

The evolution of man has always been a fascinating, if not sensitive, topic and Fred Spoor from University College London explained in his October talk how it now seems that there were several species of hominids living together in the past before our species came to dominate the world.

In February, the society performed its annual clear-up of the geological sites at the Brown's Folly nature reserve. In April, the chairman took the society on a fieldtrip to Sully Island and Bendrick Rock, near Barry, on a fine day with 30 people attending. The Triassic rocks here in South Wales were deposited around the edge of an enormous lake or inland sea in which the Mercia Mudstone (Keuper Marl) was deposited. A range of shoreline limestones was developed, with stromatolites, tepees, palaeosoils and evaporites (gypsum). The highlight was being able to still see dinosaur footprints since unfortunately many have been removed by professional collectors. The field trip to Anglesey led by Dave Green in May was well supported with 16 attendees enjoying the geologically fascinating but frustrating island. The main focus of excursion was the controversial Precambrian to Cambrian sequence, of high grade metamorphic rocks and granites, the Mona Complex with volcanics and enigmatic mélange, and the Eastern Schist Zone with blue schist of oceanic affinities. A fieldtrip to the Vale of Wardour in June with the Wiltshire Geology Group led by Isobel Geddes and Steve Hannath involved a walk across the vale from one side of the eroded anticline to the other, seeing exposures of upper Jurassic to Cretaceous strata.

One of the staunch members of the Bath Geological Society and its committee, Elizabeth Devon, is leaving the area for pastures new in the northeast-borders. We should thank Elizabeth for all her work for the Society over the years, but also for her major contributions to the geological community in the area. Her running of the West Country Geology Blog has kept everyone informed of regional events and Earth science news, such a great resource. Also many thanks to all committee members for their work for the society and to you the members for all your support.

Maurice Tucker

Yellowstone National Park

Mellissa Freeman

Yellowstone National Park in Wyoming, which spans 2.2 million acres, became the world's first national park in 1872. It sits as a high plateau surrounded by the Madison Range to the west, the Gallatin and Beartooth Mountains to the north, the Absaroka Mountains to the east and the Grand Tetons to the south. The geological history of this area is well known with three major eruptions over a 2 million year period, two of which are the largest known in Earth's history. It contains around 55% of the world's geysers (approximately 400 currently active) and has one of the world's largest hydrothermal systems.

Yellowstone sits above a hotspot where magma from deep within the earth rises close to the surface. The crust is very thin here - in the region of 2 to 3 miles in thickness compared to continental crust in other parts of the world (30 to 40 miles in thickness). It is also the only place on earth where there is a hotspot below continental crust. Other well-known places with hotspots are Hawaii, Iceland and Galapagos where the crust is oceanic, see Fig 1.

There was a large amount of geological activity in this region long before the emergence of the hotspot. During the Palaeozoic era (540 to 245 million years ago) the Yellowstone region was subject to many marine transgressions and regressions. Deep sea sediments including limestones, sandstones and shales can still be found mostly in the north west of the National Park and sit beneath Hucklebury Ridge tuff, a product of the first large eruption at Yellowstone. Triassic rocks (245 to 205 million years ago) are represented by deposits of siltstone and shales in the east of the park that would have accumulated in swamps and shallow muddy seas. Hydrocarbons and coal that formed from Cretaceous sandstones and shale deposits that were later subjected to pressure and heat can also be found. The late Cretaceous saw the start of mountain building. There were two major

