A New Interpretation of Ptolemy's *Germania Magna*

Cartometric Evidence and a Geodynamic Framework
for Post-Antique Landscape Transformation in Central Europe

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Disclaimer and scope

This manuscript presents an interdisciplinary working hypothesis integrating cartometry, geodynamics, palaeohydrology, palynology, and historical sources. It formulates concrete, falsifiable predictions and is intended to stimulate further empirical testing. It does not claim to constitute a definitive reconstruction, and has not been evaluated by peer review.

Contents

Abstract

This paper revises and extends the author's earlier interpretation of Claudius Ptolemy's *Germania Magna* (c. 150 AD) by combining a cartometric analysis of the medieval map redaction of Donnus Nicolaus Germanus with evidence drawn from geodynamics, palaeohydrology, palynology, archaeology, and historical chronology. Its central thesis is that the apparent discrepancies between Ptolemy's coordinate system and the modern Central European landscape are not primarily the result of ancient measurement error, as the prevailing geodetic-rectification school has assumed, but the cumulative product of two superimposed factors: a substantial, geologically recent transformation of the landscape itself, and the inevitable cartographic distortion that arose when medieval and early-modern editors re-projected Ptolemy's coordinates onto an already changed terrain without recognising the underlying shift.

The most consequential change concerned the coastline of the *Oceanus Germanicus*. During antiquity, this coastline ran approximately 120 km south of its present position, just north of present-day Berlin, at the latitude of Eberswalde. North of this line stretched not open sea in the modern sense, but a wide amphibious zone of marshes, reed flats, shallow lagoons and reticulated waterways — a landscape that on approach from the sea offered no clear shoreline at all. Within this framework, the *Vistula Fluvius* of Ptolemy corresponds not to the modern Polish Vistula but to the Lusatian river system of the Schwarze Elster, Spree and Oder; the *Asciburgius Mons* corresponds not to the Sudetes but to the Fläming and its south-eastern foothills; and the southern boundary river that Ptolemy calls *Danubius* may, on a revised reading, correspond to the modern Main rather than to today's Danube, with the *Abnoba Mons* of his text identified with the Taunus rather than the Black Forest.

The hypothesis advanced here is that the relevant landscape transformation occurred in geologically recent time — most plausibly during a window centred on the mid-sixth century AD — and was driven by a late-stage reactivation of the Caledonian Deformation Front (CDF) and adjacent structures of the Trans-European Suture Zone under the compressional regime of the closing Alpine orogeny, with the possibility of an impact or airburst trigger of cometary origin that may have catalysed the deformation. The proposed framework offers a unified explanation for the archaeological settlement hiatus of the fifth to seventh centuries, the abrupt collapse of arboreal pollen curves in the same window, the Late Antique Little Ice Age now widely recognised in tree-ring records (Büntgen et al., 2016), the political collapse of the Thuringian kingdom in 531 AD, and the subsequent Slavic re-colonisation of an emptied and ecologically reset landscape.

1. Introduction

The geography of *Germania Magna*, transmitted in Book II, Chapter 11 of Ptolemy's *Geographike Hyphegesis*, has occupied scholars for centuries (Stückelberger & Grasshoff, 2006). The dominant modern paradigm is the statistical-geodetic rectification developed by the Berlin group of Kleineberg et al. (2010) and Karlsen et al. (2011), which treats deviations between Ptolemaic coordinates and the modern landscape as compounded instrumental and transmission errors, removable by spatial adjustment. The approach is methodologically rigorous, and it has produced an impressive index of identifications. Yet it rests on a premise that is rarely stated explicitly: that the physical landscape itself has remained essentially constant since antiquity. The present work proceeds from a different premise. It asks what would follow if one took the Ptolemaic record at face value as a substantially accurate description of an ancient landscape, and treated the apparent discrepancies with modern topography as evidence of real change.

Two questions then become central. First: how is the Ptolemaic map to be aligned with modern topography under the assumption of a changed landscape, and what features of antiquity does that alignment recover? Second: what physical mechanism could have produced the inferred change, and on what timescale? The first question is cartometric and topographic; the second is geological, palaeoclimatic, and archaeological. Both must be answered together, because the credibility of the reconstruction depends on the convergence of its independent lines of evidence.

The argument unfolds in five steps. Section 2 establishes the cartographic foundation: the reference lines and scaling that anchor the proposed reconstruction, including a revised reading of the southern boundary river. Section 3 reconstructs the antique coastal and amphibious zone of the southern North Sea and Baltic margins, and integrates the classical tradition of the *Cimbrian flood* as an independent witness to a major late-Holocene transgression. Section 4 develops the geodynamic framework — late reactivation of the Caledonian Deformation Front and adjacent suture zones — that may account for the inferred change. Section 5 develops the *Event-Dark-Earth* hypothesis and reinterprets the palynological record in its light. Section 6 considers the archaeological, demographic and historical consequences, before Section 7 closes with a discussion of testable predictions and outlook.

Where the Berlin school approaches the Ptolemaic record as a defective image of the modern landscape to be corrected, the present approach reads it as a substantially intact image of an ancient one, whose recovery requires the geological as much as the cartographic imagination. The two approaches are not in direct competition; they answer different questions, and the question pursued here — whether the late-Holocene landscape of Central Europe has remained as stable as conventionally assumed — must be addressed before the conventional geodetic-rectification question can be properly framed.

2. Cartographic Foundation

The principal cartographic source for the reconstruction is the *Quarta Europe Tabula* of Donnus Nicolaus Germanus, transmitted through the late-fifteenth-century printed editions of Ptolemy's *Geographia*. This map is a medieval reconstruction rather than an original document of antiquity, and it carries the inevitable imprint of its time. Yet its topological structure — the relative positions of rivers, mountains, settlements and the coastline of the *Oceanus Germanicus* — preserves Ptolemy's coordinate data with a fidelity sufficient for cartometric overlay. The fidelity is, in fact, surprisingly high, and as the present analysis shows, the apparent errors in the medieval map are systematic in a way that points to their underlying cause.

2.1 Reference Lines and the Global Scaling Factor

For the overlay analysis, the Rhine serves as a robust western invariant: its middle and lower course has not migrated materially since antiquity, and it can be matched directly to the modern river. The southern reference is provided by the river that Ptolemy calls *Danubius*, although — as Section 2.4 discusses in more detail — the identification of this river with the modern Danube is no longer regarded here as the sole admissible option, and an alternative identification with the modern Main is explored. For the present cartometric analysis, the southern anchor is therefore taken as the Ptolemaic *Danubius* understood topologically (a river running approximately west–east along the southern map margin), without prejudging its identification with either modern referent.

Two further structural reference points complete the anchor set: the *Asciburgius Mons*, here identified with the Fläming and its south-eastern foothills, including the present-day town of Baruth/Mark in the north-east, which Ptolemy calls *Limios alsos*; and the eastern margin of the map, where the Oderbruch and the Ziltendorfer Niederung mark the boundary toward Sarmatia.

When the Ptolemaic grid is overlaid on the modern topography using these four anchors and the geometric length ratios are preserved, a striking result emerges. The northern coastline of the *Oceanus Germanicus*, as recorded in the Ptolemaic data, does not coincide with the present-day coastline at all. It falls approximately 120 kilometres further south, at a latitude of roughly 52°50′ N, in the latitudinal vicinity of Eberswalde and just north of Berlin.

The implied scaling factor, derived from the Rhine–Elbe baseline, comes to approximately 28 kilometres per Ptolemaic degree of longitude. What is significant is not the precise numerical value but the fact that this single scaling factor, applied uniformly across the entire map, reproduces the relative positions of the Harz, the Thuringian Forest and the other significant landmarks with a fit that is substantially better than reconstructions that retain the modern coastline as the northern reference. The cartometric anomaly, in other words, is concentrated almost entirely along the northern axis of the map: as one moves north, the Ptolemaic positions diverge progressively from the modern ones, in a manner consistent with the systematic northward stretching that would be expected if a medieval editor were forced to reconcile an ancient grid anchored on a southerly coastline with the present-day coast.

