Newsletter #4- 19th May 2020

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Editorial

I'll start this Newsletter differently from the previous three. I issued a challenge in Newsletter #3 on p 17; what geological features do you see in Betrice Egli's video *Ob Du's glaubst oder nicht?* So I'll begin the current issue with my responses ("answers"?) to the challenge. See p 5.

There are also a couple of YouTube videos from Faroese singer Eivør Pálsdóttir showing some spectacular scenery, and interesting geology, in the Faroe Islands and Norway. See pp19, 22 and 23. These YouTube videos illustrate a favourite theme of mine; there is geology all around us. Even if we can't get out there yet, we can always go on-line and apply our knowledge and skills to what we view.

As in previous Newsletters, I've put in some science videos, starting on p 24. As before, most of them are fairly long, and some are rather high-brow. I prefer scientist presenters to celebrities. To balance things up I have included a couple of websites from geology populariser Nick Zentner of Central Washington University (USA); and a series of videos suited to the layperson, celebrating the 50th Anniversary of the fall of the Murchison meteorite in northern Victoria.

For your entertainment I've included scenic videos, starting on p 27, of the Faroe Islands, Norway, and Iceland; then I switch to a few places I've visited in South Africa. Keep in mind that the geology at these locations is a big factor behind their scenic appeal.

These newsletters are in part a response to our inability to get into the field because of measures to limit the spread Covid-19 infections. So I have included a few articles about the beneficial effects of these precautions, and another about the biology of the interaction of humans and coronavirus. Coronavirus is the organism, Covid-19 is the disease it causes (in human beings). Compare the effects of Covid-19 with the Black Death and other diseases in our past. See pp 29-40.

The moon has now been fully mapped at 1:50,000 scale, and I have included a notice about this on p 41. This leads into a little article about a recent publication by the Northern Territory Geological Survey called *Meteorites and Impact Structures in the Northern Territory* (p 42). I have included links to a few asteroid impact structures I have visited (see pp 42-43).

There's some light-hearted stuff too, on p 43.

In an earlier Editorial (Newsletter #2) I foreshadowed articles on various types of round structures on the ground surface. I've included "Circular Mounds" in this issue, mentioning features in NW USA, South Africa, and inland Australia. See pp 44.

Members who went on the 2018 Safari will remember George Winter of Esk (SE Queensland). He helped us on the day in and around Esk. George has kindly written an article on lime, limestone and marble for the Newsletter. See p 57.

I've included another article in my series about unusual waterfalls, this time Thina Falls in South Africa. See p 57. This waterfall cuts off an incised river meander, an instance of a change in a stream-course. This leads me into yet another alteration of a stream-course: Bear River in the western USA. The deviation of this river by a fairly small volcano increased the inflow into a lake-basin that had no outlet, until it overflowed, leading to the ninth-greatest known flood in the Quaternary (the last 2.6 million years). This was the Lake Bonneville Flood. See p 62.

One thing missing from this issue is a contribution from Winston Pratt in his Paleo Period Plants series. This series is a work in progress; so, watch this space (patiently).

I've had enough of people telling me to "stay safe" or to "be safe"; so I won't insult you that way... I'll invite all of you to play up like second-hand lawnmowers.

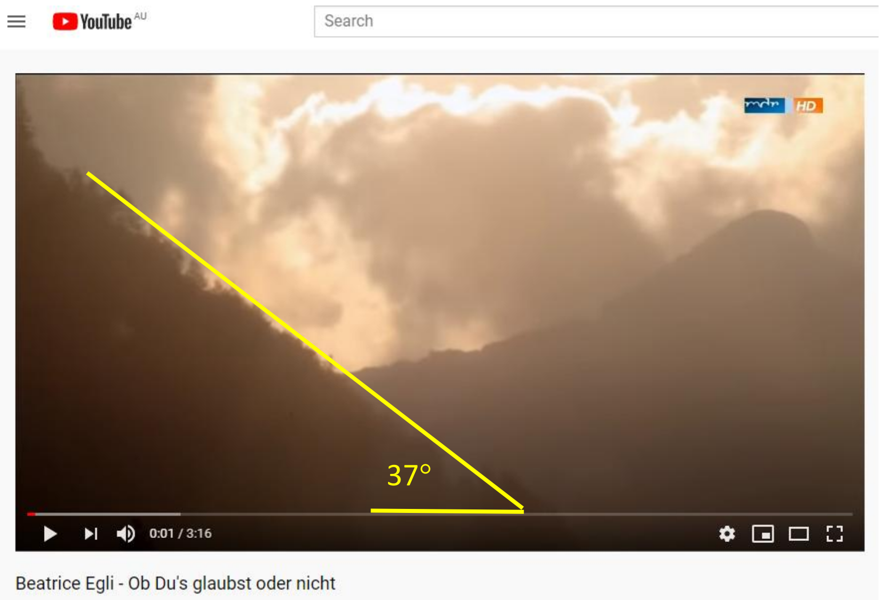
Geological features in *Ob Du's glaubst oder nicht* YouTube video

Let’s refresh your memory (from Newsletter #3). The challenge was to watch the video straight through, and see what geological features you can identify; then watch again as slowly as you like, pausing and replaying as many times as you need; and once again looking for geological features (both observations and deductions).

Beatrice Egli - Ob Du's glaubst oder nicht: https://www.youtube.com/watch?v=RyLLfp_DYV4

The features I point out here are not necessarily “the correct answers”; rather, they are things that caught my eye, set me thinking, and prompted to me to work them out. I suggest how to go about resolving them.

I don’t know where this video was shot. Beatrice Egli is Swiss (that’s why she sings in German), and that may be a clue; however she tours internationally, so the scenes might have been shot somewhere else.



Beatrice Egli - Ob Du's glaubst oder nicht

The hill-slope is about as steep as the Angle of Repose, the natural angle of heaping of a pile of granular material. If a slope is flatter than the angle of repose, loose material will sit on the slope. At the angle of repose, loose material is at the point of sliding/rolling down-slope. Vegetation helps stabilise any hill-slope. If the vegetation is removed (fire, landslide) loose material *e g* boulders can roll down-slope ... to the streambed.

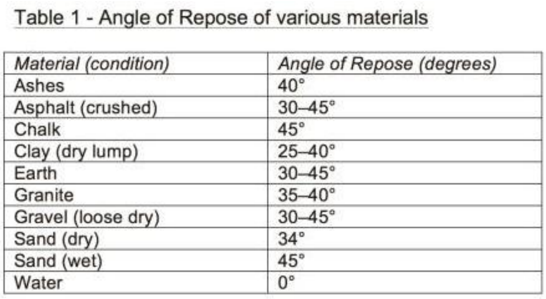
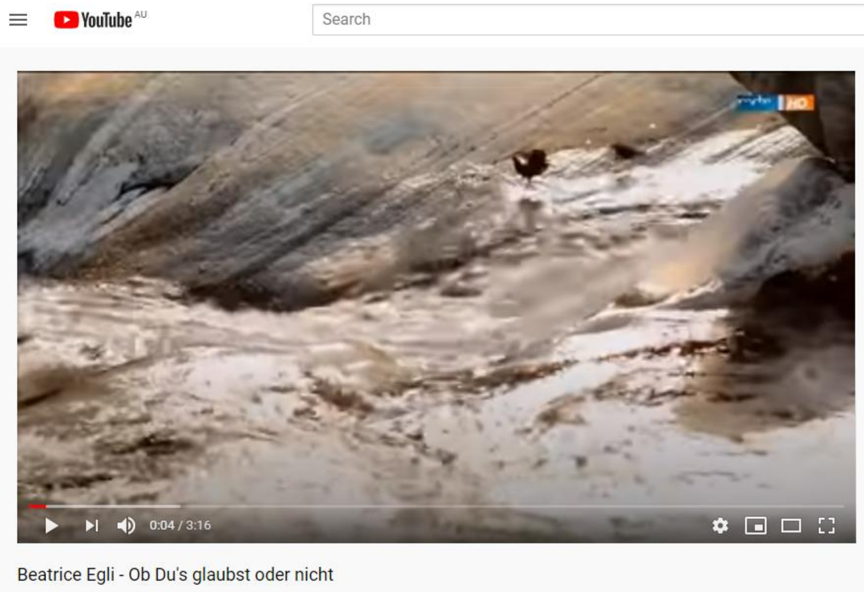


Table 1 - Angle of Repose of various materials

Material (condition)	*Angle of Repose (degrees)*
Ashes	40°
Asphalt (crushed)	30–45°
Chalk	45°
Clay (dry lump)	25–40°
Earth	30–45°
Granite	35–40°
Gravel (loose dry)	30–45°
Sand (dry)	34°
Sand (wet)	45°
Water	0°

Not all boulders in a streambed have been washed down-stream to wherever they are now found; they can roll down-hill, and sit where they entered, without being washed down-stream.

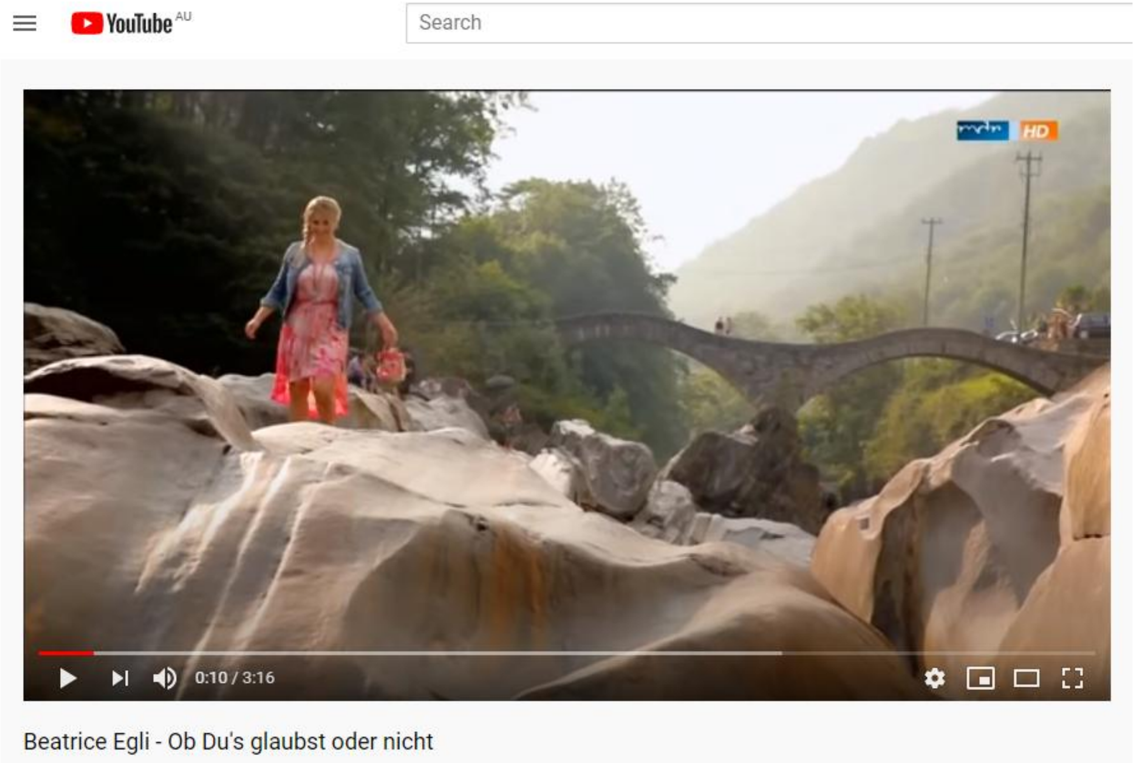


Note the very straight fine layering above and left of the birds... a first guess is planar bedding. But, look in the upper-left to see folded veins (white). They are strongly-folded in the curve (or nose) of the fold, but straight in the flanks (called the limbs) of the fold. So the layering is probably schistosity, not planar bedding. Such planar schistosity suggests strong deformation (maybe in a shear zone).

Beatrice is prancing over the rocks barefoot, carrying her shoes; the rock is smooth enough to allow her to do this without discomfort (*i e* waterworn smooth in the streambed).

There is a steep planar white vein ~50-mm thick to **her** right. (Hydrothermal/groundwater entered a planar crack deep underground in the distant past, and deposited the white mineral there.)

There aren’t many clues to the specific white mineral. Likely candidates are quartz and calcite. Calcite is the more-easily eroded, but the clues are ambiguous in this video (in later scenes, some veins stand out a little from the wall-rock, others are recessed a little below).



Beatrice Egli - Ob Du's glaubst oder nicht

Cavities in the lower-right foreground rocks resemble tafoni... (Who's been to Kangaroo Island and seen the Remarkable Rocks?) Tafoni usually develop in rocks with massive texture (*e g* granite, sandstone). Often, crystallisation of salt (from evaporating sea-spray that soaked into the rock) is invoked as an explanation... unlikely in this video. Maybe wetting-drying of fresh water is involved. The process is not understood definitively.

124 **Tafoni and Other Rock Basins**

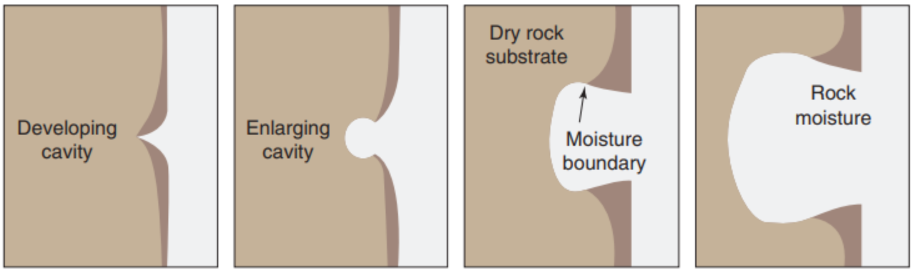
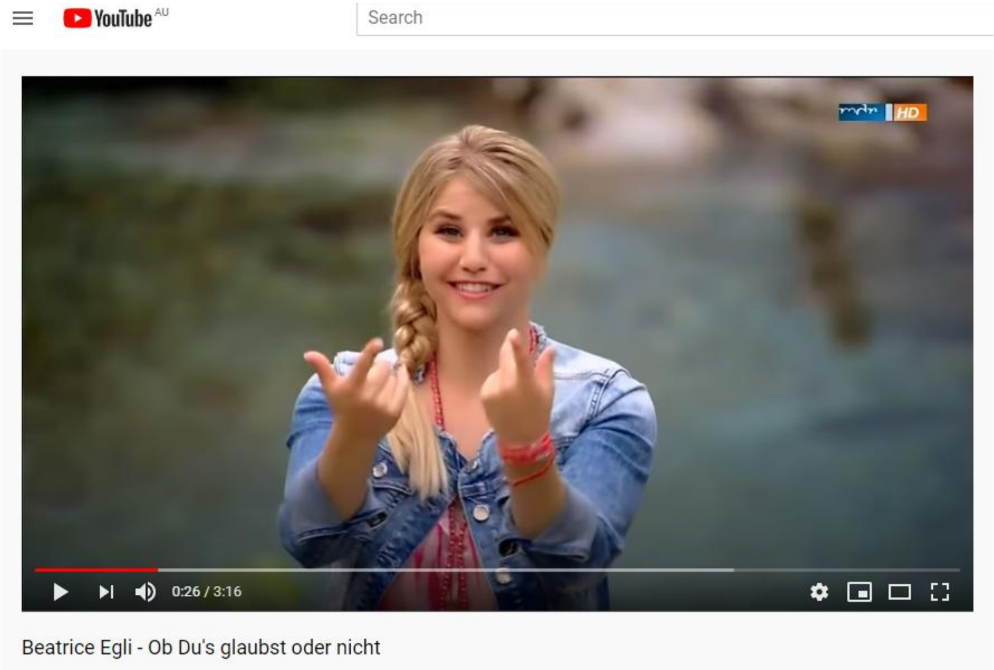


Figure 10 Diagram of cavity development illustrating the importance of the moisture boundary and its relationship to tafoni or gnamma morphology. The cavity evolves fastest (through deepening and/or widening) at the moisture boundary where wetting and drying cycles may be diurnal or seasonal. Reproduced from Huinink, H.P., Pel, L., Kopinga, K., 2004. Simulating the growth of tafoni. Earth surface process. Landforms 29, 1225–1233.

From: *Encyclopedia of Geomorphology*

Beatrice Egli - Ob Du's glaubst oder nicht

There are obvious folds in the pale grey rock in the lower-right quarter. These folded layers are cut off by a planar-layered mid-grey unit with layers dipping steeply left (but there is no fracture along the contact). Most likely, the planar-layered material is a shear-zone cutting the pale grey unit, which is very likely also to be shear zone rock (either an earlier shear zone, or an earlier phase of multi-stage deformation in the same shear-zone). The large mid-grey round “boulder” in the centre has vague broad layering similar to the foreground material; it may be *in-situ* rock, or a loose boulder.



Beatrice Egli - Ob Du's glaubst oder nicht

A person’s reflection in upper right, though out-of-focus, is distorted very little, showing that the water surface is quite smooth (*i e* gentle flow). This is characteristic of bedrock streams at low-flow stage... narrow gutters with rapidly flowing, turbulent water between large still-water pools.

Beatrice Egli - Ob Du's glaubst oder nicht

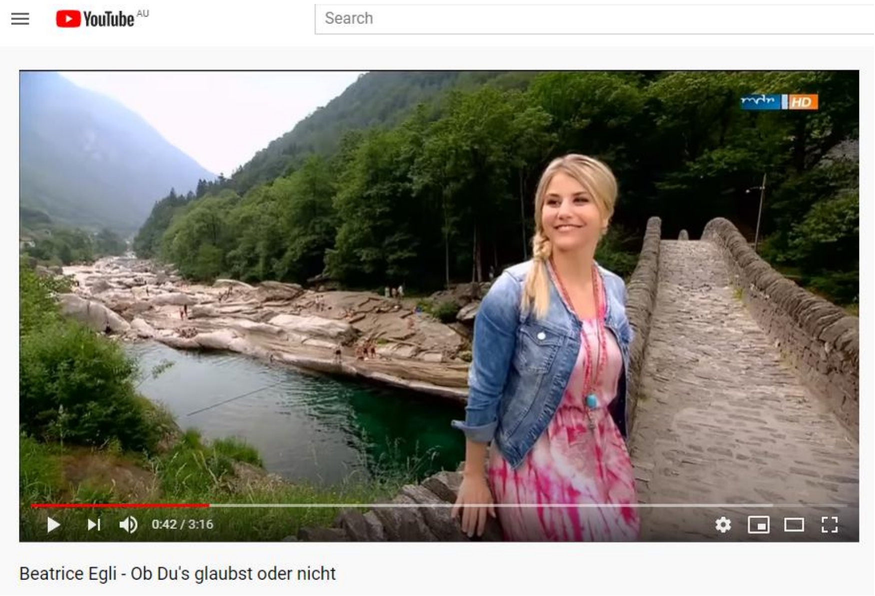
The opposite bank is a bare rock face ~6-7 times as high as the distant person dressed in white (upper-right), perhaps 5-6 m high, suggesting that floods rarely rise higher, otherwise the soil and vegetation above the cliff would have been stripped away.

The pale grey unit to Beatrice's left (that's **her** left) is strongly layered; a few fold noses can be seen scattered through the mostly planar layers, suggesting strong deformation (in a shear-zone?). The thin dark grey units presumably have different mineralogy (extra biotite, or amphibole - metamorphic minerals, or extra carbon - inherited from a sedimentary precursor?) The two dark grey units are not in-line and are also separated along the direction of banding; they may have been one continuous layer, since drawn-out and separated as **boudins**, a feature common in strongly-deformed rocks, especially in shear-zones. Thin white bands in the sharp ridge of rock (just near the swimmer, and running back towards the bridge) are veins. The vein material is a mineral quite resistant to erosion (quartz?); evidently, vein mineral "seeped" into the wall-rocks of the vein, giving the rocks next to the vein extra resistance to erosion. A good case can be made for **these** veins to be quartz rather than calcite.

Larger scale banding (2-5 m): the 2-m pale grey unit, and the >5-m brown unit Beatrice is standing on may reflect differences in the original rock types *e g* sandstone *vs* shale etc. The brown unit may be richer in iron than the grey unit; they may be both weathered to the same degree, but if there was little iron in the pale grey unit it would not have turned brown on weathering.

Beatrice Egli - Ob Du's glaubst oder nicht

White en-echelon veins above Beatrice's left shoulder appear to be geometrically related to the veins in the sharp ridge adjacent to the pool. Presumably they are members of a set of en-echelon veins.



Beatrice Egli - Ob Du's glaubst oder nicht

You can see ~1-km unobstructed along the stream's bedrock, and the skyline coming down from the right doesn't overlap the more distant skyline (coming down from the left) by much. These observations suggest that the stream isn't strongly-meandering. (These aren't incised meanders, just gentle curves.)

Streams are often straight along narrow, easily eroded features such as many faults. Gentle curves such as these would occupy a band hundreds of metres wide (much wider than the stream bed, so we might expect deformed rock some distance up the slopes). If the rocks seen in the stream bed really do represent a shear zone, either they aren't significantly more-easily eroded than he surrounding rocks, or maybe we are seeing a stream-course that occupies a narrow, curved shear zone.

Beatrice Egli - Ob Du's glaubst oder nicht

Veins behind Beatrice and to **her** right in the pale grey unit are not quite parallel to each other; some are oblique to the layering in the host rock, a fairly common situation in metamorphic rocks, including shear-zones.

Beatrice Egli - Ob Du's glaubst oder nicht

The bridge is made from slabs of stone, a shape easily obtained when quarrying metamorphic rocks. It is almost certain that the rocks used in construction would not have been hauled very far from the source quarry of the bridge site.

Beatrice Egli - Ob Du's glaubst oder nicht

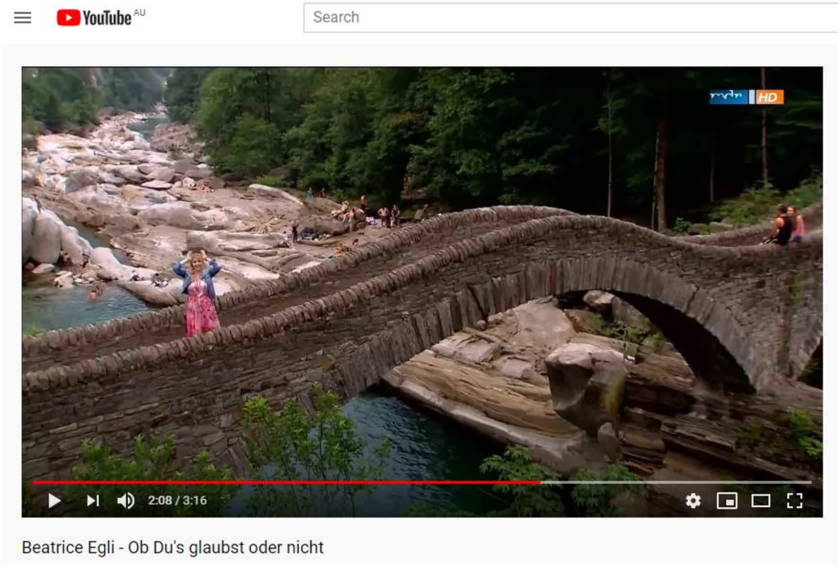
The ~2-m blocks at upper-middle in the far background are angular, suggesting little erosion; they may have rolled down slope into the stream bed. Evidently, even in flood-stage, the flow was insufficient to sweep these boulders away (unless they have been swept downstream to here).

The dark-brown platform on the right side (with two people reclining on it) appears to be a higher part of the bedrock, rather than a loose (unattached) slab, so it shouldn't be included in any (qualitative) assessment of the size limit of the largest boulders the stream can move.

Beatrice was sitting on a rock in the left-foreground, in a scene soon after the video started.

Beatrice Egli - Ob Du's glaubst oder nicht

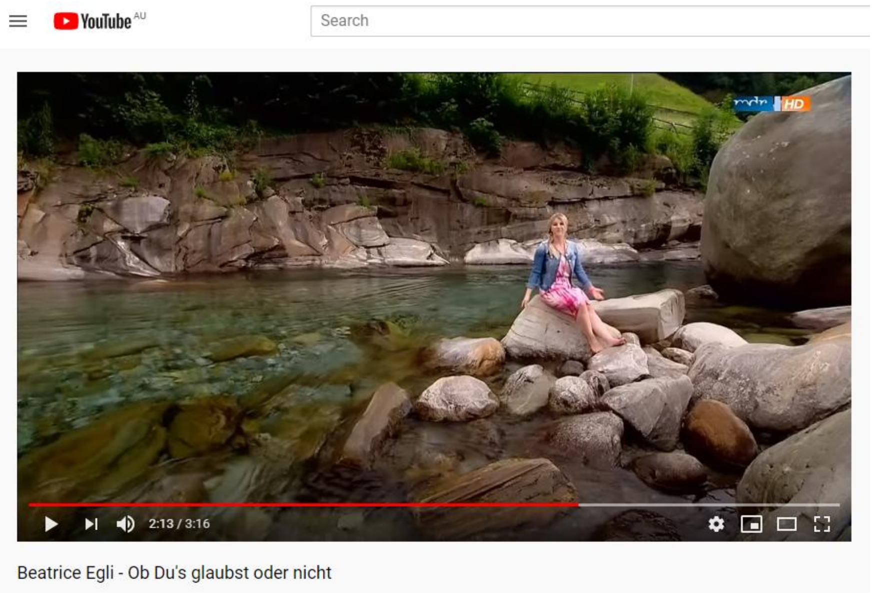
Note numerous steep planar white veins behind Beatrice. Most of them narrow down to pointed terminations; few extend right across the view. The veins fill individual sub-parallel planar cracks.



Beatrice Egli - Ob Du's glaubst oder nicht

There is a pool of water below the bridge, another small one beyond, to the left of Beatrice, and another about 100 m further along. This pattern is very common in bedrock streams at a low stage of flow; turbulent water flowing rapidly along narrow gutters (or even below and between boulders) from pool to pool of very still water.

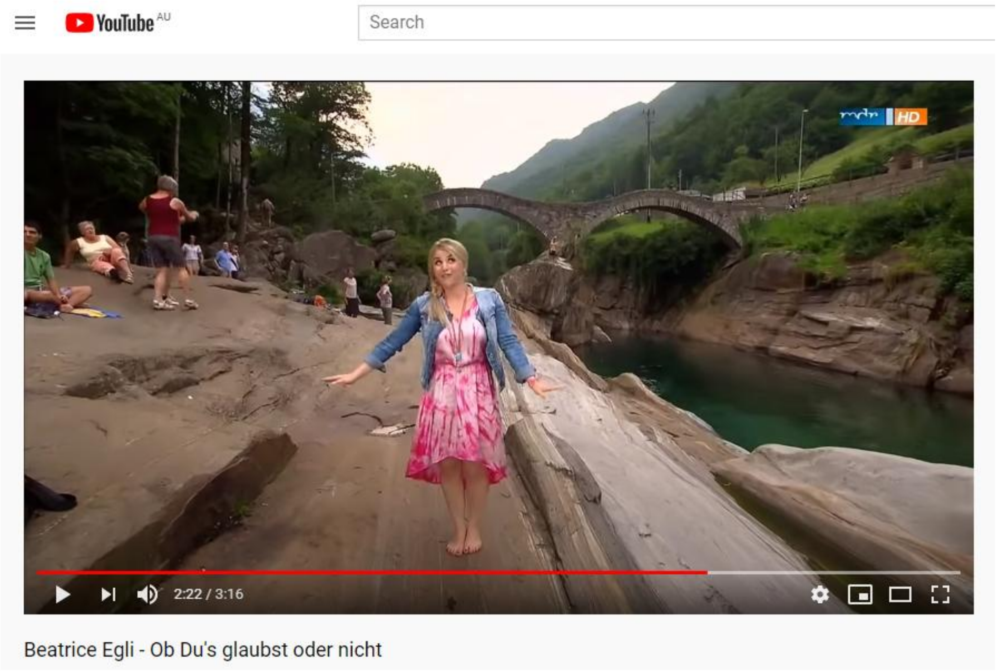
Through the bridge's arch is a mid-grey equi-dimensional block of mid-grey rock with a shallow tafone (singular of tafoni). This block is in-line with, but doesn't "match" the layering in the ridge of rock on which the bridge's foundation rests. It appears to be a boulder, rather than *in situ;* and may have been washed up against the ridge (or rolled down-slope into just that position). For reasons given two still images later, I think the stream flow is from right to left, and this view is downstream (see below); if so, the boulder is in the lee of the ridge (calmer water?) during floods. It may be a good indication of the power of the stream when in flood. Further examination **in the field** would be useful.



