Diodorus Siculus and the Black Sea Flood

Paul Dunbavin

Summary: *The oft-maligned ancient historian Diodorus Siculus who lived in Sicily during the first century BC, leaves us numerous references to pre-historical events that survive from no other source. These can now be compared to the ever-improving record of archaeology and earth sciences. Among them is an account of the flooding of the Bosphorus strait and Dardanelles from the Black Sea, together with a foundation myth for the city of Troy. However, his version does not quite fit the model of flooding for the Black Sea since the Ice Age that specialists now accept. Of course, it is always the mythology that is dismissed by the modern specialists! Although modern geology denies the possibility of a 'Great Flood' event in human history there remain glaring inconsistencies in the sea level science that are glossed over. The following is a review of a few of those anomalies and a critique, which argues that we should look deeper into the geography and events recorded by ancient human witnesses.*

Geologists typically consider processes that evolve over millions of years rather than over mere thousands. They may often fail to appreciate that 'gradual' geological processes cease to be quite so gradual as we approach the Holocene and historical times, where variations must be described in only hundreds or even tens of years. Is an ice-age event that unfolds over mere decades still to be considered gradual or is it 'catastrophic'? Similarly, when archaeologists discuss human migrations, do they realise the changes of sea level and climate that were ongoing at those same eras? Do they consider that throughout all that time the Earth rotated daily on its axis and that this motion, as revealed by modern geophysics, is not as stable as it appears to our everyday senses. Do any of these specialists consider the surprises that might overwhelm us from the cosmos? Each academic discipline functions within its own box, where the specialist is obliged to adhere to current theories regardless of the inconsistencies that appear when one looks across the arbitrary academic divisions. In the interests of cross-disciplinary study, I shall therefore try to restrict the use of specialist jargon-terms to a minimum; and when helpful, make use of quotations from published papers to illustrate some of the constraints in thinking that beset modern research.

Ryan and Pitman: the Black Sea and the Biblical Flood

In 1998 oceanographers William Ryan and Walter Pitman published their theory about the formation of the Black Sea and its likely connection to the legends (myths) of a Great Flood in human memory. They were not the first to propose that the Black Sea was young; and that the flooding of the Euxine basin was post-glacial. The novelty was their suggestion that the Black Sea flood might be the same event that was later remembered as the Flood of Noah. If such a suggestion had come from unknown authors then it might have achieved little prominence. However their solid academic status associated with the Glomar Challenger deep-sea drilling project, allowed their book *Noah's Flood* to achieve mass-market awareness; a television program duly followed. [1]

In essence, the hypothesis suggests that, during and at the end of the last Ice Age, freshwater lakes formed in the depressed basins of the ancient Tethys Ocean. These lakes lay below world sea level and ingress of the external sea was prevented only by a natural barrier at what is now the Bosphorus (the

Strait of Istanbul). There was perhaps a river course or a waterfall crossing the active North Anatolian fault that still threatens modern Istanbul. Around 5600 BC this natural dam collapsed allowing a rapid ingress by the sea, thus transforming the landlocked Euxine Lake into the modern Black Sea. We may see that the theory requires only the action of orthodox geological processes.

While the science employed to establish the date of inundation has withstood subsequent analysis the association with the worldwide memories of a Great Flood remains open to challenge. If I may quote my own sceptical remarks from my 2005 book: *Under Ancient Skies*:

> *The Biblical Flood is a deluge from above and Ryan and Pitman's theory does not explain the torrents of rain. Although the theory plausibly explains how a flood story could radiate to Europe and Mesopotamia, it cannot explain how such stories came to spread as far afield as China, South America and Australia (though apparently not to Africa)…The era of the Euxine Lake corresponds to the period when the North Sea was dry and Britain was linked to continental Europe. Ireland and Britain may also have been linked by a land-bridge at that same era. The submergence of the North Sea land barrier around 5500 BC may be sufficient to explain the transition from the warm-dry climate that had prevailed in Northern Europe, to the warm-maritime conditions of the Atlantic Period. Moreover, is there a connection with the acid spike found in the Greenland ice at around the same era? It is not explained how the collapse of the Bosphorus Strait alone could have triggered other sea level and climate changes in the wider world. As with so many other academic hypotheses, the Black Sea flood theory is found wanting when its arguments are extended beyond the chosen subject area, or into fields of expertise beyond the excellence of the specialists who have proposed it.* [pp200-202] [2]

This date around 7500 BP, as I discussed in 2005, would coincide with the final submergence of 'Doggerland' in the North Sea; and the climate changes associated with the Boreal-Atlantic transition, which may indicate a common causal event. [* Note 2]

It is unusual for scientists to include any reference to mythology or for geologists to talk about the Biblical Flood – a nineteenth century clash with the Church, which they won. This is perhaps in part what made the contribution by Ryan & Pitman a valuable step-forward for cross-disciplinary research. The present author's view would be that the Flood myth remembers a very ancient Ice Age trauma, continuously updated and merged as a single event with the recollection of more-recent lesser floods and their survivors. The decaying oral history meets the fiction going the other way.

It was the suggestion of Ryan & Pitman that the various memories of a Great Flood in prehistory found their way to all the regions surrounding the former Euxine Lake, as the survivors migrated: to Mesopotamia, to Greece and further west into Europe. The human migrations at this era are now also confirmed by archaeology and DNA studies.

In the 1970s, Petko Dimitrov from the Bulgarian academy of Sciences had suggested that the Black Sea was a freshwater lake before 9750 BC. [3] This was the core upon which Ryan & Pitman based their own book aimed at a more popular audience. They had expected that the date of the flooding would coincide with the close of the last Ice Age and the so-called Younger Dryas oscillation: a final cold snap lasting perhaps as little as 20 years, before the final melting of the northern ice caps and the resultant rise of world sea level. However, it came as something of a surprise when their Russian-backed expedition derived a later date c.7500 BP from shells found between 123m and 68m depths.

The weak circulation from the outer ocean via the Bosphorus ensures that even today the waters of the Black Sea remain anoxic below 70-100m; nothing can live at these depths. Any ancient wooden shipwrecks that have fallen into it remain virtually intact; the oldest so far discovered being a Greek vessel from the classical era c. 400 BC.

According to Diodorus Siculus

We may compare the modern scientific consensus with the story that we are given by the historian Diodorus Siculus, which would seem to indicate that the rapid overflow of water via the Bosphorus was actually in the opposite direction. He offers us the local indigenous folklore:

> *And the Samothracians have a story that, before the floods which befell other peoples, a great one took place among them, in the course of which the outlet at the Cyanean Rocks was first rent asunder and then the Hellespont. For the Pontus, which had at the time the form of a lake, was so swollen by the rivers which flow into it, that, because of the great flood which had poured into it, its waters burst forth violently into the Hellespont and flooded a large part of the coast of Asia and made no small amount of the level part of the island of Samothrace into a sea; and this is the reason, we are told, why in later times fishermen have now and then brought up in their nets the stone capitals of columns, since even cities were covered by the inundation.* [Histories 5.47.3-4] [3]

For the benefit of the general reader, the *Pontus* here is the Black Sea, which Diodorus knew had formerly been an enclosed lake. The *Hellespont* we would recognise today as the Dardanelles Strait. The island of Samothrace, on the opposite side of the peninsula seems to have suffered a permanent submergence around its shores, as recalled by its aboriginal inhabitants. The description of a "great flood" here extends too widely into Europe and Anatolia to be just a local storm. The legend would suggest that the surging waters overtopped the neck of the peninsula at its narrowest point north of Gelibolu (Gallipoli) and along the geological fault line into the Saros Gulf.

The *Cyanean Rocks*, sometimes called the *Clashing Rocks*, marked the northern end of the Bosphorus, where it enters the Black Sea, but these seem rather to refer to a narrow channel with rapids or perhaps a waterfall that formerly held back the lake waters from the *Propontis* (the Sea of Marmora). Their location is further confirmed by the Roman geographer Strabo:

> *The Cyaneae are two islets near the mouth of the Pontus, one close to Europe and the other to Asia; they are separated by a channel of about twenty stadia...And this is the narrowest part of the mouth of the Euxine, for when one proceeds only ten stadia farther one comes to a headland which makes the strait only five stadia in width, and then the strait opens to a greater width and begins to form the Propontis.* [Strabo, Geography 7.6.1] [4]

The modern Bosphorus is some 32 km long and 550 m at its narrowest; that it was formerly a narrower and more tortuous strait for navigation is also evident in the legend of Jason and the Argonauts.