2.2 The Vistula Fluvius as the Lusatian River System

This observation has a direct consequence for the eastern boundary of *Germania Magna*. If the northern reference line is displaced southward by 120 kilometres, then the mouth of the *Vistula Fluvius*, which Ptolemy places at this coastline, must correspondingly lie further south than has traditionally been assumed. Overlay analysis with preserved aspect ratios indicates that the *Vistula Fluvius* of the Ptolemaic record corresponds — at least over significant portions of its course — not to the present-day Polish Vistula but to the river system of the Schwarze Elster, the Spree, and the Oder in Lusatia. Under this identification, one source area of the river lies in the Königsbrücker Heide, where a Sorbian settlement called Krakow is later attested; the other lies further east, near Königswartha. The river's reconstructed course runs from these sources northwards through the Lusatian lowlands to a mouth in the area of the present-day Oderbruch.

Three considerations support this identification. The first is **topological**. Ptolemy's text, faithfully visualised by Germanus, requires that more than half of the *Vistula Fluvius*'s course lie south of the *Asciburgius Mons* and that two principal source branches converge east of that range. This topology is structurally incompatible with the modern Polish Vistula, which rises on the slopes of the Silesian Beskids well to the north and east of the required positions. By contrast, the Lusatian Schwarze Elster–Spree system satisfies both topological constraints exactly: its source areas lie south of the Fläming, and its tributaries converge in the lowlands to the east before reaching the Oder.

The second consideration is **etymological**. The Greek form appears to derive from Latin *ustulō*, "to scorch or char by fire" — a verb related to the English adjective *ustulate*, applied both to the blackened appearance of charred material and to the roasting of ores in metallurgical processing. The Lusatian region in question is archaeologically attested as a major centre of bog-iron extraction and charcoal-based bloomery iron production from the late pre-Roman Iron Age through the Roman Iron Age, with concentrations of iron-smelting sites at, among other places, Elsterwerda. A river flowing through a "smoke-scarred" landscape of charcoal piles and bloomeries supplies a plausible referent for the toponym, and the modern German name *Schwarze Elster* (Black Elster) may itself preserve a memory of that landscape.

The third consideration is **historical and demographic**. The eastward migration of the name *Vistula* during the medieval reception of Ptolemy can be coherently explained by the well-attested demographic discontinuity of the late fifth and sixth centuries (Volkmann, 2013, 2014; Bemmann, 2023; Czerwiński et al., 2024). With the disappearance or withdrawal of the Germanic groups — Burgundians, Lugii, and others — who had carried the oral tradition linking the name *Vistula* to its Lusatian referent, the name became detached from the river. When medieval scholars rediscovered the *Geographike Hyphegesis* and projected its coordinates onto a landscape whose coastline had in the meantime retreated some 120 km northward, they were obliged to stretch the eastern part of the grid correspondingly. The result was that the name *Vistula* attached itself to the next plausible eastern river: the modern Polish Vistula. This is not a hypothesis of physical river migration: the river itself did not move; only the cartographic projection did, under the compounding pressure of an unrecognised coastal shift and a broken chain of toponymic transmission.

2.3 The Asciburgius Mons as the Fläming

The same framework resolves a long-standing puzzle regarding the *Asciburgius Mons*. Under the conventional identification with the Sudetes or the Krkonoše, Ptolemy's topology requires the *Vistula Fluvius* to flow more than half its length south of those mountains — a hydrography that the modern Polish Vistula cannot satisfy and that the geography of central Bohemia in fact precludes. Identification with the Fläming dissolves the puzzle: the distinctive bend of the depicted mountain range, visible on the Germanus map, corresponds geometrically and structurally to the tectonic hinge zone of the Fläming–Lusatia complex, with the rigid Lusatian Block acting as a kinematic pivot. What had seemed an impossible Ptolemaic topology turns out to be an accurate description of a real central European tectonic feature, once the underlying coastal shift is restored.

2.4 A Revised Southern Boundary: *Danubius Fluvius* as the Modern Main, *Abnoba Mons* as the Taunus

The conventional identification of Ptolemy's *Danubius Fluvius* with the modern Danube has long appeared self-evident, not least because Tacitus explicitly locates the source of the Danube on the *Abnoba Mons*: *"Danuvius molli et clementer edito montis Abnobae iugo effusus pluris populos adit"* (Tacitus, c. 98 AD, *Germania* 1). The traditional identification of *Abnoba Mons* with the Black Forest has then made the identification of *Danubius* with the modern Danube appear unavoidable. Recent cartometric work by the present author, however, suggests that this received identification deserves re-examination within the framework developed here (Mildner, 2026b).

Two observations point toward a revised reading. First, the relative geometry of the Ptolemaic *Abnoba Mons*, when scaled by the ≈28 km per Ptolemaic degree of longitude derived from the Rhine–Elbe baseline, places it considerably further north than the Black Forest: in the area of the present-day Taunus, immediately south of the lower Rhine valley. Tacitus' description of the Danubius rising on the "gently and softly elevated ridge" of the *Abnoba Mons* is consistent with the morphology of the Taunus crest, and the position is also consistent with Ptolemy's placement of Mogontiacum (Mainz) at the river's headwaters — a placement that the standard Black-Forest identification cannot easily reconcile. Second, the deeply meandering course of the modern Main between Bamberg and Mainz, which contrasts strikingly with the relatively straight courses of comparable Central European rivers, may itself be a late-tectonic feature: the consequence of NNW–SSE-directed crustal shortening associated with the proposed block rotation of the Thuringian Forest and the northward approach of the Erzgebirge. Under the present framework, the Main is therefore plausibly read as the antique *Danubius Fluvius*, with its source area on the *Abnoba Mons* (Taunus) and its general west–east course consistent with Ptolemy's description.

The Mercator map of 1569 (*Nova et aucta orbis terrae descriptio*) appears to preserve a closely related cartographic problem on its left margin, where the placement of Mogontiacum (Mainz) does *not* fall south of the Taunus as Ptolemy's coordinates would require, and where Budoris (near Cologne-Deutz) does not lie directly opposite Agrippinensis (Cologne-Altstadt). This is most plausibly explained as a scaling error introduced when Mercator joined the coordinates of *Gallia Belgica* (Ptolemy's Book II, Chapter 8) at the western edge of the map with those of *Germania Magna* (Book II, Chapter 11) on the right side of the Rhine. Correctly rescaled, the western Ptolemaic landscape and the western fringe of *Germania Magna* align coherently around a southern boundary river that is most consistent with the Main and its Taunus headwaters, rather than with the modern Danube.

This revised reading does not invalidate the cartometric overlay developed in Section 2.1: the global scaling factor remains anchored on the Rhine–Elbe baseline, and the eastern margin remains anchored on the Oderbruch zone. It does, however, imply that *Germania Magna* as Ptolemy described it was more compact in north–south extent than the conventional reading allows — bounded to the north by the amphibious zone of the *Oceanus Germanicus* at $\approx 52°50'$ N, and to the south by a southern boundary river running along the present-day Main valley. The reading is offered as a working hypothesis, mutually consistent with the other reidentifications proposed in this paper, and explicitly open to falsification through targeted geomorphological re-evaluation of the Main valley and through high-resolution topographic re-analysis of the relevant Ptolemaic coordinates (Mildner, 2026b).

Section Summary: Cartographic Foundation

The cartometric reconstruction anchors on four physically invariant reference structures (Rhine, southern boundary river, Fläming–Lusatia hinge, Oderbruch eastern margin) and a single global scaling factor of ≈28 km per Ptolemaic degree of longitude. This places the northern coastline of the *Oceanus Germanicus* approximately 120 km south of its present position, at ≈ 52°50′ N. The *Vistula Fluvius* is identified with the Lusatian Schwarze Elster–Spree–Oder system on convergent topological, etymological, and demographic grounds; the *Asciburgius Mons* with the Fläming. The southern boundary river *Danubius Fluvius* may, on a revised reading, correspond to the modern Main, with *Abnoba Mons* identified as the Taunus rather than the Black Forest. The dominant systematic discrepancy in the Germanus map arises not from primary measurement error in Ptolemy but from medieval re-projection onto a transformed landscape, compounded by editorial scaling errors at the boundary between adjacent chapters of the *Geographike Hyphegesis*.

3. The Antique Coastal and Amphibious Zone

If the cartometric reconstruction is taken seriously, it requires that during the Ptolemaic period the coastline of the *Oceanus Germanicus* lay approximately 120 kilometres south of its present-day position, at a latitude of about 52°50′ N. The implied submarine, marshy or intermittently dry area encompassed substantial portions of present-day Brandenburg, Mecklenburg-Vorpommern, Schleswig-Holstein and the Cimbrian (Jutland) Peninsula, the last of which had, in this reconstruction, not yet consolidated into a continuous landmass with the European mainland.