Just above the water-line at the left are curved white veins, suggesting that these are shear zone rocks. The round "boulder" on the right side resembles the rock material in the cliff behind Beatrice's head; is it a boulder that has rolled downhill from the slope behind her?

Folded layers and white veins just above water level on the left in pale grey and brown rocks are consistent with a shear-zone. In the mid-grey cliff the rocks lack veins and appear to have vague broad (0.5-m) shallow-dipping layers that may be sedimentary bedding. Upper layers in the left half dip gently right, lower layers on the right half dip left, suggesting low-angle cross-bedding. **Is the mid-grey rock of the cliff outside the postulated shear zone?**

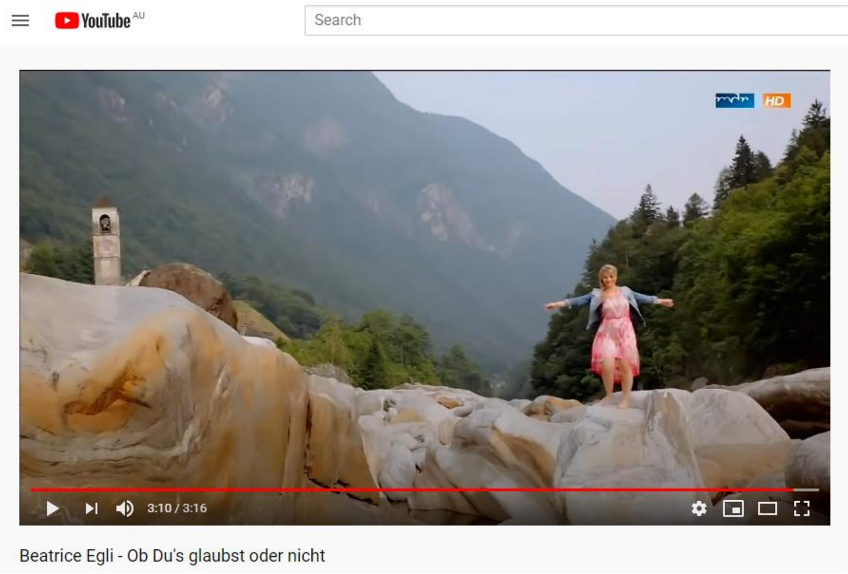
The ruffled water in the bottom-left is flowing left to right; this is about the only good clue to the overall flow direction. I can't relate the **close-ups** of flowing water to the bigger picture. By working out the relationships between the various views, starting from this one, we see that the stream flows from the bridge towards the church tower.



Boulders beyond the spectators evidently rolled downhill to their current positions from the hillside on the left, rather than being washed up onto this bench.

The standing wave beyond Beatrice’s left shoulder is a flow feature very that forms at very particular combinations of flow velocity and water depth.

The waterline on the flat rock-face beyond Beatrice’s right elbow is horizontal. The bearing or direction of this waterline is by definition the **strike** of the flat rock-face.



Layers in the left-foreground curve in 3-D, in a manner like the nose of an airliner (or at least one side of the nose). This may be a sheath fold. Sheath folds are characteristic of shear zones; their axes are parallel to the transport-direction of the shearing movement.

Also, there is a prominent fold-pair visible high on the hill-slope just above centre, and a horizontal section of skyline above this fold. The stream bed aligns roughly with these features, so maybe all three trace out a straight shear zone, along this stretch of stream, then up through the fold-pair and over the ridge at the flat spot.

About 1 metre to the right of Beatrice's feet is the nose of a tight fold; the limbs can be seen on the rock platform, trailing away a few metres towards the buildings. "*Beatrice! Wait a bit! Where are your shoes? You've left them behind somewhere.*"

For a detailed explanation of shear zones see**:**
Shear zones by Haakon Fossen
or https://www.youtube.com/watch?v=G4YjhYhCXbc

Boulders in streams – roll-along *vs* roll-down-into

A question arises... how far do big boulders travel downstream? This is difficult to answer for the stream in Beatrice’s video, but there are some hints from a locality in S E Queensland, about 120 km NW of Brisbane, in the headwaters of the Brisbane River.

Mount Stanley is at the push-pin in the top-left.

The rocks at Mt Stanley were deposited in a sedimentary basin (Esk Basin) during the Mid-Triassic, and were intruded by small granites bodies later during the Mid-Triassic.

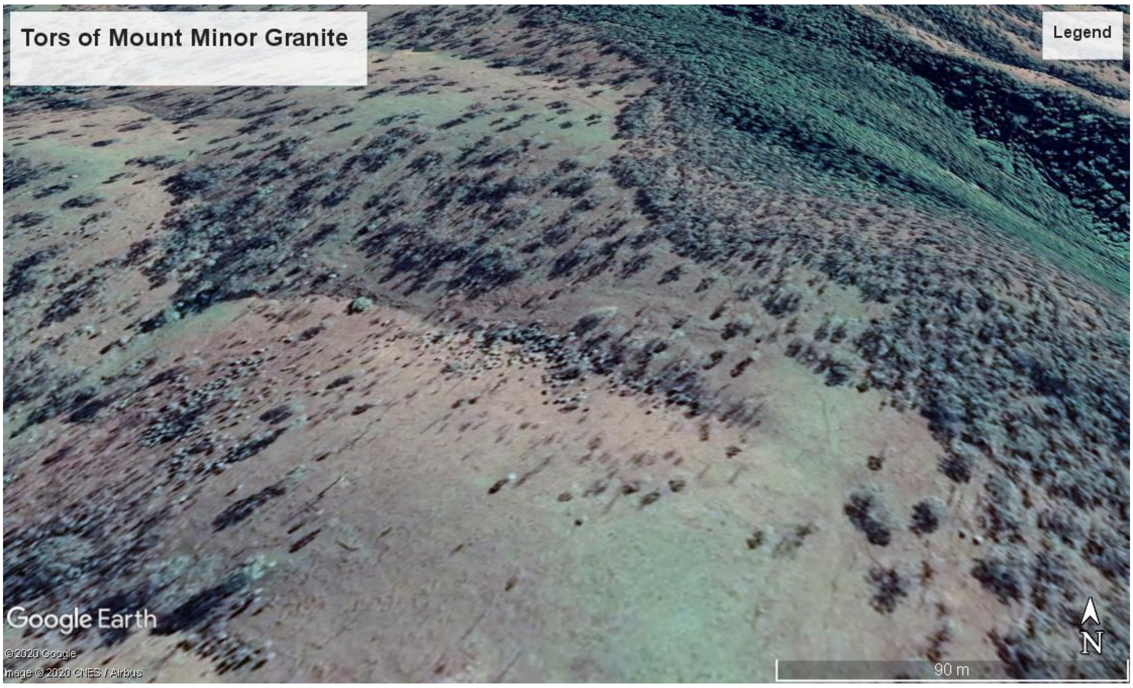
There is a small granite intrusion (Mount Minor Granite) cropping out at the top of Mt Stanley, about 322 m above Brisbane River. Most boulders in the river are sandstone (the regional “background” rock), and generally smaller than 2 m, down to sand-sized. There are several large (1-2m) and one huge (5 m) granite boulders in the river-bed alluvium.

Short steep intermittent streams flow down from Mt Stanley. The granite boulders are restricted to a ~100-m stretch of the river downstream from the point where the tributaries join the main stream. The granite boulders are round (not “rounded”) and smooth. They are “water-worn”. Clearly, the boulders rolled down from the mountain-top, but didn’t travel far downstream. According to a middle-aged grazier from nearby, his grandmother remembered the 5-m granite boulder from when she was about 8 years old, so this boulder hasn’t moved noticeably for ~100 years. So, here at least, big boulders haven’t travelled far downstream. Their smoothness is probably due to abrasion by the impact of smaller fragments (cobbles and sand), rather than tumbling downstream. The process is more like sand-blasting than gemstone-tumbling. This situation may apply worldwide.

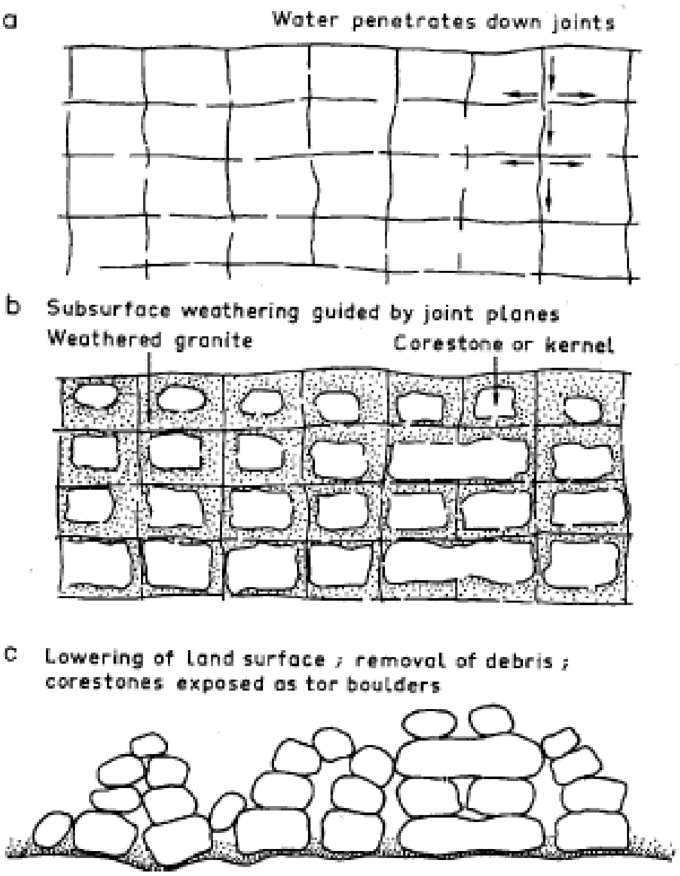
The roundness of these granite boulders is pre-conditioned; close scrutiny in Google Earth shows that the top of Mt Stanley has plenty of granite tors. These round (not “rounded”) boulders rolled easily down to the main riverbed, but despite their shape, do not roll far downstream in floods.

Granite boulder 5-m in diameter that probably rolled down the slope in the background.

Mt Stanley (522 m) stands over 300m above the East Branch of Brisbane River. The steep slope begins ~100-300 m out from the granite contact, suggesting there is a "hardened" contact metamorphic aureole 100-300 metres wide around the granite. The pink is Mount Minor Granite.



Tors (centre and mid-left) of Mount Minor Granite on the top of Mount Stanley. Brisbane River (East Branch) is down the timbered slope on the right.



Formation of tors

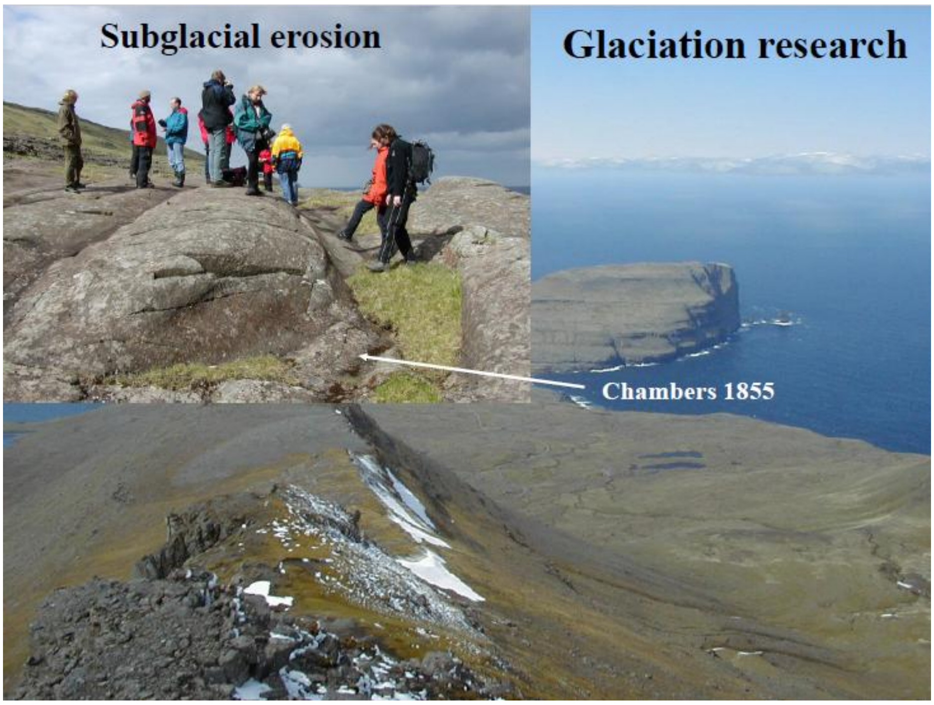
From: *Structural Landforms* (1971) by C R Twidle

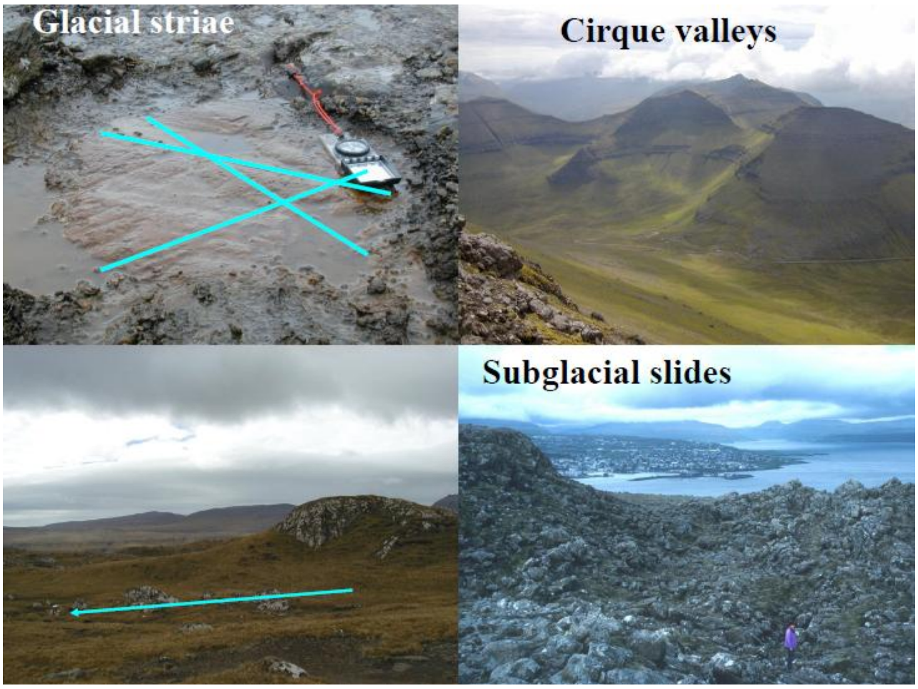
We're not finished with Eivør's YouTube video *Mín Móðir* just yet.

There is something else (geological) in Eivør's (Eivør Pálsdóttir) YouTube track *Mín Móðir* (My Mother), besides waterfalls plunging into the ocean. (See AGSHV Newsletter #3.)

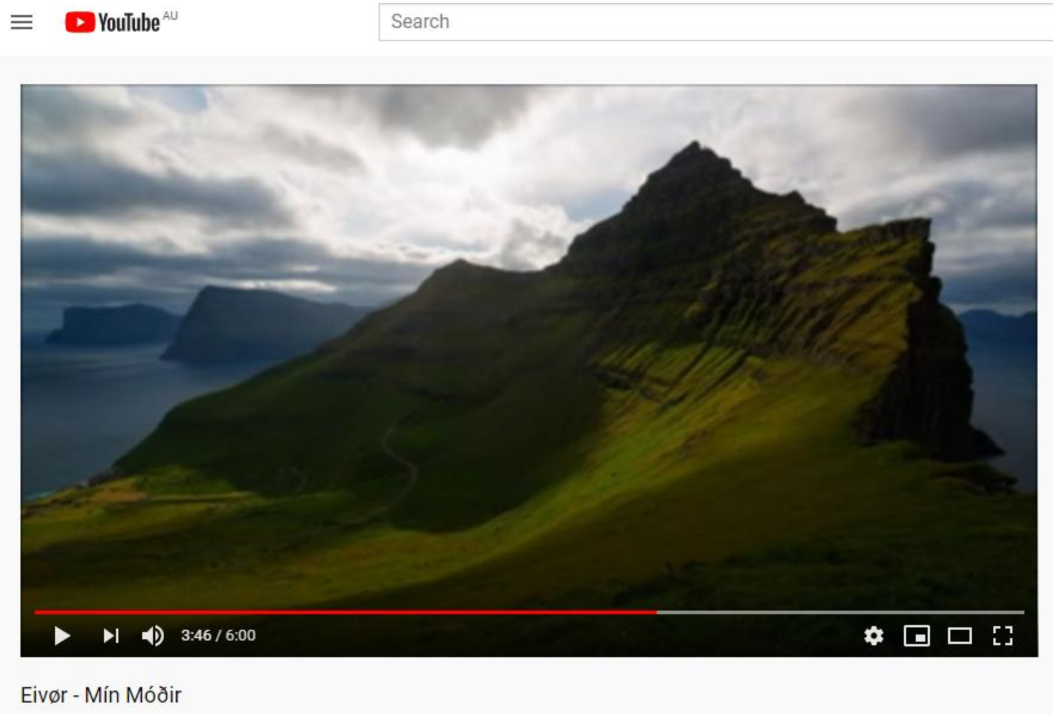
https://www.youtube.com/watch?v=zm3wa2LtJQM

During the Weichselian Glaciation (the "Last Ice-Age") between 115,000 and 10,700 years ago, there were glaciers in the Faroe Islands.



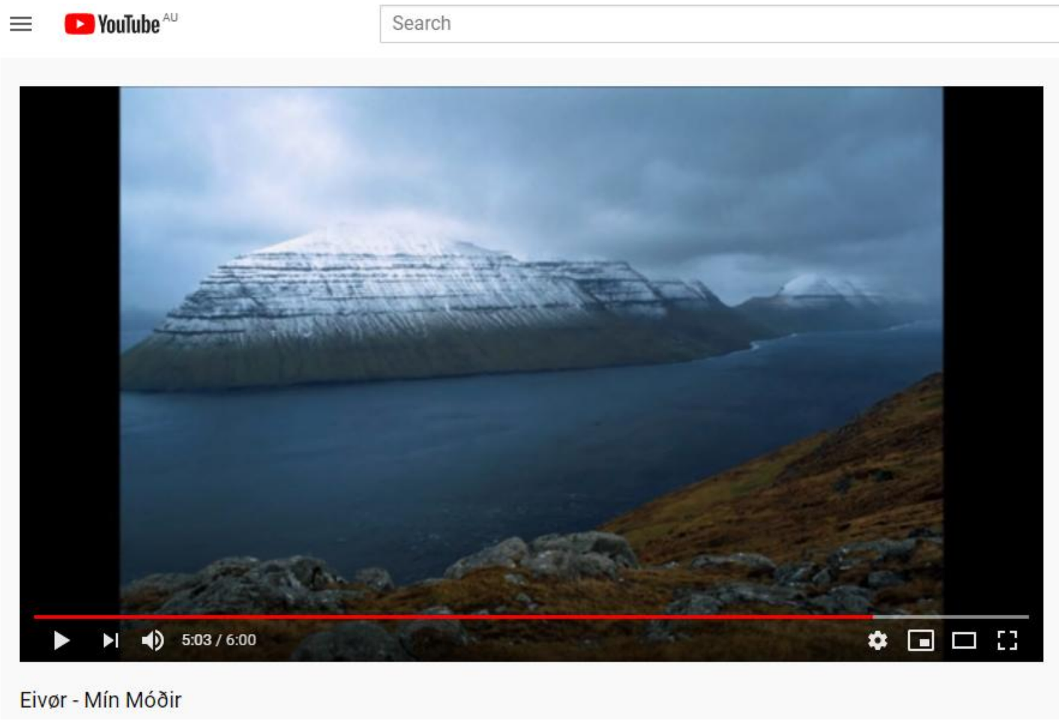


This scene from the *Mín Móðir* video shows a beautiful cirque, the “headwater” basin of a short mountain glacier:



Eivør - Mín Móðir

There are also fjords, valleys cut into the bedrock by glaciers during low-stands in sea-level. The sea-level rise in the Holocene Epoch since Weichselian times allowed the rising sea (rising because the on-land continental glaciers were melting) to flood the valley floors, leaving narrow arms of ocean reaching into the coast (as in Norway), or straits between islands as in the Faroes.



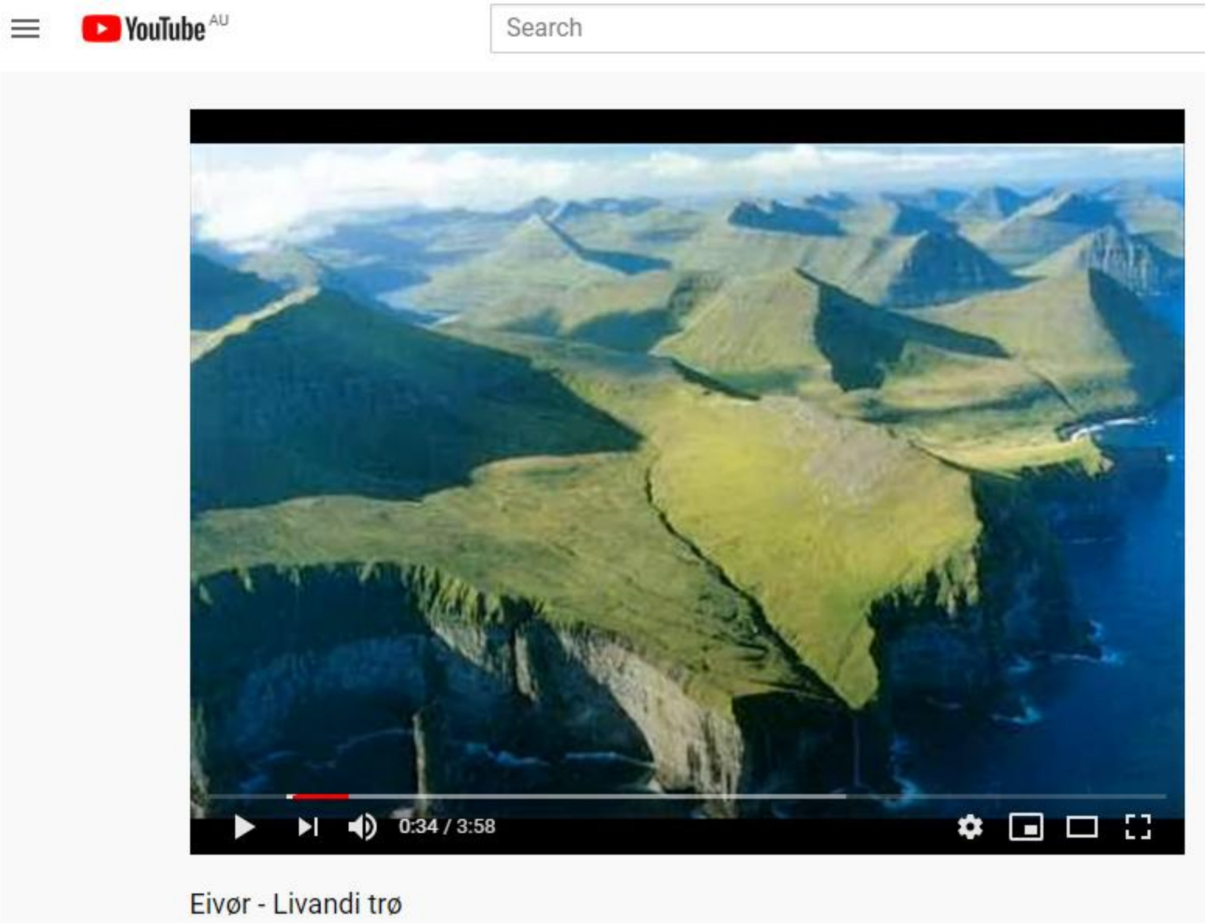
Looking across the fjord Kalsoyarfjørður from Kalsoy Is. to Kunoy Is. in the Faroes.

Map of the Faroe Islands

Another waterfall into the ocean, from Eivør's *Livandi trø* video

Eivør Pálsdóttir has another YouTube video with yet another waterfall dropping into the sea (as well as images of Múlafossur again). The song is *Livandi trø (Living faith)*:

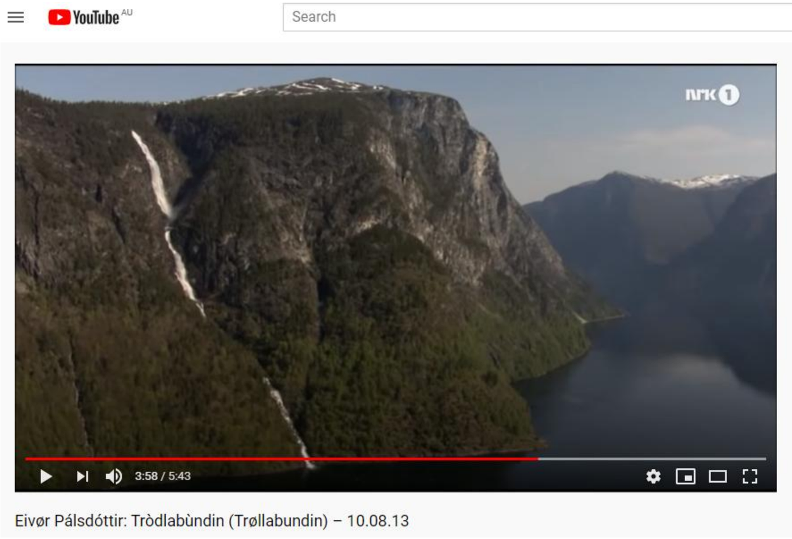
https://www.youtube.com/watch?v=oar2C34ek_s



This scene just didn't look quite right to be in the Faroe Islands. The cliffs are pale rocks, and the hills stretch a long way into the distance; this place seems bigger than the largest of the Faroe Islands. However, careful scrutiny, and comparison with Google Earth shows that this image is of the northernmost tip of Eysturoy Island, but left-right reversed! The large apparent extent of the land is an illusion. Eysturoy is in the foreground, with Streymoy behind; the intervening sound (Sundini) is hidden behind Eysturoy. I don't know why the cliff rocks are pale. The Geological Map of the Faroe Islands suggests that the northern tip of Esturoy is Malinstindur Formation, previously called Middle Basalt. I would have expected a mid- to dark-grey colour.

