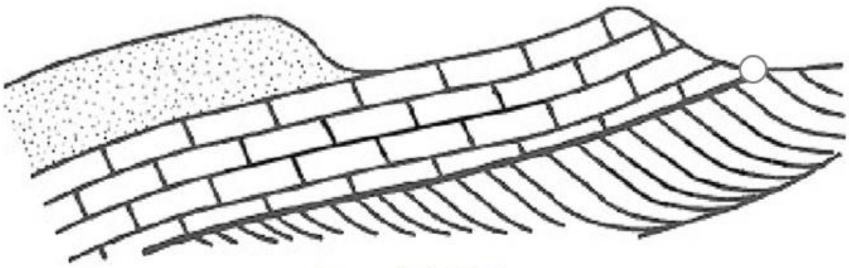
Farnham Geological Society

Farnhamia farnhamensis



Founded 1970

A local group within the GA

Volume 23, No. 2

Newsletter

Issue No. 105

April 2020

www.farnhamgeosoc.org.uk

Contents

Editorial

This edition of the newsletter is different – I felt at the end of 2019 as I was compiling the February Newsletter that it needed a face lift (like me) but was not sure how to accomplish that. Then, following the AGM, Mick Caulfield announced that he would be keen to help the Society in any way he could, sending me his CV along with his email. He has had a parallel career to mine - just two decades later - and so I am thrilled to say that after the first page or so, it will be all his work.

I have enjoyed being editor, but it is definitely time to hand over to another person and I know he is the right person for the job.

Before I go, I want to thank all those people who have helped me –

- **Janet Catchpole** who has diligently spent time urging our speakers to provide a summary of their talk, which I know a lot of members enjoy being able to go through whilst they sit and relax, absorbing the details which had been given.
- To all the members who have provided me with reports and photographs of their exploits on the FGS field trips which I have included.
- To **Mike Weaver** who has taken my offerings and compiled them into an attractive newsletter and to Mike and the webmasters who have then added them to the website.
- Then there is **Peter Luckham**, our revered treasurer, who has been with the Society for almost 50 years and who has been a source of information on members, outings and meetings and all manner of other things, including providing me with all the paper copies of the newsletters since day one. I put these into digital format, and they have been put onto the website – thank you webmaster for that.

- And last but not least, I must thank **John Stanley** who has painstakingly gone through every one of those 50 years' worth of newsletters to provide us with an index itemising all the entries in each newsletter. Hence, if any one of you wants to know details of the field trip to *'Lalaland'* run by FGS in *199x* you can easily search for it on his archive and actually then read the article on the website.

So, I wish Mick good luck and I am sure you will enjoy the future articles he will be bringing to you.

Our Constitution notes:

The objective of the Society shall be to promote interest in geology and its allied sciences by:

i) holding Meetings for the reading of original papers and the delivery of lectures,

ii) holding Field Meetings, and

iii) extending knowledge of the science by research, by publication and by such other means as the Committee may from time to time determine.

On that note I will now hand you over to Mick – please help him in any way you can.

Liz Aston

As your new editor I would like to give you a quick introduction as to who I am. I am married to Anne and have 3 children and 4 grandchildren, with 1 on the way. I began my geological career in 1981 when I joined an American oil company, Sedco Energy, in London and while working full-time completed my BSc in Geology at Birkbeck College in 1983. After joining Texaco in 1984 I went on to complete an MSc in Stratigraphy, again part-time, at Birkbeck College. Since leaving Texaco in 2002 I have worked for a number of oil companies based in the southeast, the last being a small independent company who focused on sub-Saharan exploration.

I joined the FGS in late 2016 when my wife and I moved to Farnham from Bexleyheath in Kent. Our children had left home, got married and started their own families and we needed to downsize, but stay within commuting distance of the Big Smoke.

I would like to say thank you to Liz as I have thoroughly enjoyed her editorship of the Newsletter; she will be a difficult act to follow but I look forward to the challenge. I will attempt to follow her example of including articles from various sources, both members and academics, covering the monthly talks, FGS field trips and the members' own views of their geological experiences.

I will need your help though, both in providing reports from monthly talks, meetings, field trips and excursions, as well as ideas for improving the Newsletter … for example, have you read a geological book recently and would like to submit a review? Or have you discovered an interesting geological website or Facebook page that you would like members to know about?

If you do have any ideas please feel free to forward them to me at caulfm@hotmail.com.

Mick Caulfield

I am writing this in mid-April while in lockdown due to the Covid-19 virus. As you know we have already had to cancel a number of our monthly meetings and may have to cancel future meetings … it will also impact our plans for the 50th anniversary of the founding of the Society.

Please keep an eye on your emails from the Society, as this will be the easiest way we will be able to inform you as to when we will be able to begin to return to normal.

Let's hope the situation begins to improve very soon. Be careful out there!