3.1 Character and Extent of the Amphibious Zone

The character of this zone deserves close attention, because it determines what an ancient observer would actually have seen on approach from the sea. Rather than a sharply defined coastline of the modern type, the northern boundary of *Germania Magna* is here reconstructed as a broad, gradational amphibious zone — a vast, possibly long-term flooded floodplain and delta landscape comparable in character, if not in scale, to extant analogues such as the Mississippi Delta, the Everglades, or the Pripyat Marshes. Extensive reed beds, shallow lagoons and a labyrinth of waterways would have characterised the transition between solid land and open sea, and the visual horizon for an approaching observer would have consisted not of a fixed shoreline but of water and varying densities of vegetation, navigable in places with small boats but impassable to larger seagoing vessels. The strategic implication is direct: such a zone would have constituted a highly effective natural barrier against seaborne incursion, a fact whose significance for the security of *Germania Magna* would not have escaped its inhabitants.

3.2 Stratigraphic and Sea-Level Evidence

Several lines of evidence support this reconstruction. The first comes from the peat stratigraphy of the classic fen areas of north-eastern Germany. In the Oderbruch, the Rhinluch, the Havelländisches Luch, and the glacial valley near Eberswalde, peat layers of metre-scale thickness rest directly on sand or lacustrine mud. These stratigraphies record the long-lived activity of exactly the kind of reed-and-water-grass environments that the reconstruction calls for, at or near a fluctuating shoreline. Peat of this kind does not form in dry uplands; it forms where reeds, sedges, and rushes accumulate organic matter under waterlogged, oxygen-poor conditions, and its persistent presence in these regions across thousands of years of the late Holocene attests to the long-term character of the underlying hydrological regime.

A second line of evidence comes from the systematic study of relative sea-level (RSL) along the southern Baltic coast. Lampe et al. (2011), in their compilation of three new RSL curves for the north-eastern German Baltic Sea coast spanning the last 9,000 years, document a complex pattern of post-glacial coastal evolution in which the eustatic and glacio-isostatic components combine differently along the coast. Their analysis shows that the south-western section of the German Baltic coast is presently undergoing slight submergence, plausibly as the consequence of a collapsing glacial forebulge, while further north isostatic uplift is still ongoing. For the southern North Sea, Bungenstock et al. (2021) have likewise produced a high-resolution RSL curve for the East Frisian barrier coast, documenting substantial Holocene variability. None of these studies, individually, demonstrates the specific 120-kilometre coastline displacement proposed here for the Ptolemaic period; but collectively they establish that the late-Holocene coastal zone of the southern Baltic and southern North Sea is hydrologically dynamic on timescales that admit of substantial change, and that the assumption of long-term coastal stability — which underlies the dominant rectification paradigm — is not warranted. Arfai et al. (2018) provide additional evidence for rapid Quaternary subsidence in the north-western German North Sea, with documented subsidence rates that exceed Cenozoic averages by an order of magnitude.

3.3 The Blinkerwall and the Long-Term Transgression of the Southern Baltic

A third line of evidence, from the prehistoric record, demonstrates the magnitude and the long-term character of the geographical changes of which this region is capable. The discovery by Geersen et al. (2024) of the *Blinkerwall* — a 971-metre-long submerged Stone Age hunting structure of 1,673 stones at 21 metres water depth in the Bay of Mecklenburg, terminus post quem 9,143 $\pm$ 36 BP — is decisive here. The Blinkerwall predates the Ptolemaic horizon by more than ten thousand years, and the dominant mechanism of its submersion was the Littorina transgression rather than the kind of geodynamic event proposed here for the sixth century AD. Its significance for the present argument is not that it dates the proposed event, but that it documents an unambiguous historical example of the same kind of process: a gradual, multi-millennial transgression that progressively submerged substantial inhabited and humanly modified terrain in the southern Baltic basin.

This long-term transgression is precisely the kind of process whose cumulative effect, by the late antique horizon, would have progressively reduced the available land area of any limited landmass in the southern Baltic shelf zone — including, on the reinterpretation developed in Section 3.6, the island massif here identified as Ptolemaic and Jordanean *Scandia*. A territory that may have been substantially larger in the late Pleistocene and early Holocene would, by the early centuries AD, have shrunk to a fraction of its former extent. Under such a process, demographic pressure on the remaining inhabited core would have intensified progressively, providing exactly the kind of mechanism that the migration tradition transmitted by Jordanes presupposes. The Blinkerwall thus functions not as direct evidence for the proposed mid-sixth-century event, but as an independent, well-dated demonstration that the type of process required by the model is empirically documented in the relevant basin.

3.4 A Volumetric Plausibility Check

A simple volumetric estimate places the proposed coastline regression in further physical context. A northward retreat of approximately 120 km along a 400-km coastline, with an average seafloor elevation of order 7.5 m in the affected zone, implies a sediment exposure volume of order 360 km^3. For comparison, the early-Holocene Storegga Slide is estimated at approximately 2,400–3,200 km^3 (Weninger et al., 2008), so the required volume represents roughly 13 per cent of that event — well within the range of a single major compressional-foreland sediment redistribution event, and therefore physically admissible within the geodynamic framework developed below.

3.5 The Cimbrian Flood as Classical Witness to Transgression

The classical historiographic record itself preserves a tradition of catastrophic marine flooding on the southern North Sea coast that deserves explicit consideration in this context. Poseidonios, as transmitted by Strabo (Strabo, c. 7 BC–AD 23, *Geographika* VII.2.1–3), attributed the migration of the Cimbri and Teutoni at the close of the second century BC to a violent inundation of their coastal homeland: the Cimbri were said to have been driven from their settlements by a great flood. Earlier in the tradition, Ephoros and Aristotle had already referred to the conflict of the North Sea coastal peoples with the sea, and Poseidonios is reported as having hypothesised a sudden marine transgression caused by a violent uplift of the sea floor — a description physically consistent with what would today be called a tectonic tsunami or an earthquake-driven seiche. Ammianus Marcellinus, writing in the fourth century, preserves the tradition as an established element of the classical ethnographic record (Ammianus Marcellinus, c. 390 AD, XV.10.7), transmitting the flood-causation account into late antiquity.

Modern philological scholarship has long debated whether such a flood can have been the sole cause of so substantial a population movement, and has been right to point out that demographic, agricultural, and social pressures are more plausibly the principal drivers of any large-scale migration (Beckers, 1934). But the question of sufficient causation is independent of the question of what the classical sources transmit. They transmit, with remarkable consistency across multiple independent traditions, the memory of a catastrophic marine inundation on the southern North Sea coast in the late pre-Roman Iron Age. Within the framework developed here, this tradition is most naturally read not as an isolated meteorological event but as one episode in the long-term, episodic transgression sequence that the geological record (Section 3.3) independently documents. The Cimbrian flood tradition and the Blinkerwall record converge on the same conclusion: the southern North Sea and southern Baltic coastlines have been subject, throughout the late Holocene, to substantial transgressive events whose cumulative effect was a progressive reduction of inhabited coastal and offshore land area, and whose late-antique culmination is precisely what the framework developed in this paper infers.

3.6 The Scandian Question

The position of *Scandia* in Ptolemy and Jordanes admits of fresh consideration in this light. Under the conventional identification with the Scandinavian Peninsula, Jordanes' description of *Scandia* as the *vagina nationum* and *officina gentium* sits poorly with the population demography: it is difficult to motivate the migration of the Goths under Berig from so vast a territory on grounds of resource scarcity. Within the framework developed here, an alternative reading becomes available (Mildner, 2026c), in which *Scandia* originally designates a topographically bounded island massif within the shallow-shelf zone of the southern Baltic, in the area of present-day Mecklenburg-Vorpommern, separated from the mainland by the amphibious zone of the *Oceanus Germanicus*. Such a limited territory — and more importantly, one that the long-term transgression documented by the Blinkerwall record and by the Cimbrian flood tradition would have been progressively reducing throughout prehistory and antiquity — would render the demographic pressure mechanism plausible. The identification is consistent with the position assigned by Ptolemy (opposite the mouths of the *Vistula Fluvius*, as reconstructed in Lusatia), and accords with the documented prehistoric capacity of the southern Baltic for substantial landmasses now submerged.

