200. Geburtstag der Katholischen Kantonssekundarschule "Flade" Katalog zur Jahresausstellung in der Stiftsbibliothek St. Gallen* (St. Gallen: Verlag am Klosterhof, 2009), 59 and 68.

³¹ "Having found the colours (celestial circles) on a round sphere, and the sphere itself divided into sixty, to find our *almucantaratus*, this is the method." Quote after Jacques-Paul Migne, *Patrologia Latina* (Paris, 1844/1864), PL 90,937-942B.

³² Elly Dekker, *Illustrating the Phaenomena*, 206.

³³ Migne, PL 90,937-942B.

“about astronomy,” by Hyginus (1st century BCE).³⁴ But on closer examination, the corresponding shelf number in Zurich reveals there to be no such second part. The subsequent text promised by Migne with instructions on how to draw almucantarats or construct spheres is missing and was certainly never part of the quire. Still, the physical source belonging to this text must have existed somewhere, and there are chances that it originated in St. Gallen in the 11th century.³⁵ That classical sources such as Aratus and Hyginus were still so well-received after the turn of the millennium shows that not all interest was suddenly focused on Islamic texts.

A Re-creation Experiment

Based on the findings mentioned earlier, a sketch (**Figure 9**) was drawn. This served as the model when re-creating the globe (**Figures 10 and 11**) between December 2022 and March 2023.³⁶ As was the case with the old model, the new Notker globe holds a didactic aim: It is intended to impart an early medieval understanding of cosmography to the wider public. In the interest of improved readability, the craftspeople and scholars involved abstained from a scholarly distinction between known and conjectured features. The replica should thus be regarded as an extrapolation, starting from the known and informative key data on the historical Notker globe, and then moving towards creating an object whose appearance was theoretically possible, based on the level of knowledge in St. Gallen at the time. The details reproduced in the terrestrial cartography, for instance, are therefore based to a greater extent on scholarly imagination, since only some of them are conveyed explicitly by Notker’s notes.

³⁴ *Ibid.*

³⁵ The source was not listed by Kunitzsch, “Glossar der arabischen Fachausdrücke in der mittelalterlichen europäischen Astrolabliteratur,” 475-508.

³⁶ Regarding the works run by different craftspeople, see detailed report (in press): Schmid-Lanter, “Notker Teutonicus’ Cosmographic Globe: A Re-Creation Experiment,” *passim*. The following is an abridged version enriched with additional images.



Figure 10 Notker Globe, re-creation 2023. Photo: St. Gallen, Abbey Library.

The re-creation stands as a strong reminder that the earth's spherical form was not seriously debated in the medieval period, not even by the hierarchy of the Roman

Church.³⁷ As Peter Sloterdijk puts it in the second volume of his *Spheres*, the medieval church handed down an “orb piety” from antiquity without interruption.³⁸ A strong contextualization within salvation history, not only of the sphere, but also of its topographical map, seems plausible at the monastery of St. Gallen at this time. Perhaps Notker was not personally responsible for the cartography and calligraphy. We can imagine a situation in which a colleague left behind his own signature (and possibly added some biblical content). Based on the re-creation experiment, it became clear that various learned individuals and artisans must also have worked together on the early medieval original. Like the modern construction team, the medieval predecessors almost certainly included at least one scholar, a designer, a master carpenter, a calligrapher, and a colleague adept at painting.

The expert artisans in their modern workshops tried to immerse themselves in the time around 1000 CE, using existing literature to achieve this and therefore come as close as possible to a plausible re-creation of Notker’s globe. This included an understanding of the creative processes involved as well as a consideration of what was feasible in that period. Since many production steps were only recognized as “best practice” after a series of painstaking experiments, this project should be referred to as a “re-creation experiment” wholly in line with approaches from experimental archaeology.