Obituary

Dr Edward Finch

4th September 1935 - 30th January 2020

It is customary to report the deaths of our members in the first newsletter of the year, but earlier this year one of our founding fathers died, namely Ted Finch. Many of our older members will remember him from the 70s so I felt it would be important to mention him in this edition.

My first and endearing memories of Ted Finch were when I worked at the BP Research Centre in Sunbury-on-Thames. We (petroleum geologists) had coffee in our lab every morning discussing the odds and ends of projects and in would walk Ted with the latest tale of his adventures with this group of enthusiastic geologists that he was teaching and taking on field trips – and who were they? – many of the Farnham Geology group. He always had another anecdote of this or that which had occurred (or not occurred). From his teachings and their efforts, so the Society was founded.

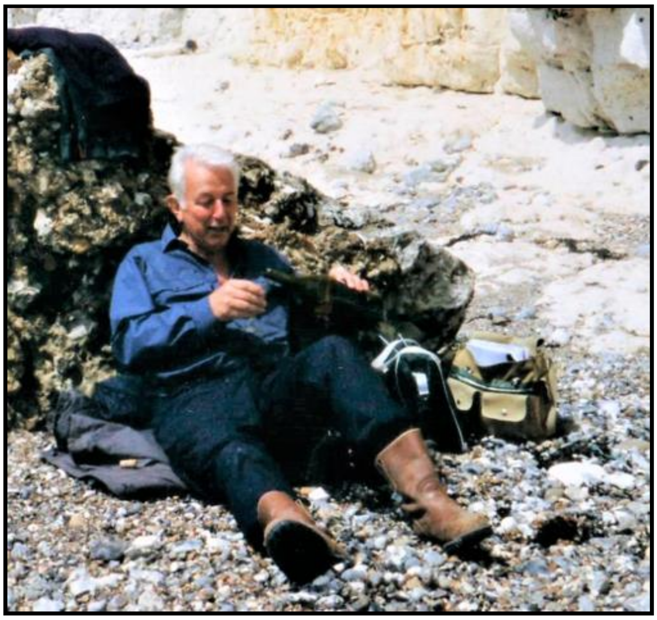
As far as I remember he also preferred to socialise with us, the petroleum geologists, rather than the palaeontologists, not only for coffee but for other events – table tennis and other mild sporting events and gentle gambling (e.g. sweepstakes).

He always had a smile on his face and a cheery disposition. But he managed to keep me away from the brand new scanning electron microscope that had just been installed, and that was just before I had to leave BP to have my first baby - when, as a friend put it, pregnancy was a dismissible offence.

I know that many of our early (first members) will remember him with great affection. He helped them all, but I will leave them to tell their story.

Liz Aston

Edward will be greatly missed by me and many of his geology students; he was the inspirational geologist, albeit a soft rock man, and he was a great friend. I first met Edward in the early 1970s when he started a geology class at the Winston Churchill School in Woking. He was at his best on Field Trips when he was explaining the rocks in front of you, but you had to be prepared for the false information that he slipped in just to see if you were paying attention.



His first geology course was at Farnham in 1970 and this class resulted in the formation of the Farnham Geological Society. Many of his students, including myself, went on from these local lectures to do geology degrees. To the best of my knowledge Edward talked at least 5 of his students into doing university degrees: Diane, Gilia, Janet, Helena & John. I finished my degree in the late 1980s at Birkbeck College; Edward was still running field trips and I started to tag along to visit new geological places of interest.

He was an excellent companion on these adventures, falling for his practical jokes was part of our trips. Edward and I found that we had similar cynical outlook on life and enjoyed one another's company so much so that in the 1990s through to the 2000s, we started going on geology trips around the Scottish Islands, unfortunately due to my failing mobility we didn't succeed in visiting all of our target islands. Of all the islands we visited Edward's favourite were The Orkney Islands. The things that we found magical on Orkney was the friendliness of the locals, the archaeology, the flora and fauna, and the non-existence H&S in the numerous quarries.

Even when Edward and his wife Judith moved to Ramsgate we continued to meet up for a Chinese when we could; I was still falling for his jokes in 2019. I will miss the talks with him on both hard and soft rock geology and on our grandchildren.

John Stanley, FGS

All of us at FGS wish his wife Judith and their family our sincerest condolences.

News

The dinosaur Thanatotheristes, a tyrannosaur

Article from National Geographic, 12 Feb 2020 by Victoria Jaggard, SCIENCE Executive Editor.

The tyrannosaur, Thanatotheristes - referred to as "reaper of death" - was unveiled as the first new tyrannosaurid found in Canada in the last 50 yrs.

Maya Wei-Haas and Michael Greshko *(both staff of National Geographic)* reported as follows: "the 26-foot-long predator was found by a local family in 2010 and then sat unnoticed for years in Alberta's Royal Tyrrell Museum of Palaeontology. A visiting graduate student (Jared Voris) was touring the collection, noticed something odd about one set of unidentified bones and eventually identified this dinosaur as a relative of Tyrannosaurus rex, an apex predator".

