Coastal erosion too fast for continents to be millions of years old

Michael J. Oard

Continental erosion, measured mostly by present river sediment input into the oceans, is very rapid. All of the continents should have eroded to sea level within 15 to 50 Myr. Uniformitarian scientists claim that erosion rates today are much faster than they were in the past. This claim cannot be sustained. Coastal erosion has been assumed to be small, but a recent estimate of worldwide coastal erosion has produced rates of 0.029, 0.10, and 0.23 m/yr for hard, intermediate, and soft rocks, respectively. An estimate of cliff erosion rates for England reinforces this result, while radiometric methods give much slower rates. These values are about 38% of river erosional input to the oceans. Thus, the continents wear down even faster. Glaciation apparently has had little effect on erosion rates. England and Europe should have eroded away in, at most, several million years. These increased estimates for coastal erosion rates deepen the conundrum: erosion happens so fast that the continents should not exist today if deep time were true.

All continents can be levelled to sea level in 15 to 50 million years

Creation scientists have calculated that continental erosion on a millions-of-years timescale is too rapid for deep time.[1] Roth estimated that at a present-day erosion rate of 61 mm / 1,000 years, all of North America (and presumably other continents) would have eroded to sea level in about 10 million years (Myr).[2,3] These estimates are based on the amount of sediments added to the oceans by rivers, which is a rough estimate because of many variables and complications in the global measurements.[4]

Roth used old estimates of continental erosion but performed a second estimate of 24 billion metric tons/yr (Gt/yr). A newer, extensive compilation done by Milliman and Farnsworth has 20 Gt of solid and dissolved sediments that enter the ocean per year from rivers.[5] This is the same estimate that Milliman and Syvitski came up with in 1992 by including numerous small mountainous rivers.[6] So, Roth's second estimate is close enough.

However, present rates of continental erosion cannot be extrapolated into the past in a linear fashion to calculate time to denudation. There are other processes that would slow down the erosion rate. For instance, man has caused erosion, which must be factored in.[7] Some researchers estimate that farming and deforestation has more than doubled the erosion rate into the oceans.[4] But people also build dams, which collect sediment from erosion, temporarily reducing the present flux into the ocean.[7] This would tend to partially balance out man's influence on the river measurements. Moreover, some researchers think mankind's influence is presently small.[8] Syvitski *et al*. have calculated that human contributions to continental erosion are around 2.3 Gt/yr, while reservoirs trap 1.4 Gt/yr,[4] which amounts to about 1 billion t/yr to the ocean at present. This is only 5% of the total. However, sediment trapped behind dams will inevitably also make it to the ocean. Therefore, human influence on erosion would add a little more than 10% to the natural continental erosion. So, subtracting human influence, the natural continental erosion rate would be around 18 Gt/yr, and would take perhaps as much as 15 Myr to flatten North America to sea level.

Another factor is that erosion is proportional to the relief and climate of the continent.[9] As the relief decreases, so does the erosion rate. The influence of decreasing relief is difficult to include. Nonetheless, it would take well over 15 Myr to flatten all the continents. Conventional scientists have come up with a few estimates. Schumm estimated that in a warm humid climate the United States would be flattened in about 33 Myr.[10] Young similarly calculated that the continents could be levelled in 10 to 25 Myr.[11] Geomorphologists Twidale and Campbell also accept these results:

> "However, in all cases, assuming no further major uplift or lowering of sea-level, it has been estimated that a small area like New Zealand, although mountainous, would be base-leveled [reduced to sea level] in about 11 million years. Larger land areas, like the continental United States, sub-Saharan Africa, peninsular India or Australia, would be reduced to base-level [sea level] in 33 million years or so."[12]

Other geomorphologists have also accepted these estimates.[13,14] Although estimates vary from 10–33 Myr, 50 Myr to level the continents should be a conservative maximum. Therefore, all the continents of the world could be flattened to sea level in 15–50 Myr, with the actual value in the middle.

Uniformitarian responses

However, uniformitarian scientists have developed some responses to this problem.

Isostatic uplift counterbalances erosion?