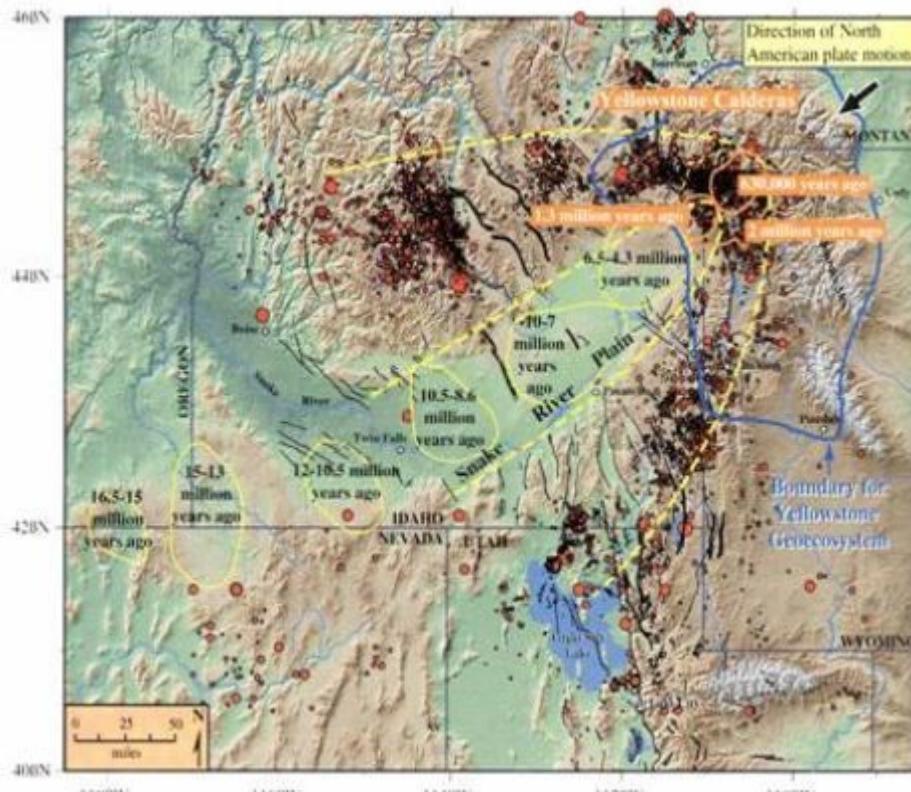


Fig 1, *The path of the Yellowstone Hotspot* (Siegel, 2000)

mountain building episodes that affected the Yellowstone area displacing the

Western American Interior Seaway, eventually creating the Rockies. The Sevier orogeny started approximately 110 million years ago followed by the Laramide orogeny 80 million years ago. Uplift continued into the Cenozoic. The western interior began stretching approximately 30 million years ago and continues today in an east to west direction producing the basin and range topography.

Back to the volcanics...

There are three major volcanic cycles that account for more than half of the volcanic material in the region. The first and largest was the