Artist's impression of head of the dinosaur, Thanatotheristes, a tyrannosaur

Tyrannosaurs can look similar, but the newly identified Thanatotheristes has several distinctive features that set it apart from the others, including a set of prominent ridges that run down its snout.

"It's interesting to have the opportunity to name a new species" said Voris.

Summarised for FGS by Liz Aston

Stegosaurus footprints found on Isle of Skye

Grapefruit-sized tracks are first evidence that iconic dinosaurs roamed Scotland

Article from The Guardian, 11 Mar 2020 by Nicola Davis

Grapefruit-sized depressions found in rocks on the Isle of Skye have revealed that a type of stegosaurus once wandered the landscape, researchers say.

The newly discovered tracks form a single line, a few metres long, with a right-left pattern and two different-sized prints – as would be expected for an animal on all fours – with one set larger and triangular-shaped, and the other set smaller and further forwards.

"Those proportions match up quite well to the hands and feet of stegosaurus skeletons," said Dr Stephen Brusatte, a palaeontologist and co-author of the study from the University of Edinburgh. "These footprints are the first evidence we have that this very major, very iconic group of dinosaurs lived in Scotland."

Brusatte added that the dinosaur who made the prints was about the size of a cow, while the prints themselves are the size of a grapefruit or small teapot. The team add that the tracks were found in sedimentary rocks thought to be about 170 million years old, which formed from mudflats that once bordered a lagoon.

The new study, published in the journal *Plos One*, follows previous finds by the team, including tracks which revealed that as well as huge, long-necked plant-eating dinosaurs known as sauropods, Skye was once home to meat-eating dinosaurs, probably theropods.

The team say the new findings expand our understanding of the community of dinosaurs that once roamed the Scottish isle.

"Skye was an island in the middle of the ever-widening Atlantic with this subtropical, wet, humid, hot climate with rivers draining mountains in the middle of the island, emptying out into the ocean; and then beaches and lagoons fringing the coasts

– and these places were havens for dinosaurs" Brusatte said.

The latest finds highlight the importance of re-examining well-known areas, the team noting that one of the sites has been scrutinised by palaeontologists and geologists for decades, yet its secrets remained hidden until a storm shifted some boulders.

Summarised for FGS by Mick Caulfield

Lecture Summary

14 February 2020

A Volcano Valentine's Day – The eruptions of Santorini

Dr Matthew Genge

Dept. Earth Science and Engineering, Royal School of Mines, Imperial College London

Fig. 1: Aerial view of Santorini (from the south) (MacGillivray Freeman Films)

The island of Santorini in the Aegean is a well-known holiday destination. The blue and white Greek buildings adorning the cliff tops of the island are iconic and it is one of the most popular location for weddings in Europe. Most who visit know there is also a volcano, but few realise that the whole archipelago not just the steaming central island are the volcano. Few also know just how young the rocks beneath their feet are when sipping cocktails in Fira - the upper 20 metres of Santorini wasn't there a mere 3,000 years ago.

In this talk about the "Valentine's Volcano" Matt Genge described the tremendous volcanic eruptions that have rocked the island, destroying civilisations and even inspiring the Legend of Atlantis. These eruptions are all recorded in the layers of volcanic rock exposed around the crater.

Matthew Genge

13 December 2019

The Cretaceous World – Living in a greenhouse

Professor Andy Gale

Portsmouth University

Fig. 1: Chalk cliffs (Andy Gale) http://www.paleobiologischekring.org

The epicontinental Chalk Sea occupied a vast region, extending from western Europe to central Asia, and lasted for approximately 40 million years, from the Cenomanian (Cretaceous, 100 Ma) to the end of the Danian (Paleocene, 60 Ma). Its characteristic deposit, nannofossil chalk, is a typical sediment of deep-water ocean basins, not relatively shallow settings.

Why did such a deposit develop and dominate successions for so long? The high sea-level stand and greenhouse of the Late Cretaceous are partly, but not entirely responsible, as are oceanic conditions and locally arid climates. Chalk sedimentation, and subsequent diagenesis, were partly controlled by orbital cyclicity which created the regular rhythmicity so commonly seen in chalks, and for this reason individual beds can extend over great distances.

Bottom currents also played an important role, creating channels and erosion surfaces, sometimes witnessed by hardground formation. Diagenesis beneath the Chalk Sea floor was dominated by the dissolution and reprecipitation of silica and calcium carbonate phases (silica and aragonite), which picked out and augmented the primary climatic cycles. However, the absence of pervasive cementation in chalks is both unusual and difficult to explain – most limestones are hardened.

The demise of the Chalk Sea, and its replacement by clastic sediments in the Selandian, can be related to major palaeoclimatic reorganisation.