Uniformitarian scientists claim that as all the rocks are rapidly eroded they are replaced by isostatic uplift.[15] However, this would imply that surficial sedimentary rocks would be constantly replaced every few million years. Nonetheless, geologic maps clearly indicate the widespread presence of sedimentary rocks that ‘date’ hundreds of millions of years old, even in areas of high erosion rates.[2] They should have eroded away long ago.

Are erosion rates much faster today?

Uniformitarian scientists claim that the present continental erosion rate is much faster than in the past. If true, this would mean that we cannot extrapolate present rates into the past. One piece of evidence they give is the early Tertiary rocks in southern England, which signifies southern England existed, according to their timescale, for many tens of millions of years, despite erosion being much more rapid today.[1]

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Figure 1. Coastal erosion destroys houses at Valiyathura, Kerala, India

Image: NormanEinstein, Wikimedia / CC BY SA 3.0

Figure 2. Location of the Laptev Sea, north of Siberia, Russia. The sea is part of the Arctic Ocean and neighbours the Kara Sea, on the west, and the East Siberian Sea, on the east.

Radiometric methods give much slower erosion rates than observed today. For instance, Hurst *et al.* using a cosmogenic isotope concluded the East Sussex coastline has been eroding slowly:

> “The ^{10}Be [a cosmogenic isotope] concentrations are consistent with retreat rates of chalk cliffs that were relatively slow (2–6 cm y^{-1}) until a few hundred years ago. Historical observations reveal that retreat rates have subsequently accelerated by an order of magnitude (22–32 cm y^{-1}).”[16]

^{10}Be isotope dating depends upon the *in situ* surface production of radioactive ^{10}Be by cosmic rays, which subsequently decays with a half-life of 1.386 Myr.[17] But, the method is tied to the uniformitarian timescale, like the vast majority of radiometric dating methods, and results in dates that are too old and erosion that is too slow. Therefore, the calculated 2–6 cm/yr is almost certainly too low an estimate. It is contrary to observations (see below), necessitating the excuse of much more erosion in the present.

‘Old rocks’ and radiometric estimates seem to be their only proof of much less erosion in the past. Since radiometric dating conveniently stretches out almost every present process into long periods of time, uniformitarian dating supposedly ‘verifies’ their claim that erosion was much slower in the past. On the other hand, if it can be shown that there is no reason for erosion to have increased in the past 150 years or so, then those radiometric dating methods greatly exaggerate the ages of the rocks and their erosion rate.

Secular estimates insufficiently account for sea cliff erosion

The above estimates of continental erosion in the literature either neglect sea cliff erosion or have assumed that it is small. Scientists have been measuring the continent-to-ocean sediment input for many years and have assumed that rivers provide 72–89% of the sediments, glacial input 6–11%, and aeolian dust 2–3%.[18] They had thought that coastal erosion amounted to only 2–4% of the total input. However, new research is showing that coastal erosion has been greatly underestimated (figure 1).[18]

Coastal erosion is difficult to calculate because historical observations rarely exceed 150 years. It is known that in some places along the Arctic coast, erosion occurs on a scale of m/yr.[19] The 5,200 km coastline of the Laptev Sea of the Arctic Ocean (figure 2) provides 15% of the global estimate of coastal erosion, while only being 0.3% of the global coast length.[18] Man also affects the geomorphology of low coastal areas,[20] but such changes would rarely affect cliffs.

Moreover, coastal erosion is episodic. Some sections of cliffs may not be observed to fall into the sea for a hundred years, but some sections can erode over 1 metre in a short time when large blocks fall off a cliff into the sea or in rotational slump events. Cliff retreat is caused by a combination of wave-induced cliff-base erosion, subaerial weathering, and mass wasting, which all vary with lithology and climate. Erosion is especially rapid on 'soft cliffs' such as chalk.[21] The fallen blocks help protect the beach from further erosion but only for a short time. The sea then gradually removes the fallen material from the beach and the beach continues to progress inland. That is why it is necessary to gather data over many years and many locations to accurately determine the overall rate of coastal erosion.