> *...ye will see the twin Cyanean rocks where the two seas meet. No one, I ween, has won his escape between them. For they are not firmly fixed with roots beneath, but constantly clash against one another to one point, and above a huge mass of saltwater rises in a crest, boiling up, and loudly dashes upon the hard beach.* [Apollonius of Rhodes, Argonautica 2.316] [5]

One may regard the voyage of the Argonauts as a fictional recreation set within a popular memory of real yet timeless ancient geography. The waters were confined to the north and a flow too strong for navigation prevented ships from entering the Black Sea. From two independent ancient sources we may see that the drainage of the Bosphorus was in *the opposite sense* to that determined by modern science. How could this be? The Clashing Rocks may be rationalised as an ancient navigator's recollection of the waves rising and falling in a constricted channel. Within the Mediterranean and Aegean Seas the lunar tides are greatly diminished, so any abnormal variation would be remembered – whereas similar waves would scarcely be noticed on the stormy coasts of the Ocean. Perhaps occasional movements along the fault line during earthquakes also contributed to the memory of the clashing rocks.

Before you determine to dismiss Diodorus and the other sources as mere mythology you should ask how the ancient sources remembered at all that the Black Sea was formerly a freshwater lake. This part at least is a true memory, so on what grounds do we disbelieve and discard the rest? But here I *euhemerise*, just as Diodorus might be accused! [* Note 1]

As for the likely date of this Black Sea overflow, Diodorus is quite clear in his assertion that the flood remembered by the native Samothraki occurred: "*before the floods which befell other peoples*". We may see that the Black Sea overflow was an *antediluvian* event, to use that somewhat outmoded term. Here Diodorus is referring to the Flood of Deucalion; an equally timeless memory that may be equated with the Biblical and Mesopotamian Flood myths. Strict Biblical chronology would place Noah's Flood during the third millennium BC. Modern analysis of the Babylonian king lists would suggest a flood in Mesopotamia rather earlier, around 3100 BC; and Manetho's Egyptian King list would place Menes at a similar date, as the first pharaoh after the Flood; both chronologies are now broadly confirmed by archaeology. However, it would be a digression to pursue here the various theories about the Flood of Noah.

Ryan and Pitman preferred to dismiss the "reverse flood" of Diodorus as mythology, declaring it "not plausible" (pp 250-251). This is sadly typical of the way that even the best modern scientists and academics treat the evidence of ancient eyewitnesses; it did not support their science so it must be the ancient source that has it wrong!

Diodorus supplies another useful dating indicator; he records that one of the native Samothracians, after the flood of their island, went on to found the first settlement at Troy:

> *…of these children Dardanus, who was a man who entertained great designs and was the first to make his way across to Asia in a make-shift boat, founded at the outset a city called Dardanus, organized the kingdom which lay about the city which was called Troy at a later time, and called the peoples Dardanians after himself.* [Diodorus, Histories 5.48.2]

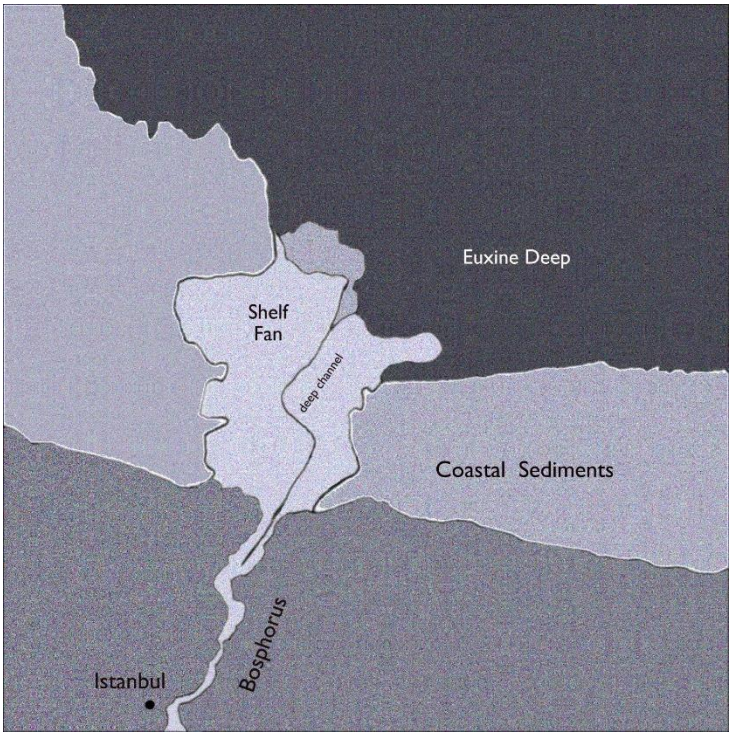
Since its identification with the mound of Hissarlik, archaeologists have loosely dated the oldest level of Troy 1 to around 3000 BC. However in 2019 a new excavation revealed an even earlier level of occupation, termed Troy 0, radiocarbon dated c.3600 BC. [6] We must hope that the archaeologists do not need to declare a Troy -1 level at some future date.

The Black Sea and the Caspian Basin

Before we can analyse this problem further with modern science it is necessary to update the evidence and summarise the origin of the inland seas and basins of central Asia.

A 2019 study by Lericolais-et-al of the depositional fan, where the waters of the Bosphorus enter the Black Sea, has revised and summarised our understanding of the Black Sea inundation. [7] The researchers cite a 2002 study revealing two opposing currents within the Bosphorus. [8] A strong undercurrent carries warm saline water from the Marmara Sea northward, while the less-saline surface water flows south out of the Black Sea. The waters mix within the Bosphorus due to the varying morphology and its winding channel.

North of the Bosphorus, the sonar studies reveal a submerged depositional fan-delta formed when the flood waters from the south flowed into the Euxine lake. The deep channel cut within the recent sediment exhibits a sharp bend to the west before turning north again as it entered the ancient floor of the lake. This submerged river channel is explained as a final temporary feature carved as the Black Sea filled to its modern level.



Left: *a simplified chart showing the extent of the sediment fan created on the shelf of the Black Sea as it filled. For more details click the diagram for a link.*

Estimates for the date of first ingress from the Mediterranean now range from 8.4 to 8.2 14C ky BP and it is considered that flooding was completed within just 40 years, perhaps as little as 10 years. This date is derived largely from the study of molluscs. These show a mix of lacustrine (fresh water) species and euryhaline (salt-tolerant) species until 7.8 14C ky BP after which the salt-water molluscs begin to predominate (or to aid archaeological comparisons c.6000 BC transitioning to fully marine conditions since c.5000 BC).

Investigations within the Bosphorus Strait itself offer some further interesting dates. If one may quote again from the same study:

> *Previous drilling borehole data in the Central part of the Bosphorus indicate the intermittent deposition over the basement rock during the last 26ky BP with the appearance of first euryhaline molluscs dated as young as 5.3 14C ky BP, suggesting an erosional event.*

In other words, a vestige of the Bosphorus barrier may have remained until the late fourth millennium BC, restricting but not completely preventing the mixing of sea and fresh water. We may see that exchanges in both directions could have continued long after the primary flooding event. These conditions were ongoing when the region was first occupied by Neolithic cultures and therefore fall within the timescale that corresponds to the various myths and legends. Yet, for all its excellence, the study by Lericolais-et-al avoids the folklore and myths that might support or contradict the scientific conclusions; an omission that is typical of so many scientific studies.

Further east, the Caspian and Aral Seas are also thought to have filled with meltwater during and since the Last Glacial Maximum. However, unlike the Black Sea, the Caspian is considered a freshwater lake, being most lacustrine in the north where the Volga and Ural rivers constantly replenish the freshwater. The sea becomes more saline towards the south; however, the average salinity remains only a third that of the world's oceans, brackish rather than fresh. The changing shorelines of a landlocked lake over time should bear some relationship to external world sea levels, with the added complication of climatic factors, and so again, it is necessary to summarise the current status of research before we can draw any conclusions.

Holocene Sea Level Changes – an Enigma and a Challenge!

During the 1980s the present author attempted a review of published Holocene sea level studies. At that time theories of sea level change and glaciology were rapidly evolving and older research contained only uncalibrated radiocarbon dates, or none at all, making it difficult to compare contemporary data from around the world. The science of plate tectonics and continental drift were

still relatively recent concepts. In 1961 the eminent oceanographer Rhodes Fairbridge had briefly considered the concept of polar wandering and a change in the world geoid as a possible explanation for former high and low sea levels; but he quietly discarded this idea in pursuit of a worldwide eustatic sea level curve. [9] This led to a profusion of published curves within local studies, showing how the shoreline has varied at specific locations around the world. Few of these studies agreed with each other and so Fairbridge, and his contemporaries, abandoned the search for a worldwide eustatic curve as futile. The fieldwork therefore focused upon localised isostatic uplift that must have disguised the eustatic sea level rise. The obvious suspect is tectonic forces (earthquakes) and volcanism; and so researchers concentrated their attention on coastlines well away from seismic zones.