This is the second of the waterfalls in my article about Eivør Pálsdóttir's YouTube track *Mín Móðir* (My Mother). (See p 28 in Newslatter #3).

More geology from Eivør: YouTube video *Tròdlabùndin*



Eivør Pálsdóttir: Tròdlabùndin (Trøllabundin) – 10.08.13

https://www.youtube.com/watch?v=wsl-KHGe4Kk

“Faroese Eivør Pálsdóttir performs her own song "Tròdlabùndin" (from the album "Trøllabundin" 2005) at an outdoor concert with Vamp on the mountain farm Stigen in Aurland, 10.08.13. Stigen Farm is a UNESCO World Heritage Site from 2005, and it is located by the Aurlandsfjord.”

This performance was in Norway; Faroese singer-songwriter Eivør (Eivør Pálsdóttir) sang "Tròdlabùndin" in the Faroese language. The setting is high up the side of the fjord Aurlansfjorden. Some of the video is a live recording of the performance; there is also beautiful scenery, some seen from Stigen Farm, some from further afield. The scene above shows Ramnefjellsfossen, which falls into the glacially eroded lake Lovatnet. At 818 m (including cascades between four tiers that total 585 m), many people say it is the third-highest waterfall in the world. Lake Lovatnet is almost a fjord; there are rapids on the 2.5 km stream connecting Lovatnet (~52 m ASL) and the fjord Innvikfjorden (sea-level) downstream. This is *almost* another waterfall dropping into the ocean (as in Newsletters #1, #2and #3). Ramnefjellsfossen is about 100 km from the farm Stigen Farm, the location of the concert.

The notion of waterfalls dropping into the ocean opens up with fjords. It really depends on the difference between a waterfall and a set of rapids. Fjords generally have steep valley walls, and more rarely cliffs, so what some people will call a waterfall is a set of rapids to others. Also, many steep slopes and cliffs (such as fjord walls) have piles of talus or alluvial fans at the bottom; in certain cases a waterfall will drop onto this talus or fan, rather than directly into the ocean, and this disqualifies such a situation from being an example of a waterfall dropping *directly* into the ocean.

There is Geology all around us. You can’t always get to the field; sometimes you need to bring the field to yourself (even from an overseas location). There is a parallel situation when we get out and about after the COVID-19-prevention restrictions are lifted. You can take in the geology on one of our ably-led field trips; or look at, observe, and understand the geology surrounding you all time, off your own bat, wherever you are. This is the message to take from “All of the Above” – pp 5-23.

“Geology is all around us, scarcely thought of as we go about our lives.” The first line from:
Written In Stone...seen through my lens
or http://written-in-stone-seen-through-my-lens.blogspot.com/

Science Videos

Let's start with Australian Dinosaurs:

BrisScience (May 2017): Australia's Jurassic Park
or https://www.youtube.com/watch?v=ZkkJgFHkHI0

Australian Dinosaurs
or https://www.youtube.com/watch?v=sMUZk1JRbDw
(one mistake: dinosaurs aren't "reptilian")

Discovery Dinosaurs: Australia and Antarctica
or https://www.youtube.com/watch?v=BrqOGsLbNeU&t=2483s

One of my favourite go-to sites for geological videos is Nick Zentner's. He is more a geology teaching specialist than a research scientist, and is based at Central Washington University in Ellensburg, Washington, USA. His topics relate mostly to his local area (NW USA), but many of his videos are more widely applicable. They are also a good insight into how geologists think and link things together. The level of these videos is well-suited to non-specialists (he gives regular 1-hour live lectures to audiences that mostly look like retirees). When the coronavirus lockdown began, he switched from studio-base videos and lectures to live-streaming from home (starting on St Patrick's Day, 17th March).

I have put links to a few of his videos in previous Newsletters. Here is one of the main sources:

https://www.youtube.com/user/GeologyNick/videos

Zentner also has YouTube videos on the Huge Floods website: http://hugefloods.com/

https://www.youtube.com/channel/UCJzgDS6e4qCcklywGxCyvgw

This YouTube by Laurence Robb is pitched for high-school teachers. He has written a nice textbook too (which I've read): *Introduction to Ore-Forming Processes* (2005):

EGU GIFT2015: Mineral deposits
or https://www.youtube.com/watch?v=JZhHysaJVzk

Another video, featuring orogenic-gold specialist Dr Rick Goldfarb:

Orogenic Gold Deposits
or https://www.youtube.com/watch?v=RBGuaCDMPzM

Here are two ore-system videos:

GSA WA special - Dr Vitor Barrote "4D EVOLUTION OF REPLACEMENT-TYPE VHMS ORE SYSTEMS, YILGARN, WA"
or https://www.youtube.com/watch?reload=9&v=8CXV5eeemck&feature=youtu.be

GSA-WA March speaker 2019 - Cecilio Quesada - The Iberian Pyrite Belt
or https://www.youtube.com/watch?v=WK2xUUkueWo

Here is a superb very scenic general field geology website. Blogger Dr Jack Share is a geologist. Explore the website:

Written In Stone...seen through my lens
or http://written-in-stone-seen-through-my-lens.blogspot.com/

How about some volcanology?

The 20th Century's Greatest Volcanic Eruption: Mt Katmai 100 Years Later
or https://www.youtube.com/watch?v=7nOSLGSsb1s

ITALY'S SUPERVOLCANO, 2015
or https://www.youtube.com/watch?v=96026QEl-44

EGU GIFT2017: Living in a caldera: The case of Campi Flegrei, Italy
or https://www.youtube.com/watch?v=HuoMiUXf1YY

CAMPI FLEGREI: Italy's Super volcano And Its Mega Eruptions - Part 1
or https://www.youtube.com/watch?v=6CG-sjjDI1w

CAMPI FLEGREI: Italy's Super volcano And Its Mega Eruptions - Part 2
or https://www.youtube.com/watch?v=iDyIeC5CQTo

CAMPI FLEGREI: Italy's Super volcano And Its Mega Eruptions - Part 3
or https://www.youtube.com/watch?v=npXwB_ZXDNk

CAMPI FLEGREI: Italy's Super volcano And Its Mega Eruptions - Part 4
or https://www.youtube.com/watch?v=nWhOvPsrT7k

Lake Toba Supervolcano: The Mega Eruption 77,000 Years Ago
or https://www.youtube.com/watch?v=W5Cs4Rcmtk8

Mt. Tambora & The Year Without a Summer - Dalton Grand Solar Minimum [DW]
or https://www.youtube.com/watch?v=bB3Jx0N9mWo

Tambora 1815: How Climate Change Shaped the Nineteenth-Century World
or https://www.youtube.com/watch?v=z_aGO19RG30

Tambora: The Eruption That Changed The World
or https://www.youtube.com/watch?v=naB-QTUNHfk

Yes! Yellowstone is a Volcano
or https://www.youtube.com/watch?v=-GRJK0k1sBw

Yellowstone Eruptions
or https://www.youtube.com/watch?v=pbrps7r-hmY

The Yellowstone Volcano: Past, Present and Future
or https://www.youtube.com/watch?v=gNdMZ6CGKm8

You Don’t Need to Worry About Yellowstone (or Any Other Supervolcano)
or https://www.youtube.com/watch?v=v0c7wcpJslg

The Most Dangerous Type of Eruptions - Flood Volcanism explained
or https://www.youtube.com/watch?v=st_2C_Wrw4A

Long-past extinction events:

Mass Extinctions: A Brief History Of Life's Worst Moments
or https://www.youtube.com/watch?v=EZqbeGc7KBE

Periodic Extinctions of Life on Earth and the Question of a Second Star in Our Solar System
or https://www.youtube.com/watch?v=3kjK4ibhI4s&t=856s

Permian-Triassic Mayhem: Earth's Largest Mass Extinction
or https://www.youtube.com/watch?v=VnUq33HCLzU&t=60s

The Mother of Mass Extinctions: How Life on Earth Nearly Ended 250 Million Years Ago
or https://www.youtube.com/watch?v=X3p_8UvWq44&t=3432s

The Great Dying (with sound)
or https://www.youtube.com/watch?v=h6wTgso7yzw&t=1119s

GIFT2011: The delicate balance between Chicxulub impact and/or Deccan traps
or https://www.youtube.com/watch?v=bdOledzfaXk

The Cretaceous-Tertiary Mass Extinction: What Really Killed the Dinosaurs?
or https://www.youtube.com/watch?v=bRNA_xct5JU

Extraterrestrial impact in Yucatán, lava floods & Cretaceous-Tertiary extinction
or https://www.youtube.com/watch?v=LiFF04rOq3Y

And asteroid impacts:

Asteroid Impacts with Earth
or https://www.youtube.com/watch?v=WS1_cBs7ki4

Last year was the 50th anniversary of the fall of the Murchison meteorite, named for the small town of Murchison, near Shepparton in northern Victoria. The Anniversary was commemorated in Murchison on 28-29th September 2019. The event was organised by the Murchison and District Historical Society (MDHS), and pitched for the non-specialist.

Murchison Meteorite 50th Anniversary Public Talk Series
or https://www.youtube.com/channel/UC_7RRHntytrwDcYQ7_A1UOw/videos

An extra talk not accessible off the above webpage:

Talk 11. Andy Gleadow, A student's collection of MM fragments & the science impact, Melbourne Uni
or https://www.youtube.com/watch?v=BGf8km1M344

When did plate tectonics begin?

Plate Tectonics or Lack Thereof Thru Time by Robert Stern
or https://www.youtube.com/watch?v=9dxC6Z2ILzI

How and when did plate tectonics start on Earth, what came before, and why does it matter?
or https://www.youtube.com/watch?v=YETUDd30jvg

The Australian Institute of Geoscientists (AIG) is a professional body, especially catering for geoscientists in the Exploration and Mining sectors. They hold monthly technical talks... April & May have been put on-line:

AIG-ALS Monthly Technical Series - April 2020 | Geological View of Thermageddon - Howard Dewhirst
or https://www.youtube.com/watch?v=e1F8Mz1zaw8&feature=youtu.be

Exploring with the crowd: Can tapping into a global network accelerate discovery of mineral deposits
or https://www.youtube.com/watch?v=GpBsEvsybiM

Scenic Videos

Enjoy some beautiful scenery.

Northern Islands 4K | Drone | Faroe, Lofoten & Senja
or https://www.youtube.com/watch?v=icZotxynzJI

The Faroes consist of stacked horizontal basalt flows interleaved with thinner units of sedimentary rocks; Lofoten is a Norwegian archipelago consisting of gneiss (high-grade metamorphic rock) intruded by granite; and Senja is Norwegian island consisting of gneiss intruded by granite, and overlain by deformed medium-grade metamorphic rocks. Lofoten and Sneja aren’t very far apart, and are in the same geological province, so their geological features are similar. The scenes in the video swap backwards and forwards between the three locations. You should be able to work out which scenes are from the Faroes by the dark, flat-lying layered rocks; the rocks of Lofoten and Senja (granites and gneisses) are pale grey and display round smooth outcrops. There are two views of Múlafossur (the Faroese waterfall that drops into the sea – Newsletter #3, p27), one from in front, the other from overhead.

Aurlandsfjord and Nærøyfjord, Norway in HD
or https://www.youtube.com/watch?v=n0mR4IutFOs

Geiranger, Norway in 4K
or https://www.youtube.com/watch?v=wX_57jdp0VM

Top 7 INCREDIBLE Places In NORWAY you WONT BELIEVE EXIST
or https://www.youtube.com/watch?v=bsfQzJBkVkg

Kjerag Hike and Kjeragbolten, Norway in HD
or https://www.youtube.com/watch?v=Dri6-t7-6_M

DJI - Trolltunga, Preikestolen and Kjeragbolten 2017 - Drone Video
or https://www.youtube.com/watch?v=PqyPW-Bdd4E

FLYING OVER NORWAY (4K UHD) 1HR Ambient Drone Film + Music by Nature Relaxation™ for Stress Relief
or https://www.youtube.com/watch?v=ftlvreFtA2A

And some of Iceland's scenery:
Amazing Iceland all seasons 4K
or https://www.youtube.com/watch?v=q1nXtm4GbnY

Iceland in 4K (UHD)
or https://www.youtube.com/watch?v=96K53N94kdc

If you've got your ear "in", the sound-track from 12:23 to 15:24 may ring a bell - Eivør (Pálsdóttir), this time with *Dansaðu vindur* (Dance, wind) – in Icelandic:

https://www.youtube.com/watch?v=x1qSD-fsTh8 (live performance)

https://www.youtube.com/watch?v=hjHZLeHDeC0 (live performance, another occasion)

https://www.youtube.com/watch?v=pDHotAaNeEM (this version has lyrics, Icelandic & English)

Here are a couple of videos from South Africa:

Flying in Blyde River Canyon (South Africa)
or https://www.youtube.com/watch?v=MMmrM_HMabE

Blyde (pronounced Blayder) River canyon is said to be the second-biggest in the World (after USA's Grand Canyon). It's in Mpumalanga, South Africa, ~330 km ENE of Johannesburg. ***Been there!***

GEOLOGICAL WONDER | Bourke's Luck Potholes, Sabie, Mpumalanga, South Africa Tourism
or https://www.youtube.com/watch?v=gTYcDI_aYqg&t=500s

Erosional potholes where the Treur River joins the Blyde, about 20 km upstream from Blyde River Canyon. ***Been there too!***

The rivers' names have a rather moving origin. A party of voortrekkers looking for new land to settle camped here in 1844. The party split; one group led by Hendrik Potgeiter made their way to the Portuguese outpost of Delagoa Bay (now Maputo in Moçambique) on the Indian Ocean coast. Their delay in returning made the other group think Potgeiter's party had perished, so they named the stream they camped on Treurrivier (Sorrowful River). The camping party moved on in sadness, but soon encountered Potgeiter's party returning a few days later. They named the stream that they were fording at the time Blyderivier (Joyful River).

South Africa is also spectacular at ground level, especially along drives over and through the many mountain passes. Here is a four-part series over Swartberg Pass, (**Been there, done that)** over Swartberg Range, part of the Cape Fold (and Thrust) Belt. The Cape Fold Belt is a package of quartz-rich sandstone units with minor shales of the Cape Supergroup, deposited through Ordovician-Silurian-Devonian Periods (between ~490 & ~360 Ma), and strongly deformed (Fold and Thrust Belt) in the Permian ~253 Ma:

https://www.youtube.com/watch?v=IWK7MjBY36A&t=4s Part 1 (1:54)

https://www.youtube.com/watch?v=Q-QA6bJBu4E Part 2 (5:00)

https://www.youtube.com/watch?v=eGYA-HU96tw Part 3 (5:38)

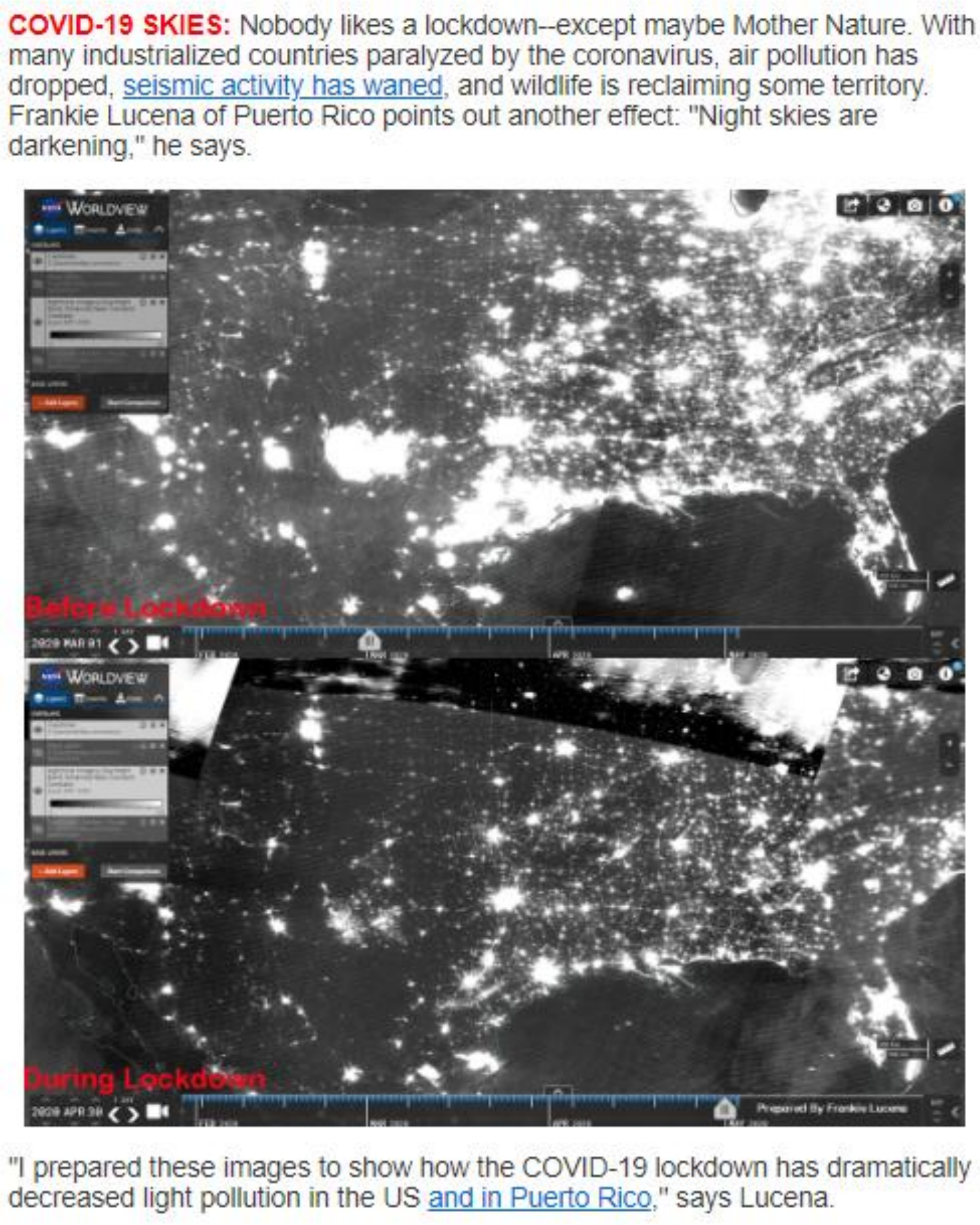
https://www.youtube.com/watch?v=VRlllcvK8Xk Part 4 (5:24)

I might do a pass each issue from Trygve Roberts' *Mountain Passes of South Africa* website.

Covid-19 Dark Skies

There are several global signs of the effects of precautions taken against the Coronavirus. This is from:

spaceweather.com
News and information about the Sun-Earth environment Tuesday 5th May
https://www.spaceweather.com/

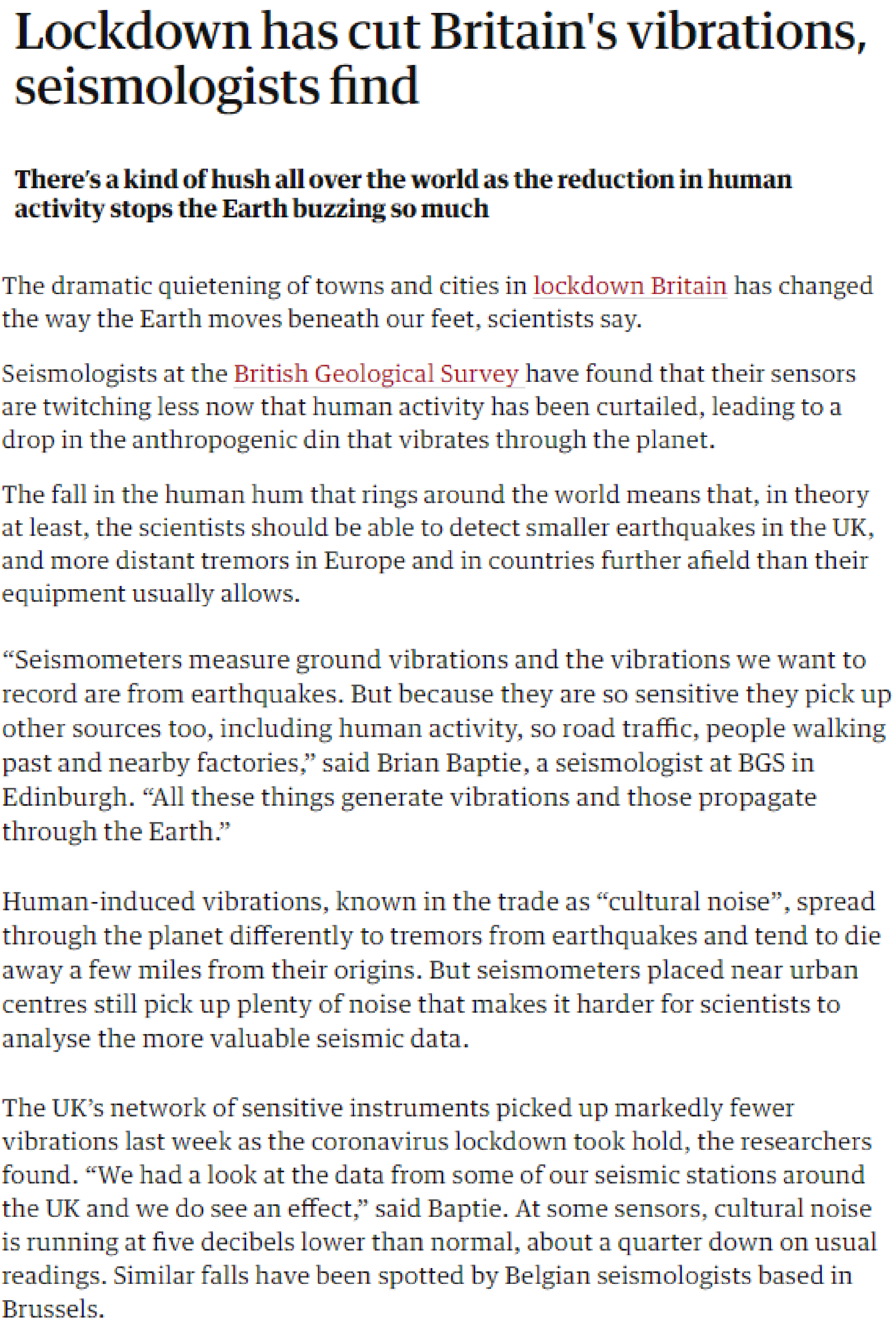


COVID-19 SKIES: Nobody likes a lockdown--except maybe Mother Nature. With many industrialized countries paralyzed by the coronavirus, air pollution has dropped, seismic activity has waned, and wildlife is reclaiming some territory. Frankie Lucena of Puerto Rico points out another effect: "Night skies are darkening," he says.

"I prepared these images to show how the COVID-19 lockdown has dramatically decreased light pollution in the US and in Puerto Rico," says Lucena.

See the next page for a snippet about the similar waning of (artificial) seismic activity during the lockdown.

Sign in Search Australia edition The Guardian 6th April, 2020.



Lockdown has cut Britain's vibrations, seismologists find

There's a kind of hush all over the world as the reduction in human activity stops the Earth buzzing so much

The dramatic quietening of towns and cities in lockdown Britain has changed the way the Earth moves beneath our feet, scientists say.

Seismologists at the British Geological Survey have found that their sensors are twitching less now that human activity has been curtailed, leading to a drop in the anthropogenic din that vibrates through the planet.

The fall in the human hum that rings around the world means that, in theory at least, the scientists should be able to detect smaller earthquakes in the UK, and more distant tremors in Europe and in countries further afield than their equipment usually allows.

"Seismometers measure ground vibrations and the vibrations we want to record are from earthquakes. But because they are so sensitive they pick up other sources too, including human activity, so road traffic, people walking past and nearby factories," said Brian Baptie, a seismologist at BGS in Edinburgh. "All these things generate vibrations and those propagate through the Earth."

Human-induced vibrations, known in the trade as "cultural noise", spread through the planet differently to tremors from earthquakes and tend to die away a few miles from their origins. But seismometers placed near urban centres still pick up plenty of noise that makes it harder for scientists to analyse the more valuable seismic data.

The UK's network of sensitive instruments picked up markedly fewer vibrations last week as the coronavirus lockdown took hold, the researchers found. "We had a look at the data from some of our seismic stations around the UK and we do see an effect," said Baptie. At some sensors, cultural noise is running at five decibels lower than normal, about a quarter down on usual readings. Similar falls have been spotted by Belgian seismologists based in Brussels.

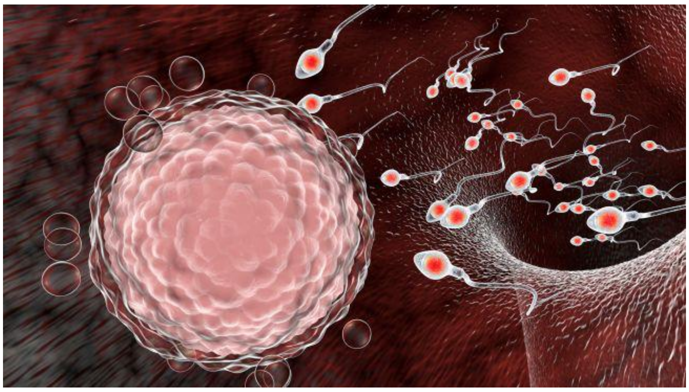
https://www.theguardian.com/science/2020/apr/06/lockdown-has-cut-britains-vibrations-seismologists-find

LIVESCI=NCE https://www.livescience.com/coronavirus-found-in-semen.html

Coronavirus found in infected men's semen

By Rachael Rettner - Senior Writer 5 hours ago *(7th May 2020)*.

It's still unclear whether the virus can be sexually transmitted through contact with semen.



After the new coronavirus called SARS-CoV-2 enters the human body, it seems to reach sites well beyond the lungs — it's been found in the kidneys, heart, liver and gastrointestinal tract. And now, researchers have detected the virus in semen, according to a small study.

However, the findings, published Thursday (May 7) in the journal JAMA Network Open, don't necessarily mean that the virus can be sexually transmitted through contact with semen.

The study involved 38 men in Shangqiu, China, who had tested positive for COVID-19 and were experiencing symptoms of the disease or had recently recovered.

Participants provided semen samples, which doctors analyzed for the

presence of SARS-CoV-2, the virus that causes COVID-19.

The researchers detected SARS-CoV-2 in sperm from six participants, or 16% overall. Of these, four patients were currently experiencing symptoms of COVID-

19, and two patients had recently recovered.

However, it's important to note that although the researchers detected genetic material from SARS-CoV-2 in semen, the study does not prove that these virus particles are "viable," or capable of transmitting infection, according to The New York Times.

"This is an interesting finding, but it must be confirmed that there is infectious virus — not just a virus product in the semen," Dr. Stanley Perlman, a professor of microbiology, immunology and pediatrics at the University of Iowa, who was not involved in the study, told the Times.

In addition, it's unclear how long the virus lingers in semen, given that participants in the study were still showing symptoms of COVID-19 or had only recently recovered. (The two "recovered" patients whose semen samples tested positive for SARS-CoV-2 had only been well for two to three days before they gave the samples.)