Nonetheless, researchers recently published a rough estimate of global coastal erosion (sea cliff retreat), summarizing numerous observations.[22] The researchers assembled a global database of cliff erosion called GlobR2C2, which stands for Global Recession Rates of Coastal Cliffs. They used 58 publications with 1,530 studied cliffs and more than 1,680 estimated erosion rates. They had to interpolate their results to sea cliffs that had not been monitored.

Recognizing that about half of the world's shorelines consist of coastal cliffs, the investigators concluded that rock resistance is the most important variable in determining the cliff erosion rates, and that rock resistance is related to lithology and the degree of weathering, jointing, folding,

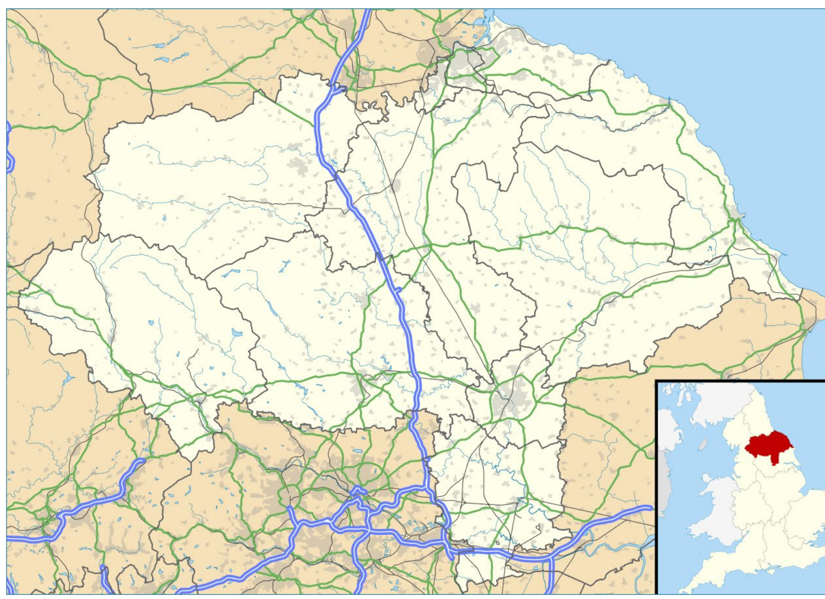

Image: Nilfanion, Wikimedia / CC BY SA 3.0

Figure 3. Map of north Yorkshire, UK, in red

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Figure 4. Chalk cliffs of the Jurassic Coast, Dorset, England

etc. Prémaillon *et al*. estimated average cliff erosion rates of 0.029, 0.10, and 0.23 m/yr for hard, intermediate, and soft rocks, respectively.[22] They also discovered that climate and marine conditions at study sites were only weakly related to cliff recession rates. Focusing in on Europe helped determine average global sea cliff erosion worldwide.

European coastal erosion

Regard *et al.* estimated that European rock coastlines accounted for 52% of the total coastal length in Europe, a rock coast proportion close to the global estimate.[18] The main rock coasts were in northern Europe. For their estimates of sediment flux, they used observations over 1 to 100 years over only 0.5% of the coastline and 1% of rocky coastlines, which required much interpolation between observations. The researchers estimated that more than 90% of the coastal erosion was by sediments and less than 10% by solutes. Therefore, the percentage of solutes from the rock was not included, which would make the erosional estimates minimums. For their calculations, they used an equation that included the height of the cliff, the average retreat rate that depended upon rock resistance, the length of the cliff, and the density of the rock. They discovered that the average coastal erosion in Europe was 38% of the continental erosion, and this amount had to be added to the continental erosion.[18] Coastal erosion is not as insignificant as previously thought, so continental erosion is even faster than previous estimates.