Another new concept from the 1960s onward was the Milankovitch theory revealing how Earth's orbital variations had shaped the ice age climate. This was rapidly adopted by related branches of science to explain the changes of environment and icecaps during the Pleistocene ice ages; this despite the fact that the correspondence becomes less convincing as we approach the shorter timescale of Holocene and recent times. While we need not doubt that these orbital influences must be present, the question remains whether other forces were at work.

During the 1980s I would have read (or speed-read) over a hundred of these research papers and books on Holocene sea level and climate, in search of dating evidence from published fieldwork to establish a pattern of sea level change at various epochs. My goal was to establish the era at which the most recent worldwide modification of the geoid might have occurred and thus probe for patterns of earlier pole-shifts and geoid changes at the end-of and during the ice ages. In the pre-internet era this exercise was only possible using the facilities of the British Library and its Document Supply Centre, where such papers are available all in one place. The majority of such field studies proved inadequate for the purpose. Availability of dated evidence tended to be haphazard, depending on such chance fossils as a researcher might discover at the chosen site: a piece of wood here, a seashell there. Perhaps the most frustrating factor would be that often they would go in search of evidence to fit the prevailing eustatic-isostatic theories that they were expected to find. Unbiased dated samples with simple particulars of height and location were elusive. While it was a thankless task that I would not care to repeat, a recent update of a small sample of current research merely confirms an even longer list of research fieldwork building on the established base.

My own analysis showed correspondence in alternate quarter-spheres since c.6000 BP with (apparent) rising coastlines in East Asia and South America and (apparent) submergence along Atlantic European and North American coasts. The strong signal of this event, together with the postglacial sea-level rise, effectively disguises any older geoid patterns. [* Note 2]

From the mid 1970's onward new concepts began to appear. A series of papers by Niels Axel Mörner introduced the concept of 'geoid eustasy' due to melting and regrowth of the icecaps. This would cause the axis of figure (the axis of maximum moment of inertia) to wander. The axis of rotation must then hunt to align with it causing a pole shift or apparent polar drift. The proposed mechanism would produce a pattern of sea level correspondence in *alternate quarter spheres*, obviating the need to introduce random isostatic variations to explain every local divergence from the expected eustasy. In many subsequent studies the researchers might include Mörner's papers in their references yet display little grasp of the actual theory. Perhaps a few example quotations from Mörner's work will best illustrate his proposed mechanism of geoid eustasy.

> *Consequently, from the point of Holocene sea levels there are strong reasons to suspect that the geoid really has changed significantly, horizontally and/or vertically during this time unit.*
>
> *…*

Conclusion 2. The distribution of relief features on the geoidal surface may have changed horizontally and vertically. If this is true, eustasy is not valid globally as previously believed.

…

Conclusion 9. The rotation of the earth is affected by numerous factors which may also affect the geodetic sea level. [10]

In 1976 this cautious wording was probably as far as a scientist dare go in hinting at the possibility of an impact or other external astronomical cause for geoid changes (aka pole-shifts) without fear of censure from his peers. It predated the 1994 impact of comet Shoemaker-Levy 9 on Jupiter, which subsequently allowed astronomers to openly discuss the outcome of similar impacts on the Earth. There was previously a 'giggle factor' associated with catastrophism and no credible academic would want their work to become associated with the V-author. The mechanism that Mörner advanced remained fully in line with gradualist geology.

It is evident that in earlier sea level studies the researchers had scarcely considered the Earth as a delicately balanced rotating system with a semi-fluid interior. From reading some sea-level studies one might perceive the Earth as a stationary orb, unaffected by the rest of the cosmos. If I may quote from Michael. J Tooley's 1978 book: *Sea Level Changes in North-west England…*; an author recognized for his many field studies of the British coastline.

Mörner (1976b) has drawn attention to the fact that the geoid pattern – the distribution and amplitude of the high and low values – is not stable in geological time…The implications for sea-level studies are apparent: the free ocean surface can intersect different continents simultaneously at different absolute altitudes…and the changing pattern of the geoid may occasion a record of a marine transgression or regression, when no addition or abstraction of water to the ocean basins has occurred. [11]

One therefore has to revisit all the conclusions about regional sea level change derived from earlier fieldwork, which embodied the Milankovitch orbital factors without considering geodesy. It must also cast doubt on the modelled extent of the Pleistocene ice caps based on such assumptions and the calculated rise of the oceans after they melted. Many of these old concepts still stand unchallenged.

In speed-reading sea level and climate studies during the 1980s it was possible to reject many as unreliable if they displayed no insight that the geoid can be modified by changes of the rotation. Since the advent of the internet, this task is made somewhat easier as one can now search for the presence of indicative keywords, such as: 'geoid' or 'wobble' or 'pole-tide'. Sadly, even in many recent sea level studies the Earth still presents as if it were just a stationary blob hanging in space.

It is rare to find Mörner's work directly cited in more recent studies, however, geoidal-eustasy has become absorbed in new and extended glacio-isostatic concepts based on the effect that melting icecaps had on the ocean basins. Since the millennium, researchers have preferred to cite the theories of 'near field' and 'far field' glaciology to explain the divergences of geodesy and apparent sea level between the continents. This has grown from the original derivation of a 'sea-level equation' by Farrell and Clark in 1976 (contemporary with Mörner's work). To quote the first line of their own summary.

An exact method is presented for calculating the changes in sea level that occur when ice and water masses are rearranged on the surface of elastic and viscoelastic non-rotating Earth models. [12]

The key phrase here is '*non-rotating Earth models*' although later theorists have now included the extra terms. An 'equation' conveys the impression of mathematical proof and thereafter everyone pretends to see the emperor's new suit of clothes! An equation, or a mathematical model, is only as

good as the data that you put in; if an apparent sea level variation was caused by something other than the melting of ice then any conclusions derived from it would be false.

A good synopsis of the development of these *glacio-isostatic* theories (for the benefit of the semi-interested general reader) may be found in the recent study on glacial isostatic adjustment modelling by Pippa L. Whitehouse from which I would here quote. [13]

> *However, the situation is more complicated...because the shrinking of the ice sheet and the transferral of water to the ocean causes the solid Earth to deform, and this redistribution of mass inside the Earth further alters the shape of the geoid.*
>
> *[Figure 3] Variations in ocean area...Retreat of marine grounded ice increases the area of the ocean over which water can be redistributed. Onlap and offlap changes the areal extent of the ocean. In the near field of a melting ice sheet, rebound results in local sea-level fall, causing the shoreline to migrate offshore (offlap). In the far field of a melting ice sheet, sea-level rise causes the shoreline to migrate onshore*
>
> *[Figure 4] Rotational feedback. (a) Earth's rotation vector moves towards a region of mass loss, causing a change in the shape of the solid Earth and the geoid. Relative sea level rises and falls in opposing quadrants of the Earth. (b) Polar ice loss results in a decrease in the oblateness of the Earth...*

In brief summary, regions of grounded ice, where the crust is depressed are defined as 'near field' while the crust further away is defined as 'far field', thus even apparent differences of sea level in distant oceans can be explained away. Gradual melting of ice triggers incremental pole shifts, which can then be translated into gradual polar drift and a slow adjustment of the apparent sea level. Gradualist geology is thus preserved; the geoid-eustasy is referred-back to melting ice and any other potential triggers need not be discussed.

Again, one does not doubt that such processes occur, merely that there may have been other forces at work. In the various field studies that try to explain the world-wide sea level anomalies via this mechanism, one sees little appreciation that the Earth is a rotating planet with a fluid interior. In fact, it is an inner sphere and an outer sphere rotating separately, their motions linked only via the medium of the fluid nickel-iron core. Our everyday perception of its stability is an illusion.

The geoid pattern of apparent sea level change in "opposing quadrants" of the Earth mirror my own 1980's conclusions, except that I was considering external impact events and flows of magma within the mantle as the trigger for pole shifts, rather than incremental changes due to melting ice. The possibility of catastrophic interventions in Earth history has long been a no-go area for any scientist who wished to preserve their academic credibility.

At the close of the last Ice Age some 11,700 years ago the ongoing planetary warming was interrupted by the *Younger Dryas Oscillation,* a period of rapid cooling , after which the warming accelerated and the worldwide rise of sea level resumed. [14] This marks the collapse of the northern ice sheet and the beginning of the Holocene epoch. The sharpest oscillation, as is suggested by Greenland ice-cores, lasted for no more than 20-40 years [15] Various theories and books have been spawned to explain this short-term event as the consequence of a comet or asteroid impact; some scientifically sound, others not. I shall not explore these theories here.

The true cause of the rapid deglaciation and subsequent rise of worldwide sea level remains unexplained. Geologists would massage it away as the inexorable climatic consequence of the Milankovitch orbital variations. The ice caps melted because the climate warmed; the climate warmed because the ice caps melted; and round in a circle we go.