What's more, other studies have not detected the virus among patients who had been recovered for a longer period. For example, a study published April 17 in the journal Fertility and Sterility, which involved 34 men in Wuhan, China, failed to detect the virus in patients about one month after their COVID-19 diagnosis.

Transmission of COVID-19 during sex still seems much more likely through close contact and inhalation of respiratory droplets, rather than through semen, the Times reported.

(Many thanks Chris Morton)

LIVESCI=NCE has plenty of interesting stuff to keep you going for hours.
Here's a small selection from their **Planet Earth** tab:

Hundreds of towering hydrothermal chimneys discovered on seafloor off Washington

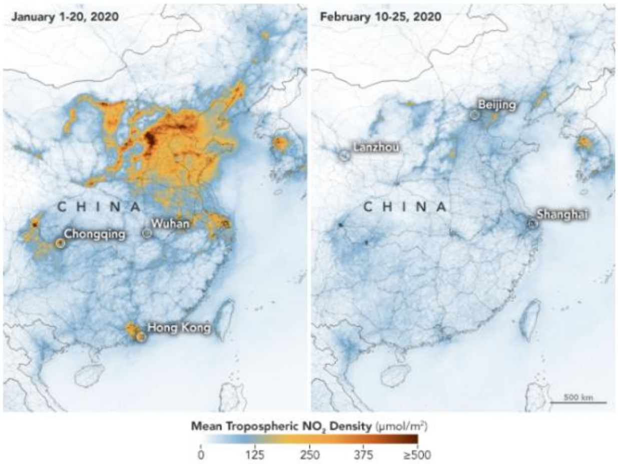
or https://www.livescience.com/hundreds-hydrothermal-vents.html

Piece of lost continent discovered beneath Canada

or https://www.livescience.com/lost-continent-diamonds-canada.html

Dramatic effect of coronavirus lockdowns seen from space

or https://www.livescience.com/coronavirus-changes-pollution-over-china.html



A map shows the sharp decline in emissions *(mostly from motor vehicles?)* over China between early January and late February as parts of the country went on lockdown in an attempt to contain the COVID-19 coronavirus.
(Image: © NASA Earth Observatory)

Just go to: https://www.livescience.com/planet-earth *and browse around.*

You thought Covid-19 was bad... try Black Death and Smallpox

Science

In this 1625 illustration, Londoners fleeing the plague are barred by country dwellers.
NEW YORK PUBLIC LIBRARY/SCIENCE SOURCE

From Black Death to fatal flu, past pandemics show why people on the margins suffer most

By **Lizzie Wade**; May14, 2020, 8:00 AM

When the Black Death arrived in London by January 1349, the city had been waiting with dread for months. Londoners had heard reports of devastation from cities such as Florence, where 60% of people had died of plague the year before. In the summer of 1348, the disease had reached English ports from continental Europe and begun to ravage its way toward the capital. The plague caused painful and frightening symptoms, including fever, vomiting, coughing up blood, black pustules on the skin, and swollen lymph nodes. Death usually came within 3 days.

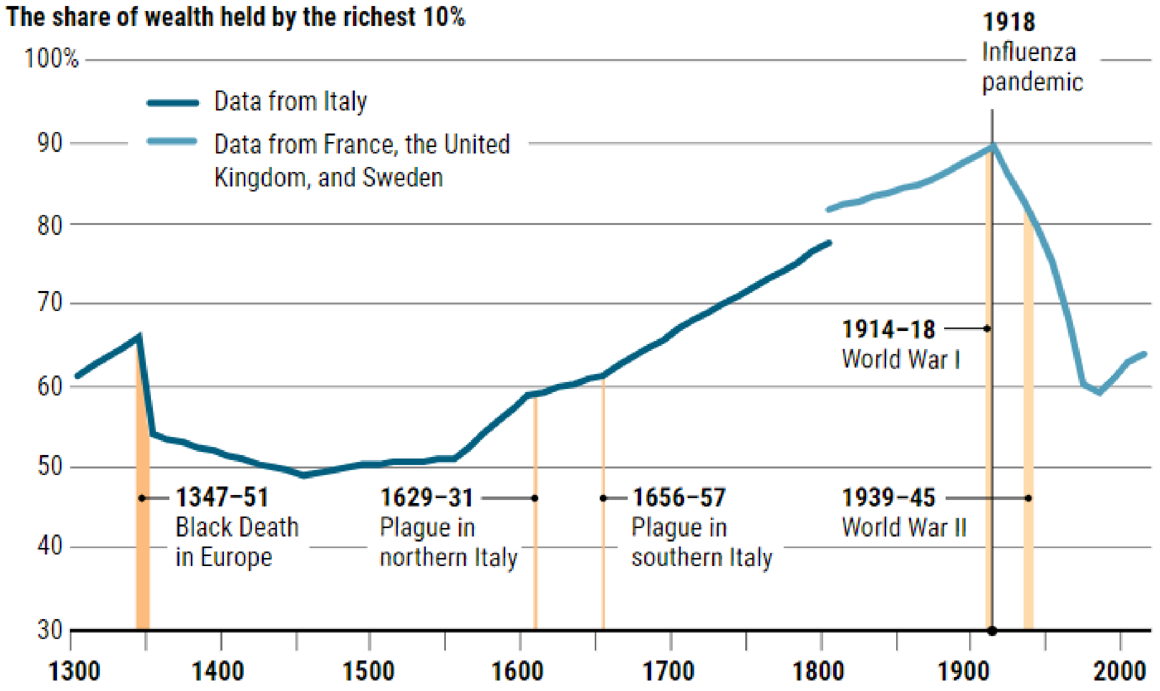
The city prepared the best way it knew how: Officials built a massive cemetery, called East Smithfield, to bury as many victims as possible in consecrated ground, which the faithful believed would allow God to identify the dead as Christians on Judgment Day. Unable to save lives, the city tried to save souls.

The impact was as dreadful as feared: In 1349, the Black Death killed about half of all Londoners; from 1347 to 1351, it killed between 30% and 60% of all Europeans. For those who lived through that awful time, it seemed no one was safe. In France, which also lost about half its population, chronicler Gilles Li Muisis wrote, “neither the rich, the middling sort, nor the pauper was secure; each had to await God’s will.”

But careful archaeological and historical work at East Smithfield and elsewhere has revealed that intersecting social and economic inequalities shaped the course of the Black Death and other epidemics. “Bioarchaeology and other social sciences have repeatedly demonstrated that these kinds of crises play out along the preexisting fault lines of each society,” says Gwen Robbins Schug, a bioarchaeologist at Appalachian State University who studies health and inequality in ancient societies. The people at greatest risk were often those already marginalized—the poor and minorities who faced discrimination in ways that damaged their health or limited their access to medical care even in prepandemic times. In turn, the pandemics themselves affected societal inequality, by either undermining or reinforcing existing power structures.

Sometimes a leveler

Before the 20th century, rising economic inequality in Italy was reversed only once: during and after the Black Death, according to tax records. Data from elsewhere in Europe suggest economic inequality dropped again after 1918, but the impact of that year’s influenza pandemic can’t be separated from that of two world wars.



(GRAPHIC) N. DESAI/*SCIENCE*; (DATA) GUIDO ALFANI AND THOMAS PIKETTY

That reality is on stark display during the COVID-19 pandemic. Although the disease has memorably struck some of the world’s rich and powerful, including U.K. Prime Minister Boris Johnson and actor Tom Hanks, it is not an equal-opportunity killer. In hard-hit New York City, Latino and black people have been twice as likely to die from COVID-19 as white people. Cases there have been concentrated in poorer ZIP codes, where people live in crowded apartments and can’t work from home or flee to vacation homes.

“The ways that social inequalities are manifested … put people at higher risk,” says Monica Green, an independent historian who studies the Black Death. “We should all be learning in our bones, in a way that will never be forgotten, why [the coronavirus pandemic] has happened the way it has."

WHEN THE BLACK DEATH STRUCK, many places in Europe were already beleaguered. The late 13th and 14th centuries were a time of climatic cooling and erratic weather. Harvests had failed and famines had struck in the century or so before the pandemic emerged. In the Great Famine of 1315–17, up to 15% of the population of England and Wales died, according to historical records. As wages fell and grain prices soared, more people were driven into poverty. Household account books and records of payments to workers on English manors show that by 1290, 70% of English families were living at or below the poverty line, defined as being able to buy enough food and goods to not go hungry or be cold. Meanwhile, the wealthiest 3% of households received 15% of the national income.

Sharon DeWitte, a biological anthropologist at the University of South Carolina, Columbia, investigates how those famines and rising poverty affected people's health by studying skeletons excavated from London's medieval cemeteries. People who died in the century leading up to the Black Death tended to be shorter and more likely to die young than people who died during the two previous centuries. Those who lived in the century before plague also had more grooves on their teeth from disrupted enamel growth, a sign of malnutrition, disease, or other physiological stressors during childhood.

DeWitte lacks samples from the decades immediately before the Black Death, but historical evidence of the Great Famine and low wages until the 1340s make it likely that those trends continued right up until the pandemic struck, she says.

To see whether ill health made people more susceptible to plague, DeWitte turned to hundreds of skeletons excavated from East Smithfield. She calculated the age distribution of people in the cemetery, as well as the life expectancies of people with markers of stress on their skeletons. Her rigorous models show older adults and people already in poor health were more likely to die during the Black Death. Contrary to the assumption that "everyone who was exposed to the disease was at the same risk of death … health status really did have an effect," she says.

In the 1980s, archaeologists excavated plague victims buried in London's East Smithfield cemetery in 1349.
MOLA/GETTY IMAGES

Skeletons don’t announce their possessors’ social class, so DeWitte can’t be sure any particular person buried in East Smithfield was rich or poor. But then, as now, malnutrition and disease were likely more common among people at society’s margins. And historical evidence suggests England’s wealthiest may have gotten off more lightly than the growing ranks of poor. Perhaps 27% of wealthy English landowners appear to have succumbed to plague, whereas counts of rural tenant farmers in 1348 and 1349 show mortality rates mostly from 40% to 70%. DeWitte argues the unequal economic conditions that damaged people’s health “made the Black Death worse than it had to be.”

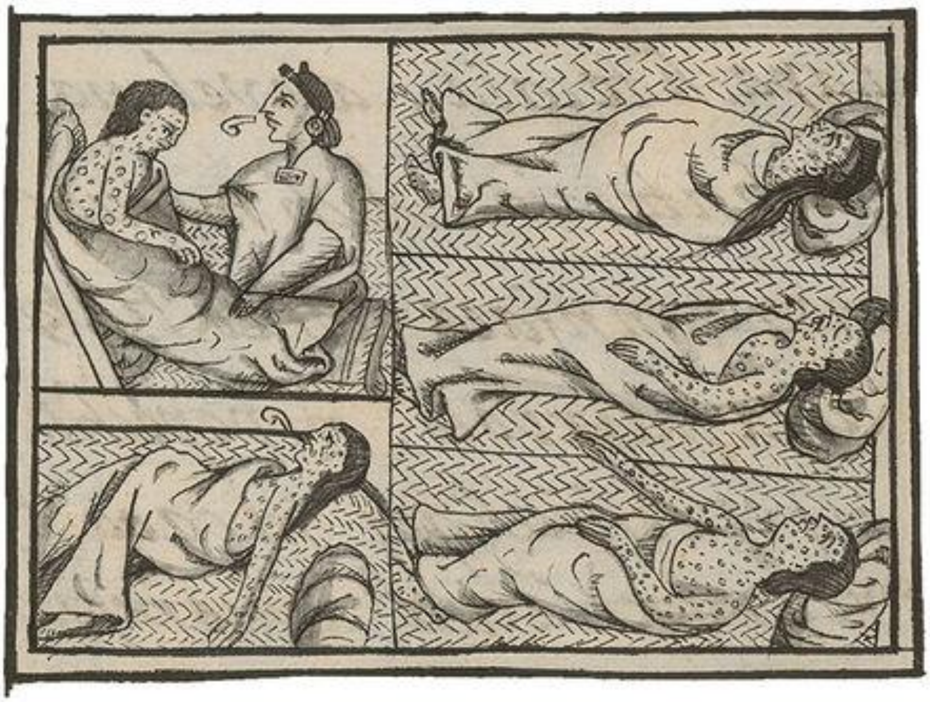
FOUR HUNDRED YEARS LATER and half a world away, smallpox struck Cherokee communities in what would become the southeastern United States. Elsewhere in the world, the disease—with its fever and eruption of pustules—killed about 30% of people infected. But among the Cherokee, the feared pathogen had help, and likely became even more devastating, says Paul Kelton, a historian at Stony Brook University.

Although a lack of acquired immunity often gets all the blame for Native Americans’ high mortality from disease during the colonial period, social conditions amplified the impacts of biological factors. The mid–18th century smallpox epidemic in the Southeast, for example, coincided with escalated British attacks on Cherokee communities in what’s called the Anglo-Cherokee War. The British used a scorched-earth strategy, burning Cherokee farms and forcing residents to flee their homes, causing famine and spreading smallpox to more Cherokee communities. Historians think by the end of the epidemic and the war, the Cherokee population had fallen to its smallest recorded size, before or since. War “created the conditions for smallpox to have a devastating effect,” Kelton says.

Similar tragedies were repeated for hundreds of years in Indigenous communities across the Americas as colonial violence and oppression rendered Native Americans susceptible to epidemics, says Michael Wilcox, a Native American archaeologist of Yuman descent at Stanford University. Indigenous communities forced off their land often lacked access to clean water or healthy diets. People living on Catholic missions were forced to do grueling labor and live in crowded conditions that Wilcox calls “petri dishes for diseases.” The skeletons of people buried on 16th century Spanish missions in Florida show many of the signs of ill health that DeWitte finds in London cemeteries from before the Black Death.

Such oppression and its biological effects “was not a ‘natural’ thing. It was something that could have been changed,” Wilcox says.

The contrasting experience of Native American communities who managed to live outside colonial rule for a time supports his point. One such community was the Awahnichi, hunter-gatherers who lived in California’s Yosemite Valley. According to an account from the late 19th century, an Awahnichi chief named Tenaya told an American miner and militia volunteer in the 1850s about a “black sickness”—likely smallpox—that swept through his community before they had direct contact with white settlers. The disease probably arrived with Indigenous people fleeing missions, says Kathleen Hull, an archaeologist at the University of California, Merced.



Indigenous artists documented smallpox in 16th century Mexico City. Colonial violence made recovery from such outbreaks difficult.
FLORENCE, LAURENTIAN MEDICEAN LIBRARY, MS. MAD. PALAT. 220, F. 461V
COURTESY OF MIBACT

She excavated in the valley and analyzed data on the number of villages occupied, the amount of debris created by manufacturing obsidian tools, and changes in controlled burns as revealed by tree ring data. Those indicators suggested the Awahnichi experienced a 30% population decline around 1800. Before the epidemic struck, the Awahnichi numbered only about 300; the death of about 90 people would have been devastating.

Chief Tenaya told the militia volunteer that after the black sickness, the Awahnichi left their traditional home and moved to the eastern Sierra Nevada mountains, likely to the territory of the Kutzadika’a people. There, the Awahnichi found support and, in the longer term, an opportunity to rebuild their community through intermarriage. After about 20 years, they moved back to their valley homeland, their numbers bolstered and their culture preserved.

Hull’s data support that account, showing the Awahnichi left their valley for 2 decades. She sees their departure and return to their way of life as a sign of resilience. “They persevered despite this really challenging event,” she says.

The Awahnichi experience was rare. By the turn of the 20th century, many Indigenous communities had been forced to move to remote reservations with little access to traditional food sources and basic medical care. When another disease swept through—the 1918 influenza pandemic—Indigenous people died “at a rate about four times higher than the rest of the U.S. population,” says Mikaëla Adams, a medical historian at the University of Mississippi, Oxford. “Part of the reason is that they were already suffering from extreme poor health, poverty, and malnourishment.”

Some cases were particularly extreme. The Navajo Nation, for example, suffered a 12% mortality in that pandemic, whereas the mortality rate across the globe was an estimated 2.5% to 5%. Some Indigenous communities in remote Canada and Alaska lost up to 90% of their people in the pandemic, says Lisa Sattenspiel, an anthropologist at the University of Missouri, Columbia.

Today, during the coronavirus pandemic, the Navajo Nation has reported more per capita cases of COVID-19 than any state except New York and New Jersey, although the testing rate on the reservation is also high. Diabetes, a risk factor for COVID-19 complications, is common on the reservation, and many people there live in poverty, some without running water.

The coronavirus pandemic reveals the dangers caused by centuries of discrimination and neglect, says Rene Begay, a geneticist and public health researcher at the University of Colorado Anschutz Medical Campus and a member of the Navajo Nation. But she cautions against characterizing the Diné—the traditional name for the Navajo people—as passive victims. “We’ve gone through pandemics. We can get through this, too.”

ALTHOUGH THE 1918 FLU hit the Diné particularly hard, few people outside the reservation realized it at the time. For those living through the pandemic, which killed 50 million people worldwide, flu gave the impression of being an indiscriminate killer, just as the Black Death had 600 years before. “This pesky flu’s all over town! And white and black and rich and poor are all included in its tour,” went a prose poem in the *American Journal of Nursing* in 1919.

But recent demographic studies have shown many groups on the lower end of the socioeconomic spectrum, not just Native Americans, suffered disproportionately in 1918. In 2006, Svenn-Erik Mamelund, a demographer at Oslo Metropolitan University, published a study of census records and death certificates that reported a 50% higher mortality rate in the poorest area of Oslo than in a wealthy parish. In the United States, miners and factory workers died at higher rates than the general population, says Nancy Bristow, a historian at the University of Puget Sound.

So did black people, who already faced astonishingly high death rates from infectious disease. In 1906, the mortality rate from infectious diseases among nonwhite (at the time, mostly black) people living in U.S. cities was a shocking 1123 deaths per 100,000 people, Elizabeth Wrigley-Field, a sociologist at the University of Minnesota, Twin Cities, has found. By comparison, in the heat of the 1918 pandemic, urban white people’s mortality from infectious disease was 928 deaths per 100,000 people. Nonwhite urban mortality didn’t drop below that level until 1921. “It’s as though blacks were experiencing whites’ 1918 flu every single year,” Wrigley-Field says. “It’s truly staggering.”

In 1918, barriers were erected around soldiers’ beds at a naval station in San Francisco to slow the spread of flu.

U.S. NAVAL HISTORY AND HERITAGE COMMAND PHOTOGRAPH

The 1918 pandemic struck in a spring and an autumn wave, and black people were more likely than white people to get sick in the first wave, according to a study by Mamelund and a colleague of military and insurance records and surveys from the time. Then, in the deadlier autumn wave, black people were infected at lower rates, presumably because many had already acquired immunity. But when black people did get sick in the fall of 1918, they were more likely to develop pneumonia and other complications, and more likely to die, than white people. That may be because black people had higher rates of pre-existing conditions such as tuberculosis, Mamelund says.

Discrimination also played a role. “This time period is called the nadir of race relations,” says Vanessa Northington Gamble, a doctor and medical historian at George Washington University. Jim Crow laws in the South and de facto segregation in the North meant black flu patients received care at segregated black hospitals. Those facilities were overwhelmed, and the care of black flu patients suffered, Gamble says.

Today in Washington, D.C., 45% of COVID-19 cases but 79% of deaths are of black people. As of late April, black people made up more than 80% of hospitalized COVID-19 patients in Georgia, and almost all COVID-19 deaths in St. Louis. Similar trends have been seen for black and South Asian patients in the United Kingdom. And in Iowa, Latinos comprise more than 20% of patients, despite being only 6% of the population.

IN 1350, BURIALS stopped in East Smithfield cemetery. But the Black Death’s impact lingered, thanks to its extraordinary economic consequences, says Guido Alfani, an economic historian at Bocconi University. By studying more than 500 years of records of taxes on property and other forms of wealth, he found that economic inequality plummeted in much of Europe during and after the Black Death.

For example, in the Sabaudian state in what is now northwestern Italy, the share of wealth owned by the richest 10% fell from about 61% in 1300 to 47% in 1450, with a dramatic drop during the Black Death and a slower slide in the century after (see graph, above). Alfani found similar trends in the south of France, northeastern Spain, and Germany. Analyses of household accounts and manor records show a similar trend in England, where real wages nearly tripled between the early 1300s and the late 1400s and general standards of living improved.

Alfani says so many workers died of plague that labor was in demand, driving up wages for those who survived. And as owners died, great swaths of property went on the market. Many heirs sold plots to people who never could have owned property before, such as peasant farmers.

Plague didn’t disappear after the Black Death; many countries, including Italy and England, suffered recurring outbreaks. Yet later bouts seem to have entrenched inequality instead of reducing it. Alfani thinks by the time later epidemics hit, the elite had found ways to preserve their fortunes and even their health. “Plague becomes a feature of Western societies. It’s something you have to expect,” he says.

Across Europe, wills changed so large estates could be transferred to single heirs instead of being broken up. The rich also began to quarantine in country estates as soon as an outbreak began. From 1563 to 1665, mortality during plague outbreaks declined dramatically in the wealthy parishes of London but remained roughly the same or increased in poorer, more crowded areas, according to burial and baptism records. During the 15th and 16th centuries, Italian doctors “increasingly characterize plague as a disease of the poor,” Alfani says.

That class prejudice is “seen over and over again in history,” Kelton says. For example, during 19th century cholera epidemics in the United States, elites “created this idea that somehow it’s only going to hit people with a predisposition to the disease. Who was predisposed? The poor, the filthy, the intemperate." But it wasn't a moral failing that made poor people vulnerable: The bacterium *Vibrio cholerae* was more likely to contaminate their substandard water supplies.

The economic legacy of the 1918 flu is unclear. According to data gathered by economist Thomas Piketty of the Paris School of Economics, economic inequality in Europe fell dramatically beginning in 1918, a decline that lasted until the 1970s. But Alfani says disentangling the flu pandemic's effects from those of World War I is impossible. That war destroyed property in Europe, and the rich lost access to foreign property and investments, lowering inequality, he says.

In the United States, that pandemic did nothing to blunt structural racism. "The 1918 pandemic revealed the racial inequalities and fault lines in health care," Gamble says. At the time, black doctors and nurses hoped it would prompt improvements. "But nothing changed. After the pandemic there were no major public health efforts to address the health care of African Americans."

Could the COVID-19 pandemic, by revealing similar fault lines in countries around the world, lead to the kinds of lasting societal transformations the 1918 flu did not? "I want to be optimistic," Bristow says. "It's up to all of us to decide what happens next."

With reporting by Ann Gibbons.

How London has changed... the churches were the tallest buildings those days.

And where did they believe diseases come from? The illustration suggests that diseases are weather-borne, they came out of the black clouds as thunderbolts.

Interesting too is the variation in spelling those days... "We fly." *vs* "Wee dye."

The notion of the wealthy quarantining themselves in country estates is paralleled in Giovanni Boccacio's book *The Decameron*. Seven wealthy men and three wealthy women (and a few servants) retreat to a villa outside Florence to escape the Black Death. For amusement, they decide to tell one story each during ten evenings of their fortnight-long stay. One day per week is devoted to housework and other chores, plus two Sundays off for rest, leaving ten evenings for story-telling (100 stories in all). There is a different story-telling King or Queen elected each day, who chooses the following day's theme; comedy, romance, tragedy etc. Boccaccio conceived the plot probably in 1348, and finished writing it in 1353.

Surely we are doing something similar? I'm the AGHSV King (Editor), and I choose the theme(s) for each Newsletter. (President Chris Morton has given me plenty of freedom to do things my way.)

The Moon is fully mapped for the first time

A bit of news from Geological Society of Australia:

geoz 209 May 2020

NEWSBREAKERS

The Moon is fully mapped for the first time

The entire lunar surface has been completely mapped and uniformly classified geologically. The *Unified Geologic Map of the Moon* as it is called has been compiled using maps made during the Apollo program and recent satellite data. The map is available online at a 1:50,000 scale and uses a unified description of the stratigraphy to remove inconsistencies in rock names, descriptions and ages introduced by earlier maps. Download an animated version here.
Images courtesy of the NASA/GSFC/USGS
Press release: https://tinyurl.com/yan3q93j
Research abstract: https://tinyurl.com/y9cl6s6e

Download an animated version here

Press release: https://tinyurl.com/yan3q93j

Research abstract: https://tinyurl.com/y9cl6s6e

Many aspects of the geology of the Moon were worked out before the Apollo landings. Most of the data came from Moon-orbiting photographic spacecraft, with lesser amounts using Earth-based telescopes. The various observers and remote sensing specialists used stratigraphic principles (younger units cover older ones etc) so familiar to geologists, to work out the relative ages of units. The samples returned from Apollo missions (and robotic Russian Luna missions) were used to assign absolute radiometric ages to the units. Naturally, many other aspects of the samples were studied also by the petrology teams and associated researchers.

I had a very slight indirect brush against the early stratigraphic mapping... One of the telescope-based mappers was Blair Hostettler, then of the United States Geological Survey (USGS) – Astrogeology Science Center. Some years later (early 1980s) I worked at Macquarie University, where Blair was Head of Department (Earth Sciences). *OK, I'm dropping names here*.

Anybody going there on a trip? At least you can get a good up-to-date map now.

Meteorites and Impact Structures in the Northern Territory

Chris Morton has sent in the pdf file of a Northern Territory Geological Survey publication: *Meteorites and Impact Structures in the Northern Territory* NTGS Record 2014-007. Here is a web-link to this publication:

https://geoscience.nt.gov.au/gemis/ntgsjspui/handle/1/81425/simple-search?query=%222014-007%22&location=1/81425

This takes you to the NTGS search page; scroll down the page to the sole search result (the link to the publication); and you can now download Record 2014-007 (free of charge).

I've had a tiny bit of experience with two of the impact structures:

In 1986 I had a quick look at Henbury Craters in passing, on a trip to Kings Canyon, Uluru (Ayre's Rock) and Kata Tjuta (The Olgas); and to see Halley's Comet from dark skies. I didn't know much about impact craters those days, so to me it was just a couple of wide shallow holes in the ground.

Then in 2008 I was working at Tennant Creek, and one day two of us set out to drive to Kelly Crater, about 40 km SSW of town. Unfortunately, the track was under water (after heavy rain), and as we had only one vehicle, we bailed out about 5 km short. I had done a fair bit of homework on the impact, though.

I had more luck in South Africa on holiday, visiting Tswaing and Vredefort impact structures (with a better understanding of features and processes) in December 2005.

Let's follow up with some videos...

I couldn't find anything on Kelly Crater, and Henbury has little that isn't dash-cam video of the drive to get there, or overhead drone footage; anyway, here is Henbury:

Steve Droning On... Henbury Meteorite Craters
or https://www.youtube.com/watch?v=LmZK3ipi230

There isn't much more about Tswaing, mostly "this is my trip to..." style travelogues. I found an awful video from WizScience: artificial voice, badly mis-pronounced South African placenames, all gimmick (stylised images of organic molecules to make it look "Sciencey"), and little explanation:

Tswaing crater - Video Learning - WizScience.com
or https://www.youtube.com/watch?v=Hp-yct2D1-s

WizScience also has a Vredefort video, but I'll spare you. Instead:

VREDEFORT DOME – ORIGINS
or https://www.youtube.com/watch?v=DjE354S5C_Q&t=739s

VREDEFORT DOME - NOT REALLY A WORLD HERITAGE SITE (YET)
or https://www.youtube.com/watch?v=O1VSyWAMLIo

South Africa, Vredefort Dome, Parijs 4th april 2019
or https://www.youtube.com/watch?v=ez1TQ27IbKc

The “other town” in the Vredefort Dome is Parys, named after Paris in France. The locals push this connection rather hard, with miniature Eiffel Towers (I’ve seen two), and lots of French shop names etc.