In their calculations, they did not include the growth of beaches, because they represent stored sediment that has already eroded from the continents:

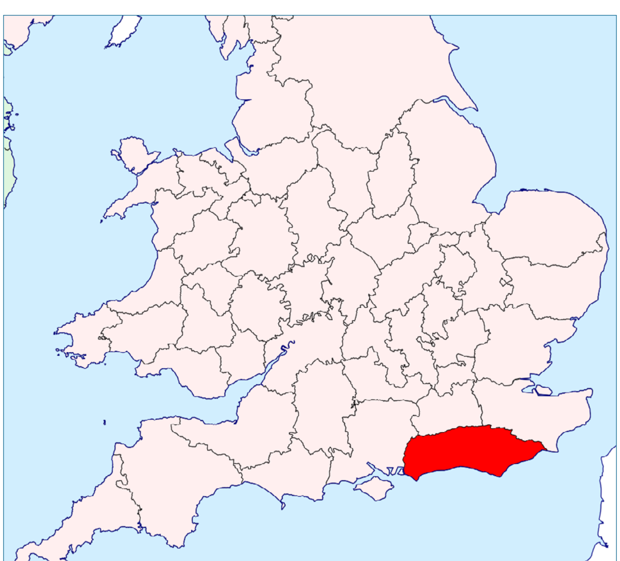

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Figure 5. Map of Sussex, UK, in red. Kent county is northeast of Sussex.

> "Sedimentary coastal traps such as beaches or mudflats only temporarily store sediments, their erosion (either physical or chemical) at a later time only corresponds to the remobilization of sediments that are already in the coastal system."[23]

They further state, "Because they are open systems, beaches always loose [*sic*] sediments, which is balanced by a continuous supply of sediments from rivers and rock coasts."[24]

Of course, much uncertainty occurs with the estimates done by Regard *et al*. As a result, they give wide ranges for coastal erosion rates. Regardless, they calculated that coastal erosion was of the *same* order of magnitude as erosional estimates from rivers; coastal erosion amounts to about 38% of the total solid discharge from European rivers.

The historical erosion rates of English and French chalk cliffs

Such rapid erosion rates are supported by several published estimates of the erosion rate of English and French sea cliffs. The rocky coastal cliffs of the Yorkshire shoreline along the North Sea (figure 3), composed of sedimentary rocks, have a slow average erosion rate of 5 cm/yr.[25] John Matthews has estimated erosion of the chalk cliffs of the Jurassic Coast of south-central England (figure 4)[26] at about 2–5 cm/yr over 50 years,[27] which seems low, since these are 'soft rocks'. On the other hand, Goudie and Brunsden recorded a very high cliff retreat rate at Lyme Regis on the Jurassic Coast at 40–70 cm/yr.[28] More detailed calculations of the recent erosion rate of the chalk cliffs from southeast England have been made.[21,29] Between the 1870s and 2001, erosion ranged from zero to 70 cm/yr. The average was about 25 to 30 cm/yr in East Sussex (figure 5) but only 10 cm/yr in Kent.[29] Regard *et al.* earlier suggested that erosion may cause chalk cliffs to retreat as fast as 20 cm/yr while the shore platform undergoes downwearing.[30]

Cliff retreat on the chalk cliffs across the English Channel at Mesnil-Val, France, is claimed to have been 11–13 cm/yr for about the past 6,000 years (mid-Holocene, after sea level stabilized from the Ice Age), but this estimate is based on cosmogenic isotope dating.[30] It is likely a minimum because of uniformitarian assumptions of deep time. Based on their estimate of 6,000 years of coastal retreat since the end of sea level rise from the Ice Age, at a conservative 10 cm/yr, the researchers expected to find the signature of an Ice Age cliff 600 m away from the chalk cliff. They did not find it, which implies that the cliff retreated at a rate greater than 10 cm/yr. The current rate is estimated at 15 cm/yr.