Andy Gale

---

8 November 2019

The Black Country – Powerhouse of the Industrial Revolution

Colin Knipe

BSc CEng CGeol MIMMM FGS

Engineering geologist and mining engineer, Principal Consultant and previously Senior Partner of Johnson Poole & Bloomer, geotechnical and environmental engineers.

All figures Colin Knipe.

The 'Black Country' is a fuzzy-edged area west of Birmingham corresponding roughly to the South Staffordshire / North Worcestershire Coalfield, now more conveniently called the Black Country Coalfield. It extends from Wolverhampton to Walsall in the north and Stourbridge to Halesowen at the south and takes in towns such as Willenhall, Wednesfield, West Bromwich and Dudley, the self-proclaimed capital of the Black Country.

In 1868 Elihu Burritt, a widely travelled American diplomat and philanthropist, described the area as 'Black by day and red by night', which 'cannot be matched for vast and varied production by any other place of equal radius on the surface of the earth'. Indeed, the district was so smoky, grimy and derelict looking that Queen Victoria supposedly pulled down the blinds of her railway carriage as she passed through!

The area truly was the Birthplace of the Industrial Revolution. In 1619, Dud Dudley, manager of an ironworks at Pensnett, Dudley, first successfully made iron with coal (at three tons/week). This stimulated the rapid growth of local iron making and associated production of wrought iron goods. Another great leap forward in technology was in 1705 when Abraham Darby the Elder from Woodsetton, Dudley, first produced pig iron in a coke-fired blast furnace and over the next few years developed the technique of making iron and brass castings in sand moulds. Yet another was the installation in 1712 of the world's first successful atmospheric steam engine by Thomas Newcomen to pump water from a mine near Dudley.

The area's remarkable mineral wealth made all this possible. There was an abundance of:

- Coal - providing heat for industrial processes and raising steam, later a source of coke and 'town gas', and of course used for heating homes and other buildings.
- Ironstone - which was converted to pig iron and later to steel.
- Fireclay - made into refractory products, vital for the metal and glass-industry furnaces and crucibles.
- Limestone - roasted to make iron smelting flux, and lime for mortar and agriculture.
- Brick Clay - for high quality engineering bricks etc.
- 'Soft' Sandstone - crushed to make foundry moulding sand.

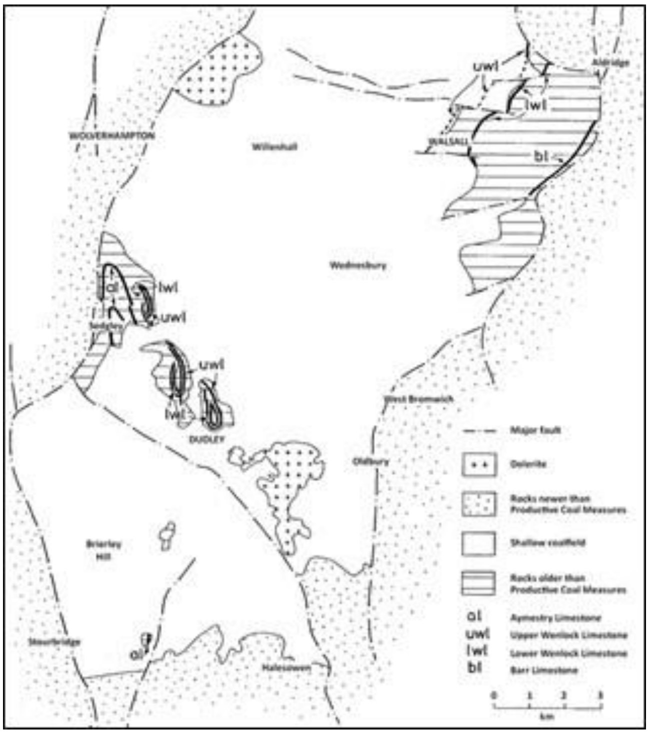


Fig. 1: Geological map of the Black Country

The area of the shallow coalfield is shown on the geological map (Fig 1). It comprises a gentle basin of Coal Measures strata resting unconformably on Silurian, and locally Devonian, rocks. The Coal Measures rise gently at the northeast to crop against Silurian mudstones and limestones around