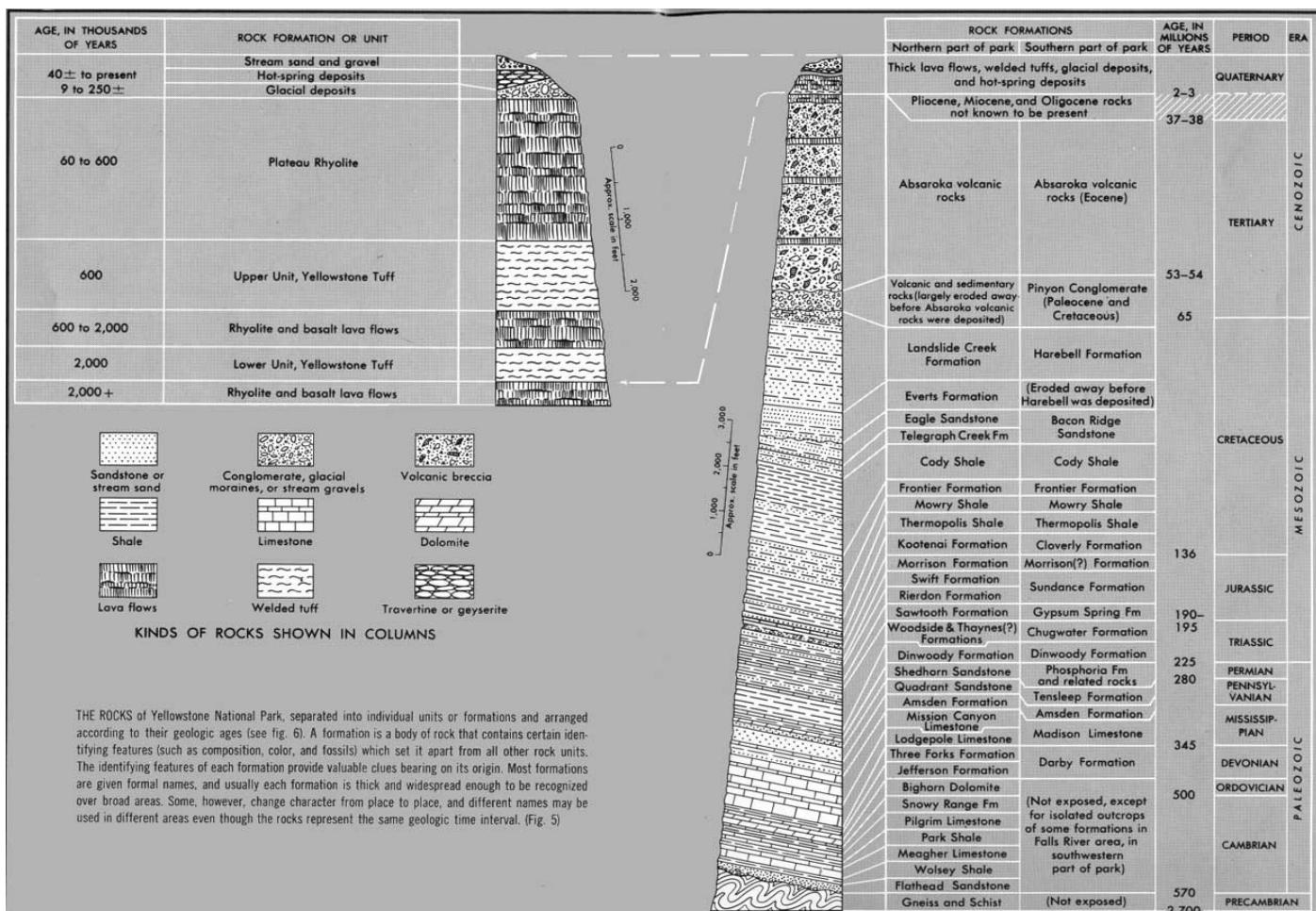


Fig 2, *The Rocks of Yellowstone National Park*

Huckleberry Ridge eruption. It has been estimated that deposits from this eruption covered an area of approximately 15,500 km³! Following inflation and uplift of the area above the magma chamber, over-pressurised rhyolitic magma erupted explosively causing the roof of the caldera to collapse. The huge amounts of superheated silica-rich ash and rocks produced throughout this episode were welded together to form the Huckleberry Ridge



Fig 3. Thick Huckleberry Ridge ash deposits

tuff, a 500 – 2,500 thick sheet of volcanic rock.

Another period of inflation and uplift preceded the second largest eruption. The Mesa Falls eruption occurred approximately 1.3 million years ago and ejected around 288 km³ of material creating the Island Park caldera (aka the Henry's Fork caldera). The Mesa Falls tuff was formed by the hot ash fall from the



Fig 4, Columnar jointing from the 1.3 ma eruption sitting on top of altered rhyolite deposits at the Grand Canyon of Yellowstone River.

explosion and in places can be up to 500 feet thick.

The third caldera blast, approximately 630,000 years ago, occurred to the north east of the other two eruptions. This one completely drained the magma chamber and created the caldera that forms the topography of the Yellowstone Plateau. The Lava Creek tuff overlays some of the Huckleberry Ridge deposits and in places is up to 1,600 feet thick. Fig 5.

There is evidence of large rhyolitic lava flows in the caldera between 180,000 years ago and 70,000 years ago but nothing volcanic since then only hydrothermal activity. Fig 6.

It is common knowledge that the Yellowstone region is still geologically active. The evidence can be witnessed every day by the hordes of visitors that queue to see the geysers, mud pots, hot springs, fumaroles and the travertine terraces at Mammoth Springs. Most significantly though are the two resurgent domes - Sour Creek and Mallard Lake. Recent measurements show a significant rise over the last few years although they are also known to subside giving the overall effect that the park is breathing.

I won't mention the hydrothermal plumbing system beneath Yellowstone but have added a couple of photos showing some of these features and the amazing colours produced by the extremophiles living in the hot and acidic conditions that exist there. These were referred to by Professor Richard Fortey during his talk for the Bath Geological Society in September 2016 entitled "Survivors" the Living Fossils".