The chronological framework of Jordanes' migration narrative places Berig's voyage roughly two millennia before the mid-sixth century AD, that is, in the thirteenth to fifteenth centuries BC — a window that overlaps closely with the radiocarbon dating of the Tollense Valley conflict horizon (c. 1300–1250 BC) and its remarkable evidence for organised Bronze-Age warfare in the immediate southern-Baltic hinterland (Jantzen et al., 2011). While no direct causal linkage between the two records can presently be demonstrated, their chronological and geographical proximity, together with the Cimbrian flood tradition for the late pre-Roman Iron Age and the documented late-Holocene transgression record, warrant serious consideration of an integrated scenario in which progressive demographic pressure on a constrained and shrinking southern-Baltic island massif drove both the Tollense conflict, the later Cimbrian migration, and the Gothic migration tradition transmitted by Jordanes.

Section Summary: The Antique Coastal and Amphibious Zone

The northern boundary of *Germania Magna* in the Ptolemaic period is reconstructed as a wide amphibious delta-and-marsh landscape at approximately 52°50′ N. The reconstruction is supported by peat stratigraphies, by the late-Holocene variability of southern Baltic and North Sea RSL records, by a volumetric estimate ($\approx$360 km^3) that places the required sediment exposure within plausible geological parameters, and by two independent witnesses to long-term marine transgression in the same region: the *Blinkerwall* as direct geological evidence, and the *Cimbrian flood* tradition transmitted by Poseidonios, Strabo, Ephoros, Aristotle and Ammianus Marcellinus as historical witness. The cumulative effect of this transgression progressively reduced any limited southern-Baltic landmass, supplying the demographic pressure mechanism that Jordanes' Gothic migration narrative presupposes; a reinterpretation of *Scandia* as a southern-Baltic island massif rather than as the Scandinavian Peninsula resolves the demographic difficulties of that narrative and links the chronology to the Tollense Bronze-Age conflict horizon as one in a sequence of pressure-driven episodes.

4. Geodynamic Framework

The cartometric and palaeoenvironmental evidence developed in the preceding sections requires a geodynamic mechanism capable of producing the inferred coastal regression on the relevant timescale. This section outlines such a mechanism, drawing on the substantial recent literature on the structural architecture of the southern North Sea, the Baltic margin, and the Central European Basin System.

4.1 Late Reactivation of the Caledonian Deformation Front

The proposed dominant mechanism is a late-stage reactivation of the Caledonian Deformation Front (CDF) — the long-lived suture zone marking the boundary between the ancient continents of Avalonia and Baltica — and of the associated structures of the Trans-European Suture Zone (TESZ) (Pharaoh, 1999), under the compressional stress regime of the closing phases of Alpine convergence. The mechanical sensitivity of the European intraplate domain to plate-boundary stress variations is by now well established. Nielsen et al. (2007), examining the mid-Palaeocene record of the Sorgenfrei–Tornquist Zone, demonstrated that the European intraplate basins can respond plate-wide and near-instantaneously to changes in plate-boundary forces, with no requirement for an underlying mantle-plume driver. Their elastic-shell modelling places the relevant compressive force of Africa–Europe convergence at the order of 3–4×10^{12} N m^{-1}, comfortably sufficient to drive intraplate deformation at the magnitude required.

The structural architecture that permits this response is by now imaged in detail. Lyngsie & Thybo (2007), working along MONA LISA Profile 3, document a 150-kilometre-wide overthrust zone in which Avalonian upper crust was obliquely thrust over Baltica lower crust in a ramp–flat–ramp geometry — precisely the structural template that could permit renewed northward thrusting under appropriate stress conditions. Thybo & Nielsen (2012) further refine the picture through analysis of crustal intrusions in the Danish Basin. More recent work by Smit et al. (2016) has refined the position of the Thor suture and identified a hitherto unrecognised low-velocity crustal segment between Avalonia and Baltica that extends the previously assumed Avalonian margin some 150 kilometres further south. Deutschmann et al. (2018), working with reprocessed seismic data from the Baltic Sea west of Rügen, identify six polyphase reactivation episodes of the TESZ between the Caledonian collision and Late Cretaceous inversion tectonics — establishing the structural domain as a recurrently reactivatable weakness, not a single-event suture.

The recognition that this domain is repeatedly reactivatable has gained substantial weight from more recent work on the Late Cretaceous to early Tertiary inversion of the Central European Basin System. Kley & Voigt (2008), in a paper that explicitly redirected attention away from Alpine collision as the relevant driver, showed that the Late Cretaceous intraplate thrusting in central Europe is the kinematic and chronological signature of Africa–Iberia–Europe convergence rather than of Alpine collision proper, with the deformation onset coinciding with the change of Africa's relative motion from sinistral transform to NE-directed convergence around 90 Ma. Voigt et al. (2021) have refined the chronology, dating the synchronous onset of basin inversion to approximately 95 Ma. Mazur et al. (2005), comparing the modes of inversion in the North German and Polish basins, show that the inherited basement architecture controls the spatial distribution of the inversion structures, with the Elbe Fault System in north Germany and the Teisseyre–Tornquist Zone in Poland providing the principal weakness zones that the compression exploits. The Zechstein evaporites, where present, act as a mechanical décollement, decoupling the supra-salt cover from the sub-salt basement and producing thin-skinned inversion structures in the cover. The whole architecture is one of layered, structurally pre-conditioned weakness, in which late-stage compressional reactivation under appropriate stress conditions is not only possible but, on the available evidence, recurrent.

Within this framework, the mechanism proposed for the inferred late-Holocene transformation of *Germania Magna* is a renewed northward thrust of the Avalonian leading edge onto the Baltic plate — possibly representing the initiation of a localised and temporally limited new subduction phase — under the late phase of Alpine convergence. The kinematic consequence would be a lowering of the relative sea level on the North German coast, exposing previously submerged portions of the Central European Basin, while the leading edge of the Avalonian plate would be expressed at the surface as the uplift of Rügen, today an eroded surface remnant of what was once a more substantial structural high. The associated north–south compressive shortening of the continental crust would account for the documented graben structures of central Europe and may have contributed to the present-day topographic relief of the Erzgebirge and the surrounding ranges; the historical seismic record of the Erzgebirge (Meier, 1998) suggests that this deformation history is not entirely quiescent.

4.2 Block Rotation about the Lusatian Anchor

A specific kinematic consequence of the proposed CDF reactivation is the documented dextral rotation and lateral displacement of crustal blocks within the deformation field, with the rigid **Lusatian Block** (Lusatian Granodiorite, Neoproterozoic–Cambrian, 505–520 Ma) acting as a kinematic anchor. Too rigid to deform internally, the block would rotate about its margins, imparting a characteristic curvature to overlying and flanking sedimentary structures. Rotation about this anchor accounts simultaneously for several observable cartometric features: the characteristic southward curvature of the Fläming (= *Asciburgius Mons*) as depicted by Germanus, mirroring the structural curvature of the Fläming–Lusatia tectonic hinge; the systematic offset of the Harz and Thuringian Forest blocks relative to their expected positions under a simple northward-convergence model; the deeply meandering course of the modern Main between Bamberg and Mainz, consistent with NNW–SSE compression of an originally straighter *Danubius Fluvius* channel (Section 2.4); and, most diagnostically, the systematic eastward displacement of the eastern Ptolemaic place-name cluster (*Budorigum*, *Limis Lucus*, *Lugidunum*, *Stragona*) relative to the reconstructed pre-displacement positions in the eastern Harz foreland. What conventional geodetic approaches dismiss as measurement noise here appears as a coherent directional signal whose orientation matches the kinematic prediction of block rotation about the Lusatian anchor.

4.3 The Question of a Trigger

The mechanisms outlined above can in principle proceed under slowly accumulated tectonic stress alone. Stresses accumulated in the European lithosphere over tens of millennia — partly through the load-and-unload cycle of the great Pleistocene ice sheets — could in principle have been released episodically, with the late-Holocene phase representing one such episode. The systematic Holocene RSL record (Lampe et al., 2011; Bungenstock et al., 2021; Lambeck et al., 1998) is consistent with ongoing isostatic adjustment. Yet the cartometric evidence developed here implies a relatively rapid reorganisation, on sub-centennial timescales, and the convergent body of historical and palaeoclimatic evidence — to which the discussion returns in Section 6 — concentrates in a narrow window around the mid-sixth century AD. This raises the question whether some external trigger may have catalysed the deformation.