Early Medieval Craftsmanship on the Wooden Sphere and Stand

Byzantine sources indicate the use of wood in the 7th century for the construction of small earth models to demonstrate certain cosmic phenomena.³⁹ As indicated below, the only known contemporary globes by Gerbert d’Aurillac were also made from wood. Thus, it is safe to assume that this kind of material was also used for

³⁷ See Jeffrey Russell, *Inventing the Flat Earth: Columbus and Modern Historians* (New York: Praeger, 1991), *passim*.

³⁸ Peter Sloterdijk, *Globes: Macrospherology: Spheres 2* (South Pasadena: Semiotext[e], 2014), 40.

³⁹ Obrist, *La cosmologie médiévale*, 115.



Figure 11 Exhibition of the re-created Notker Globe in the Abbey Library, St. Gallen. Photo: Silvio Frigg.



Figure 12 Calottes in the workshop after being hollowed out. Photo: Hanspeter Strang.

Notker's globe, for it was the most abundant building material at hand in remote St. Gallen.

The wood restorer turned, carved, and assembled the stand and the globe sphere.⁴⁰ The latter, as was likely in the case of the original, was made from solid wood; more precisely, from two calottes (half spheres) that were hollowed out on the inside to reduce weight (**Figure 12**). This process draws closely on a source describing the construction of Gerbert's globes at the end of the 10th century.⁴¹ In the case of the replica, the limewood calottes retain walls of a reasonable thickness, not only to prevent any significant warping, but also to prevent the sphere from collapsing under the subsequent vellum covering, a material also used by Gerbert.

⁴⁰ The following statements by Hans-Peter Strang (Wittenbach, Switzerland) draw on the podcast "Vom Spannen des Pergaments über die Welt," *Notker-Globus*; <<https://www.stiftsbezirk.ch/de/podcasts>> (accessed July 12, 2024).

⁴¹ See Oscar Darlington, "Gerbert, the Teacher," 470.

When it came to the weight of the sphere, its long-term functionality had to be taken into account. An ability to rotate the sphere on its axis and tilt the meridian ring in the horizon would place a limit on its diameter. At the same time, making an object that was too small would render it useless as a didactic tool. The sphere had to have a surface area of sufficient size to contain the required geographical information. In the case of the re-created model, a diameter of roughly 30 centimetres was settled upon as the optimum value to take each of these considerations into account. Such a size for the original can be inferred directly from Notker's cosmographic excursion.⁴² The diameter of approximately 30 centimetres also corresponds to that of didactic globes in antiquity.⁴³

When constructing the globe, calottes were turned from two blocks of wood and then glued together to grind the whole sphere into a near-perfect shape. Before being covered with animal skin, the calottes were taken apart again (**Figure 13**). While the sources regarding similar early medieval globes speak of "horsehide,"⁴⁴ goatskin was used as an alternative for the replica, since it is nowadays easier to procure in the quality required. One of the central insights from the test series was that the vellum has to be soaked in water at a temperature of approximately 50°C. Once removed, a five-to-ten-minute window exists to stretch the vellum over the wooden sphere. This needs to be done with some physical force (**Figure 14**). In contrast to human labour, material, particularly metal, was very expensive at the time of the globe's construction. It can therefore be assumed that everything possible was done with locally sourced wood. The sole exceptions were two handmade bronze pins with tubes for connecting the sphere with the meridian ring. The sphere of the replica rotates flawlessly round this axis.

The form of the stand, with its turned columns, draws on globe pictures in the above-mentioned text by Aratos that was available in St. Gallen around 1000 CE

⁴² Schmid-Lanter, "The Construction of a Terrestrial and Celestial Globe," 142.

⁴³ See illustrations in Christian Jacob, "Looking at the Earth from Outer Space: Ancient Views on the Power of Globes", *Globe Studies* 49/50 (2002): 9-23, 14-15, and in Sloterdijk, *Globes*, 36.

⁴⁴ Darlington, "Gerbert, the Teacher," 471.