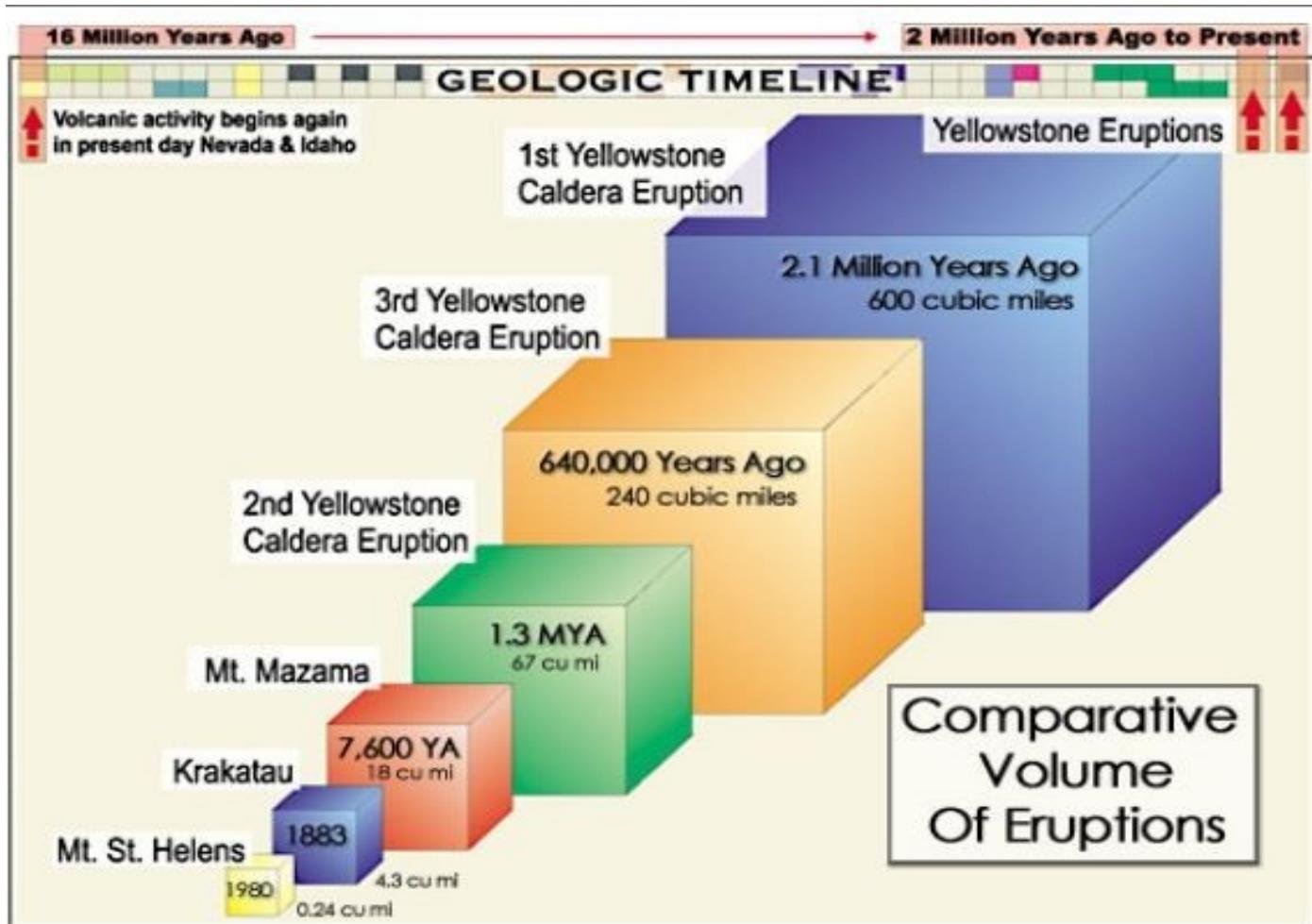


Fig 5, Comparative volume of eruption (daveinthehills, n.d.)

Age	Volcanic cycle	Precaldera rhyolite	Caldera-forming ash-flow tuff (Yellowstone Group)	Postcaldera rhyolite	Contemporaneous plateau-marginal basalts
Pleistocene	Third			Plateau Rhyolite	Basalts of Snake River Group Osprey Basalt Madison River Basalt Basalt of Geode Creek Swan Lake Flat Basalt Gerrit Basalt Falls River Basalt Basalt of Mariposa Lake
		Mount Jackson Rhyolite Lewis Canyon Rhyolite	Lava Creek Tuff		Undine Falls Basalt Basalt of Warm River Basalt of Shotgun Valley
	Second			Island Park Rhyolite	Basalt of the Narrows
		Big Bend Ridge Rhyolite ¹	Mesa Falls Tuff		
Pliocene	First			Big Bend Ridge Rhyolite ¹	
		Rhyolite of Snake River Butte	Huckleberry Ridge Tuff		Junction Butte Basalt

Fig 6, Stratigraphy of the Yellowstone Plateau volcanic field (Christiansen, 2001)