Three broad classes of trigger are admissible. The first is **endogenic stress relaxation** of the kind just outlined: the slow accumulation of compressive stress, episodically released. The second is **enhanced regional volcanism**. High-resolution ice-core chronologies have now established that the period 536–550 AD in particular was marked by a cluster of substantial volcanic events. Larsen et al. (2008) identified a major near-equatorial eruption dated to 533–534 $\pm$ 2 AD; Sigl et al. (2015) refined the chronology to identify the events of 536 and 540 AD as the dominant volcanic forcings of the mid-sixth century, with Toohey et al. (2016) characterising the sequence as a volcanic "double event"; and Büntgen et al. (2016) showed, on the basis of Russian Altai and European Alpine tree-ring chronologies, that the cooling sustained by these eruptions, together with ocean and sea-ice feedbacks and a solar minimum, defines an extended cold phase from 536 to about 660 AD — the *Late Antique Little Ice Age.* The Late Antique Little Ice Age has now entered the mainstream literature as an environmental factor contributing to the establishment of the Justinianic plague, the transformation of the Eastern Roman Empire, the collapse of the Sasanian state, the movements out of the Asian steppe, the spread of Slavic-speaking peoples, and the political upheavals in China (Harper, 2017; Wickham, 2009; Curta, 2001). Its existence is no longer in serious dispute.

The third class of trigger, more speculative but explicitly admissible, is a **cosmic-impact or airburst event of cometary origin**. The most direct evidence comes from the GISP2 Greenland ice core, in which Abbott et al. (2014) document four discrete chondritic and Sn-rich cosmic-spherule horizons in the window 533–540 AD, together with elevated atmospheric dust loading and the signature of a low-latitude oceanic disturbance. The morphology of the cosmic particles, their volatile enrichment, and the late-spring seasonality of their peak deposition are all consistent with cometary rather than asteroidal origin. Two specific cometary parent bodies are candidate sources for the relevant debris stream. The first is Comet 1P/Halley, whose well-documented perihelion of 530 AD, together with orbital modelling of the Eta Aquariid stream and the historical record of close approach to Jupiter in 164 BC, provides a plausible fragmentation history and a debris-stream intersection geometry consistent with the late-spring deposition peak in GISP2 (Sicoli et al., 2022; Yeomans, 1991). The second, identified in more recent astronomical work, is comet C/539 W1, a long-period comet observed across Europe and Asia from 17 November 539 AD onward, described in contemporary chronicles as exceptionally bright and characterised in the JPL Small-Body Database as a long-period comet with semi-major axis of ≈91 AU and an orbital period of approximately 870 years (JPL Small-Body Database; Kronk, 1999). NASA and SETI Institute work has linked the debris stream of this comet to the irregular 15-Boötid meteor shower (IAU #923) that produced anomalous activity in 2019, raising the possibility that the parent body underwent fragmentation in close passage to one of the inner planets (plausibly Venus) and that fragments of this stream were responsible for one or more of the discrete chondritic horizons recorded by Abbott et al. (2014). The cometary scenario does not require an entirely new mechanism; on the contrary, it sits comfortably within the broader framework of the Late Antique Little Ice Age, with the volcanic and cosmic forcings as complementary rather than competing drivers.

A fourth and explicitly more speculative possibility, included here only for completeness, is that an additional impactor on the southern margin of the African plate could have contributed an impulsive acceleration to the Africa–Europe convergence already documented by Nielsen et al. (2007) as the dominant driver of European intraplate stress propagation. Allan & Delair (1997) have argued in broader terms for a late-Holocene impact-driven perturbation of the global plate-tectonic system; their argument is not adopted here in its strong form, but the possibility that the integrated stress budget required for CDF reactivation included a contribution of this kind cannot, on present evidence, be excluded. As the geodynamic response would in any case follow from the integrated stress state of the European plate, this speculative addition does not alter the substance of the framework developed here, and is mentioned only as an admissible component of the trigger discussion.

What is essential for the present argument is that the geodynamic framework does not depend on the question of trigger. The CDF and TESZ are demonstrably reactivatable; the late-Holocene stress regime is sufficient to drive their reactivation under appropriate conditions; and the chronology of the inferred response is consistent with the converging palaeoclimatic and historical record. Whether the deformation was catalysed by slow endogenic stress relaxation, by the volcanic-climatic forcing of the Late Antique Little Ice Age, by one or more cometary impulses, by a contribution from an impact on the southern African plate margin, or by some combination of these is a question that future work must resolve. The model outlined here is robust to the choice of trigger.

4.4 A Methodological Note on Impact-Structure Dating

A predictable objection to the cometary-trigger scenario concerns the radiometric dating of candidate impact structures within the Central European domain. The Bohemian Massif (Český Kráter; Rajlich 2007) is variously dated by the conventional literature to the Proterozoic on the basis of detrital zircon ages of approximately 2 Ga from associated breccias and sediments. This appears, at first sight, incompatible with the late-antique chronology proposed here in the companion preprint (Mildner, 2026a). A standard mineralogical consideration substantially attenuates the difficulty. Zircon ($ZrSiO_4$) is among the most refractory minerals known, with closure temperatures well above the peak temperatures reached in most impact melts and breccias. When an impactor strikes a basement composed of, for example, ≈2 Ga Bohemian crystalline rocks, the great majority of the existing zircon population survives the event mechanically and chemically essentially intact, becoming entrained as inherited xenocrysts within the new impactite. The radiometric age of the inherited zircon population reflects the age of the target rocks, not the age of the impact event. New zircon generated during the impact itself is typically rare, volumetrically subordinate, and difficult to isolate from the inherited population without targeted SHRIMP or laser-ablation methods specifically designed to identify shock-recrystallised domains. The apparent Palaeoproterozoic age of the Český Kráter structure is therefore not a decisive falsification of a younger event horizon within it: it is most naturally read as an inheritance signal from the ancient host rocks, and a properly designed dating campaign — explicitly targeting melt-glass matrix phases and shock-recrystallised domains rather than bulk detrital populations — is required before the radiometric record can be brought to bear on the question of the impact age itself. This consideration is included here not to defend any specific chronological assignment, but to clarify what the standard radiometric arguments can and cannot demonstrate.

Section Summary: Geodynamic Framework

The proposed mechanism is a late reactivation of the Caledonian Deformation Front and Trans-European Suture Zone under late-Alpine compression, producing a northward thrust of Avalonia onto Baltica and a corresponding drop in relative sea level along the North German coast. The deep-crustal architecture for such reactivation is independently imaged by MONA LISA deep-seismic profiles and is documented as recurrently reactivatable through six polyphase inversion episodes since the Caledonian collision. The rigid Lusatian Block functions as a kinematic anchor about which the observed eastward offset of the Ptolemaic place-name cluster, the curvature of the Fläming, the offsets of the Harz and Thuringian Forest, and the deeply meandering modern course of the Main can be coherently accounted for. The chronology admits several classes of catalyst — endogenic stress relaxation; the volcanic "double event" of 536–540 AD with its associated Late Antique Little Ice Age; the cometary particle horizons in GISP2 associated with Comet 1P/Halley and the newly characterised long-period comet C/539 W1; and, more speculatively, an additional impulsive contribution from the southern margin of the African plate — whose effects are complementary rather than mutually exclusive.

5. The Event-Dark-Earth Hypothesis

If the geodynamic mechanism proposed here operated on the timescale and amplitude implied, then it should have left a sedimentary signature in the Central European stratigraphic record. The most plausible candidate for that signature is to be sought in the phenomenon of *Dark Earth*.

5.1 The Stratigraphic Problem

So-called Dark Earth layers — thick, dark-brown to black, highly humic, structurally homogeneous soil horizons, commonly 0.2 to 1.0 metres thick and occasionally substantially more — are widespread in European urban and urban-adjacent excavations, where they typically separate Late Antique from High Medieval cultural strata. They have been the subject of substantial scholarly attention since at least the 1980s. The catalogue compiled by Gaberz (2014) documents the phenomenon at numerous European sites, and a substantial mainland-European research tradition has grown up around it, drawing in particular on the methodological apparatus of soil micromorphology. The classic studies of Macphail et al. (2003), the integrated archaeopedological and phytolith work of Devos et al. (2009) on the Brussels deposits, the Italian case studies of Nicosia et al. (2017) on the Florence Biblioteca Magliabechiana deposits, and the more recent geoarchaeological investigations of the Mikulčice complex in early-medieval Moravia (Lisá et al., 2022) all converge on a model in which Dark Earth represents a multi-phased product of accumulation, erosion, decomposition, and bioturbation — the result of variable combinations of human activities (pasture, agriculture, quarrying, destruction, middening) interacting with natural processes.