(Figure 8). This is consistent with the finding that early medieval globe construction in general and that of Gerbert in particular were based on the work of Aratos.⁴⁵ In this work, the globe pictures feature embellished columns with a most likely colored pattern. The columns are topped with an ending in the shape of a pomegranate. It is therefore red in color in the replica. Inspired by the green leaves of the pomegranates at the very end, the re-creation project kept the bases of the columns in the same color in reference to the Aristotelian aesthetics of balance. Unlike modern globes, there is no evidence of a cartouche on the contemporary pictures of the Aratus tradition **(Figure 8)**. It can therefore be assumed that no title, author, dedication, privilege, or year were indicated on the object.

The chromatic appearance of the patterns on the column draws on contemporary text sources and surviving book illuminations, which tell of bold colors on early medieval artifacts.⁴⁶ In terms of pigments, the master church painter used materials that were widespread in the Carolingian-Ottonian period: lapis lazuli, malachite, red lead, white lead, madder lake, and vine black applied over a white chalk base layer. When it came to the individual design of the columns, the colorful nature of early medieval architecture was taken into account. The use of particular pigments for the original is not documented. Therefore, the re-creation experiment, as an artistic act, is one that attempts to reflect the aesthetic sensibilities of that period.

Terrestrial Cartography according to Early Medieval Models

As the re-creation experiment revealed, drawing and writing down all the place names on the globe would take one person approximately five working days. The calligrapher drew on relevant previous experience. In contrast to the large

⁴⁵ Dekker, *Illustrating the Phaenomena*, 202.

⁴⁶ The following statements by Ina Link and Johanna Vogelsang are based on the podcast “Von der richtigen Tempera,” *Notker-Globus* <<https://www.stiftsbezirk.ch/de/podcasts>>. (accessed July 12, 2024).



Figure 13 Separation of the calottes after shaping the sphere. Photo: Hanspeter Strang.



Figure 14 Covering of the calottes with parchment using a special clamping device. Photo: Hanspeter Strang.

sphere replica of the St. Gallen globe, he was able to work on the smaller surface of the Notker globe with a quill pen without greater difficulties, since the sphere, mounted on a special supporting device, could easily be turned in all directions (**Figure 15**).⁴⁷ The colors are limited to four basic shades frequently found in Carolingian-Ottonian manuscripts: orange (red lead), lapis lazuli (imported from Afghanistan in that period), cupriferous green (malachite), and black oak-gall ink. Unlike the stand, on which work was done with a brush, the calligrapher mostly used a quill pen, which in this context is historically documented as the most efficient and hence most-used instrument.⁴⁸

To create the terrestrial cartography, an understanding of the geography that was theoretically known at St. Gallen, circa the turn of the first millennium CE, was extrapolated from the toponyms mentioned in Notker's cosmographic excursion. Particular attention was given to his special interpretation of the term "*ter fierdo téil*" ("a quarter [of the earth]") and the corresponding positioning of the island of Thule

⁴⁷ The Notker globe, c. 1015 CE, should not be confused with the St. Gallen Globe of 1576. On the calligraphy of the toponyms in the latter case, see Klaus-Peter Schäffel, "Beschriftung," in Martina Rohrbach and Beat Gnädinger (eds.), *Der Zürcher Globus: Projekt Globus-Replik 2007–2009, Dokumentation* (Zurich: Staatsarchiv des Kantons Zürich, 2009): 180-192. For a general introduction to the topic, see Schmid-Lanter, *Der St. Galler Globus, passim*.

⁴⁸ Podcast "Wie man die Feder hält und warum leuchtet Mennige so?" *Notker-Globus* <<https://www.stiftsbezirk.ch/de/podcasts>> (accessed July 12, 2024).