The United States should not exist because of coastal erosion

Fleming has made a number of calculations of erosion rates, showing that deep time cannot exist.[31] Based on coastal erosional estimates on the East coast of the United States

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Figure 6. Coastal erosion of a sea cliff at Hunstanton, Norfolk, UK. Although much glacial sediment occurs on this coast, in this case the white layer is chalk, the red layer is sandstone.

at about 0.8 m/yr and on the west coast at about 0.2 m/yr, then the United States should have eroded away in several million years:

> "If we take 8 inches per year as the average rate of erosion for the Pacific coast and 31 inches per year for the Atlantic coast and look forward in time, the two coasts will meet about 4.2 million years in the future near Salt Lake City, Utah."[32]

Possible mechanisms for faster sea cliff erosion today

Hurst *et al*. claim the reason cliff erosion has increased in the past 130 years is possibly because of "thinning of cliff-front beaches, exacerbated by regional storminess and anthropogenic modification of the coast."[16] But they analyzed an area that did not have any direct human influence, although there was human influence to the west that probably caused more sedimentation of East Sussex beaches, slowing erosion. Most human modification attempts are to *slow* erosion, so anthropogenic modification is a difficult variable to apply and does not seem to be significant for East Sussex.

They also suggest that, during the Little Ice Age (LIA), about 1400–1850 AD, there was greater storminess and stronger wave action. But why would such Little Ice Age storminess carry over after 1850? The researchers think the above variables unlikely to have caused increased erosion:

> "Our methods do not allow us to attribute the recent acceleration in cliff retreat rates in East Sussex to anthropogenic activity, to a response to progressive thinning of beach material, or to increased storminess during the LIA."[33]

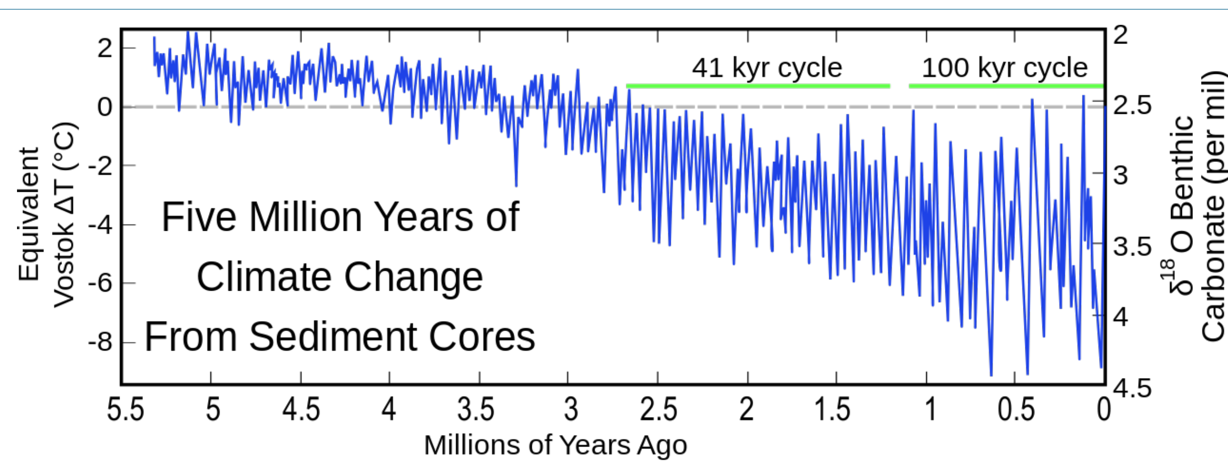

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Figure 7. Reconstruction of the past 5 Myr of climate history, based on the oxygen isotope ratio of benthic foraminifera, which serves as a proxy for ice volume. Taken by combining 57 deep sea cores that must be 'accurately dated'. The low point of each cycle represents an ice age. The 100 kyr Milankovitch eccentricity cycle dominates for the first million years and the 41 kyr tilt cycle before 1 Ma.

Regardless, the slower erosion rate in the past is against uniformitarianism, and there does not seem to be any significant reason for slower erosion rates.