The town is a real tourist trap, big on art galleries, gift shops, antique shops, boutiques etc; about 100 km SW of Johannesburg:

Visit Parys in the Freestate and see what she has to offer!
or https://www.youtube.com/watch?v=7r0aFY0Abo8

Let’s call this my contribution to the “places to go” section begun by Chris Moreton in Newsletter #3.

Light-Hearted Stuff

Here’s some really compelling video (I won’t spoil it with a hint... just watch):

VIDEO-2020-05-14-08-02-22.mp4 *(double-click)* *(Thanks Chris Morton)*

How about a lesson on projective geometry?

OK Go - The Writing's On the Wall - Official Video.mp4 *(double-click)*

Here’s a charming contribution from Chris Morton... (*thanks Chris*):

The Great Realisation
or https://www.youtube.com/watch?reload=9&v=Nw5KQMXDiM4&feature=youtu.be

Look for more videos like this one under “Probably Tomfoolery”.

Circular Mounds.

First, a few videos to set the scene.

Field Trip Friday: Olympia's mysterious Mima Mounds
or https://www.youtube.com/watch?v=ltHf91tqRqQ (short - 3:06)

Researcher says he has solved mystery of Mima mounds
or https://www.youtube.com/watch?v=lxBGgdxVfjU (short -

'Nick From Home' Livestream #39 - Mima Mounds
or https://www.youtube.com/watch?v=7-0d-Go4iSw (long - 1:37:52, but entertaining)

I've swapped emails with Nick over Australian & South African versions of Mima Mounds. *(Tut-tut, name dropping again.)*

And summaries of a couple of "popular science" articles:

Great Pyramids of the Gophers: Mima Mound Mystery Solved

By Becky Oskin; December 04, 2013

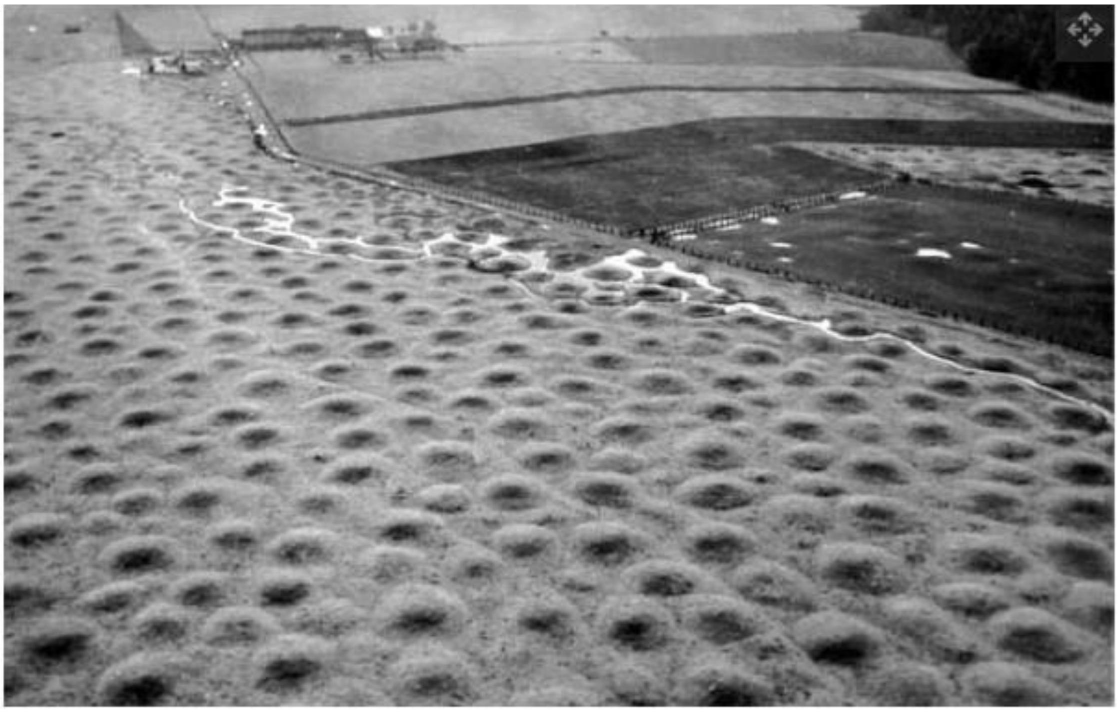
https://www.livescience.com/41693-mima-mound-mystery-explained.html

Mima mounds in western Washington as seen from the air.
(Image: © Washington State DNR)

Mima mounds (pronounced mee-ma) were named in 1841, when a vast pimply prairie (the Mima Prairie) was first seen by Europeans in western Washington. In the decades since, the origin of this strange landscape has defied explanation. Early explorers thought Mima mounds were Native American burial sites, but no skeletons or grave relics were inside.

Scientists often blamed burrowing pocket gophers, the same rodents that pockmark golf courses and lawns in USA — perhaps, scientists surmised, the gophers built up to escape drowning. But the mounds are 8 feet (2.5 meters) tall and 30 feet (9 m) wide, and their sheer size led some researchers to pooh-pooh the idea that wee gophers could ever create such vast earthen citadels.

According to a computer model, "mature" Mima mounds appear after about 500 to 700 years of scurrying and burrowing by pocket gophers. In the model, single gophers add a bit of soil, pebbles or dead plants to each mound over many generations — the animals are fiercely territorial.



Mima mounds in California's Central Valley. (Image credit: Manny Gabet)

The model suggests that gophers start pushing soil toward any existing high spots, and these budding mounds continue to beckon later generations of builders.

Eventually, the burrowing mammals run out of soil and the Mima mounds are fully developed, which takes 500 to 700 years.

The size of each mature Mima mound roughly matches the territorial range of a single gopher.

Though the study isn't proof that gophers create Mima mounds, it does show that it's possible.

While this model may hold water for Mima mounds in the West, the mysterious hills are found on every continent except Antarctica, far from the range of pocket gophers. This suggests other burrowing mammals have evolved this same type of adaptive behaviour on other continents.

These strange hillocks might be the work of gophers, termites, or something else entirely

By Jane Palmer; 28 October 2014

http://www.bbc.com/earth/story/20141028-the-strange-origins-of-mima-mounds

Over the last 150 years, the explanations have become less fanciful but no more conclusive. Mima mounds continue to mystify natives and scientists alike.

Similar formations exist in other US states and on every continent except Antarctica. They are known as hogwallow mounds in California and Oregon, prairie mounds in New Mexico and Colorado, and pimple mounds in the southeastern states. The South Africans call their sandy hill-like features "heuweltjies", or little hills, and the Brazilians call the places they occur "campos de murundus", or mound fields.

On the plains of South Africa, millions of mima-like mounds that cover a vast area are home to distinctive flora and fauna. "If you consider that many of our landscapes here are very nutrient-poor, you have these landscapes that are occupied by the mima mounds that are relatively nutrient-rich," says Michael Cramer, a biologist at the University of Cape Town in South Africa. "So they are a really important part of the ecosystem."

Some suggested causes have persisted since the late 19th century, such as the idea that gophers or termites created them or that they are formed by the accumulation of wind-blown sediments around clumps of vegetation.

The mounds built by the digital gophers bore a striking resemblance to the real thing in terms of height, width and spacing. But why would animals that typically only leave piles of earth in their wake bother with such a giant construction project?

Gophers are half blind and avoid going above ground because of the threat posed by predators, Reed says. But as landscapes age the habitable soil layer becomes thinner and the foundational layer hardens to the point where, when it rains, the topsoil becomes saturated. This leaves the soil levels in which the gophers live without sufficient oxygen.

Where does that leave those trying to explain similar features in other, gopher-less places? In drier climates the prevailing theory has been that termites build them, much like the African *Macrotermes* termite species that build large conical structures up to nine metres high.

Cramer, with his colleagues at the University of Cape Town, plans to investigate where stone layers occur in the mounds as an indication as to whether the mounds have been deposited by the wind or not, and also to look more closely at what causes their regular spacing.

But other researchers believe mound-like formations across the globe at least partially share common causes.

Heuweltjie hunting in Namaqualand

1 Nov 2016 http://www.pcu.uct.ac.za/news/heuweltjie-hunting-namaqualand
Article written by Wesley Bell & Sam Jack. Photographs supplied by Sam Jack.

Dr Joe McAuliffe taking in a landscape filled with heuweltjies in the Olifants River valley.

Dr Joe McAuliffe, Director of Research at the Desert Botanical Garden in Phoenix, Arizona has been an engaging collaborator with the Plant Conservation Unit (PCU) over the last several years, stemming from an original meeting between him and the current Director of the PCU, Prof Timm Hoffman, during Timm's post-doctoral studies at Las Cruxes, New Mexico in the early 90's. Joe visited the PCU in 2012 to begin investigations into *heuweltjie* formation, which is currently a hot (and dare I say, unsolved) topic in science. *Heuweltjies* are regularly-spaced low mounds which occur particularly within more arid regions in south-western South Africa and are often associated with a different suite of vegetation compared to the areas surrounding the mound.

Joe's initial visit led to a successful publication but also yielded many new questions and compelled Joe to return to gain a deeper understanding of the phenomenon. The additional catalyst for the recent visit was an invitation to speak at the Arid Zone Ecology Forum, held in Prince Albert in early October 2016. Here Joe spoke about his updated hypothesis for *heuweltjie* and mound formation, or lack thereof, based on climatic drivers, vegetation structure and windblown sediment supply, as well as the central role played by termites. In order to explore and examine these new ideas, Joe embarked upon an extensive fieldwork programme. The Karoo component of the fieldwork commenced with Timm subsequent to the conference, and after a short break in Cape Town, Namaqualand was the next destination.

Joe posing with a heuweltjie in cross-section, created by a roadcut south east of Klawer.

The Namaqualand leg of the trip took the team (Joe McAuliffe, Sam Jack, Wesley Bell and Timm Hoffman) from sites south of Klawer to the east of Vanrhynsdorp, east of Nuwerus and finally west of Steinkopf over a period of 11 days. Each site was unique in its characteristics and provided fascinating insights (and sometimes generated challenging questions) on the processes of *heuweltjie* formation, maintenance and decay. It soon became apparent how centrally important Joe's knowledge of soil science was to understanding *heuweltjie* formation, and he very patiently shared this knowledge with the rest of the group. Similarly, Timm's knowledge of the flora of Namaqualand helped in the compilation of comprehensive species lists for on and off *heuweltjies*. In short, the fieldwork was hugely interesting and educational and provided a rigorous test for Joe's hypotheses.

Joe explaining the use of a soil colour chart to Wesley. The percentage of sands to silts and clays is also tested by wetting the soil, forming it into a ball, and then feeling for texture and clay content by pushing the soil into a ribbon between two fingers.

Fieldwork resulted in the collection of 130 soil samples (80 more than anticipated!) and as a result you are likely to find Joe (and Wesley) hard at work in the soils lab for the next week attempting to process all of the samples. Specifically Joe will be determining soil texture (% sand, silt and clay), salinity (electrical conductivity of aqueous soil extracts) and calcium carbonate content (measured by digesting soil in HCl) of samples collected both on and off *heuweltjies*. The race is on to complete this work so that Joe can return in time to cast his vote in the US elections. He has even been forgoing his regular lunchtime siestas in order to complete this work in time!

Joe, Timm and Wesley in the field. The heuweltjie *on which they are standing is covered by* Mesembryanthemum leptarthron *(previously* Psilocaulon*), a commonly dominant heuweltjie species throughout much of Namaqualand.*

Joe’s ability to interpret how landscape features have evolved from the bedrock up and to develop testable hypotheses to explore observed patterns has been educational and inspiring. So too has been his enthusiasm for sometimes quite challenging fieldwork, and his siestas are catching on too. We thank him for visiting and for sharing his knowledge. We look forward to hearing what results emerge from this fieldwork season and hope to welcome him back in future.

Namaqualand is a paradise for flowers and botanical oddities. On the left is one of the many mesembs that occur in areas between heuweltjies, and on the right is a curious Gethyllis cf britteniana.

Here is a YouTube flyover of a tract of heuweltjies in Namaqualand:

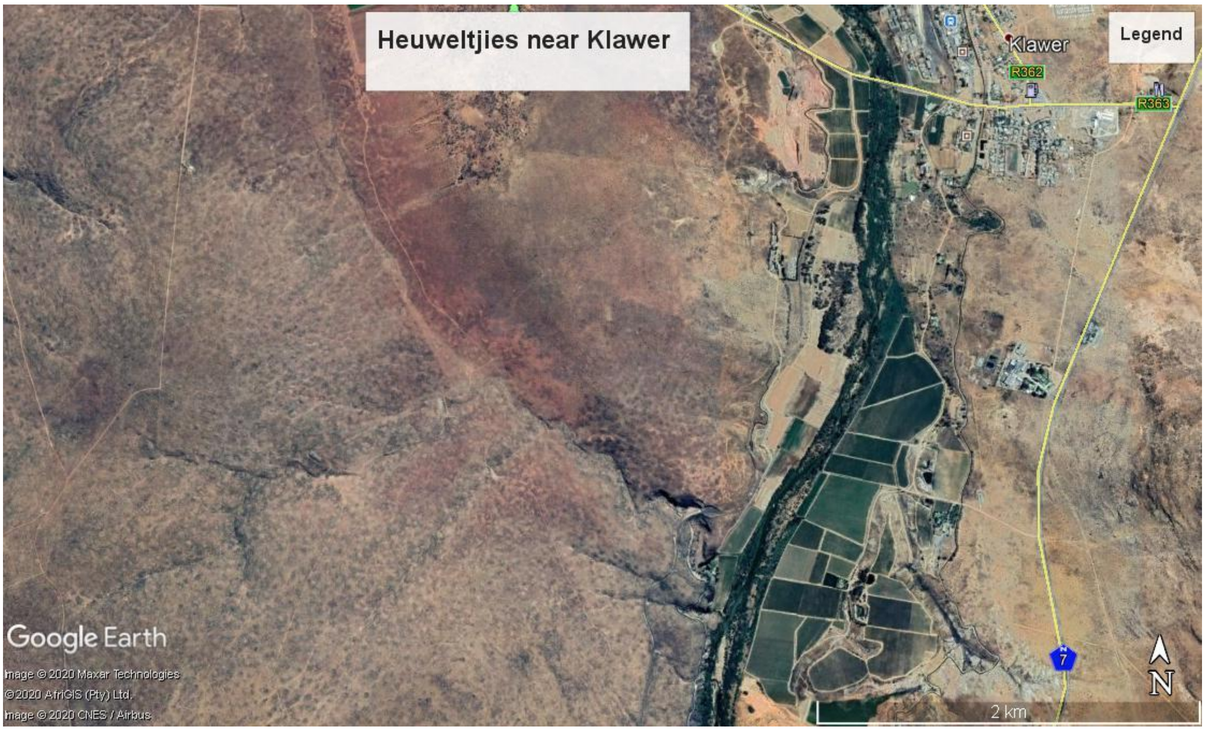
https://www.youtube.com/watch?v=24mqUhefD2k

These strange looking spots in the veld are called "heuweltjies". The yellow on them are flowers named "Oxalis sp." or "surings" The reason for their existence lies with the termites - in fact these "heuweltjies" are ancient termite nests. The termites cause the soil composition to differ from the rest of the veld and therefore different plants tend to grow on them.

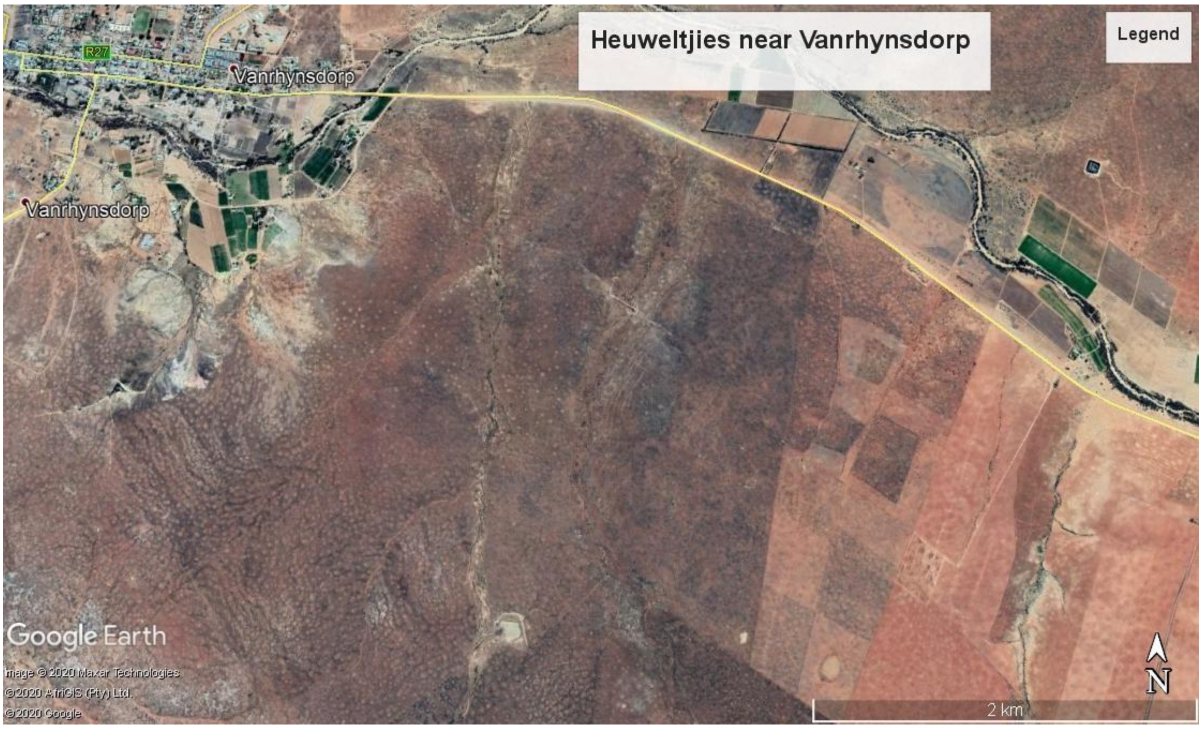
"Heuweltjies" occur throughout Namaqualand all the way to Cape Town and also in the Karoo.

Heuweltjies near Oudtshoorn, South Africa

Heuweltjies near Oudtshoorn, South Africa

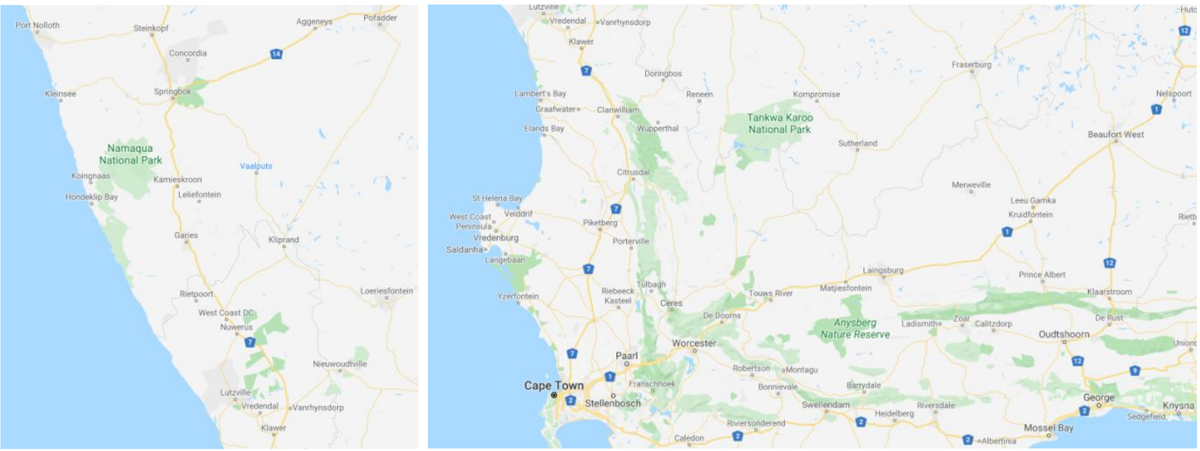


Heuweltjies near Klawer, South Africa



Heuweltjies near Vanrhynsdorp, South Africa

Heuweltjies near Steinkopf, South Africa



Location of Oudtshoorn, Klawer, Vanrhynsdorp, and Steinkopf; South Africa

AUSTRALIAN JOURNAL OF EARTH SCIENCES, 2018
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A biological origin for gravel mounds in inland Australia

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ABSTRACT
More than 1000 near-circular mounds up to 40 m diameter and 2.1 m high, which contain 15–1250 m^3 (mean 159 m^3) of gravel, have been identified in western New South Wales. Mounds are more pebble-rich than the surrounding surface regolith and contain abundant pebbles to 1196 g weight. Resemblance to smaller gravel nest mounds of the malleefowl (*Leipoa ocellata*) suggests they were constructed by a similar although larger bird. Pebbles were inadvertently concentrated in the nest mounds during construction and maintenance. Formation by geological mechanisms, as burrow spoil or burial mounds is not compatible with the features of the mounds. The mounds are undated, but partial blanketing by eolian sand suggests they predate the Last Glacial Maximum. The mounds are now spatially associated with *Casuarina* trees. Pollen records in southeastern Australia reveal that shrub and grassland replaced *Casuarina* woodland as aridity increased after *ca* 35 000 yrs BP. Climate change driven habitat loss in the semi-arid zone likely caused the extinction of the apparently *Casuarina* woodland dependent megapode responsible for the gravel mounds. The mounds partly map the megapode distribution and provide an opportunity to date the local extinction of a megafauna member, compare this to climate and vegetation changes, and determine the duration of overlap with human occupation.

Figure 1. Examples of large old gravel mounds, D008, 255, 269, and 400 at Dolo Hill are identified on Figure 9. Trees include belah in all scenes except (b) and (f). (a) GC03 (31.0290°S, 145.2974°E, 40 × 2.1 m, 1250 m^3), the largest mound, is located northwest of Cobar, view to N photographed 18/11/1989, Toyota Hilux vehicle. Silcrete pebbles are greatly concentrated compared with the surrounding thin red sand on weathered bedrock. (b) T246 (31.2008°S, 146.2601°E, 13.7 × 1.05 m, 75 m^3), in the Tooram Hills NE of Cobar, is one of the largest malleefowl mounds. Incorporation of numerous pebbles $\leq$300 g left the surrounds dominated by pebbles too large to be moved. (c) D008 (31.6937°S, 142.7620°E, 23.5 × 1.35 m, 294 m^3) is 66 km W of Wilcannia and 80 m N of the Barrier Highway. In this 26/9/2013 view NE from the highway the pale, silcrete-pebble mound is a colour and grainsize anomaly in the reddish soil. D008 is sparsely vegetated relative to the surrounds and less vegetated during even high rainfall years. Silcrete caps the low hill to the left. (d) D255 (31.7430°S, 142.7624°E, 21.1 × 1.3 m, 230 m^3), a distinct mound with an aspect ratio of 16.1 is less eroded and probably younger than D269. Southerly view on 26/3/2015 shows the pebbly surrounds and a small eolian sand remnant to the left. (e) D269 (31.7058°S, 142.7589°E, 15.3 × 0.54 m, 50 m^3) is a degraded mound partly removed by a creek that exposes the mound and substrate gravel, view to the N on 27/3/2015. The iron-rich pebble mound contains common pale, angular silcrete derived from a cap on the hill to the right background, the sole source in the creek catchment. Pale silcrete is not present in the substrate gravel. (f) KY01 (30.7999°S, 142.7259°E, 30 × 1.2 m, 425 m^3), adjacent to the White Cliffs to Tibooburra road; 600 mm of gravel overlies $\sim$200 mm of skeletal soil with abundant fragments of the sandstone bedrock. (g) D400 (31.7176°S, 142.7410°E) is surrounded by 450 mm of eolian sand. The exposed portion of the silcrete-pebble mound measures 29 × 0.85 m (280 m^3), view to the SE on 3/10/2017.

Figure 2. Distribution of large gravel mounds in southeastern Australia, megapode fossil sites, and locations cited in the text. The Darling Downs and Warburton River fossils are from fluviatile deposits, the others from limestone caves.

Introduction

Several unusual gravel mounds to 40 m diameter and 2.1 m high were identified during a mineral exploration programme northwest of Cobar, NSW (Figure 1a, 2). The mounds are older and larger, and contain larger pebbles, but otherwise resemble the many gravel malleefowl (*Leipoa ocellata)* mounds in the Tooram Hills, northeast of Cobar (Figure 1b). Old large gravel mounds (OGM) were subsequently found in far northwestern NSW. Most OGM are sited on pebbly regolith on low hills and rises that are characteristically vegetated by *Casuarina* species trees. Mounds of calcrete pebbles and sand in the Swan Reach Conservation Park in SA are larger and older, but otherwise resemble the numerous nearby malleefowl mounds.

The hundreds of gravel mounds are locally a landscape feature. Despite the recognisability of many and the accessibility of some OGM (20 are visible from the Barrier Highway near Dolo Hill, including D008; Figure 1c), they apparently have been largely overlooked by geological and other scientific investigators. Several graziers are aware of the OGM as landscape features, and noted the spatial association with *Casuarina* trees, and a few have speculated that they were megapode nests. The purpose of this paper is to document the OGM and to demonstrate that their features are consistent with construction by a megapode as nest mounds, rather than a geological or other biological origin. Megapodes, literally 'big feet,' are unusual members of the animal kingdom because most species construct durable soil edifices to enclose accumulated litter of leaves, bark and sticks. Heat from the decomposition of the damp litter incubates the eggs (Frith, 1962). These ancient megapode nest mounds are among the largest discrete structures constructed by any non-colonial animal. The longevity of nest mounds allows identification of the former presence of megapodes in an area after local or total extinction. The OGM have always been exposed and, unlike bone or other material, were not subject to the vagaries of chance for burial, preservation and re-exposure.

Identification of the large gravel mounds as megapode nests provides a reminder that not all geological features have a geological origin. The large number of mounds offers an unusual opportunity to investigate the timing of extinction of a member of the megafauna, to place this in a time-scale of climate and vegetation change, and of human occupation and hence the opportunities for predation.

The mounds are the line of slightly paler patches between the Barrier Highway and the dry creek bed. The Australian mounds are more widely spaced than either Mima mounds or heuweltjies.

I found out about the heuweltjie mounds accidentally, and in a round-about way.

My late wife was an expat South African. I sent her "back home" every now and then, whenever there was a wedding or funeral she needed to attend. I got there with her twice, once for 7 weeks (Dec 2005 – Jan 2006), and again for 5 weeks (Jul-Aug 2016). About four months ago I was on Google Earth, re-living the latter trip, and noticed lots of pale circles about 10-m across near Oudtshoorn (where we had stayed overnight). Intrigued, I sent an email to the Oudtshoorn Tourist Information Centre (OTIC) asking about these features. I waited a couple of weeks, then sent a reminder email...; the reply was along the lines "...still working on it; we'll get back to you when we have learned more...". It's now about three months on, and OTIC still haven't got back to me.