More recent field studies of sea level change remain mired in the near-field/far-field theories, which have become ever more intricate. South America lies in the opposite quarter-sphere from Asia and so it should display a similar pattern of emergence or submergence at the same epoch, but there are no landlocked seas and lakes in the southern hemisphere to compare with the history of the Black Sea and Caspian. The Argentine and Andean lakes such as Titicaca are so complicated by high altitude climate factors and mountain glaciers that such comparison would prove little. Climate science contains just as many imponderables as does the sea level research.

Studies along the Atlantic coast of Brazil and Argentina reveal a clear pattern of coastal emergence since c.6000 BP [16] To cite data by Porter-et-al from the Magellan Strait, emergence of about 3.5m began only around 5000 BP with progressive emergence continuing during the more recent Holocene. [17] This emergence is the opposite of that predicted by far-field theory for similar latitudes in the northern hemisphere. To quote from the report's conclusions:

> *Apparently anomalous data from one site located more than 100 km behind the outer limit of the last glaciation may reflect isostatic response to deglaciation.*

It would be unfair to single-out one such study. This kind of vague 'may reflect' and 'probably indicates' type of comment may be found within many published studies, as fieldworkers attempt to justify anomalous findings. One wishes that they could just present the data!

As another example, consider the excellent regional study by Melnick-et-al of the complex series of raised and tilted strandlines on Isla Santa María, opposite Coronel on the Andean coast of Chile. [18] The report studies three uplifted Pleistocene marine surfaces likely created by ancient subduction earthquakes along this active fault. On the resultant level plain, Holocene emergent strandlines can be observed. To take a few quotations from the report:

> *The island is composed of a late Pleistocene upper, tilted surface with two asymmetric tilt domains, and Holocene lowlands characterized by uplifted and tilted strandlines.*

> *The crests* [of the beach berms] *reach 12 m elevation and are late Holocene in age, as shown by eight 3.4 to 1.8 ka luminescence ages obtained from the central part of the sequence... At Isla Santa María, post glacial rebound can be rejected, because at this latitude, Pleistocene glaciers were restricted to the Main Cordillera at elevations above ~2000 m... Thus, tectonic uplift by either repeated coseismic events and/or protracted aseismic movements must have caused the emergence of these strandlines...*

But these are *not* the only possible cause of such phenomena! One can only praise the diligent fieldwork that goes into this and similar studies, however, the researchers are constrained by current theories to which they must adhere in order to retain credibility and achieve publication in the specialist journals. Some of the tilted strandlines could equally betray a pole shift that produced a slope of the local geoid – but how might these be distinguished from the tectonic uplift events on the highly active Pacific plate boundary? Until researchers can go out into the field unburdened by text-book dogmas they will not look for potential evidence of a pole shift nor will they recognise it.

It is important to appreciate that changes of geodesy would not affect just coasts and beaches; they must also tilt the land surface, changing the course of rivers and the shores of landlocked lakes. It may also bring climate changes that further disguise and complicate study of the ancient geomorphology.

However I have already digressed too far in pursuing the history of worldwide sea levels. The focus must return to the primary subject of the Black Sea Flood and the landlocked lakes of central Asia.

High Strandlines around the Caspian Sea

The level of the Caspian Sea today is around 28-30m below that of the world's oceans and has varied in historical times. Ancient strandlines can be observed around its shores, whereas contemporary shorelines of the former Euxine Lake are now submerged perhaps as much as 90-120m within the modern Black Sea. The Caspian basin was not linked to the Euxine during the Pleistocene and any such ancient connection must predate the ice ages by millions of years. However, we cannot rule-out that there may have been *temporary* exchanges between the two freshwater basins back into ice age times. The lowest spillway would be along the Kuma-Manych depression between the Don and Kuma rivers with a maximum elevation of only 27m above sea level.

The possibility of ancient linkage between the two landlocked seas and also with the Aral Sea and lakes further east has recently been re-examined by hydrologist Ronnie Gallagher. He draws attention to the high strandlines around the Caspian, some of which are also tilted and difficult to explain by standard geology. His work merits a high credibility, coming from a hydrology specialist who also makes guarded mention of the Earth's wobble and does not neglect the testimony of Diodorus Siculus. He cites the generally accepted evidence for an Ice Age high stand of +50m for the Caspian Sea around 15000 BP, which would certainly have flooded over the Manych spillway into the Euxine Lake. [19]

Yet the Caspian Sea is brackish water, not fresh; Gallagher asks the pertinent question of where has the saltwater come from if it did not arrive via the Black Sea and the Bosphorus? [20]

High Strandlines in the Gilazi Valley, Azerbaijan (picture courtesy of R. Gallagher)

There is also the puzzle that around the hills of the Gilazi Valley, near Baku, a triplet of parallel strandlines as high as 222-230m are extant in the soft deposits. The lack of erosion suggests that they are recent, but how could the lake level have risen so high? One suggestion would be a storm surge or tsunami from the Caspian Sea, creating a temporary run-up. The peninsula around Baku is an ancient mud volcano that has left behind soft sediments ideal for recording temporary flood strandlines – yet equally suggestive that nothing has occurred since to wash them away. At time of writing there is a

lack of conclusive dating evidence but the age of the features is assumed to be recent (late Pleistocene or early Holocene). Gallagher would prefer a short-lived flood event as the cause rather than tectonic uplift, since dateable shell fragments from other Caspian strandlines show older finds *below* the younger ones. The high strandlines again raise comparisons with the various myths of a worldwide Great Flood.

Yet should we consider the wider focus derived from ancient sea levels then the Biblical concept of a 'Great Flood' soon dissolves. One example cited is a creationist's map illustrating the hypothetical shorelines across Europe that would correspond to the highest 230m Caspian strandlines. The map depicts most of Germany, France and lowland Britain submerged; Denmark drowned! [21] However, such a vast hypothetical flood must also extend across Africa, even to Australia! If all this water supposedly came from melting polar ice sheets then where has it gone? Not refrozen into the ice caps – they are still melting. This concept is advanced only to show how *impossible* the Caspian high strandlines actually are! The 230m transgression only becomes feasible if you introduce the concept of geoid eustasy, whereby the Earth's ellipsoid (the geoid) stood at a temporary local maximum radius in central Asia and the vicinity of the Caspian Sea. In order to accept geoid eustasy you first have to acknowledge the validity of pole shifts and the geophysics that accompanies them. [* Note 3]

Many people will find the concept of a variable geoid (one ellipsoid of revolution intersecting another) difficult to visualise; and so read again the quotations of Mörner and Tooley above: "*no addition or abstraction of water to the ocean basins has occurred".* Rather, the radius of the geoid varies at each point on the globe, causing an *apparent* local rise, fall or tilt of the crust. No land surface is actually in motion, no isostatic uplift, no sinking! It would however divert the flow of rivers and create tilted strandlines. In two opposite quadrants of the world the new sea level would be above the old level; in adjacent quadrants it would be below the former level, with a line of neutrality between them where little has changed; and also a longitude of maximum effect, which is where we should expect the greatest apparent submergence and the maximum apparent emergence. This was the quarter-sphere pattern that I was seeking in my 1980s exercise; inspired by the work of Fairbridge and by the various nineteenth century commentators who first considered pole shifts and pole tides. [22].

A crude analogy: *squeeze a balloon; the surface expands in the other two quarter-spheres.*