Glaciation has little effect for English coastal erosion

Presently, glaciated areas have been included in continental erosion (6–11%) because glaciers more efficiently erode the substrate.[7] Syvitski and Milliman estimate that glaciers cover <10% of their 488 river watersheds used in their database.[7] So, if the area glaciated increases, so does the erosion. Some researchers estimate that erosion goes up by an order of magnitude or more during glaciation. The sediments in some coastal areas of England, such as the Norfolk coast of southeast England (figure 6), were deposited in the Ice Age, and of course these coastal areas are eroding faster. Including Pleistocene glaciation would show an acceleration of continental erosion, especially when considering that conventional scientists now believe there were about 50 ice ages of various intensities during the Pleistocene (figure 7).[34]

Glaciation would not apply to southern England, but indirect effects of glaciation, such as producing a lower sea level, would apply. Another factor to consider is the catastrophic erosion of the chalk by an Ice Age megaflood in the eastern English Channel from a lake in the southern North Sea.[35] This lake broke through and formed the Dover Strait (figure 8)[36] and probably widened the eastern English Channel a little. But other areas of England have not been affected by the Ice Age, such as the south-central and southwestern coast. Thus, the western and central English Channel would have been a bay lined with chalk cliffs. At that time the erosion would have been relatively fast from the direct onslaught of Atlantic storms.

Regard *et al.* attempt to include glacial/interglacial cycles and lower glacial sea level in their calculations, and conclude: "Consequently, there is no clear argument to support a strong imbalance between rock coast and river sediment supply to the ocean during glacial-–interglacial cycles."[37] So, the effect of glaciation apparently has had little effect on average coastal erosion.

What is the meaning of much higher coastal erosion for continental erosion rates?

Although coastal erosion rates are rough estimates, it would be difficult to refine them. But if we take just the observed coastal recession rates for Europe, we discover that coastal erosion adds another 38% to estimates of continental erosion by rivers to the oceans. So, the rate of continental erosion can be increased by about 38%.

Therefore, applying the estimates to Europe and assuming the average cliff erosion rate for Europe is 0.10 m/yr for rocks of intermediate resistance, we find that Europe should have eroded away in several million years! At this rate, coastal erosion would be 100 km in 1 Myr and 300 km in 3 Myr. The implication of adding coastal erosion rates to continental erosion rates is that England should have eroded away long ago—within several million years! Even if we used the slower erosion rate observed on hard rock cliffs along the York coast of 5 cm/yr, 50 km of coastline would have eroded in 1 Myr and 250 km in 5 Myr. Again, England, should not exist.[38] Many historical estimates are significantly greater than 5 cm/yr, such as most of those on chalk cliffs. If we used the present-day erosion rate of about 25 cm/yr for the East Sussex coast, coastal recession would be 250 km in one million years. Regardless, the chalk of England should have worn away eons ago. And even if we used the low erosion rate determined by ^{10}Be isotope dating, England still would have eroded away in less than 5 million years. England and Europe should not exist today, if deep time were true.

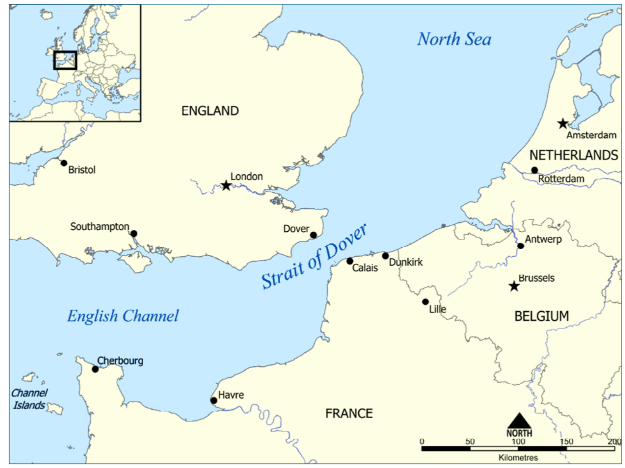

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Figure 8. Map shows the location of the Strait of Dover between England and France, and part of the English Channel and the North Sea. It also shows nearby towns such as Dover, Calais, and Dunkirk.

Conclusions

If coastal erosion is added to subaerial erosion, then all of the continents should have been levelled in significantly less time than the maximum of 50 Myr. The implication for creation science of coastal erosion rates reinforces the estimates of continental denudation: the present rates are too fast for continents to still exist if deep time and uniformitarianism is true.[15] The scientific dodge, such as present rates of erosion have accelerated (a non-uniformitarian assumption), seems to be due to circular reasoning, by first assuming the old dates from their dating methods and slowing down the present erosion rates for the past.

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