This research tradition has produced a great deal of valuable information, and the present paper does not aim to overturn it. Several features of the Dark Earth record, however, resist easy accommodation within the gradualist consensus, and these features motivate the proposal of a falsifiable subclass. The first is the extreme homogeneity of the horizon, with no internal lamination or stratification discernible to the naked eye, despite the inclusion of coarse clasts — bricks, rubble — that should be hydrodynamically and pedogenically sortable. The second is the recurrent presence of vitrified material, including the "slag" and "vitrified stones" whose formation requires temperatures in the range of 1200–1500°C, well above what domestic fires can sustain over wide areas. The third is the near-synchronous deposition of similar horizons across geographically dispersed sites in the same chronological window. The fourth is the simultaneous collapse and non-rebuilding of substantial built structures implied by the horizon. And the fifth, repeatedly stressed by Gaberz (2014), is the persistent lack of datable material within the horizon itself, which makes the layer effectively un-stratifiable by conventional means.

5.2 The Event-Deposit Reinterpretation

The hypothesis advanced here is that a stratigraphically and chronologically restricted subset of the Dark Earth record represents not the slow product of bioturbation and ruralisation but the material end-product of a sudden, high-energy depositional event: the combined action of a thermal pulse, plausibly from a firestorm of impact or airburst origin, and a subsequent flood pulse, whether of tsunami, hydrometeor, or lahar-equivalent character, reworked by decades of post-depositional bioturbation that homogenised the original chaotic matrix. This event-deposit subclass is here designated *Event-Dark-Earth* (ED-E).

Under the proposed model, the high charcoal and soot content gives the layer its characteristic black colour; the vitrified materials are reinterpreted as impactites or as clay and brick fired *in situ* by the thermal pulse rather than as industrial slag, a reinterpretation consistent with the occasionally documented occurrence of vitrified stonework on the walls of early medieval ringforts and the so-called Vitrified Forts; the chaotic clast–matrix fabric reflects the original impulsive deposition; and the absence of internal stratification reflects the rapidity of deposition combined with subsequent biological homogenisation.

The ED-E hypothesis is explicitly formulated as a falsifiable subclass, not as a replacement for the gradualist model in its entirety. Most of the Dark Earth record is plausibly the product of the slow processes that the mainstream tradition has documented in detail. The proposal here is that a subset of cases, concentrated in particular regions and in a particular chronological window, may instead represent the signature of an event of the kind that the gradualist model is not designed to recognise. The author has elsewhere specified six falsifiable predictions for an ED-E horizon (Mildner, 2026a): chaotic homogeneity with absent internal lamination; geochemical anomalies in chlorine-to-bromine ratios and in polycyclic aromatic hydrocarbons together with cosmochemical markers such as iridium and nickel; heavy-mineral basal enrichment indicative of hydraulic sorting; micromorphological evidence of impulsive mixing fabric; *in-situ* thermal anomalies incompatible with domestic fires; and a synchronous abrupt collapse of the tree-pollen curve. Each of these predictions admits of clear empirical testing, and a failure to find them at predicted sites would substantially weaken the hypothesis.

5.3 Palynology as Ecological Witness

The reinterpretation of the Dark Earth record gains support from the palynological evidence, where the conventional reading has encountered a tension that the gradualist model has been unable to resolve. The standard interpretation of the Migration-Period pollen record from bogs and lake sediments in northern Germany, the Netherlands, and Denmark describes, for the window c. 450–600 AD, an abrupt collapse of arboreal pollen — particularly oak and beech — accompanied by a sharp rise in non-arboreal pollen of grasses and herbs. This signal has classically been interpreted as massive anthropogenic deforestation. The interpretation is, however, in direct tension with the contemporaneous settlement-archaeological record. As Volkmann (2013, 2014) and Bemmann (2023) document, the same period and the same regions show a sharp settlement break: villages are abandoned, cemeteries cease, find density collapses, and the result has come to be referred to in the literature as the "hiatus." The dominant attempt at reconciliation has invoked a model of extensive pastoralism, in which the remaining population is supposed to have grazed very large livestock herds, suppressing arboreal regrowth and maintaining an open landscape. The model encounters several serious difficulties. It does not specify who managed the supposed herds in the absence of attested settlement infrastructure; it does not account for the near-total absence of livestock skeletal remains in the relevant horizons; and it requires a declining or vanishing population to undertake a substantial intensification of land use, contrary to the demographic logic of collapse.

The most recent high-resolution palynological work supports a different reading. Czerwiński et al. (2024), in their study of vegetation and human dynamics during the first millennium AD in Brandenburg, document a general decrease in settlement activities through the fourth and fifth centuries and a near-complete absence of any signs of settlement in the sixth to seventh centuries, followed by the recolonisation of a largely depopulated area by Slavic-speaking groups arriving around AD 670–700. Their pollen data show that the renewed opening of the landscape between approximately 510–650 and 650–780 AD coincides not with peak land use, as the pastoral-economy hypothesis would require, but with the recovery phase that follows the end of the cold maximum of the Late Antique Little Ice Age around the middle of the seventh century.

Under the geodynamic-impact model proposed here, the apparent contradictions of the older readings dissolve. The abrupt arboreal-pollen collapse is reinterpreted as the palynological signature of a regional firestorm triggered by the thermal pulse of an airburst or impact event, with the forest not cleared but burned, and the palynological signal correlating spatially and chronologically with the proposed ED-E sediment record. The subsequent explosive rise of grasses and herbs is reinterpreted not as evidence of pastoralism but as the pioneer-phase signal of ecological succession on a salinised, eutrophicated, post-catastrophe surface. The reinterpretation is consistent with the ecological indicator values of the relevant taxa as compiled by Ellenberg et al. (2010) and Pott (1995). Ribwort plantain (*Plantago lanceolata*), which is frequently cited as a pastoral indicator, is in the first instance an indicator of open, disturbed, light-rich soils, and its co-occurrence with mugwort (*Artemisia*), a continental steppe indicator, and with members of the goosefoot family (Chenopodiaceae), often halophytic and bearing high nitrogen-indicator values, describes not a pastoral landscape but a disturbed, nutrient-rich, salinised, climatically continental open landscape — which is precisely the expected ecological state of a recently emerged, post-marine, post-firestorm surface.

The proposed sequence of post-catastrophe ecological succession can be summarised by analogy with the well-studied recovery following the 1980 eruption of Mount St. Helens. In the first five years, the affected surface resembles a moonscape, blanketed in ash and tsunami sediment, saturated with salt, and supporting essentially no vegetation. From approximately five to thirty years, halophytic pioneers — coastal plants pushed inland by the persistent salinity — colonise the surface, and a barren, steppe-like landscape emerges. It is in this phase that the historical situation of the early Slavic and later Avar groups, the so-called horse peoples, becomes intelligible: they did not encounter, on their westward advance, the impenetrable old-growth forest that the Romans had described, but an open grassland ideally suited to a mobile livestock economy. From approximately thirty to eighty years, rain gradually leaches the salt from the soil, and the first generation of trees returns: birch, poplar, hazel. A savanna-like landscape of grasses and birch scrub emerges, and resettlement becomes feasible. It is presumably to this phase that the chronicle of Cosmas of Prague refers when it describes the *Boemus* group and its companions returning to find open land ready for arable farming, free from the labour cost of forest clearance. Only after some eighty years do the climax species — oak, beech — return on what is by then a phosphate-rich and exceptionally fertile substrate, producing the characteristically dense and dark forest that Thietmar of Merseburg, around 1000 AD, describes as the *Miriquidi* of the Ore Mountains and

Thuringia.