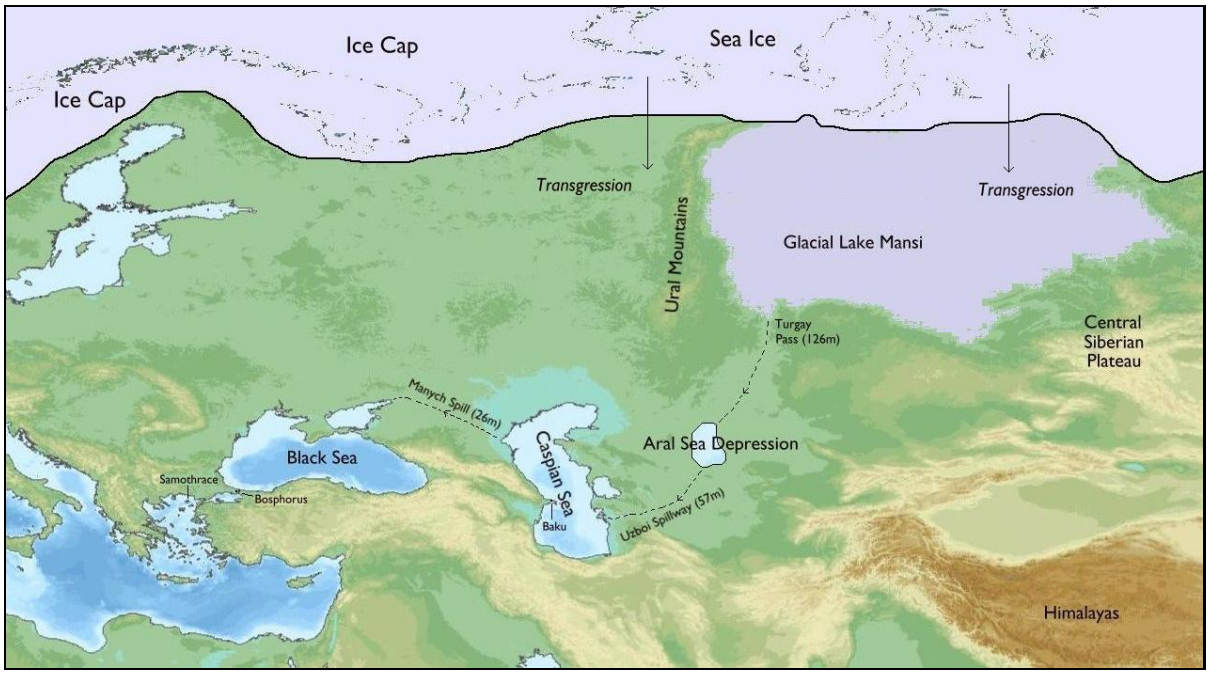
So how could saltwater reach the Caspian Basin? The Caspian Sea has a relatively limited range of fauna, all of which had to arrive there from adjacent catchments and seas. Mussel and cockle shells, which survive easily in sediments offer useful clues. Other species such as Arctic seals can be cited and perhaps also extinct whales. To quote directly from Gallagher's hypothesis:

> *DNA studies show that the Caspian* ***Mysis*** *species, a relict Arctic and endemic crustacean species, has only recently diverged from its northern cousins (Vainola, 1995). Given that there are other new arrivals into the Caspian dating to the early Holocene, this implies a time frame when marine water could have poured into the continental interior, so introducing other species.* [23]

Recent borehole analysis suggests the former existence of an ice-dammed Glacial Lake Mansi occupying the low-lying region of the West Siberian Plain, between the Ural Mountains and the Central Siberian Plateau. The plain extends all the way to the Arctic Ocean and an ancient flood could only escape south towards the Aral Sea via a potential spillway at 125m height, along the Turgay Pass.

However, the collapse of an ice-dammed freshwater lake on the West Siberian Plain still would not explain the presence of salt water in the Caspian Sea, nor the anomalous arctic fauna. The ice barrier must have collapsed completely at some point, allowing Arctic sea water to penetrate as far as the Aral and Caspian basins. How could this happen? There remains considerable uncertainty as to how

far east the Arctic ice cap and the limit of sea ice extended during the last Ice Age. Analysis is also complicated by the fact that there must have been episodes during earlier interstadials when such faunal transfer could have occurred.



Summary map of the Ice Age spillways between the Arctic Ocean and the Bosphorus.
This shows the route by which sea water could invade the Caspian-Aral Basins following a pole-tide; via a collapse of the Arctic sea-ice barrier and Glacial Lake Mansi at the end of the Ice Age (c.11 700 BP). However evidence suggest that salt water did not reach as far as the Black Sea, which remained an enclosed freshwater lake until c.7 500 BP.
(*map based on: https://commons.wikimedia.org/wiki/File:Relief_map_of_Eurasia.png*).

However, once again, Siberian hydrology during the ice ages is not the primary focus here. Interested parties who wish to pursue the various theories may like to begin by addressing some of the questions posed in Gallagher's hypothesis. Another sound analysis is found in the paper by Komatsu-et-al which is broadly similar in its conclusions. [24] The geomorphology is summarised here only in support of a more general case for pole tides and potential catastrophic episodes, as affecting the Black Sea and Bosphorus during the early Holocene. These would be remembered by the people who migrated from the Caucasus region, taking with them their myths of a catastrophic flood; an event which, to them at least, appeared to affect the whole world.

The concept of a temporary extreme flood in the Caspian Sea as an overspill from the Arctic Ocean, demands an explanation of the full mechanism. A *pole shift* and the associated changes to the geoid cannot just occur instantaneously. The cause of the excitation must be appreciated and also the wobble of the rotation axis that must accompany the transition.

The Chandler Wobble and Pole Tides

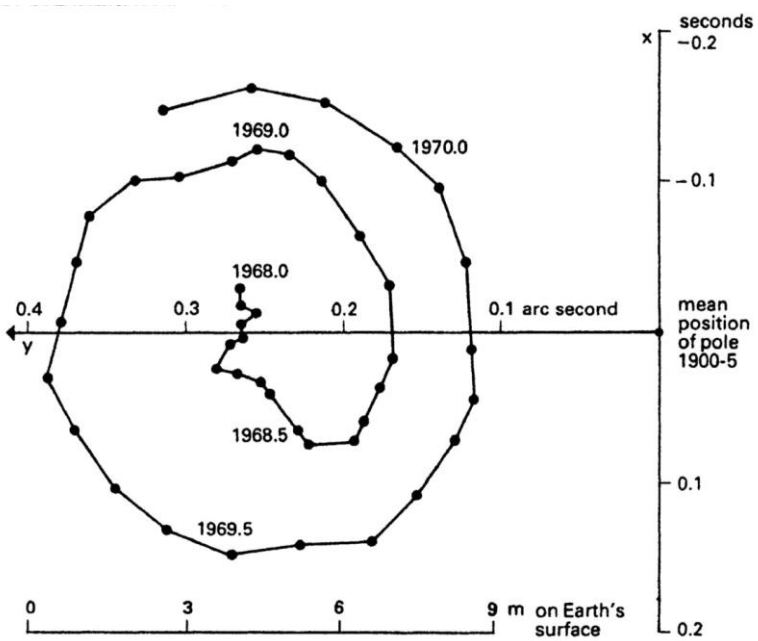
So named for its nineteenth century discoverer, the Chandler wobble is routinely measured by modern geophysicists. It is not an easy subject for non-specialists. In fact Chandler only measured the true period of a wobble first described by the mathematician Euler, thus termed *Eulerian Nutation*. The rotation of a planet can only be stable when it spins about its axis of maximum moment of inertia (its 'figure axis', or 'axis of symmetry') which is determined by its shape and internal mass distribution. The rotation creates the equatorial bulge of some 42.72 km (26.5 miles) between the polar and

equatorial diameter. This irregular oblate spheroid is the *geoid* corresponding to the actual sea level and its notional extension through the continents. Any displacement of mass on or within the earth, say: a moving car or an iceberg falling into the sea, must reposition the figure axis (an 'excitation' event). Note that no external force has to act. The axis of rotation must then attempt to realign with the figure axis and so begins an irregular spiral dance, 'hunting' for the new stable position. The difference between the axes is measured as *latitude variation* and the permanent pole shift is not complete until the transient settles to rest. Every aspect of the rotation must be affected, including the length of day, magnetic field, ocean currents and seasonal weather patterns.

The ocean must immediately conform to the geoid of the rotation axis. The solid Earth (depending upon how solid or fluid the interior may be) takes longer to adjust. The overflow of the ocean at the continental shore is the *pole tide*. The difference between this and any normal lunar tide that an observer might experience would be only one of amplitude, which is determined by how far the figure axis has been displaced in the initial excitation.

An excellent summary of the geophysics of the Earth's free wobble is now available in the paper by Na, S.-H. et al [25] The excited figure axis takes about 13-14 months to circuit around the rotation axis; evaluations of the period vary according to how elastic or fluid the mantle is calculated to be (modern estimates give 432 days). Since the wobble is a transient, then unless excited again, it will settle back to rest. It must exponentially decay completely after about 68 years, becoming negligible to a casual observer after about 20-22 years. [26] The amplitude of the modern wobble is trivial, measured as an irregular circuit of only 8-10m around the pole. Geophysicists suggest that this small motion is continuously excited by the action of ocean currents on the irregular topography of the seabed, but they do not really concur as to its cause.

In some recorded tracks we may see that the wobble is being re-excited before it is able to decay to rest. It may also be terminated earlier. In two quadrants the solid crust finds itself above its optimum height and will try to fall; in the other two quadrants it will be below the optimum and so will tend to rise. If these relaxations can bring the two axes back into agreement before the spiral hunt is complete then the wobble may be extinguished.



An example of the Chandler wobble between 1968 & 1970 illustrating the spiral 'hunting' of the pole as it seeks the new stable position (courtesy of Irwin Copplestone Books). Click the picture for a link to other examples.