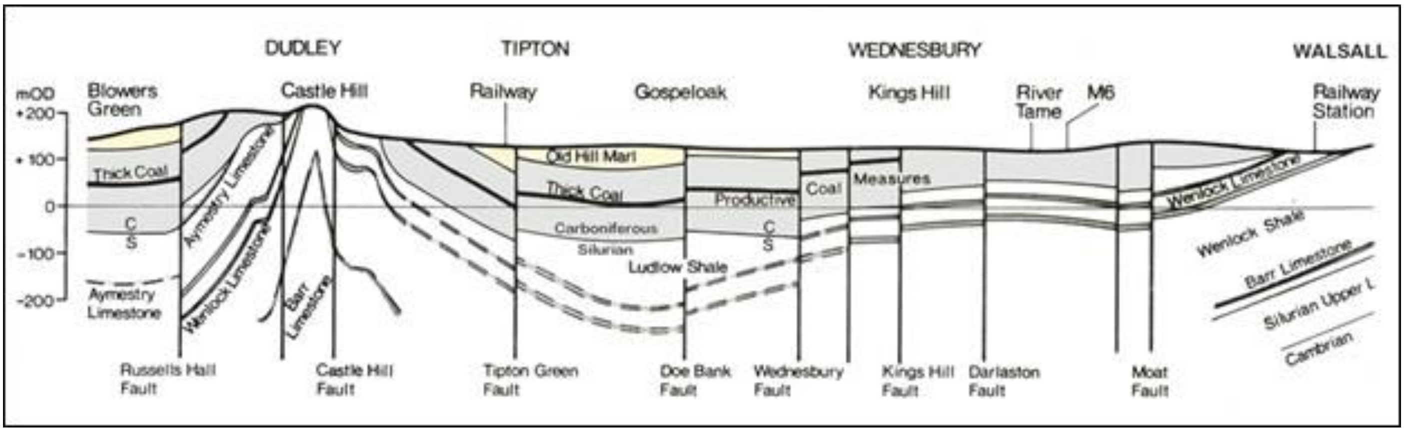


Fig. 2: Geological section, Dudley to Walsall

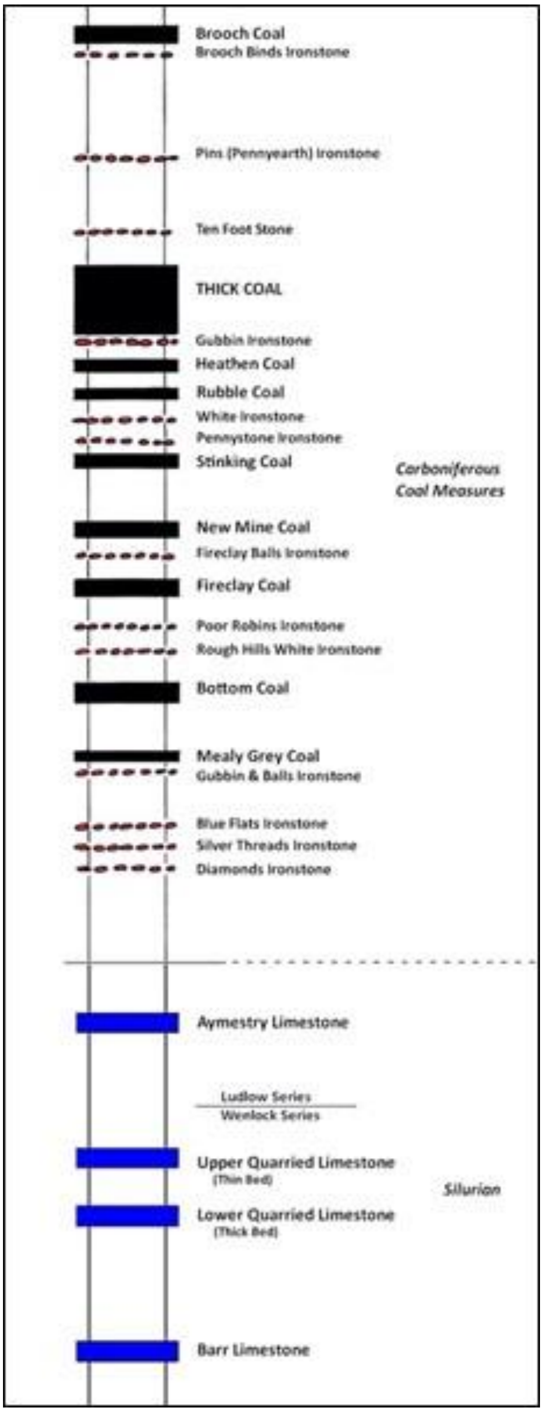


Fig. 3: Principal mineral seams

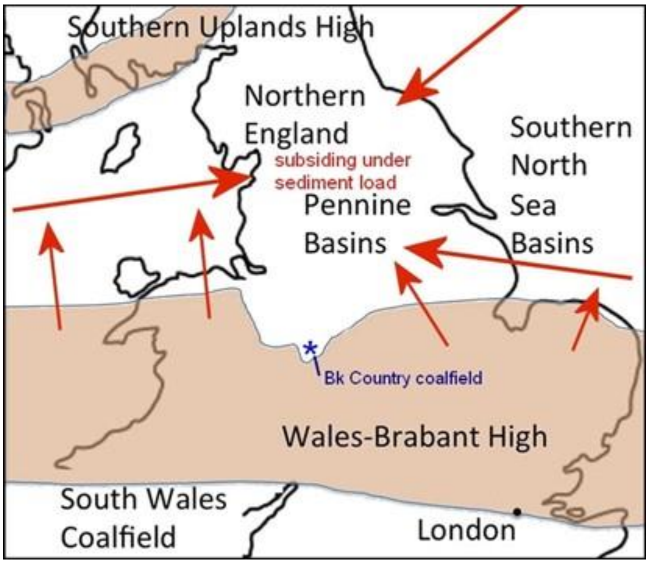


Fig. 4: Upper Carboniferous palaeo-geography

Walsall, but in the Dudley area the Silurian strata are sharply upfolded as periclines which poke through the Coal Measures to form Dudley Castle Hill, Wrens Nest Hill and the ridge of Sedgley Beacon. In a southerly direction the predominantly grey Coal Measures transition into barren red beds, and at the north, beyond the east-west Bentley Faults, the strata thicken but the seams thin and split. At the flanks of the coalfield the Western and Eastern Boundary Faults each have a downthrow of about 400m, throwing red Triassic sandstones against the shallow Coal Measures or Silurian strata.

The geological section from Dudley to Walsall shows that the Productive Coal Measures - those containing most of the mineral seams - have a vertical thickness of no more than about 150m (Fig. 2).

Within this sequence there are eight or nine major coal seams, a dozen important ironstone seams, and, in the lower part in the Stourbridge area, several thick fireclay seams, which together total

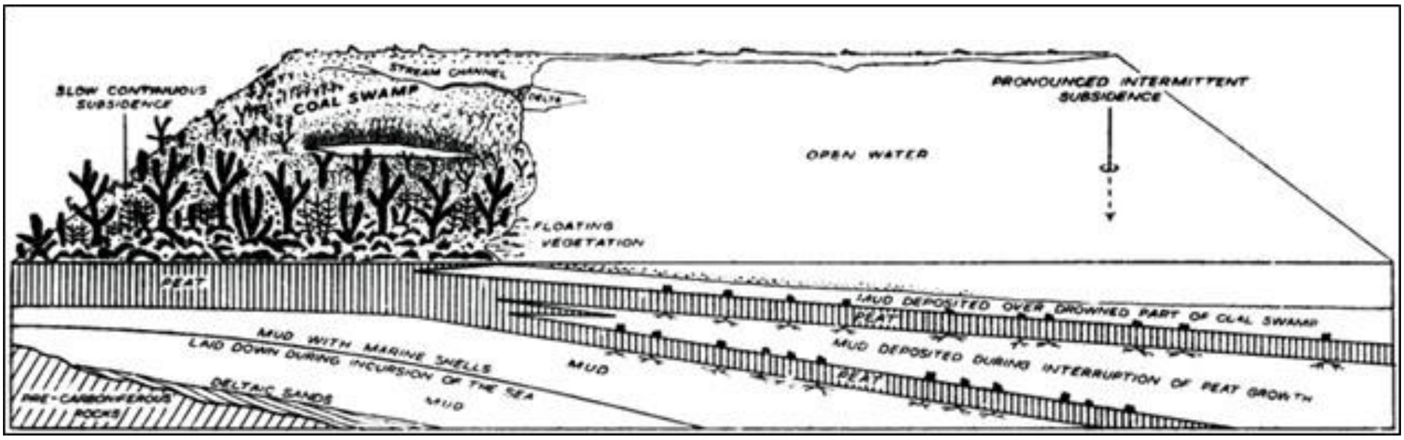


Fig. 5: Effect of slow subsidence near the basin margin

about 25m in thickness. The principal seams are shown on the stratigraphic column (Fig. 3). The coal seams are typically 1m to 2m thick, but the Thick Coal lives up to its name and is generally 7 - 9m, by far the thickest seam in Britain.

The clay ironstones - with 40%-55% ferric oxide content - occur as thin regular seams a few centimetres thick or as layers of nodules or concretions, all in uniform beds of mudstone.

This remarkable 'condensed sequence' of so many thick mineral seams in such a limited vertical thickness of strata is due to the area's unique geographic location in the Upper Carboniferous (Fig. 4).

To the south were the low mountains of the Wales-Brabant Massif and to the north were the subsiding Pennine Basins being filled by deltas carrying sediments washed from the surrounding higher land. The Black Country was right at the margin of the basins, in an embayment in the high ground, an area of swamps and lush tropical vegetation that was only slowly subsiding and was only occasionally inundated by incursions of the sea.

The slow rate of settlement meant that great thicknesses of fallen trees and other vegetation could accumulate before being buried by silt or sand, and eventually to be converted into proportionately thick seams of coal (Fig. 5).

Because there are so many mineral seams in such a relatively small vertical sequence there are many seam outcrops across the Black Country and extensive areas where workable minerals are at shallow depths.

COAL (and Ironstone and Fireclay)

The earliest exploitation of the minerals was quarrying at the seam outcrops ('openworks'), followed by shallow shafts and gin pits (horse-operated windlasses).