Section Summary: Event-Dark-Earth and Palynology

The Event-Dark-Earth (ED-E) hypothesis identifies a falsifiable subclass of Dark-Earth horizons characterised by extreme structural homogeneity, vitrification temperatures incompatible with domestic fires, geographic synchrony across sites, and the persistent absence of datable internal content. These deposits are proposed as the sedimentary product of a thermal pulse followed by a flood pulse, subsequently homogenised by bioturbation. The hypothesis makes six specific, empirically testable predictions. The palynological hiatus of the Migration Period, when re-examined in the light of Czerwiński et al. (2024), reflects not anthropogenic deforestation but a firestorm-driven ecological reset on a salinised post-marine surface, followed by pioneer halophytic vegetation and, after some eighty years, the regeneration of climax forest on an exceptionally fertile ED-E substrate.

6. Archaeological, Demographic and Historical Consequences

If the framework outlined in the preceding sections is correct in its general lines, it has substantial consequences for the interpretation of the Migration Period and its aftermath.

6.1 The Coastal Tradition: Mandränke and Maritime Cultures

The recorded coastal storm surges of the North and Baltic Seas — the *Mandränke* of the medieval record — may, at least in part, be attributable to tectonically induced or impact-induced tsunamis rather than to purely meteorological causes. The displacement of Germanic populations from coastal and amphibious zones onto offshore islands and *Halligen*-like marsh-island structures, and the subsequent development of Nordic seafaring cultures from these island bases (with a comparable role attributable to the later Varangians), becomes intelligible as a response both to the preceding marine transgression that submerged earlier settlement areas and to the subsequent Roman expansionary pressure on the mainland. The later silting and storm-destruction of such marsh-island settlements would account for their substantial absence from the present archaeological record. Cosmas of Prague's description of the later Slavic re-colonisation of Central Europe under *Boemus* speaks explicitly of a "flood of sin" (*diluvium peccati*) that had once deprived the land of its inhabitants — a tradition which, on the present reading, preserves a historical memory of the underlying environmental catastrophe (Biermann, 2005).

6.2 Disputed Ship Finds and the Usedom Boat Graves

The same framework illuminates a category of archaeological finds whose interpretation has long been disputed. Ship finds in what is now mainland Mecklenburg-Vorpommern and adjacent regions, including the so-called Usedom boat graves (Biermann, 2004), have traditionally been read as grave goods or boat-burials. Under the present model, an additional or alternative possibility presents itself: that at least some of them are the remains of vessels lost in battle or in catastrophe in what was at the time shallow water, and subsequently covered by silting, by tsunami deposition, or by aeolian sand-drift in the post-catastrophe vegetation-free interval. Future excavation strategies in this region might profitably consider this alternative depositional context, particularly where the find horizon shows evidence of rapid, high-energy burial rather than the careful covering that grave-burial would imply.

6.3 The Collapse of the Thuringian Kingdom

The political collapse of the Thuringian Kingdom around 531 AD has long been attributed, in the traditional master narrative, to Frankish military conquest. Bemmann (2023) has, however, argued on archaeological grounds that the Frankish-conquest narrative is poorly supported by the material record: there were, as he documents, no Frankish military bases on strategically located heights, no Frankish military presence demonstrable in the archaeological evidence, and no Frankish elite cemeteries in central Germany in the relevant horizon. Even if the master narrative captured the political core of the process, any putative Frankish garrison would, judging from the size of the available cemeteries, have consisted of only a few men, hopelessly outnumbered and without prospect of survival in a society without monopoly on violence. The political collapse itself accordingly requires a different explanation, and the geodynamic-impact framework proposed here — chronologically centred on the same window — supplies one: the kingdom collapsed not under Frankish military pressure but as a consequence of the environmental and demographic catastrophe that simultaneously emptied much of Central Europe and produced the climate anomaly that Büntgen et al. (2016) call the Late Antique Little Ice Age. Comparable interpretations of post-Roman demographic and political restructuring by Wickham (2009) and of early Slavic expansion by Curta (2001) fit naturally within this framework.

It is worth noting in passing, as a tentative onomastic remark, that the medieval German appellation *Barbarossa* — documented in Italy in association with members of the Hohenstaufen dynasty before being attached canonically to Friedrich I — has long defied fully satisfactory etymological explanation. Within the framework developed here, one may at least register the possibility, advanced as no more than a working speculation, that the name preserves a distant cultural memory of a fiery, red-bearded cometary apparition of the kind that late-antique chroniclers routinely described, and that the subsequent association with the dynastic recovery from the Migration-Period collapse — the "end of the barbarian age" in political-historical terms — supplied the secondary semantic anchoring of the name. The proposal is offered here only to indicate the kind of additional cultural-memory layer that the framework, if correct, would render at least admissible; it is not advanced as a serious philological claim, and is mentioned only for completeness.

6.4 Convergent Lines of Evidence

The convergence of independent lines of evidence on the window c. 525–550 AD is striking, and it is worth setting out in summary form, even though the discussion that frames it must do the substantive work. The cosmochemical record of the GISP2 ice core (Abbott et al., 2014) documents four discrete chondritic and Sn-rich particle horizons in the window 533–540 AD. The volcanic-aerosol record (Larsen et al., 2008; Sigl et al., 2015; Toohey et al., 2016) documents major eruptions in 536 and 540 AD, with a sustained climatic forcing. The tree-ring record (Büntgen et al., 2016; Hegerl et al., 2018) documents a Northern Hemisphere cooling that defines the Late Antique Little Ice Age. The Byzantine court chronicles of Procopius, Cassiodorus, and others describe a sun "without rays, like the moon" for the duration of the relevant interval. The Edessa chronicle records a catastrophic flood that came down from the mountains, struck the city walls, withdrew, and struck again, with 30,000 dead recovered and 200,000 missing. The archaeological hiatus is documented across Lower Saxony, Mecklenburg, Thuringia, and Brandenburg (Volkmann, 2013, 2014; Bemmann, 2023; Czerwiński et al., 2024). The political collapse of the Thuringian Kingdom is contemporaneous. The record of comet C/539 W1 (JPL Small-Body Database; Kronk, 1999), observed across Europe and Asia from late November 539, provides an additional, independently dated astronomical witness from precisely the relevant window. The Norse *Fimbulwinter* tradition and Cosmas of Prague's *diluvium peccati* preserve, in folkloric register, what the chronicles transmit in historical register. No single line of evidence, in isolation, is conclusive; but their mutual reinforcement across cosmochemical, dendroclimatic, Byzantine, Syrian, civic, political, archaeological, mythological, astronomical, and folkloric registers establishes the 525–550 AD window as a period of exceptional environmental and political disturbance whose explanation requires more than the volcanic-aerosol model alone, and to which the geodynamic framework developed here may contribute a missing dimension.

Table 1: Independent lines of evidence converging on a catastrophic Central European environmental event in the window c. 525–550 AD.

Evidence category	Principal source	Observation
Cosmochemistry	GISP2 ice core (Abbott et al., 2014)	Four discrete chondritic / Sn-rich particle horizons, 533–540 AD
Astronomical	i.e. Comet C/539 W1 (JPL Small-Body Database; Kronk, 1999) or Halley fragment (530AD)	Major long-period comet, observed across Europe and Asia from 17 November 539; possible Venus-perihelion fragmentation
Volcanic forcing	Greenland and Antarctic ice cores (Larsen et al., 2008; Sigl et al., 2015; Toohey et al., 2016)	Major eruptions 536 and 540 AD
Dendroclimatology	Russian Altai and European Alpine tree-rings (Büntgen et al., 2016)	Northern Hemisphere cooling, 536 to c. 660 AD (Late Antique Little Ice Age)
Byzantine chronicle	Procopius, *De Bellis* IV.14	Sun "without rays, like the moon"; persistent war, plague, disaster
Italian chronicle	Cassiodorus, *Variae*	"Summer without heat"; anomalous solar dimming
Syrian chronicle	Michael the Syrian, *World Chronicle*	Disappearance of the waters of Shiloh for fifteen years; Edessa flood; Antioch earthquake; rain of fire
Palynology	Brandenburg lake sediments (Czerwiński et al., 2024)	Settlement-pollen collapse, 5th–6th c.; Slavic recolonisation from c. 670–700 AD
Settlement archaeology	Volkmann (2013, 2014); Bemmann (2023)	Settlement hiatus, 5th–7th c., across Lower Saxony, Mecklenburg, Thuringia
Political history	Gregory of Tours; Bemmann (2023)	Collapse of Thuringian Kingdom 531 AD; archaeological absence of expected Frankish occupation
Folklore and myth	Cosmas of Prague's *diluvium peccati*; Norse *Fimbulwinter*	Tradition of a flood emptying the land; tradition of catastrophic cooling

7. Discussion and Outlook

The interpretation advanced in this paper departs in a fundamental respect from the dominant tradition. Where the dominant geodetic-rectification school treats Ptolemy's

Germania Magna as a defective description of a landscape that has remained essentially constant, the present approach treats it as a substantially accurate description of an ancient landscape that has since materially changed. The reconstruction is internally coherent, draws on a convergent body of independent evidence, and yields specific reidentifications — *Vistula Fluvius* as the Lusatian Schwarze Elster–Spree–Oder system, *Asciburgius Mons* as the Fläming, *Danubius Fluvius* possibly as the modern Main with *Abnoba Mons* as the Taunus, and the northern coastline of *Germania Magna* approximately 120 kilometres south of its present position — that are simultaneously consistent with Ptolemy's transmitted topology, with the documented archaeological and palaeoecological record, and with the structural architecture of the affected region as imaged by modern deep-seismic and potential-field methods.