The pole tide generated by the tiny modern wobble scarcely rises above the noise of the ocean waves, but for a significant excitation the pole tide would exceed the lunar tides and exhibit a 14-month pattern of tides at the shoreline; the highs and lows would thus progress around the world over a seven-year cycle, decreasing exponentially. The

precise behaviour of the Earth during an extreme event such as an impact must remain conjecture; it cannot be calculated with certainty from the tiny modern wobble. To quote from the foremost authority (Gross 2015):

> *Determining an unbiased estimate for the period and Q of the Chandler wobble is complicated by the relatively short duration of the observational record and by incomplete and inaccurate models of the mechanisms acting to excite it.* [27]

In other words it collapses or is re-excited before the full cycle can be studied. Geophysicists have endlessly tried to calculate this constant: 'Q' or quality factor that determines how anelastic the interior is; thus to derive the precise period of the wobble and the rate of decay to rest. [28] However this cannot tell us how the planet might behave under extreme circumstances.

> ***A crude analogy:*** *picture a jelly set to wobble on a rotating potter's wheel. The motion could no doubt be mathematically modelled; but give it a smack and the behaviour will be somewhat irregular!*

When one ellipsoid intersects another, the maximum difference in radius occurs at 45°. We may see that for a shift of one degree of latitude the change in radius of the Earth would be about 373 m. From this we may estimate the amplitude of a wobble that would be needed to generate a pole tide of 230m height in the Caspian Sea. Since the motion decays exponentially then the resultant pole shift once the wobble decays would be much smaller, perhaps only a small fraction of a degree. [* Note 3]

The latitude of Azerbaijan lies around 40° N whereas the maximum effect of a pole-tide would be experienced at the mid-latitude of 45°N along the longitude of the pole shift. The Black, Caspian and Aral seas all lie close to this latitude. The longitude of the maximum geodetic effect could only be derived from the pattern of worldwide sea level evidence. [29] [* Note 2]

In considering a pole tide event it is important to appreciate that it is a *tide* and not a tsunami. Its energy is distributed worldwide rather than localised. The experience would be more like a normal ocean tide, except that it would penetrate further inland or recede further out. It should not leave destructive evidence at the shoreline as would a tsunami; it would just resemble any normal high tide mark and so a geomorphologist might not recognise it. People and animals could walk away from the incoming sea. A pole shift and its pole tide might be triggered by an external astronomical event, but equally it could follow an internal readjustment to the figure of the earth deep within the mantle, overhanging from some previous excitation. It may not even be felt as an earthquake on the surface. It is disconcerting to think that an imbalance of mass may be trapped within the mantle or the core even today, waiting for its potential energy to be released by an event on the surface.

A recent discovery has been the presence of a fluid layer at the core-mantle boundary before the transition to the fluid nickel-iron core. The research would suggest that this layer is connected to the volcanic hotspots that carry magma under pressure up to the crust, where they feed the volcanoes and mid ocean ridges. [30] There may even be oceans of water trapped within the mantle. [31] These paths for fluid exchange would naturally explain why a change of geoid associated with a pole shift does not activate every supervolcano on the planet; it may indeed trigger later vulcanism, but even magma would prefer to fall under gravity than to rise. Trapped magma or water in one quarter sphere could flow via the core-mantle boundary layer causing a compensating rise in the adjacent quadrant. Any such movements of mass within the mantle would certainly alter the rotational balance, sufficient to trigger the Chandler wobble and thus generate a pole tide on the surface. [* Note 3]

> ***A crude analogy****: consider a U-tube that is suddenly tilted: on one side the fluid level falls compensated by an equal rise on the other side.*

For an observer at the shoreline the experience of a pole tide would be a matter of geography and luck. A witness near the line of maximum effect might experience the tide apparently flowing-in as normal but unexpectedly continuing to rise above their heads over the course of the day. In the adjacent quadrant of the world they would experience the opposite: the sea would recede to the horizon leaving mudflats at the shore. Along the line of neutrality an observer might experience a perfectly normal day. On top of the pole tides, the lunar tides would occur as normal, with the shoreline varying between the extremes over a 13–14-month cycle as the wobble decays. It is in the nature of exponential decay that the amplitude would have reduced by as much as half even before the first cycle is completed. Other than on the first day, people could just walk inland to safety. So how might we recognise the signature of such an event in the prehistoric record?

Recognising a Pole Tide

The temporary highest strandline, produced by a pole tide maximum would persist for just a few days and so could only be recorded in soft sediment – there is no time to erode even the softest rocks. Since the tide flows far inland then it would soon be masked by storms and vegetation. Near the coast, cliff falls and dunes could destroy or disguise the former high tide mark, but some evidence of an overflow might survive in the form of trapped saline 'lagoons'.

In addition to the low probability that a pole tide would be recorded it is also unlikely to survive in a recognizable form after thousands of years. We therefore have to seek locations with soft sediment that remain high above the waterline; and in climates with less rainfall and vegetation to disguise them. This is why landlocked seas such as the Caspian or Euxine are prime candidates to seek evidence of a pole tide. In a lake the pole tide could be recorded throughout its full circuit of the shoreline, whereas at the seacoast we would see only a segment. The highest tide mark should circuit the lake shore approximately each seven years, decreasing severely in height with each cycle. The highest strandline would be the oldest, younger ones below it, becoming less sharply-defined as they approach the new permanent shoreline.

> ***A crude analogy:*** *swish water round in a bowl and observe the high-water mark left around the bowl after it settles down. Be careful not to wet your feet!*

In Scotland we may see the Parallel Roads of Glen Roy; made so familiar to geologists by the nineteenth century debate between Darwin and Agassiz. The three parallel 'roads' are at heights of 350m, 325m and 260m above sea level. Darwin eventually conceded to Agassiz that the parallel lines were formed by the shrinking level of an ice-dammed lake that filled the valley during the last glaciation. For an observer viewing them from the modern road it is unsettling to think that a huge glacier must once have blocked the valley behind. To quote from the conclusions of a 2002 study:

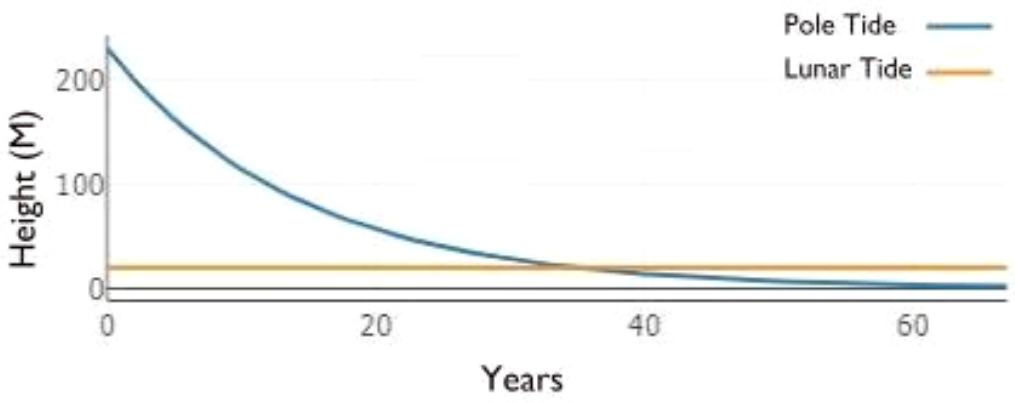
> *...each lake shoreline exhibits evidence of glacio-isostatic tilting associated with the decay of the last (Late Devensian) ice sheet. The directions of tilting of the three shorelines...are at variance with published glacio-isostatic uplift isobases based on marine shoreline data that suggest a pattern of decreased uplift towards the northwest. The gradient of shoreline tilting (between 0.11 and 0.14 m km^{-1}) is similar to measured regional tilts of a well-developed marine shoreline...considered to have been produced in Scotland during the same period of extreme cold climate.* [32]

In other words the specialists seek to model the supposed glacio-isostatic uplift of Scotland after the melting of the ice sheet and so estimate its former extent. Thus it enters the literature to be cited as proven fact – with no certainty that glacio-isostasy was the only possible cause of tilted strandlines.

Consensus holds that the parallel 'roads' record falls in the height of the glacier dam as it collapsed in stages. However, the conventional explanation would not explain why clear transitional features, as the lake level dropped, are not also recorded – a criticism that could likewise apply to gradualist explanations for marine raised-beaches worldwide.

There was no glacier in the Caspian Sea and so this mechanism could not explain the creation of the analogous high features found near Baku. As an alternative to a melting glacier, one might perhaps consider a three-stage failure of the Kuma-Manych barrier to the Black Sea and an overspill into the Aegean; an event for which there is no published evidence (unless perhaps it be the reverse-flood recorded by Diodorus). The apparent resemblance of the three high strandlines in Azerbaijan and the Parallel Roads of Glen Roy may be nothing more than a coincidence.