As technology advanced so headframes and winding and pumping engines grew as mining got deeper. From the early 19th century there were a few major collieries: the Heath Pits at West Bromwich were briefly the deepest in the world, at 302m, in 1832, and were followed by other major pits on the downthrow side of the Eastern Boundary Fault - Sandwell Park (390m deep), Jubilee (550m), and Hamstead (nearly 600m); and Baggeridge (530m) on the downthrow side of the Western Boundary Fault.

By far the greatest mining activity in terms of number of collieries and shafts was during the period 1750-1850 although the greatest annual production was around 1870 (9M tons). In 1861 there were over 500 active collieries, but by 1961 there were fewer than 200 and in 1942 fewer than 40. The last mines closed in the 1960s: Sandwell Park and Hamstead near West Bromwich, Walsall Wood and Hilton Main near Walsall, and Baggeridge west of Wolverhampton.

The thinner seams - still very thick compared with those in most other coalfields - were mined by one or other of two methods. 'Pillar and Stall' was preferred when the workings were shallow. Intersecting galleries ('stalls') were excavated, leaving a chequerboard pattern of unworked coal pillars to support the roof. Over months or a few years, the roof would tend to fall in, or the pillars would tend to sink into the seatearth floor. The more common alternative was the 'Longwall' method (Fig. 6).

A long working face would be supported by several rows of timber props. As the face advanced so more props were inserted but props further back from the face were withdrawn, allowing the roof to settle onto the floor or onto debris stowed back in the workings. Subsidence was almost immediate. The whole of the worked-out area closed up tightly except for roadways serving the working face which were protected by stone or brick walls or heavy timbers.

Fireclay seams, found mostly in the southwest corner of the coalfield around Stourbridge and west of Dudley, tended to be worked by random galleries because the clay was rather weak, and roadways closed up quickly.

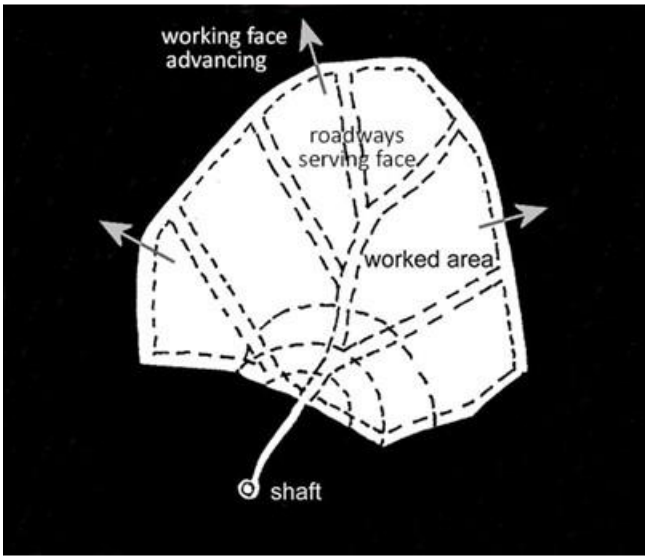


Fig. 6: Longwall method of mining

The Thick Coal ('Ten Yard' Coal) was and is exceptional. During late Victorian times quarrying at the Claycroft openworks near Dudley exposed a 12m high cliff of coal 100m long. The Thick Coal is actually a sandwich of 10 or more individual coal seams, each with their own distinct characteristics:

- Roofs or Rooves - 'a very compact, splintery coal nearly equal to cannel'
- Top Coal - 'the best coal in the measure'
- White Coal - 'a good sound coal but siliceous'
- Tow Coal and Lambs - 'a dull but good coking coal'
- Brazils - 'top and bottom is good square fracturing bright coal; middle is hard dirty coal'
- Foot Coal - 'like bottom part of Brazils'
- Slips - 'more laminated "patchy" coal'
- Stone Coal - 'rather laminated coal, usually contaminated with overlying ironstone'
- Slipper & Sawyer - 'sound hard coal'
- Benches - 'soft open-fracturing coal with siliceous veins'.

The Thick Coal was so thick that underground mining required special techniques and, most often, the same area of seam was worked through on several occasions.

The First Workings in an intact area of coal were mostly in lower half of the seam and of the 'pillar and stall' type, but with a distinct layout known as 'squarework' (Fig. 7). The Thick Coal was very prone to spontaneous combustion so it was worked in self-contained 'sides of work' so that each area could be dammed off with stone and