7.1 Methodological Status: Against Rubber-Sheeting

The framework is offered as a falsifiable working hypothesis, not as a definitive reconstruction. A predictable objection to any cartometric approach of this kind is the concern that sufficiently flexible image-distortion procedures can be made to fit any target topology — the so-called rubber-sheeting critique. The objection misses the central methodological point. The reconstruction proposed here is not an unconstrained image-distortion procedure but a **rigidly constrained affine transformation**, anchored on a small number of physically invariant reference structures and subject to a single global scaling factor of approximately 28 km per Ptolemaic degree of longitude. Any alternative reconstruction must simultaneously satisfy four constraints: the geometric scaling rigidity of the Rhine–Elbe baseline; the hydrographic topology of a river system with two principal source branches travelling more than half their course south of a specific mountain range and converging east of it; the curvature of the depicted mountain range as corresponding to a geologically demonstrable tectonic hinge zone; and the structural and geochemical anchoring of specific Ptolemaic identifications to independently measurable geological anomalies in the modern landscape. An algorithmic least-squares minimisation across an unconstrained transformation will inevitably smooth away precisely the signal of interest, by assigning the systematic offset of the eastern point cluster to measurement noise. The present approach treats the same offset not as noise but as the diagnostic signature of a real geodynamic process, and is therefore not in direct methodological competition with conventional rectification but in interpretative tension with it.

7.2 The Climatic Context

The climatic context strengthens the chronological coherence of the proposed framework. Dansgaard et al. (1969) and subsequent palaeoclimatic syntheses, including the PAGES 2k Consortium (2013) and Büntgen et al. (2016), document that mean temperatures during the Roman Climate Optimum and through the High Middle Ages were, over multi-centennial averages, higher than during the subsequent Little Ice Age (Schönwiese, 1995). The etymology of "Greenland" as *Grünland* preserves a documented late-Iron Age and early-Medieval perception of southern Greenland as habitable agricultural land — a perception not intelligible under the climatic conditions of the last five centuries. Within this warm horizon, lower glacier mass and reduced cryospheric water storage would have raised eustatic sea level relative to the present, making the proposed 120-kilometre southward position of the *Oceanus Germanicus* coastline more rather than less plausible from a eustatic perspective. The subsequent tectonically driven RSL drop on the North German coast would then represent the localised geodynamic signal superposed on a regionally elevated eustatic baseline — a sequence consistent with the late-Holocene complexity documented in the Lampe et al. (2011) and Bungenstock et al. (2021) reconstructions.

7.3 Falsification Pathways

The framework yields concrete pathways for falsification. The most direct is targeted micromorphological, geochemical, and palynological re-analysis of Dark-Earth profiles at sites within the proposed catastrophe zone, against the six falsifiable predictions of the ED-E test concept (Mildner, 2026a). High-resolution chronostratigraphy of the coastal-zone peat sequences of north-eastern Germany, with particular attention to the chronology of the basal peat-to-sand transition relative to the proposed mid-sixth-century horizon, would provide a critical independent test. Re-evaluation of radiometric and OSL dating of selected ship-find and settlement contexts in former amphibious-zone regions would address a particular weakness of the existing dating record. Geophysical re-analysis of the Rügen sub-surface for evidence of geologically recent uplift consistent with the proposed northward thrust of the Avalonian leading edge would test the geodynamic mechanism directly. Targeted archaeological deep drilling at the cartometrically predicted locations of Ptolemaic settlements within the Lusatian re-identification, and an independent geomorphological re-evaluation of the Main valley as candidate antique *Danubius Fluvius*, would test the cartometric framework at its most specific predictive points. Targeted SHRIMP and Raman dating of melt-glass matrix phases and shock-recrystallised zircon domains at candidate impact structures, designed explicitly to discriminate inherited from impact-generated populations, would address the methodological point raised in Section 4.4. Each of these pathways admits of unambiguous failure-mode outcomes that would falsify substantial portions of the present framework.

7.4 Concluding Remarks

The hypothesis is offered, in closing, neither as a definitive reconstruction nor as a competing dogma to be set against the geodetic-rectification tradition, but as a scientifically structured, falsifiable working framework whose explicit predictions invite empirical testing. Its principal claim — that the late-Holocene landscape of Central Europe has not been as stable as conventionally assumed, and that the resulting transformation has left its signature in the cartographic, sedimentary, palynological, archaeological, and historical records alike — is intended as an invitation to further interdisciplinary work, and as a reminder that the relationship between the geological and the historical record may be more intimate, and more recent, than the prevailing assumptions of either discipline allow.

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Author's Note (Version 4, May 2026)

This version (4) revises Version 3 of Feb 2025 under the same DOI. The principal substantive changes relative to Version 3.0 are:

- a clearer articulation of the central methodological claim, that the dominant inconsistency between Ptolemy and the modern landscape arises from a real coastline shift compounded with subsequent medieval re-projection error rather than from primary measurement error in Ptolemy himself;
- the integration of the *Event-Dark-Earth* (ED-E) testing framework as a falsifiable subclass of Dark-Earth interpretation, with six explicit empirical predictions;
- the integration of recent palaeohydrological evidence from the western Baltic (Geersen et al., 2024) and the southern Baltic RSL record (Lampe et al., 2011; Bungenstock et al., 2021), together with the now-established Late Antique Little Ice Age framework of Büntgen et al. (2016) and the volcanic-forcing chronology of Sigl et al. (2015) and Toohey et al. (2016);
- a more systematic treatment of the cartometric scaling derivation and the topological constraints that distinguish the present reconstruction from unconstrained rubber-sheeting;
- explicit articulation of falsification pathways;
- the removal of two earlier excursus passages whose speculative character distracted from the central argument.
- a new subsection (§2.4) exploring a revised reading of the southern boundary, in which Ptolemy's *Danubius Fluvius* is identified with the modern Main and *Abnoba Mons* with the Taunus, supported by Tacitus and consistent with the deeply meandering modern Main course as a possible signature of late tectonic shortening;
- a reframing of the *Blinkerwall* discussion (§3.3) as an independent witness to a long-term, progressive transgression mechanism that supplies the demographic pressure required by Jordanes' Gothic migration narrative;
- a new subsection on the classical *Cimbrian flood* tradition (§3.5) as an additional historical witness to a major North Sea transgression episode in the late pre-Roman Iron Age, transmitted by Poseidonios (via Strabo), Ephoros, Aristotle, and Ammianus Marcellinus;
- the integration of comet C/539 W1 (JPL Small-Body Database; Kronk, 1999) as

an additional cometary candidate for the GISP2 chondritic horizons, alongside Comet 1P/Halley;

- a brief, explicitly speculative admission of an additional African-plate impactor as a possible contribution to the Africa–Europe convergence pulse (Allan & Delair, 1997);
- a methodological subsection (§4.4) on zircon-inheritance effects, clarifying why apparent Palaeoproterozoic radiometric ages of candidate impact structures do not falsify a late-antique event horizon within them;
- a brief onomastic remark on the medieval name *Barbarossa* (§6.3) as a tentative cultural-memory possibility, explicitly flagged as speculative.

The fundamental hypothesis — that *Germania Magna* underwent a substantial, geologically recent landscape transformation whose signature is preserved in the Ptolemaic record — is unchanged from the first version. A separate, more technical companion preprint (Mildner, 2026a) develops the cartometric residual analysis, the impact-mechanical energy budget, and the spatial correlation tests in quantitative depth.