An alternative mechanism to consider for the Gilazi high strandlines may be as the signature of a transient pole tide. Consider that the initial maximum of the pole tide carried Arctic sea water far inland, breaching the Siberian spillway and into the Caspian-Aral basin – but the flow did not reach as far as the Euxine basin. As the pole tide pattern progressed around the world it should have left its signature elsewhere. The second and subsequent transgressions would not have reached so high, but the lake basins had already filled with salt water. A pole tide confined within the Caspian-Aral Basin would therefore continue to spill into the Caspian via the Uzboi valley of Turkmenistan, which directly faces the Baku peninsula and the Gilazi strandlines.



A graph to illustrate the *principle* of a pole tide that decays in height over about 68 years.
The height decays rapidly and falls below that of the lunar tide before it is fully damped.

Temporary strandlines formed during a pole shift event should exhibit three characteristics:

- Strandlines should be parallel but tilted slightly with respect to earlier and later shorelines.
- There should be no more than *three* parallel strandlines, because the seven-year cycle decays exponentially becoming negligible after about twenty years.
- All three lines should date to the same age, since the lifetime of the wobble is less than the accuracy of even the best dating method.

We must hope for more field studies and dating evidence in the years ahead; however we should expect unambiguous evidence of short-lived pole tides to be rare and difficult to recognise.

Conclusions

It is not good science simply to dismiss the evidence of mythology and to ignore the valuable testimony left by ancient human witnesses. A mechanism to fully explain the Black Sea and Bosphorus flood should also offer an explanation of the Samothracian 'reverse' flood as recorded by Diodorus as well as an explanation for the high stands of the Caspian Sea around the same era.

If we are to consider a major pole shift and pole tide event in prehistory then the prime suspect has to be the Younger Dryas oscillation around 11700 BP. The terminal ice-age event probably had an external astronomical cause, although subsequent pole shifts could have been triggered by later settlement within the mantle and core. Without confirmation from field dating evidence we should not rule out that another pole shift occurred around 7500 BP (associated with the Black Sea flood). Consideration of ice age events is not the primary focus here, however a high pole tide inundation early in the Holocene offers the best explanation for how Arctic sea water could have invaded the basin of western Siberia, spilling into the Aral and Caspian Seas and bringing with it the Arctic fauna.

The salt water from the Arctic Ocean did not reach as far west as the Euxine Lake. The overspill must have been of short duration, occurring only over a few days around the maxima of the pole tide. The mechanism of geoid-eustasy could also explain the three elevated strandlines that survive near Baku without requiring such a high level of flood to be reached elsewhere in the world. Wobble-events of lesser amplitude may have followed in later millennia, triggered by residual imbalances within the mantle left-over from the Younger Dryas event. Therefore, a worldwide 'Great Flood' is not required to explain the enduring myths.

Around 7500 BP (c. 5500 BC) according to the various dating evidence, the collapse of the Bosphorus barrier (by whatever cause) initiated the permanent flooding of the Euxine lake as suggested by Ryan and Pitman's theory. It would correspond well with the first wave of human migrations out of the Caucasus and Anatolia. We may consider a pole tide as a trigger for the breach of the Bosphorus dam; however, a crustal earthquake or natural erosion alone would suffice to break the dam if its time was up. It is important to appreciate the difference between a temporary tidal maximum and the permanent filling of the Black Sea from the Mediterranean. The Bosphorus flood allowed the level of the Euxine Lake and the external oceans to equalise but it must have left a narrower and shallower channel than today, as was remembered in the legend of the Cyanean Rocks. There may have been a reduced current, or no flow at all between the Black sea and Aegean.

The Samothracian flood, as described by Diodorus, could only have occurred *after* the Black Sea Flood. It may record a pole tide of lesser amplitude, or perhaps just a crustal earthquake along the North Anatolian Fault. A geoid-tilt could spill the waters of the Black Sea over the dam. This tsunami-like event must now be archaeologically dated earlier than 3500 BC by the discovery of the oldest settlement at Troy; it further widened the Bosphorus and demolished the Cyanean Rocks, triggering the reverse-flood that was remembered by the Samothraki. One would expect some hard geological evidence of this localised event to survive to give a more precise date.

However, there are numerous arguments, including the worldwide quarter-sphere pattern as previously discussed, to suggest that the various myths of a *Great Flood* remember a mid-Holocene pole shift event around 3200-3100 BC. The consequences of this would set in motion the second great human migration from the Caucasus and Steppe region into Europe. The mythology has swept-up the recollections of this flood with the earlier and larger pole-tides that are now remembered as a single Great Flood. The quarter-sphere pattern of geoid eustasy, as the high tide progressed around the world over its full cycle, would also explain why it is described so many different ways in various parts of the world.

***** Note 1: Euhemerus

A good example of the attitude of modern classical academics to Diodorus Siculus and to myths and legends in general would be the comment made by Edward Tripp in the Collins Dictionary of Classical Mythology: "*Diodorus was given to inventing rational explanations of myths that were often as preposterous as the originals*". We don't know that Diodorus 'invented' anything! Other commentators would accuse Diodorus of 'euhemerising'; that is: attempting to rationalise mythology into history after the manner of the writer Euhemerus (who suggested that the Greek gods recall deified ancient kings). It ill-befits modern specialists to dismiss the work of ancient historians who were closer to the events than themselves; and who had access to lost historical sources that they will never be able to read.

***** Note 2: the four quarter-sphere pattern

I shall not repeat all the detail of this 1980s sea level research here as it is contained in my earlier books and summarised in a 2019 article. It was there suggested that a pole shift during the *mid-Holocene* produced transgression at the Atlantic coasts and maximum apparent uplift over central Asia. However any proposed inundation of the central Asian lowlands (*early Holocene*) would demand an earlier pole shift in the *opposite* direction, thus creating a transgression in Arctic Russia and regression in the adjacent quadrant, around the Atlantic coasts of Europe and America.

***** Note 3: pole shifts and recent earthquakes

The magnitude 9.1 Sumatra earthquake and tsunami of 2004 generated a small pole shift and wobble that was measured by geophysicists; and the 2011 Japan earthquake shifted the figure axis by as much as 10 metres. It has proven difficult over the years for geologists to accept that major pole shifts are possible. It only requires a larger source of excitation to trigger a much more significant pole shift in order to explain many of the anomalies in earth history. The problem has always been to identify and prove what this source of excitation might be. Geologists and others continue to fall back upon deeply-embedded nineteenth century assertions that pole shifts are not possible when clearly they are – but it requires a movement of mass within the interior that is on a scale much more powerful than a magnitude 9 earthquake.

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Relevant Hyperlinks

https://www.theoi.com/Text/ApolloniusRhodius2.html
https://penelope.uchicago.edu/Thayer/e/roman/texts/strabo/7f*.html
https://www.sciencedirect.com/topics/earth-and-planetary-sciences/younger-dryas
https://www.bbc.co.uk/news/world-europe-45951132
https://www.dailysabah.com/history/2019/08/21/ancient-city-of-troy-likely-founded-600-years-earlier-than-thought
https://juniperpublishers.com/ijesnr/IJESNR.MS.ID.555959.php
https://en.wikipedia.org/wiki/West_Siberian_Glacial_Lake#/media/File:Ice_Age_glacial_lakes_of_Siberia_and_Central_Asia_-_ru.svg
https://ars.els-cdn.com/content/image/1-s2.0-S0277379103003433-gr2.jpg
https://ui.adsabs.harvard.edu/abs/2018AGUFMDI21B0011M/abstract
https://www.jagranjosh.com/general-knowledge/what-is-the-huge-ocean-near-earths-core-discovered-by-scientists-heres-what-experts-say-1664639401-1
https://www.undiscoveredscotland.co.uk/roybridge/glenroy/index.html
http://koreascience.or.kr/article/JAKO201912761598715.page
http://media.geogr.msu.ru/Caspian_2010/caspian_conference_2010.pdf
https://www.zin.ru/conferences/Aral2019/PDFs/Gallagher.pdf

https://www.academia.edu/37625564/Observations_of_Caspian_strandlines_their_use_as_highstand_indicators_with_consideration_for_their_implications_with_regard_to_regional_geomorphology_paleodrainage_and_biodiversity
https://esurf.copernicus.org/articles/6/401/2018/
https://www.cambridge.org/core/journals/quaternary-research/article/abs/holocene-sealevel-changes-along-the-strait-of-magellan-and-beagle-channel-southernmost-south-america/BB0114EE12AB9DABC69A6643AE6135B4
https://www.researchgate.net/publication/236942445_Coastal_deformation_and_great_subduction_earthquakes_Isla_Santa_Mara_Chile_37_S
https://www.jstor.org/stable/24940478
https://link.springer.com/article/10.1007/s40641-016-0045-7
https://www.space.com/milankovitch-cycles
https://www.wikiwand.com/en/Kuma%E2%80%93Manych_Depression
https://mirplaneta.com/en/istoriya-chernogo-morya/
https://academic.oup.com/gji/article/218/1/655/5487515
https://www.third-millennium.co.uk/raised-beaches-and-submerged-forests
https://www.jpl.nasa.gov/news/nasa-details-earthquake-effects-on-the-earth
https://www.nationalgeographic.com/science/article/110316-japan-earthquake-shortened-days-earth-axis-spin-nasa-science
https://www.discovermagazine.com/planet-earth/the-search-for-earths-underground-oceans
https://www.encyclopedia.com/earth-and-environment/ecology-and-environmentalism/environmental-studies/boreal-period
https://www.sciencedirect.com/science/article/pii/S0277379199000621
http://www.michaelmandeville.com/earthmonitor/polarmotion/plots/chandler_wobble_plots.htm
https://www.sciencedirect.com/topics/earth-and-planetary-sciences/chandler-wobble