Enter the AGHSV Newsletter #1, and in particular Roz Kerr's link to an interesting video about 1,500 million-year-old rocks at Rocky Cape on the northwest corner of Tasmania (https://www.youtube.com/watch?v=_f_Hcyfv5rU). I went looking for other videos with a geology theme, and chanced on the Mima mounds of Washington (above). I found that there are also similar-looking mounds in South Africa, called heuweltjies (Afrikaans for "little hills"); and these are what I had spotted on Google Earth. A little earlier (about a fortnight before becoming Newsletter Editor) I was browsing some back-issues of the *Australian Journal of Earth Sciences*, and spotted the article on Australian mounds (extracts above). The origin of heuweltjies is as controversial as Mima mounds; also, the two types probably had completely different origins. The Australian versions are said have a different origin again.

The most recent phase of the story is Nick Zentner's backyard-cast (p 44 above) on Mima mounds, on 9th May, which I watched on 17th May. We have swapped emails since. (*Shameless name dropping, again*.)

Lime, Limestone and Marble – Important But Often Overlooked

It is believed that the Egyptians were the first to use lime to plaster on the pyramids at Giza some 6,000 years ago. Indian traditional structures which are more than 4,000 years old were built with lime mortar: for example Mohenjo-daro, which is still a heritage monument in the Indus Valley civilization in Pakistan. Lime mortar is a mixture of lime, sand (or other aggregate) and water: the lime is produced by burning limestone and adding water. It replaced clay and gypsum mortars which the ancient Egyptians had used. More recently Portland cement has replaced lime mortar. A house we lived in during 1974 at Mountain Creek near Holbrook, New South Wales, was built from bricks - locally made and fired – that were cemented with lime mortar. The lime was dug from nearby hills and burned in a kiln. Lime kilns were built wherever supplies of limestone were available, ranging from small clamp kilns to large industrial plants. One clamp kiln is located at Jerangle, New South Wales, east of Bredbo. Marulan and Kandos are well known sites for these plants.

Pure limestone is calcium carbonate, while dolomite contains a significant amount of magnesium. Dolomite is sometimes preferred to pure limestone as a soil conditioner for acid soils. It has a wide application in agriculture. When subjected to metamorphism, limestone turns to marble which has calcite crystals. Marble has long been used as a building stone, and in recent years has also become popular for kitchen bench tops. Marble quarried between Almaden and Chillagoe in northern Queensland has been shipped overseas to use in place of the famous Carrara Marble.

Before the widespread availability of electricity for cinemas, theatres and music halls, limelight provided the illumination. It was produced by directing an oxyhydrogen flame at a cylinder of quicklime (calcium oxide) which can be heated to 2,572° C before melting. The term “in the limelight” came from that era and still applies to those who gain fame through movies or stage productions.

Portland cement has become the most widely used cement, and is made by mixing three parts of limestone and one part of clay and calcining it in a kiln. Concrete is a mixture of Portland cement with an aggregate, water and additives to give required properties. After World War 2, a shortage of heavy crude oil to make asphalt and bitumen for roadworks led to concrete being the main material for highways in parts of New South Wales. The Hume Highway and Great Western Highway were concrete roads in the 1950’s and 1960’s. Most new homes have concrete driveways and paths, and concrete has become a major building material.

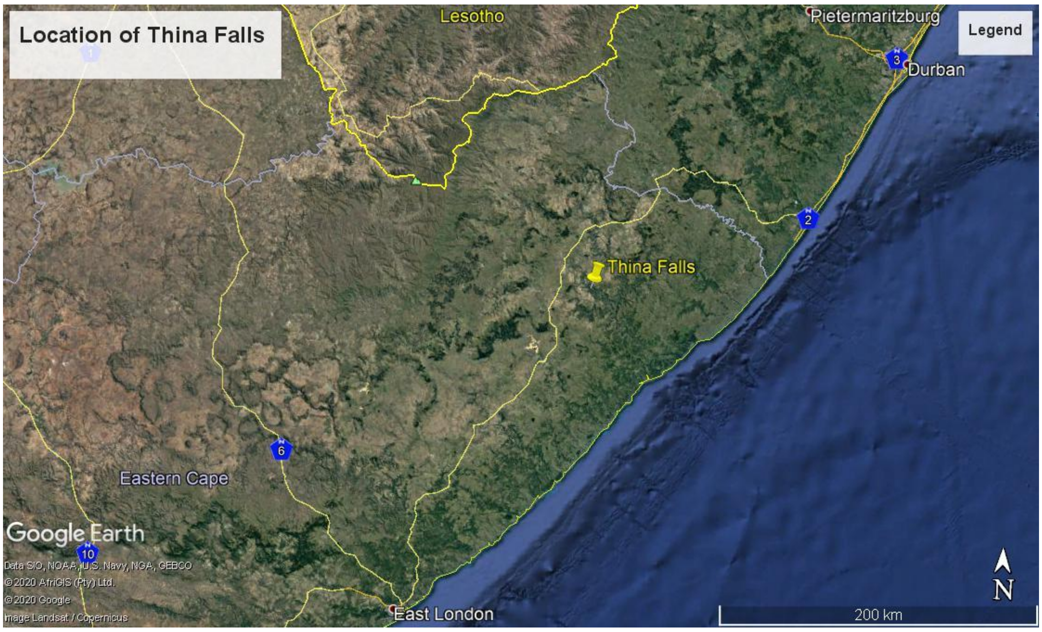
While it does not attract news headlines like exotic minerals, the humble limestone has been for thousands of years – and still is – an important part of our lives.

George Winter – 15th May 2020

[Sources: Lime kilns - the Cinderella of industrial geoarcheology – The Australian Geologist, Sep 2018 pp 36 – 38; Chambers’s Encylcopaedia 1926, Volume III, pp 57 – 59 and Volume VI, pp 661 – 662; Wikipedia]

Thina Falls, another unusual waterfall in South Africa

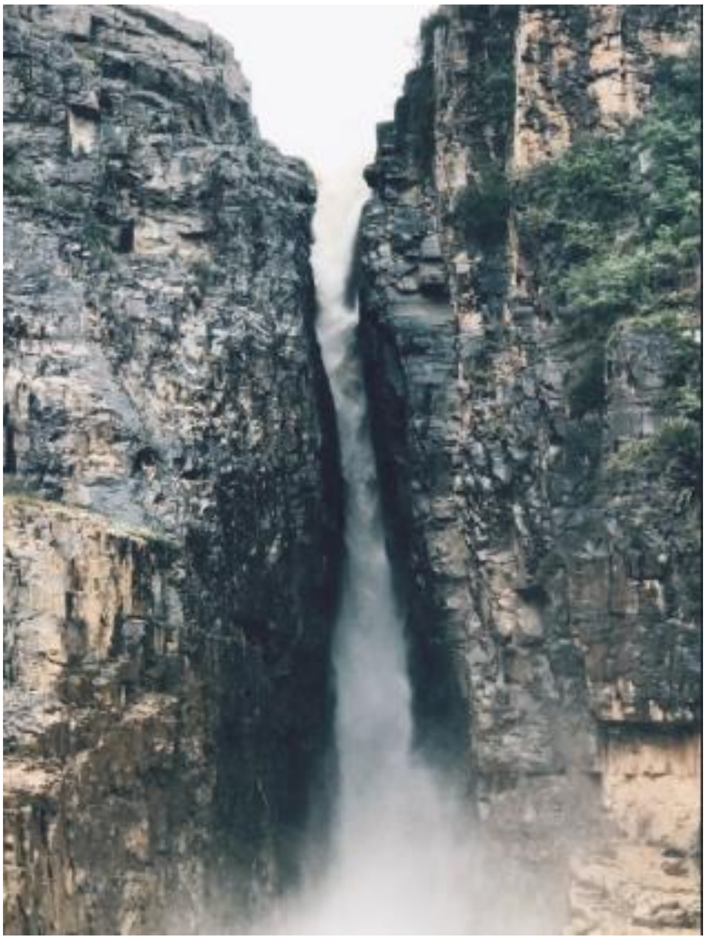
Thina Falls is on the Thina River in Eastern Cape Province, South Africa.



The Thina has incised meanders, curves that are at the bottom of a steep-sided valley hundreds of metres deep. These meanders formed at a previous time, when the ancestral river was cutting through alluvium on a flood-plain. At some later time, the land began to rise; and the stream began cutting down into the bedrock beneath the alluvium, while retaining its position. The stream is antecedent, being older than the plateau into which it is incised. The uplift has steepened the stream's long profile (the river's 3-D course, but straightened out to a 2-D line).

At Thina Falls the river drops over a ~50-m waterfall, which cuts off ~6.5 km around an abandoned meander bend.

The Thina waterfall. The concrete structure at the left is part of a hydroelectric micro-power station, under construction at the time of the photo.



To the right of the waterfall is a grey rock unit with horizontal columnar joints, probably a dyke (as wide as the slot) - an intrusion of igneous rock into a (sub-)vertical fracture. The dyke rock has been partly eroded out to leave a trench. The host is horizontally-bedded sedimentary rock... sandstone?

At the top of the waterfall, the water drops into the trench, making the rather unusual sight of a pair of waterfalls facing each other, about 2 metres apart.

The trench, viewed from the top of the waterfall; the plunge-pool 50 metres lower is visible through the slot.

The sand in the foreground and at the right edge of the view is alluvium left in the abandoned meander.

The small stream from bottom centre flows into the abandoned meander, turns down-channel and flows into the plunge-pool of the waterfall. The even smaller stream flowing from the lower left turns up-channel through the alluvium of the former course of the Thina River, to join it above the waterfall.

This video is about the back-reamed bore for the penstock of the hydroelectric micro-power station, and shows scenes around the waterfall:

https://www.youtube.com/watch?v=tBjmf9Yowvo

Lake Bonneville Flood - A little problem just got out of hand

Various items in Newsletters #1 - #3 have a common theme - how rivers have changed over geological time. The articles on the pattern of streams around Esk and Moogerah Dam, and the analysis of Steve Low's aerial photo of the Finke Gorge are all examples. The above examples are typical of numerous small-scale local features; but this article treats a spectacular, huge version in the western United States... the flood event when Pleistocene Lake Bonneville partially drained. The changing climate during the Pleistocene Epoch was the background; some minor changes in the drainage pattern got out of hand, and led to one of the greatest floods known in the last few million years.

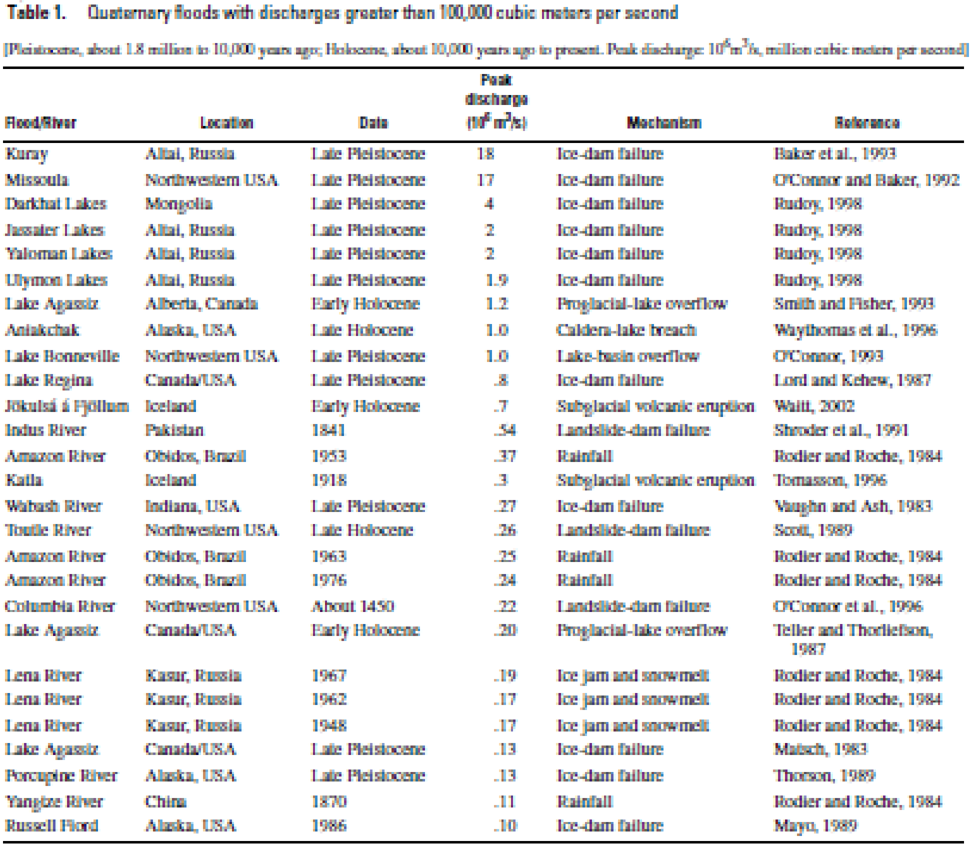


Table 1. Quaternary floods with discharges greater than 100,000 cubic meters per second

[Pleistocene, about 1.8 million to 10,000 years ago; Holocene, about 10,000 years ago to present. Peak discharge: $10^6 m^3/s$, million cubic meters per second]

Flood/River	Location	Date	Peak discharge ($10^6 m^3/s$)	Mechanism	Reference
Kuray	Altai, Russia	Late Pleistocene	18	Ice-dam failure	Baker et al., 1993
Missoula	Northwestern USA	Late Pleistocene	17	Ice-dam failure	O'Connor and Baker, 1992
Darkhat Lakes	Mongolia	Late Pleistocene	4	Ice-dam failure	Rudoy, 1998
Jassater Lakes	Altai, Russia	Late Pleistocene	2	Ice-dam failure	Rudoy, 1998
Yaloman Lakes	Altai, Russia	Late Pleistocene	2	Ice-dam failure	Rudoy, 1998
Ulymon Lakes	Altai, Russia	Late Pleistocene	1.9	Ice-dam failure	Rudoy, 1998
Lake Agassiz	Alberta, Canada	Early Holocene	1.2	Proglacial-lake overflow	Smith and Fisher, 1993
Aniakchak	Alaska, USA	Late Holocene	1.0	Caldera-lake breach	Waythomas et al., 1996
Lake Bonneville	Northwestern USA	Late Pleistocene	1.0	Lake-basin overflow	O'Connor, 1993
Lake Regina	Canada/USA	Late Pleistocene	.8	Ice-dam failure	Lord and Kehew, 1987
Jökulsá á Fjöllum	Iceland	Early Holocene	.7	Subglacial volcanic eruption	Waitt, 2002
Indus River	Pakistan	1841	.54	Landslide-dam failure	Shroder et al., 1991
Amazon River	Obidos, Brazil	1953	.37	Rainfall	Rodier and Roche, 1984
Katla	Iceland	1918	.3	Subglacial volcanic eruption	Tomasson, 1996
Wabash River	Indiana, USA	Late Pleistocene	.27	Ice-dam failure	Vaughn and Ash, 1983
Toutle River	Northwestern USA	Late Holocene	.26	Landslide-dam failure	Scott, 1989
Amazon River	Obidos, Brazil	1963	.25	Rainfall	Rodier and Roche, 1984
Amazon River	Obidos, Brazil	1976	.24	Rainfall	Rodier and Roche, 1984
Columbia River	Northwestern USA	About 1450	.22	Landslide-dam failure	O'Connor et al., 1996
Lake Agassiz	Canada/USA	Early Holocene	.20	Proglacial-lake overflow	Teller and Thorleifson, 1987
Lena River	Kasur, Russia	1967	.19	Ice jam and snowmelt	Rodier and Roche, 1984
Lena River	Kasur, Russia	1962	.17	Ice jam and snowmelt	Rodier and Roche, 1984
Lena River	Kasur, Russia	1948	.17	Ice jam and snowmelt	Rodier and Roche, 1984
Lake Agassiz	Canada/USA	Late Pleistocene	.13	Ice-dam failure	Matsch, 1983
Porcupine River	Alaska, USA	Late Pleistocene	.13	Ice-dam failure	Thorson, 1989
Yangtze River	China	1870	.11	Rainfall	Rodier and Roche, 1984
Russell Fiord	Alaska, USA	1986	.10	Ice-dam failure	Mayo, 1989

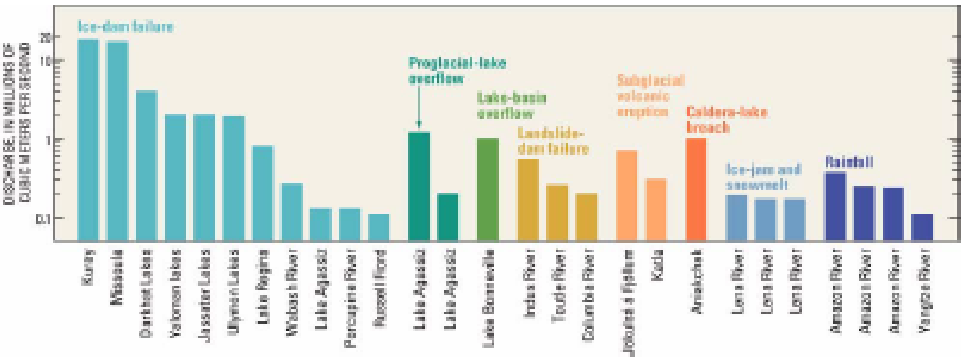


Table 1. The largest known floods in the Quarternary Period.

From: *The World's Largest Floods, Past and Present: Their Causes and Magnitudes*, J E O'Connor and J E Costa, 2004, USGS Circular 1254

The Geological Setting

The location is the Basin and Range Province of the western United States. See Figure 1. See Figure 2 for more details.

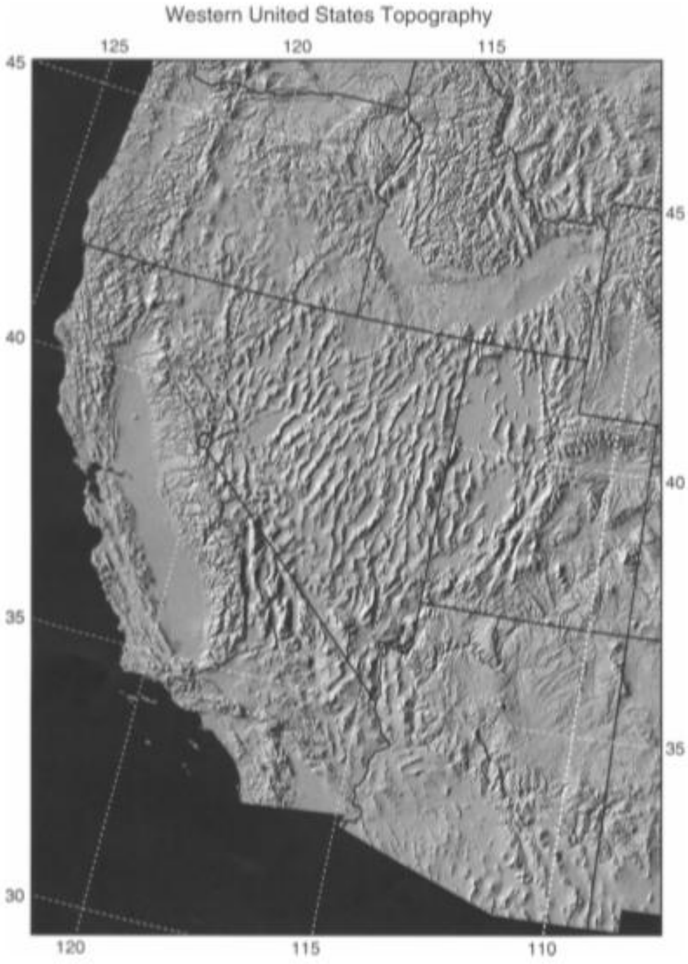


Figure 1. Western United States. Basin and Range topography extends over much of Nevada, southeastern California, western Utah, and southern Idaho. The large flat area in northern Utah, centered on 112°W 41°N is the site of Lake Bonneville; the crescent-shaped lowland in southern Idaho is the Snake River Plain; the Yellowstone hot-spot is in northwestern Wyoming at 110°W 44°N. The Western Snake River Plain (NW-SE oriented section) is a graben, dating from ~11 Ma. The Eastern Snake River Plain (SW-NE oriented section) is the track of a volcanic hotspot dating from ~16 Ma at the SW, to ~2Ma at Yellowstone Plateau. The lithosphere cooled after it moved SW over the hotpot, and the cooling rock subsided. The Sierra Nevada Mountains are along the east border of California, and the Great Valley is to their west.
From: *The Basin and Range Province*; T Parsons, 1995

Figure 2. Details of the Basin and Range Province. Modern Great Salt Lake is the blue patch in the upper-right. The endorheic (no outlet) Lake Bonneville basin occupied essentially all of the surrounding flat land. The Snake River Valley is the flat, curved area near the north edge. The Snake River flows into a gorge in the wide Western Snake River Plain, starting NW of Great Salt Lake. Upstream from this point, the Snake flows SW down a shallow channel, in a wide valley (the Eastern Snake River Plain). The significance of these features will become clear later.
From: The Great Bonneville Flood – Part 1; https://sacredgeometryinternational.com/great-bonneville-flood-part-1/

I'll go back to the Miocene Epoch, about 17 million years ago (Ma). The crust of what is now the western United States began to extend E-W, and it thinned. On a broad scale the crust thinned from 40-45 km to 30-35 km; on a more detailed scale the mechanism of thinning involved the upper crust fracturing along N-S trending faults, and alternate fault blocks sank between their bounding faults. This process produced the basin and range topography, consisting of alternating ridges and troughs, typically 10-15 km wide, 100 km long, and 1-2 km deep. Subsequent erosion has narrowed many of the ridges and widened the adjacent troughs; so the faults are out some distance from the toes of the ridges, and buried below alluvial fans in many locations. This tract of basin and range topography is about 800 km wide from east to west. Minor tectonic activity is ongoing; earthquakes and tremors are common, and thermal springs are abundant. See Figures 3 and 4.

Figure 3. Tectonic provinces of western North America. The Basin and Range Province is shown by the dot-pattern; note its continuation into northern Mexico. Cross-section along the line A-A' is displayed in Figure 4 below.
From: *The Basin and Range Province*; T Parsons, 1995

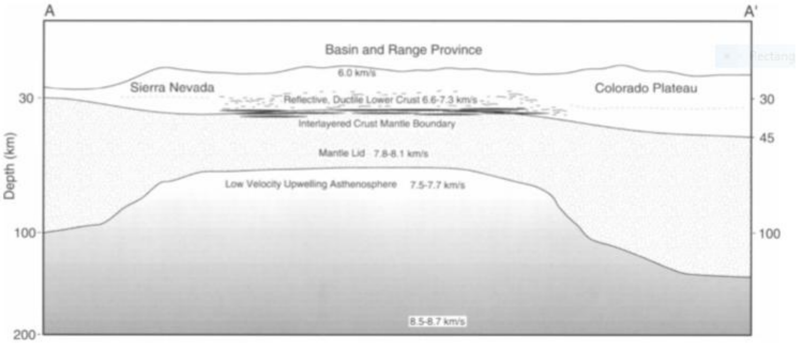


Figure 4. E-W crustal section across the Basin and Range Province. The crust is ~30km thick, about 10 km thinner than in the adjacent tectonic provinces.
From: *The Basin and Range Province*; T Parsons, 1995

The exposed rocks on the fault ridges (or horsts) are the pre-extension continental crustal rocks (sedimentary, metamorphic, plutonic igneous rocks), and younger volcanics which range in age from Precambrian to Cenozoic (Older than 542 Ma to <1 Ma); whereas the fault-troughs (or graben/grabens) are filled with younger sedimentary rocks, loose sediments, and volcanic rocks (mainly basaltic), culminating with current-day sediment at the surface. The thickness of trough-fill sequences ranges from hundreds to thousands of metres. The source of much of the sediment-fill is the horsts adjacent to each graben, however many of the graben were interconnect, so some streams carried sediment from any one graben to others nearby. The horsts have been eroded, and in many case the steep sides have retreated, the resulting sediment aprons covering the bounding faults. As erosion proceeds, the ridges narrow and the basins widen. See Figure 5 and 6.

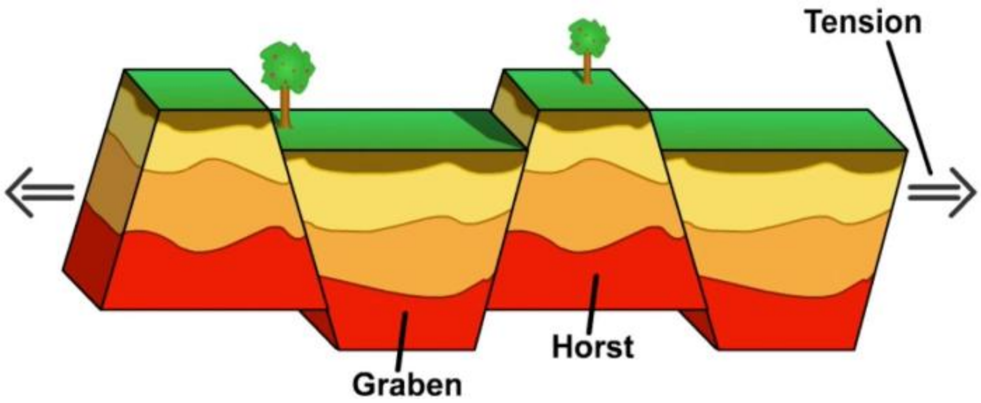


Figure 5. Cartoon of horsts and graben.

(United States Geological Survey:USGS)

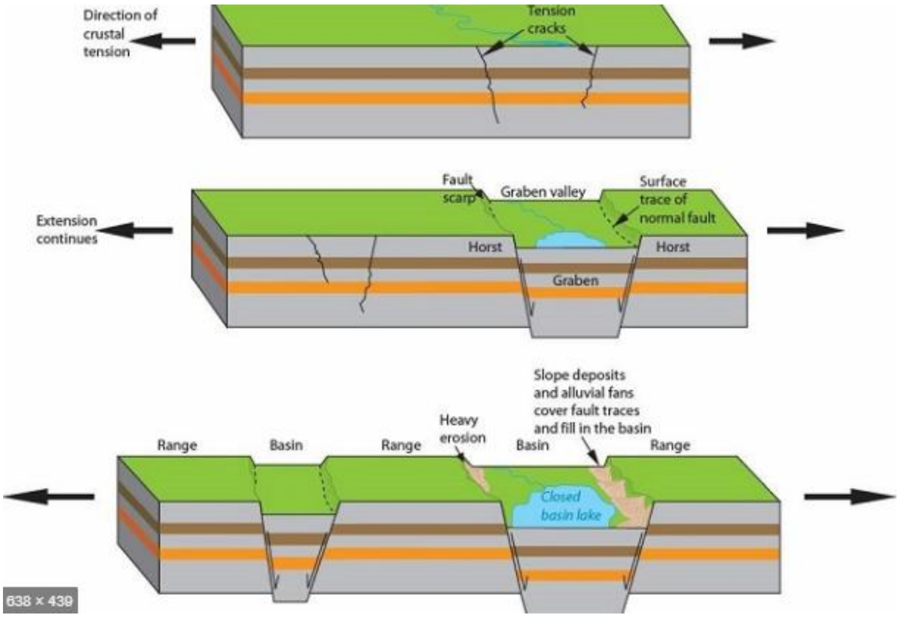


Figure 6. Cartoon of horst and graben structure as expressed in the Basin and Range Province.