“below the north pole.” Notker’s literal (and rather unique) understanding of the ancient designation of the ecumene, the inhabited part of the world, as a quarter, led to his description of an ecumene that extends precisely from the equator to the north pole or the island of Thule (**Figure 16**).⁴⁹ The cartography is based partially on the discovery that Notker was strongly influenced by Macrobius. It is safe to assume that he was also familiar with the geographical works of Pliny the Elder, Beatus von Liébana, and Isidore of Seville, all available during Notker’s time at St. Gallen. There was a large and detailed *mappa mundi* also available to Notker at this time, one that was possibly created by relying on similar works.⁵⁰ In all likelihood, this *mappa mundi* served as a model for the depiction of the ecumene on the globe.

Figure 15
Calligrapher
Klaus-Peter
Schäffel drawing
the zodiacal band.
Photo: Silvio
Frigg.



The Grand Circles on Notker’s Globe

Regarding star constellations, Notker refers only to the band of the zodiac:

“*signa zodiaci [sint] ze ougon.*”⁵¹ As is the case on later cosmographic globes, the

⁴⁹ See Hellgardt, “Geographie und Astronomie im Werk Notkers des Deutschen,” 54-68.

⁵⁰ Karl Schmuki, “Mittelalterliche Weltkarten,” 34-35.

⁵¹ Notker Teutonicus, *Boethius, De consolatione philosophiae* (Old High German translation and commentary); Cod. Sang. 825: pag. 96-97.

terrestrial cartography was supplemented with representations of the zodiac or ecliptic. It probably had a width of 24° to properly show all twelve signs on it, considering the source for Gerbert's globes. Most likely, there were additional circles on Notker's globe, namely the equator and the tropics ($\varphi = 23.5^\circ$). They were crucial when it came to explaining the movement of the sun or its height above horizon and their relationship with geographical latitude. Therefore, Notker mentions these grand circles in his treatise. He does not refer to the polar circles ($\varphi = 66.5^\circ$), and it is reasonable to infer that the latter were absent on the globe. The concept underlying the polar circles became familiar in St. Gallen only decades later as a result of the rediscovery of astronomical texts by Ptolemy. On many ancient and early medieval globes, or in drawings of them, a circle at 54° latitude was highlighted, as is the case in the work of Aratos and Gerbert d'Aurillac, a key follower to Aratos' school. Such circles did not concern an incorrect estimate of Ptolemy's polar circles (at $\varphi = 66.5^\circ$), but rather an ancient Greek circle of visibility.⁵² It showed the night sky as always visible around the celestial north pole at the Cilician degree of latitude ($\varphi = 36^\circ$). This also pertains to a tradition associated with Aratos, whose home was the Cilician southern coast of Asia Minor. Globes based on the writings of Aratos, with a circle of visibility at 54° latitude (complementary angle = $90^\circ - 36^\circ$), had an axis fixed at a particular inclination so that the latitudinal angle of 36° degrees was located between it and the horizon ring. Five large latitudinal circles are correspondingly found in this Cilician conception of equator, tropics, and circle of visibility.

But Notker's model had an adjustable axis so that observations of the sky could be demonstrated for all degrees of latitude in lessons at the school.⁵³ Therefore this applied, to use Notker's words, to "the domiciles of all peoples living in the ecumene."⁵⁴ Aratos' circle of visibility therefore became obsolete. It disappeared completely with the introduction of adjustable axes and horizon rings in the 11th

⁵² Dekker, "The Celestial Globe of Gerbert d'Aurillac," 64-67.

⁵³ Schmid-Lanter, "The Construction of a Terrestrial and Celestial Globe," *passim*.

⁵⁴ Based on a translation from the Old High German according to Schmuki, "Mittelalterliche Weltkarten," 36.

Gallen. Apart from some expensive pigments, the most valuable inputs are the know-how and skills of the craftsmen and, first and foremost, the erudite knowledge of a scholar like Notker Teutonicus. This knowledge was one of the key assets in the wealth of the St. Gallen monastery. 🐼