References

1. Ryan, W. & Pitman, W. (1998) *Noah's Flood: The New Scientific Discoveries About the Event that Changed History*, Simon & Schuster, New Jersey, ISBN-13: 978-0684810522
2 Dunbavin, P. (2005) *Under Ancient Skies: Ancient Astronomy and Terrestrial Catastrophism*, Third Millennium Publishing, Nottingham; ISBN:0-9525029-2-5
3 Oldfather, C.H. (translator) (1939) *Diodorus Siculus, Library of History*, Vol 3, Loeb Classical Library, London, ISBN: 0-674-99334-9
4 Jones, H.L. (translator) (1988) *The Geography of Strabo*, Volume 3, Loeb Classical Library, London, ISBN: 0-434-99050-7
5 Race, W.H. (translator) (2009) *Apollonius Rhodius, Argonautica*, Loeb Classical Library, London, ISBN: 9780674996304
6 *Daily Sabah History. Istanbul. 9 January 2019.*
7 Lericolais G, Algan O, Morigi C, Okay S, Kirci-Elmas E, Çifçi G. (2019) Overview of the Bosphorus Depositional Fan from Data Sets Recovered on the Black Sea Shelf off the Strait of Istanbul. *Int J Environ Sci Nat Res*. 2019; 17(2): 555959. doi: 10.19080/IJESNR.2019.17.555959 https://juniperpublishers.com/ijesnr/IJESNR.MS.ID.555959.php
8 M.N. Çağatay, N. Görür, O. Algan, C. Eastoe, A. Tchapalyga, D. Ongan, T. Kuhn, I. Kuşcu, (2000) Late Glacial–Holocene palaeoceanography of the Sea of Marmara: timing of connections with the Mediterranean and the Black Seas, Marine Geology, Volume 167, Issues 3–4, 2000, Pages 191-206, ISSN 0025-3227 https://www.sciencedirect.com/science/article/abs/pii/S0025322700000311
9 Fairbridge R.W. (1961) Eustatic changes in sea level: *Physics and Chemistry of the Earth*, V.4, pp99-185. Pergamon Press
10 Mörner N-A (1976) Eustasy and Geoid Changes, *J. geol*. 84 (2): 123-51
11 Tooley M.J. (1978) *Sea-Level Changes in North-West England during the Flandrian Stage*, Clarendon Press, Oxford, ISBN: 0-19-823228-4.

12 Farrell, W.E., Clark, J.A., 1976. On postglacial sea level, *Geophysical Journal of the Royal Astronomical Society* 46, 647–667.
13 Whitehouse, P. L. (2018) Glacial isostatic adjustment modelling: historical perspectives, recent advances, and future directions, *Earth Surf. Dynam*., 6, 401–429, https://doi.org/10.5194/esurf-6-401-2018, 2018.
14 Svend Funder , Anita H. L. Sørensen , Nicolaj K. Larsen , Anders A. Bjørk , Jason P. Briner, Jesper Olsen , Anders Schomacker , Laura B. Levy, and Kurt H. Younger (2021) Dryas ice margin retreat in Greenland: new evidence from southwestern Greenland, *Past,* 17, 587–601, 2021 https://doi.org/10.5194/cp-17-587-2021
15 Alley, R.B. (2000) The Younger Dryas cold interval as viewed from central Greenland, Quaternary Science Reviews, Volume 19, Issues 1–5, 2000, Pages 213-226, ISSN 0277-3791, https://doi.org/10.1016/S0277-3791(99)00062-1.
16 Prieto A.R et al. (2017) Relative sea-level changes during the Holocene in the Río de la Plata, Argentina and Uruguay: A review, Quaternary International 442 (2017) 35-49. http://dx.doi.org/10.1016/j.quaint.2016.02.044
17 Porter, S., Stuiver, M., & Heusser, C. (1984). Holocene Sea-Level Changes Along the Strait of Magellan and Beagle Channel, Southernmost South America. Quaternary Research, 22(1), 59-67. doi:10.1016/0033-5894(84)90006-1
18 Melnick, Daniel & Bookhagen, Bodo & Echtler, Helmut & Strecker, Manfred. (2006). Coastal deformation and great subduction earthquakes, Isla Santa Mar??a, Chile (37 S). Geological Society of America Bulletin. 118. 1463-1480. 10.1130/B25865.
19 Gallagher R. (2019), St Petersburg - The Second International Conference on the Aral Sea Problems, 15-18 November 2019. https://www.zin.ru/conferences/Aral2019/PDFs/Gallagher.pdf
20 Gallagher R. - https://www.academia.edu/37625564/Observations_of_Caspian_strandlines_their_use_as_highstand_indicators_with_consideration_for_their_implications_with_regard_to_regional_geomorphology_paleodrainage_and_biodiversity
21 *see ref. 19 page 28*
22 Dunbavin, Paul (2020) Raised Beaches and Submerged Forests: Curious Anomalies, *Prehistory Papers*, pp 98-111, Third Millennium Publishing, ISBN: 978-0-9525029-4-4
23 *see ref. 20 page 4*
24 Komatsu, Goro & Baker, Victor & Arzhannikov, S.G. & Gallagher, Ronnie & Arzhannikova, Anastasia & Murana, Alessio & Oguchi, Takashi. (2016). Catastrophic flooding, palaeolakes, and late Quaternary drainage reorganization in northern Eurasia. *International Geology Review*. 58. 1693-1722. 10.1080/00206814.2015.1048314.
25 Na, S.-H. *et al.* (2019) “Chandler Wobble and Free Core Nutation: Theory and Features”, *Journal of Astronomy and Space Sciences*. 한국우주과학회, 36(1), pp. 11–20. doi: 10.5140/JASS.2019.36.1.11. http://koreascience.or.kr/article/JAKO201912761598715.page
26 Wang, G., Liu, L., Su, X. *et al.* (2016) Variable Chandler and Annual Wobbles in Earth’s Polar Motion During 1900–2015. *Surv Geophys* **37**, 1075–1093. https://doi.org/10.1007/s10712-016-9384-0
27 R.S. Gross (2015) in *Treatise on Geophysics (Second Edition)* 3.09.4.2.4 The Chandler wobble and its excitation. https://www.sciencedirect.com/referencework/9780444538031/treatise-on-geophysics
28 Yachong An, Hao Ding (2022) Revisiting the period and quality factor of the Chandler wobble and its possible geomagnetic jerk excitation, *Geodesy and Geodynamics*, Volume 13, Issue 5, 2022, Pages 427-434, ISSN 1674-9847, https://doi.org/10.1016/j.geog.2022.02.002 https://www.sciencedirect.com/science/article/pii/S167498472200026X
29 see ref. 22 above
30 Matsushima}, M. (2018) Core flow interaction at the core-mantle boundary and at the inner core boundary inferred from a core surface flow model, *AGU Fall Meeting Abstracts*}, Dec 2018, Pages DI21B-0011, https://ui.adsabs.harvard.edu/abs/2018AGUFMDI21B0011M

31 Schmandt, B., Jacobsen, S.D. Becker, T.W., Liu, Z., Dueker, K.G. (2014) Kenneth G. Dehydration Melting at the top of the lower mantle, *Science*, 1265-1268, 344, 6189. doi:10.1126/science.1253358, https://www.science.org/doi/abs/10.1126/science.1253358

32 Dawson, A.G., Hampton, S., Fretwell, P., Harrison, S. and Greengrass, P. (2002), Defining the centre of glacio-isostatic uplift of the last Scottish ice-sheet: the Parallel Roads of Glen Roy, Scottish Highlands. J. Quaternary Sci., 17: 527-533. https://doi.org/10.1002/jqs.712

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