For: U S National Parks Service *by Trista L. Thornberry-Ehrlich, Colorado State University.*

The cause of this extension is still controvertial, but a good case can be made for an unusual arrangement of plate tectonics. Before about 30 Ma, the oceanic Farallon Plate (eastern Pacific Ocean) was subducting easterly under the North American Continent, putting the western part of the North American Continent into an E-W compressive regime, all in fairly standard fashion. As expected, the western edge of the Farallon Plate was a spreading centre, the earlier version of the East Pacific Rise. The other side of the spreading system was the Pacific Plate, spreading northwesterly. The whole spreading system was moving eastwards meanwhile, so the proto East Pacific Rise line of spreading was approaching the North American Continent. Once the spreading ridge reached the continent, the hotter, thinner lithosphere near the spreading ridge was passing under the continental plate, heating the latter from below. This east-moving heat source was followed by the Pacific Plate, still spreading northwesterly from the easterly-moving spreading ridge now underneath the western part of the North American Continent. The combination of northwesterly sea-floor spreading and easterly ridge motion resulted in a low nett velocity relative to the overlying continent, and the previous compressive stress regime relaxed, allowing the heated continental crust to extend. The Farallon Plate broke up into smaller microplates (Juan de Fuca, Explorer, Gorda, Cocos, Kula,Rivera and Nazca Plates), and subduction ceased. The northwesterly motion of the subducted Pacific Plate was transformed into right-lateral movement in the continental crust as the San Andreas fault system. Associated with the high heat flow and extension was wide-spread volcanic activity, and adjustment between the fault-blocks to produce the Basin and Range Province's topography. See Figure 7.

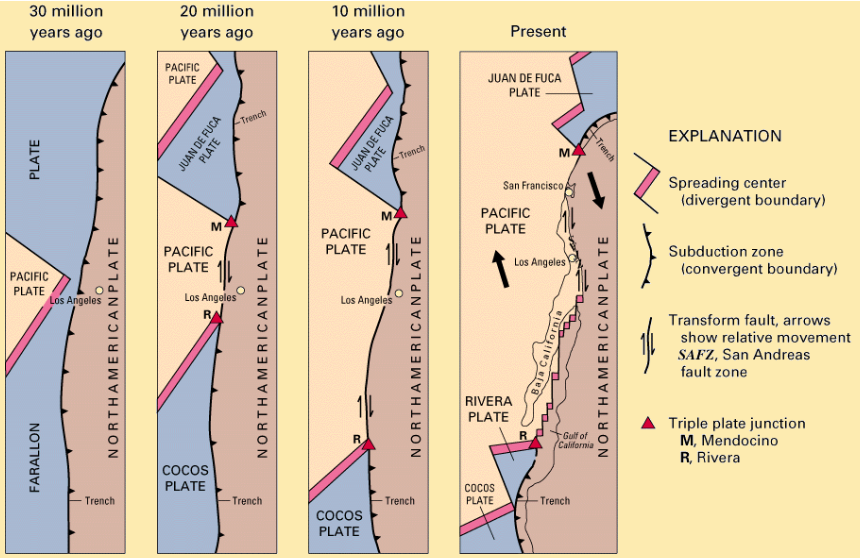


Figure 7. Plate tectonic interaction between the eastern Pacific Ocean and the North American continent, from 30 Ma to the Present. After the Farallon Plate impinged on the continent, the subductiing Farallon Plate was disconnected from the ancestral spreading ridge, and subduction ceased.
From: https://pubs.usgs.gov/gip/dynamic/Farallon.html *(USGS)*

For a video that deals with some of this, see:

Volcanic evolution of the Pacific Northwest: 55 million year history
Click on: https://www.youtube.com/watch?v=3o3IJlAHhTE

The peculiar topography of the Basin and Range Province meant that that there would be endorheic (= no outflow) lakes if rainfall was plentiful, or if the climate was dry there would be waterless basins between ridges.

The Pleistocene Epoch, stretching from 2.6 Ma to 11 ka is sometimes called The Ice Age, but this term hides the fact that colder (glacial) episodes alternated with warmer (pluvial) ones. See Figure 8.

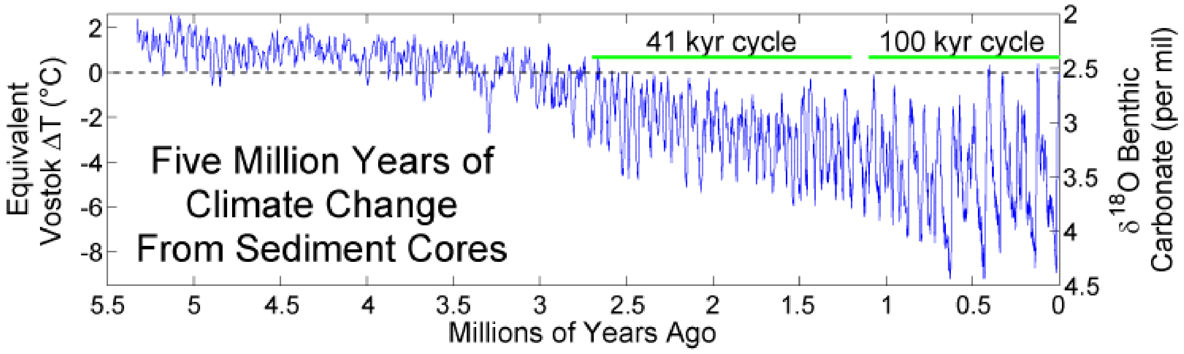


Figure 8. Temperature change over the past five million years. The Pliocene Epoch began at 5.33 Ma, the Pleistocene at 2.58 Ma, and the Holocene at 11.7 ka. Proxy for temperature is δ^{18}O, the oxygen isotope ratio of cores recovered from ocean-floor sediment. Note the swings from near-present-day average values down to values 4°-8° C lower.
From: http://joannenova.com.au/2010/02/the-big-picture-65-million-years-of-temperature-swings/

Lake Bonneville's Development

The Basin and Range Province lies east of the Sierra Nevada range (in eastern California). This caused a rain-shadow in the Basin and Range Province, which became desert or semi-desert during drier climates. In wetter times enough rain fell to keep the lakes topped up, and the streams flowing. A wide graben in northern Utah held a huge body of freshwater, called Lake Bonneville, in wetter times. (The highest level was ~1552 m ASL.) Its old shorelines can still be seen in the surrounding mountain ranges. In drier times, when evaporation exceeded rainfall and inflow, the water level fell, and the lake contracted to a small area in the lowest part of the lake basin. Minerals dissolved in the lake became greatly concentrated in the remaining body of water (~25% salinity) during drier episodes; even precipitating as the salinas or salt flats (elevation 1292 m ASL) of the Great Salt Lake Desert west of the current briny Great Salt Lake. Today's lake surface is around 1280 m ASL (depending on rainfall *vs* drought), about 272 m lower than the highest shoreline. Much of the information in this paragraph was recognised by United States Geologic Survey (USGS) geologist Grove Karl Gilbert, and described by him in *USGS Monograph 1: Lake Bonneville*, published in 1890. He also recognised, named, and described some of what I will write about in the rest of this article. Some people would say that Gilbert worked out what happened, and everybody since him has merely refined the numbers. Other workers since Gilbert's time studied the flood downstream in the Marsh Creek, Portneuf River and Snake River valleys, beyond the range of Gilbert's investigation. See Figure 9, 10, & 11.

Lake Bonneville was so large that the elevations need adjustment for later isostatic rebound. The lake's water weighed down the crust, which flexed downwards elastically, and displaced underlying mantle by viscous flow. After the lake partially drained, then evaporated (lightening the load on Earth's surface), the displaced mantle flowed back (slowly), and the crust "rebounded" (slowly). The amount of rebound has a central maximum of 74 metres, and decreases outwards. The amount of the rebound can be seen in the current elevations of the Bonneville Shoreline on what were islands scattered throughout Lake Bonneville's footprint. See Figure 9.

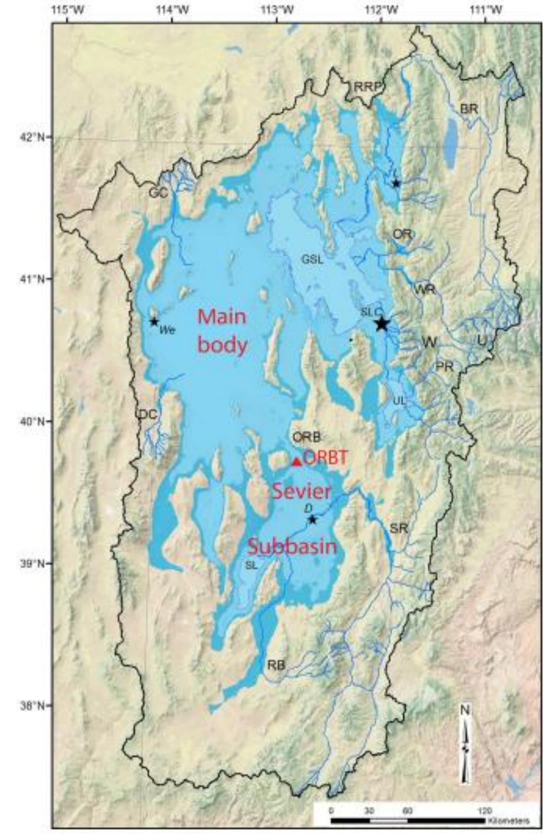


Figure 9. Map of Lake Bonneville produced by Ken Adams. The solid black line represents the drainage divide of the Bonneville basin. Three shades of blue show lakes in the Bonneville basin; the lightest shade is for modern lakes, Great Salt Lake (GSL), Utah Lake (UL), and Sevier Lake (SL). Lake Bonneville at the Provo shoreline is the next darker blue, and the darkest blue shade shows the lake extent at the Bonneville shoreline. Two primary subbasins merged at lake levels higher than the Stansbury shoreline – the main body, which includes the Great Salt Lake basin and some smaller closed basins, and the Sevier body. The primary connection between the main body and the Sevier body was a strait at the modern topographic divide between the two bodies,the Old River Bed threshold (ORBT). Two additional straits to the southwest of the ORBT connect the two bodies at lake levels higher than the Provo Shoreline. Major rivers tributary to Lake Bonneville were the Beaver River (BR), Sevier (SR), Provo (PR), Weber (WR), Ogden (OR) and Bear (BR). The highest and most extensive mountain ranges along the east side of the basin are the Uinta Mountains (U) and the Wasatch Mountains (W). Two tributaries on the west side are labeled: Deep Creek (DC) and Grouse Creek (GC). SLC, (Salt Lake City); D, (Delta); We. (Wendover); L, (Logan); and RRP, (Red Rock Pass).

The drainage divide (at Lake Bonneville time) and the highest shoreline came together at the overflow point – Zenda, 5 km north of Red Rock Pass (RRP). Note the Bear River (BR) in the northeast, the largest feeder into the Great Salt Lake basin, which also makes a close approach to the drainage divide. From: *Lake Bonneville: A Scientific Update,* J F Schroder Jr, 2016

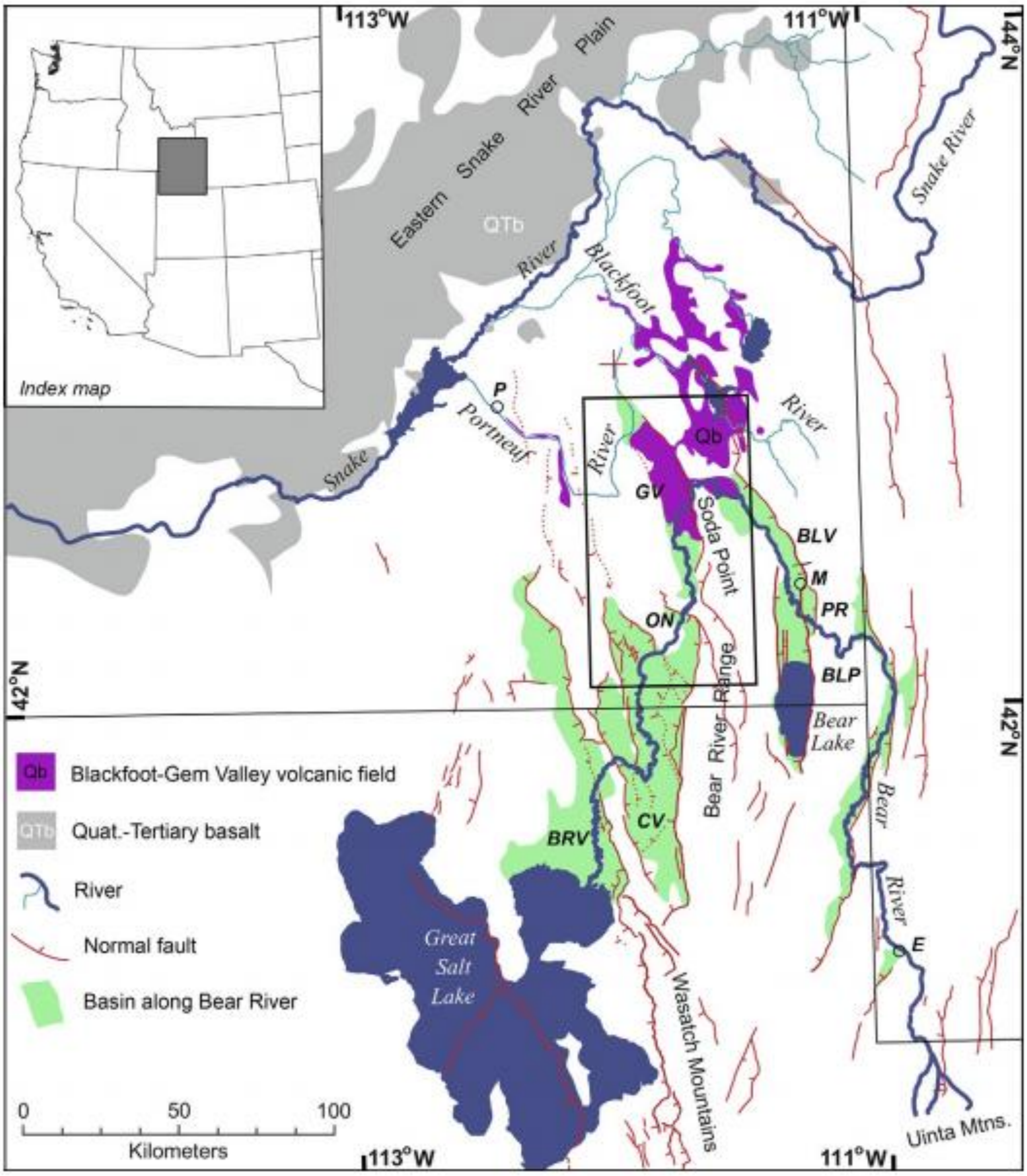


Figure 10. Northeastern Bonneville basin and Bear River drainage region. Rectangle outlines area of Figure 11. Key locations and features along the path of the Bear River are labelled: E. Evanston; BLP. Bear Lake Plateau; PR. Preuss Range; M. Montpelier; BLV. Bear Lake Valley; GV. Gem Valley; P. Pocatello; ON. Oneida Narrows; CV. Cache Valley; BRV. Bear River Valley.
From: *Lake Bonneville: A Scientific Update,* J F Schroder Jr, 2016

“Butch” Cassidy (real name Robert Leroy Parker) and his Wild Bunch, including the Sundance Kid (Harry Alonzo Longabaugh) were active in this area in the late 1890s. The 1969 movie *Butch Cassidy and the Sundance Kid* is loosely based on two of the Wild Bunch.

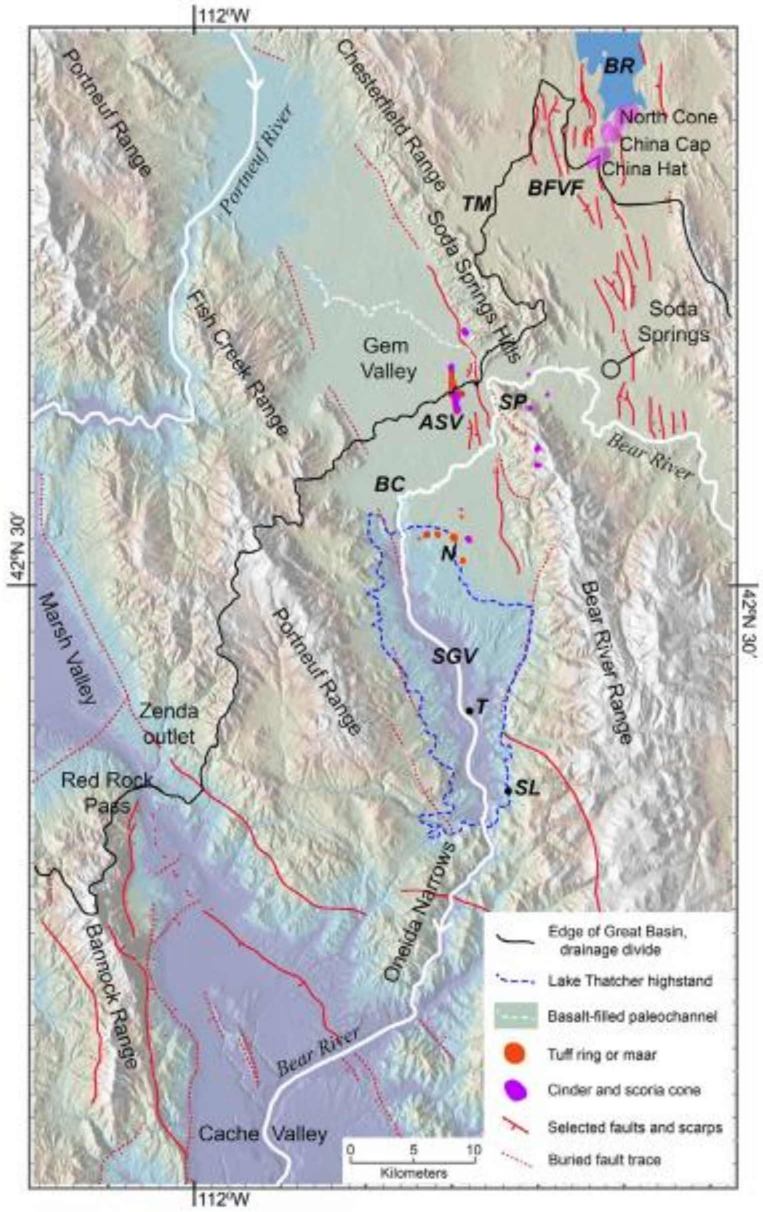


Figure 11. Locations and features of the Gem Valley and Oneida Narrows area where the Bear River was diverted southward into the Bonneville basin. The highest shoreline of Lake Bonneville corresponds to the violet-to-blue transition of the background map at 1540 m, and the highest shoreline of Lake Thatcher is marked by the dark blue dashed line at 1660 m. BR. Blackfoot Reservoir; BFVR. Blackfoot volcanic field; TM. Tenmile shield volcano; SP. Soda Point; ASV. Alexander shield volcano; BC. Black Canyon; N. Niter cluster of volcanic vents; SGV; southern Gem Valley; T. Thatcher. Note the current minor intermittent stream running northwest from SP (Soda Point). This is interpreted as a former course of the ancestral Bear River, connecting to the Portneuf River (thence to the Snake River). Note also the Anderson Shield Volcano, which interrupted the former course of the Bear River.

Portneuf Range, Gem Valley, Bear River Range etc are all part of the horst-and-graben structures, typical features of the Basin and Range Province.
From: *Lake Bonneville: A Scientific Update,* J F Schroder Jr, 2016

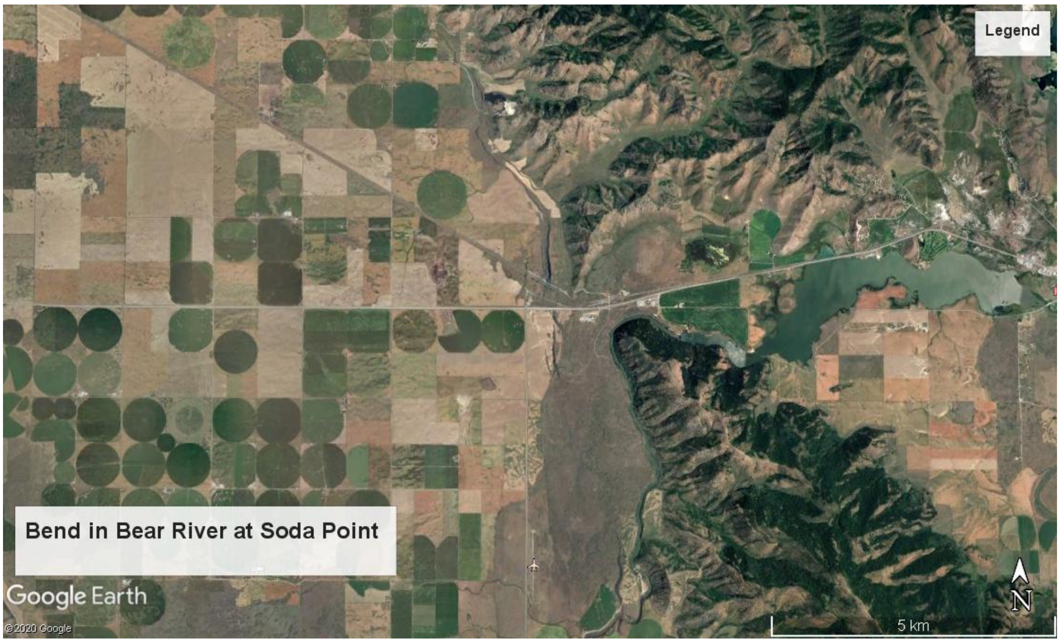
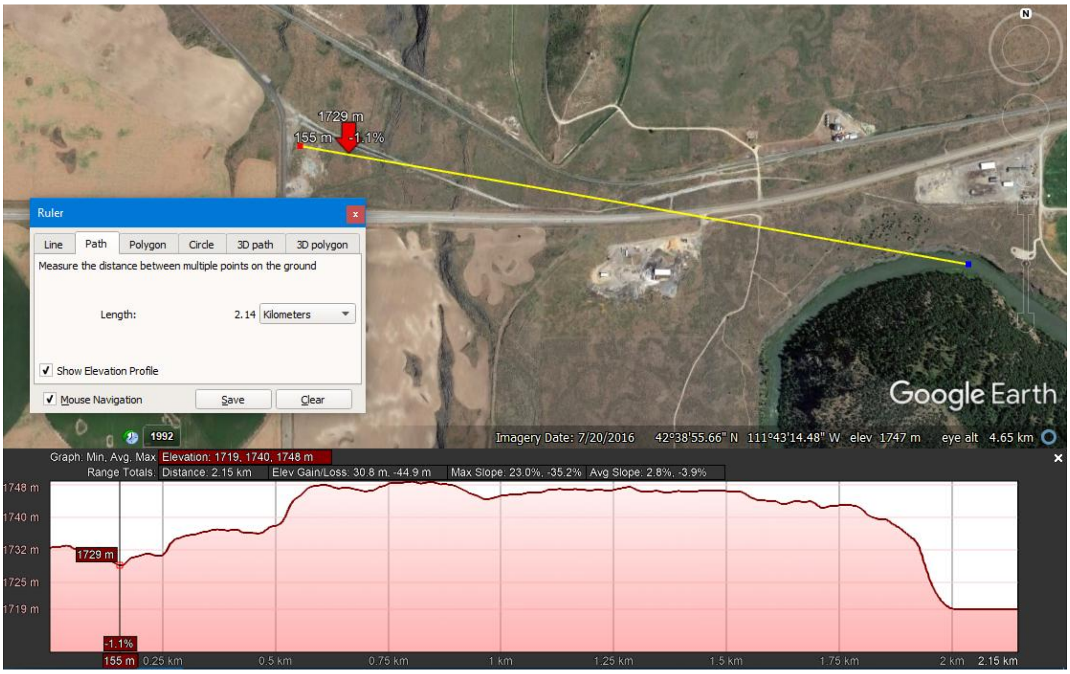


Figure 12. Bear River (dammed as Alexander Reservoir) enters from the east, and angles southwards around Soda Point. Note the minor stream flowing along the foot of the mountains in the northern half of the view; interpreted as a part of the former course of the Bear River. Basalt lavas in the northwest quadrant cover and obscure the former channel of the Bear River across the Gem Valley (the circular areas of irrigation). One meandering flow occupies part of the stream channel. Apparently, lava and water competed for the low topography, until the diversion became permanent, and the new course of the Bear Rivertook it southwards into the South Gem Valley, ponding up as Lake Thatcher. Lake Thatcher overflowed southward into Lake Bonneville, increasing its inflow by ~33%. The grey area in the mid-south of the view (between the mountains and the cultivated fields) is a flow of the Anderson Shield Volcano.



Measure the distance between multiple points on the ground

Length: 2.14 Kilometers

☑ Show Elevation Profile

☑ Mouse Navigation

Imagery Date: 7/20/2016 42°38'55.66" N 111°43'14.48" W elev 1747 m eye alt 4.65 km

Graph: Min, Avg, Max Elevation: 1719, 1740, 1748 m

Range Totals: Distance: 2.15 km Elev Gain/Loss: 30.8 m, -44.9 m Max Slope: 23.0%, -35.2% Avg Slope: 2.8%, -3.9%

Figure 13. Profile across a flow of the Anderson Shield Volcano at Soda Point, where it diverted the Bear River. Note, erosion may have altered (especially lowered) this profile.

The low Anderson Shield Volcano (now only a few tens of metres high) diverted the Bear River, so that it no longer drained to the ancestral Snake River via the Portneuf, but delivered the rain-water that fell in the eastern mountains soth towards the basin, rather than away to the north. The water ponded in the southern Gem Valley (a fault-basin or graben) as Lake Thatcher, which overflowed, and in due course the stream incised a gorge through the bedrock ridge, forming Oneida Narrows.

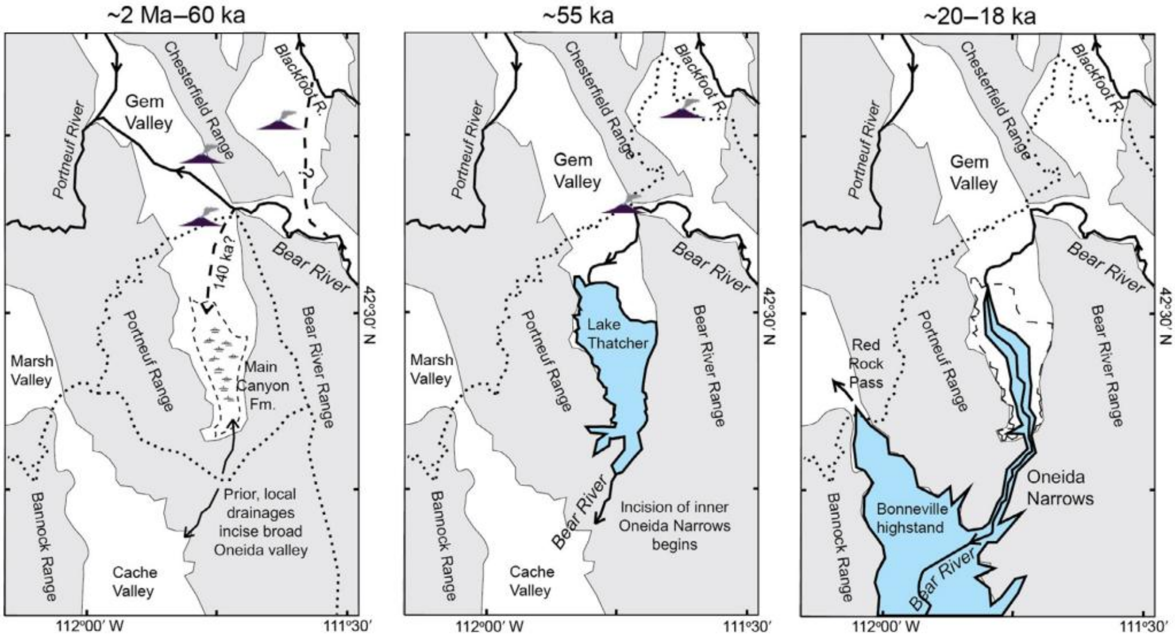


Figure 14. History of the diversion of Bear River, and the manner in which it caused Lake Bonneville to overflow its basin.
From: *Lake Bonneville: A Scientific Update,* J F Schroder Jr, 2016

The extra flow from the Bear River topped up Lake Bonneville, flooding Cache Valley to the sill or overflow lip at Zenda near Red Rock Pass. This is the drainage divide between Cache Valley and Marsh Valley, where Marsh Creek flows northwards towards the Snake River. The topographic high consisted of alluvial fan sediments up to 100 m thick, extending from Bannock Range and Portneuf Range lying to the west and east espectively.