Fig, 7 *Hot Spring*

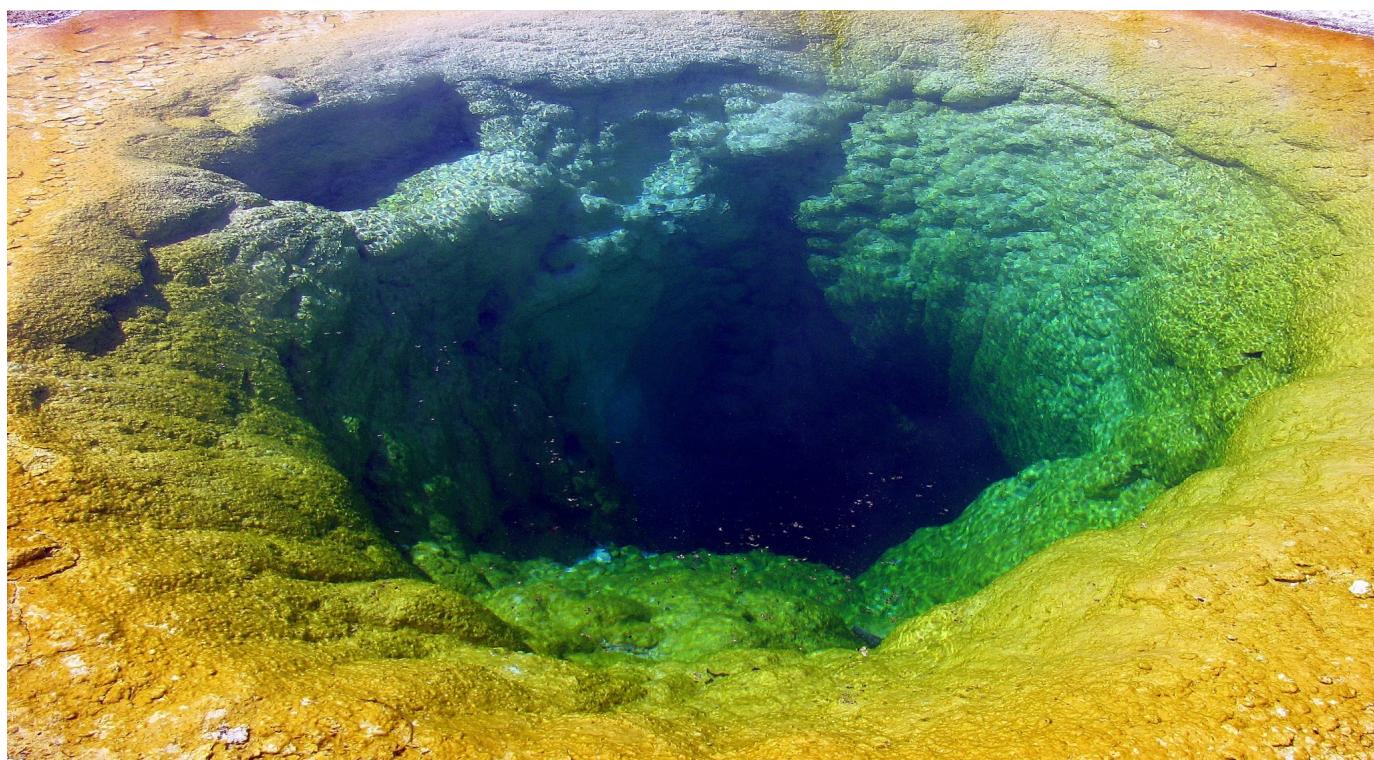


Fig 8, *Morning Glory Pool*



Fig 9, *Extremophiles living in the Park*



Fig 10, *Rainbow Geysers*

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THE BRORA COALFIELD

Charles Hiscock

The Background

Britain is noted worldwide as the cradle of the Industrial Revolution. This fame is down to one geological factor – the presence of widespread reserves of coal which literally fuelled the Revolution, was exploited by the early industrialists and entrepreneurs and put the 'great' in Great Britain. Even before the start of the Industrial Revolution in the late 18th century, these coal reserves were being extracted in small quantities. There are records of the Romans using coal as a fuel and it was as early as 1603 that a landowner called Huntingdon Beaumont started drift mining in Nottinghamshire, using a horse drawn tramway to carry the coal. In 1621 the Whickham Grand Leaseway mine was opened on Tyneside while, in 1721, the first true colliery was opened at Middleton, Leeds. The revolution gathered pace so that by the late 19th century, coal mines had been sunk in all the localities of Coal Measures across Britain from Kent to Tyneside, from Somerset to Scotland and from the Wales to the west Midlands. In 1947, 1503 mines were operating.

One can be forgiven for assuming that the coal reserves in Britain were all laid down during the Carboniferous period, particularly the Westphalian Stage, known as the Coal Measures. However, coal was formed during other geological epochs. In Britain, small reserves of lignite have been mined from the Neogene of Devon and the Cretaceous of Kent while the Jurassic has been the source of coal in Cleveland and the east coast of Scotland. It is the history and unique geology of the latter, the Brora Coalfield, that is the subject of this article.