Apparently, for ~500 years there was fairly steady drainage from Lake Bonneville northwards into Marsh Valley through the permeable alluvial fan sediments (and possibly through karst passageways - *i e* caves in the underlying limestone bedrock). The stable episode allowed the prominent Bonneville Shoreline to develop at ~1552 m ASL, marked by beaches, deltas from small tributary streams etc. A channel about 13 m (42 ft) deep was cut fairly rapidly down into the threshold sill; resulting in a similar drop in the lake level. A drop, then a rise in lake level between 15,000 years go and 14,550 years ago reflects a drying phase, then a phase of increasing rain, combined in an episode called the Keg Mountain Oscillation.

The Bonneville Flood

An unidentified event caused a partial collapse of the alluvial fan system that dammed the lake. Evidently the failed section was large, allowing a huge flow of draining water to flush away the failed volume of alluvium. Undercutting of the remaining alluvial fan sediment encouraged it to collapse into the spillway, where it too was wash away northwards down Marsh Valley.

The result was the Bonneville Flood, a torrent of water with a total volume of about 4,700 km³. (This is an easy estimation... Calculation of the volumes of the basin up to both the Bonneville and Provo shorelines is straighforward. You don't need to worry about the isostatic rise, because it applies to both lake volumes, and came after both shorelines developed anyway. The flood volume is the difference between the two lake volumes.) The calculated peak flow rate at Red Rock Pass was 1,000,000 m³ per second ± 100,000 m³ per second. Some simple arithmatic:

> 1 km³ = 1 billion m³;
> So 1 second at peak flow delivered ~0.001 km³; and 1 km³ took 1,000 seconds to pass.
> (1,000 seconds is 16 m 40 s.)
>
> If the total of 4,700 km³ flowed out at the peak rate (1,000,000 m³ per second), the flow would have lasted 4,700 × (16m 40s) ~78,333 minutes or about 54 days (a little less than 2 months). It is very likely that the flow would have waned substantially after the peak, so ~1 year seems a reasonable maximum duration for the flood.

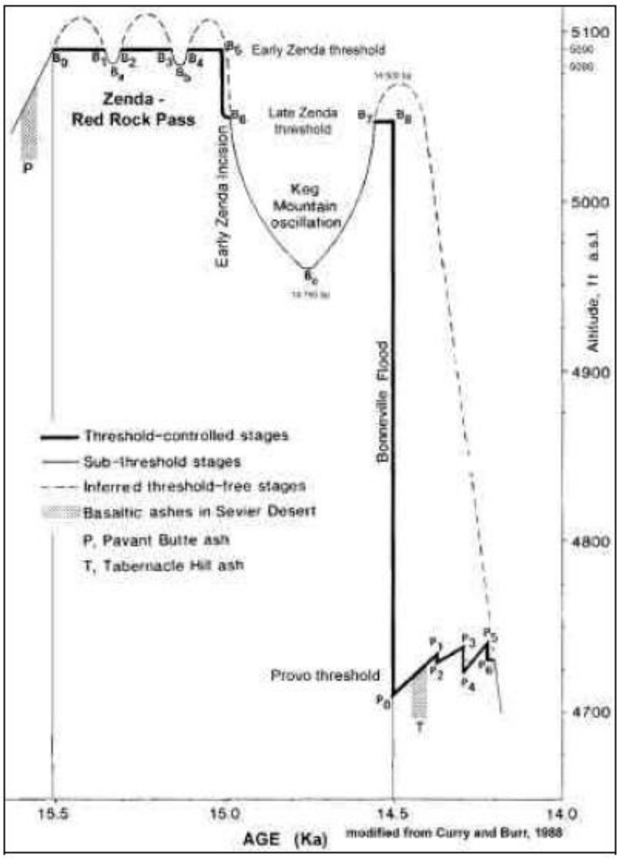


Figure 15. Water level vs time for Lake Bonneville and its successor, Lake Provo. Converting to metres: Early Zenda threshold at 5090 ft = ~1552m; Late Zenda threshold at 5050 ft = ~1539 m (a drop of ~13 m); Provo threshold at 4710 ft = ~1436 m (a further drop of ~116 m). From: *The Bonneville Flood,* Keenan Lee, 7 March 2004

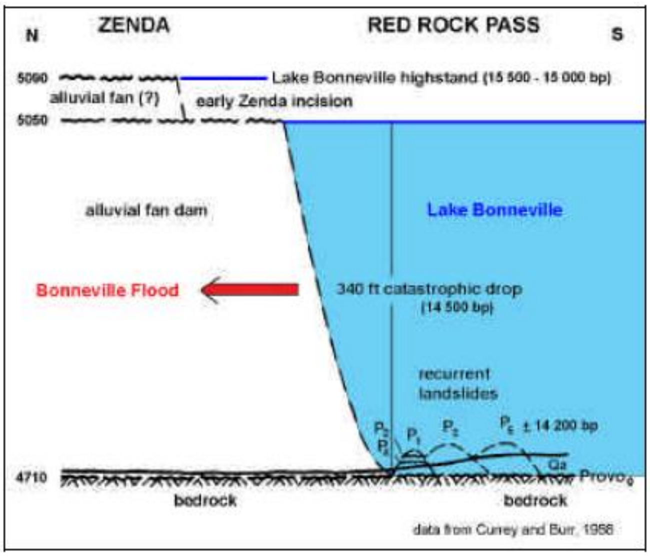
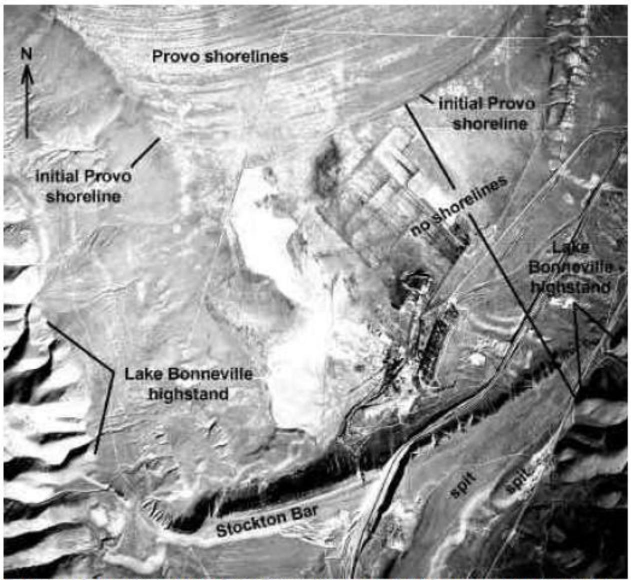


Figure 16. Schematic N-S cross-section at the Zenda – Red Rock Pass threshold at the northern end of Lake Bonneville-Lake Provo.
From: *The Bonneville Flood,* Keenan Lee, 7 March 2004

The Provo Shoreline(s) represent the level after the flood, and subsequent lower levels as the climate dried episodically. The Bonneville and (uppermost) Provo shoreline are prominent because the water level was near-constant at both shorelines for centuries. No shorelines are found between Bonneville and Provo; indicating a rapid change from one level to the other (rapid compared with a centuries timescale).



Evidence of the sudden drop in Lake Bonneville that resulted from a catastrophic discharge of the lake known as The Bonneville Flood. Bars, spits and shorelines near Stockton, UT, mark the highstand of Lake Bonneville. Provo shorelines are obvious to the north, but the absence of shorelines in between show that Lake Bonneville did not recede gradually; rather, the drop of 340 ft was sudden.

Figure 17. Absence of intermediate shorelines between Bonneville and Provo Shorelines confirms a rapid fall in lake level.
From: *The Bonneville Flood,* Keenan Lee, 7 March 2004

Downstream

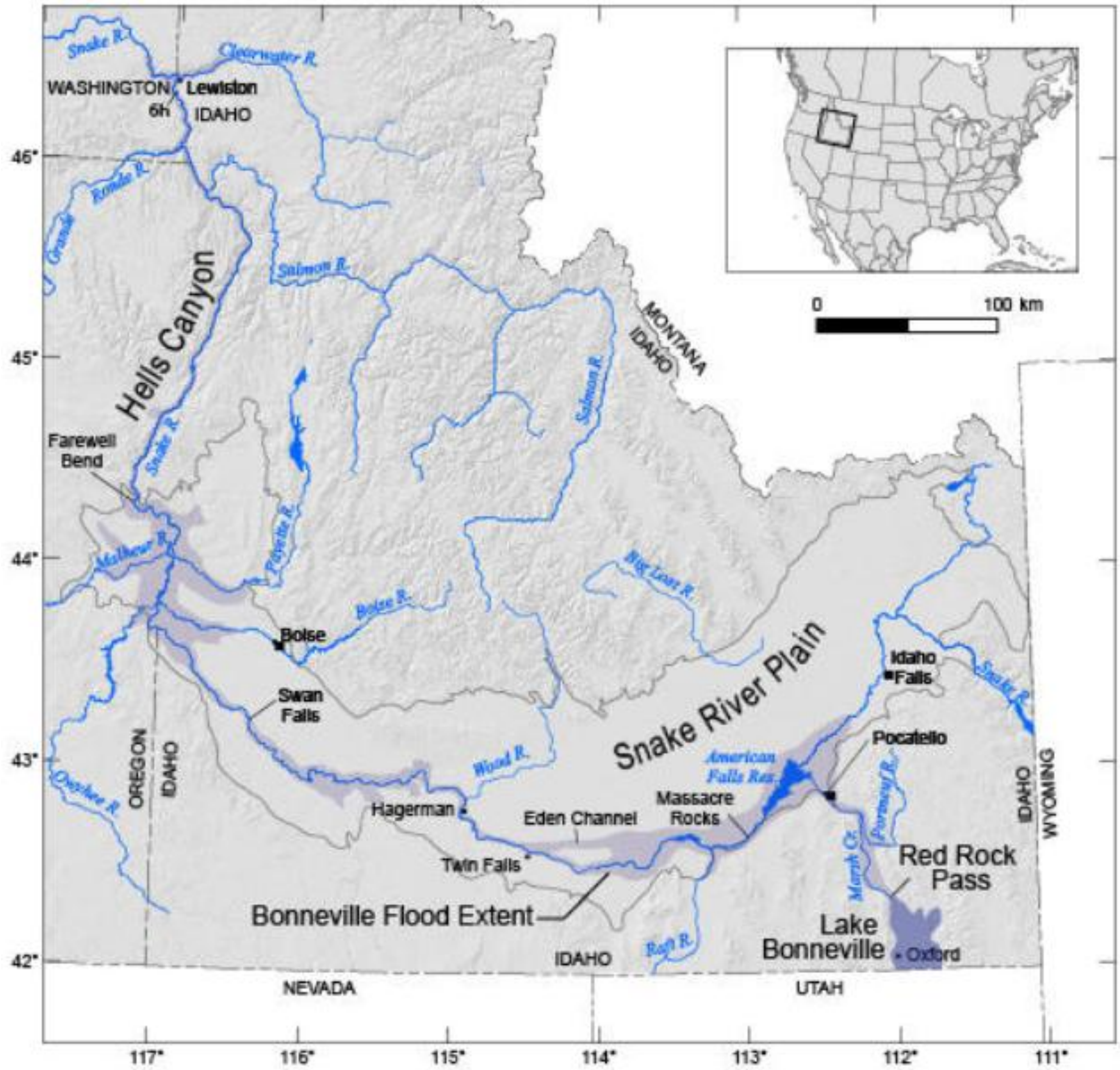


Figure 18. The path and extent of the Bonneville Flood. The floodwaters filled the broad Marsh Valley. Constrictions along the Snake River canyon caused a back-up upstream from American Falls, and up the Boise, Fayette, Malheur and Clearwater Rivers. The flood overfilled the canyon and stripped vegetation and soil from the adjacent plateau, forming scablands of mostly bare basalt (too infertile for cultivation). Eden Channel carried overbank water "cross-country", and returned its flow to the canyon, downstream. The flood continued downstream off the map, along the Snake River to its junction with the Columbia River, then down to the Pacific Ocean. The Snake River canyon begins where the Bonneville floodwater (coming down the Portneuf River) joined the Snake at American Falls Reservoir. Upstream from the Portneuf junction, the Snake flows in a shallow channel. See also Figure 2.
From: *How Did The Bonneville Flood Help Shape The Snake River Canyon?*; https://www.boisestatepublicradio.org/post/how-did-bonneville-flood-help-shape-snake-river-canyon

As the floodwater flowed down Marsh Valley into Portneuf River, then into the Snake River, it eroded the valley sides up to a high-water level. Also, it left floodwater deposits on the valley flanks. These features can be seen to this day. The water depth at high-water was about 100 m.

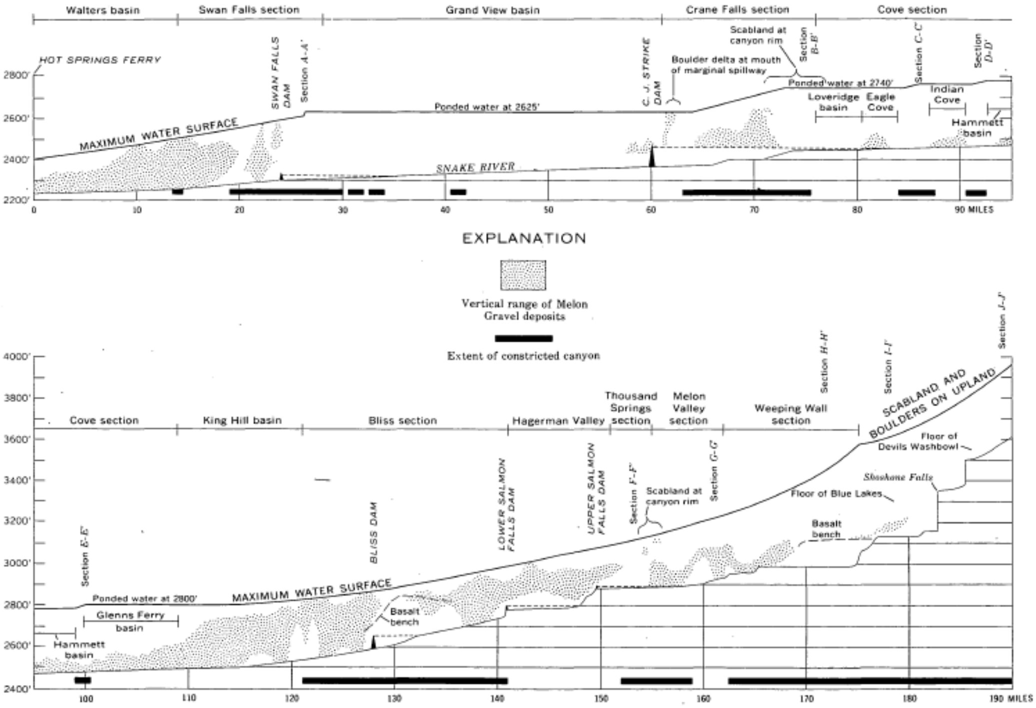


Figure 19. Bonneville Flood record in the Snake River Gorge. The inferred high water level is about 300ft/100m above the bedrock profile.

From: *The Catestrophic Late Pleistocene Bonneville Flood in the Snake River Plain, Idaho (1968),* H E Maulde, USGS Professional Paper 596

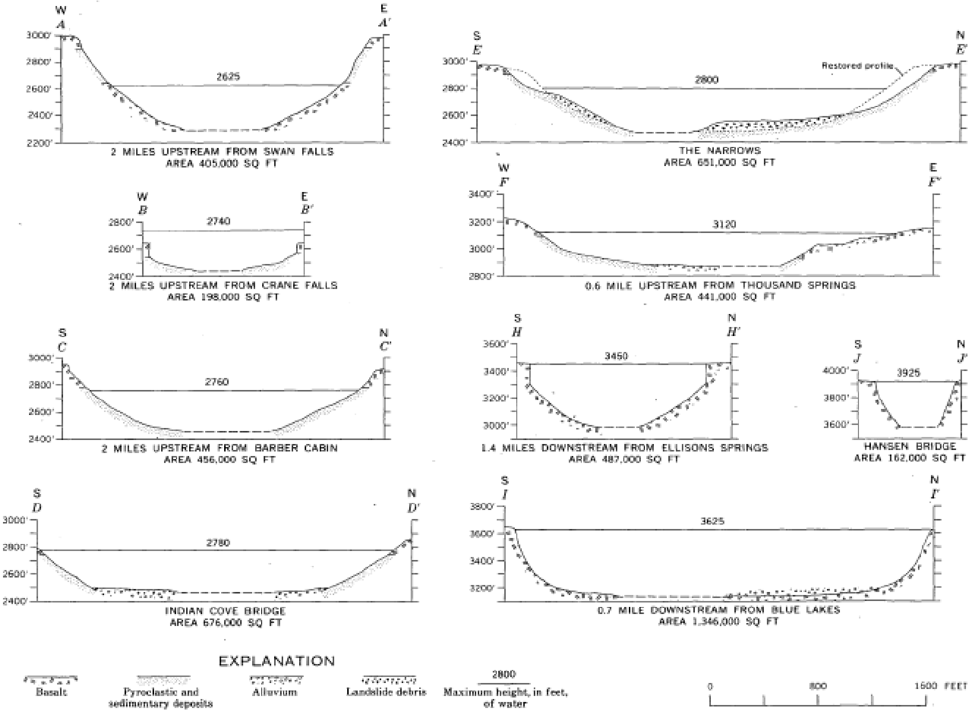


Figure 20a. Cross-sections of Snake River Gorge keyed to the long profile in Figure 19. The Bonneville Flood largely to completely filled the gorge, and overflowed it in places.

From: *The Catastrophic Late Pleistocene Bonneville Flood in the Snake River Plain, Idaho (1968),* H E Maulde, USGS Professional Paper 596

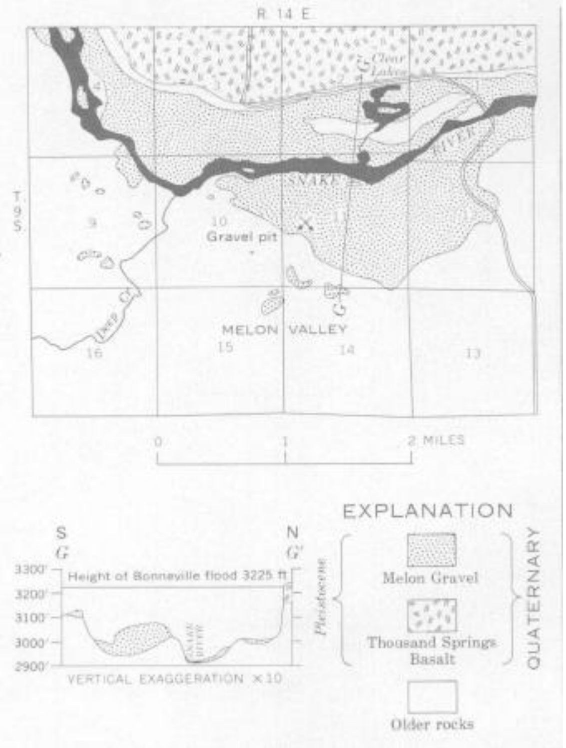


Figure 20b. Gross-section GG of the Snake River Gorge at full Bonneyville Flood level.
From: *The Catestrophic Late Pleistocene Bonneville Flood in the Snake River Plain, Idaho (1968)*, H E Maulde, USGS Professional Paper 596

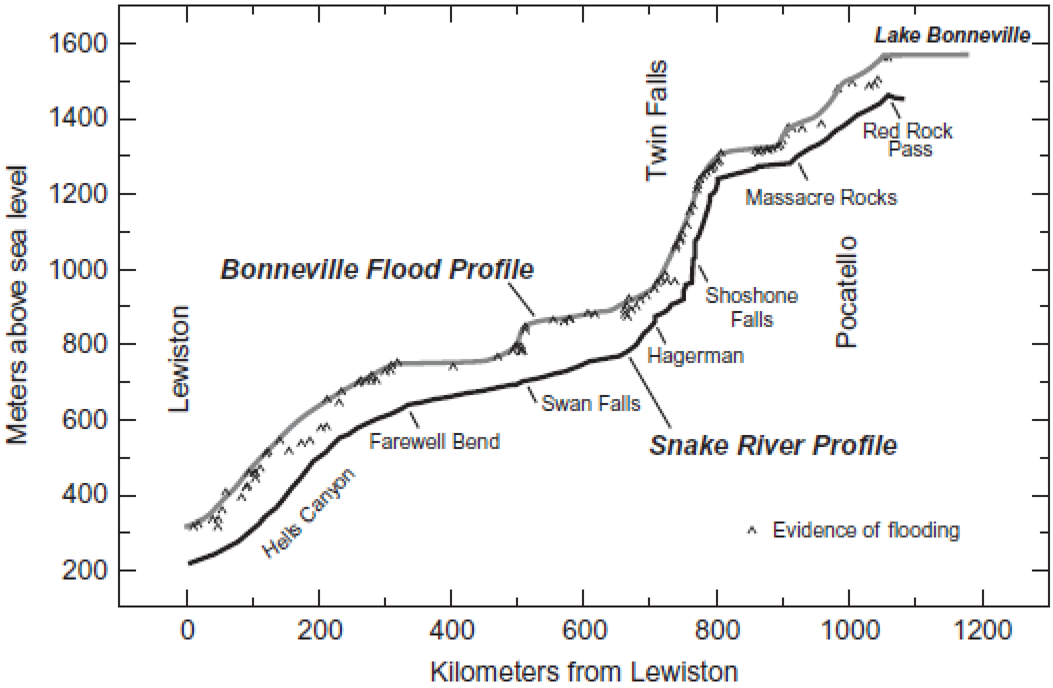


Figure 21. Updated (and metric-system adjusted) profile of the Bonneville Flood.
From: *Lake Bonneville: A Scientific Update*, J F Schroder Jr, 2016

Figure 22. Snake River Gorge near profile F-F ' (Figures 19, 20a). Stream velocity was sufficiently high to strip out talus and any landslide deposits; and prevent deposition of sediment bars.
From: *The Catestrophic Late Pleistocene Bonneville Flood in the Snake River Plain, Idaho (1968),* H E Maulde, USGS Professional Paper 596

The height of the flood can be used to estimate the flow of water through the gorge.

Figure 23. The Bonneville Flood overflowed the gorge, and stripped soil and vegtation, leaving scablands (pale), which are less-fertile, and are not cultivated.
From: The Great Bonneville Flood – Part 2; https://sacredgeometryinternational.com/great-bonneville-flood-part-2/

Figure 24. Shoshone Falls on the Snake River. View looking easterly up Eden Channel scabland. This stretch of scablands extends 5 km upstream from the Falls, and 10 km downstream.
From: *Lake Bonneville and the Bonneville Flood*; http://hugefloods.com/Bonneville.html

Figure 25. Rounded boulders of basalt transported by the Bonneville Flood. The Flood virtually filled the canyon; the modern Snake River is the much smaller stream in the background, at the foot of the canyon wall.
From: *Lake Bonneville and the Bonneville Flood*; http://hugefloods.com/Bonneville.html

The ***101 Ranch*** *along US HWY 30 appears to be looking for help removing basalt boulders from their pasture near King Hill, ID. The material was ripped from bedrock upstream, then tumbled by floodwaters before being dropped near this location.*

Figure 26. The boulder-gravel deposited by the Bonneville Flood was given the nickname "melon gravel", and this has become semi-formalised as Melon Gravel.
From: *Lake Bonneville and the Bonneville Flood*; http://hugefloods.com/Bonneville.html

Figure 27. Hells Canyon, with a point bar constructed by the Bonneville Flood. Contrast this with the modern bar deposits of today's Snake River (white). The ground uphill to ~200 m was partially stripped of vegetation and soil by the same flood.
From: *Lake Bonneville: A Scientific Update,* J F Schroder Jr, 2016

Figure 28. The depositional flood terraces are the pale-straw material, overlying mid-grey bedrock.
From: *Lake Bonneville and the Bonneville Flood*; http://hugefloods.com/Bonneville.html

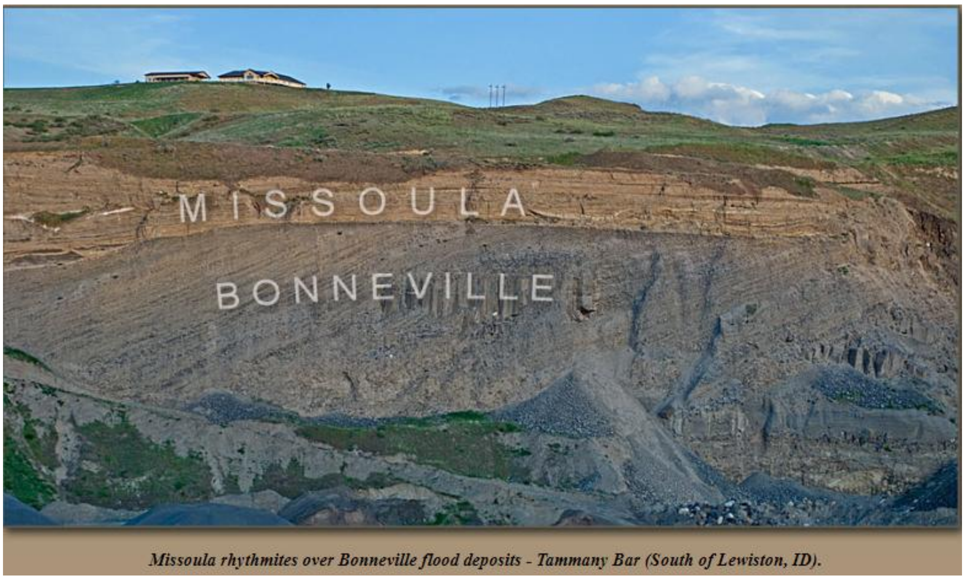


Figure 29. The Bonneville deposit reveals moderately dipping cross-bedding; demonstrating a right-to-left flow direction. The overlying Missoula material was deposited from water that backed upstream from the approximately twenty floods caused by repeated failures of an ice-dam near the Canadian border, but that's a different story. Clearly, the Missoula flooding occurred after the Bonneville Flood, as the Law of Superposition requires.
From: http://hugefloods.com/Jim-OConnor.html

All of the above resulted from the diversion of the Bear River by a rather small volcano!