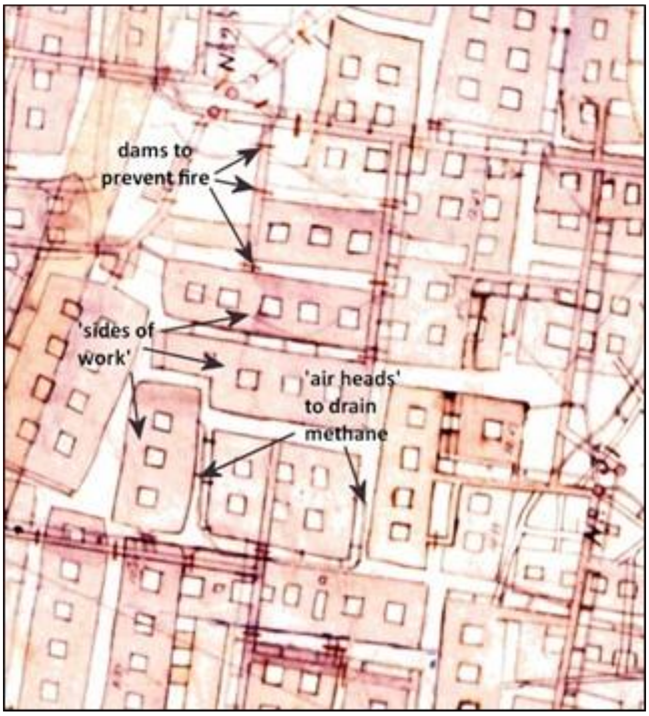


Fig. 7: Thick Coal first workings - 'Squarework'

clay walls to exclude fresh air and contain any heating. The seam was also very 'gassy'. Escapes of methane led to many explosions until James Ryan, pioneer Irish mineral prospector, came to the district in the early 1800s and devised a method of draining the gas by constructing narrow tunnels ('air heads') at high level behind the side walls of the galleries.

Second Workings often followed a few years later, primarily to recover some of the remaining 'ribs and pillars', i.e. solid coal. However, the mined areas still contained much small coal and slack which was not brought to the surface because, until the late 1800s, industrial furnaces only burned lump coal. With a change in furnace technology it then became economic for Third or even 4th and 5th workings in same area of Thick Coal seam to recover slack and broken coal 'pickings'. Despite this intensive mining, there often remains today 4 or 5m thickness of broken coal in place of the original 7 - 9m of intact seam.

Mining caused great subsidence, partly countered by the dumping of mining and industrial spoil to raise ground levels. Extensive districts were lowered by many metres.

Shafts. Intensive mining over more than two centuries left a legacy of old pit shafts. There are approximately 30,000 recorded shafts in the Black Country but without doubt several times more than that are unrecorded; Operators were not required to keep mine plans until 1850 and not obliged to deposit a copy with the Government until 1872, by which time the great majority of local collieries had come and gone. For example, on the site of a recently built college near Wolverhampton, there were four known shafts, but an additional 29 unrecorded shafts were found; however, it took 14,100 boreholes at 1 metre centres to find them! Where the Thick Coal is very shallow there are typically 250 known shafts per sq km.

Most of the old shafts are circular, brick lined, and only 1.5 to 2.0m in diameter, and the majority were backfilled with colliery spoil, boiler ash or other rubbish when they were abandoned but generally not capped or treated. Over time the fill and shaft lining can weaken, leading to the fill sinking or even rushing away into the underground roadways, so there are several subsidence incidents each year. Fortunately, they rarely cause damage to buildings.

Minewater was a major problem. Mining subsidence fractured the strata above the workings, so encouraging rainwater and surface watercourses to drain into the ground and into the mines themselves. The problem became so great that in 1872 a private act of parliament established the South Staffordshire Mines Drainage scheme. This started with the systematic culverting of surface watercourses followed by much improved pumping. The coalfield was divided into 'pounds', relatively self-contained hydrogeological districts mostly separated from their neighbouring pounds by geological faults. The idea was to have a small number of large pumping stations - usually one per pound - which could draw down the water level over a wide area, but still supplemented by pumping at individual pits. A levy of 1d per ton of coal raised from each mine was charged by the Mines Drainage Commission to maintain the pumps and the improved surface drainage. However, as the next few decades passed into the early 20th century, many collieries became exhausted and stopped pumping water. The total production of coal fell sharply so the Commission's revenues similarly fell whilst the pumping load became greater than it could cope with. In consequence groundwater levels rose, many small pits became flooded, and whole districts became impossible to mine.

Today just one pumping station continues but intermittently, operated by the Canal and River Trust to top up the local canals as required. The lack of pumping means that minewater levels have risen so that mine water spills out at the surface at numerous locations, polluting watercourses with ferruginous deposits (ochre) and other metals.

LIMESTONE

Four seams of Silurian limestone were worked in the district. Most of the stone was 'burnt', i.e. calcined, from early times to make lime for lime mortar and agriculture but, vitally for the development of the Industrial Revolution, later for use as a flux in the iron furnaces.

The highest seam in the stratigraphic sequence, the Aymestry Limestone (Ludlovian, late Silurian), and the lowest, the Barr Limestone (Wenlockian, mid Silurian), were mostly worked by surface quarrying around Sedgley and Aldridge. Much more important were the Thin Bed and Thick Bed Wenlock limestones which were quarried at outcrop in the Dudley area up to the 18th century before mining progressing underground. There were extensive underground workings around Dudley (the mines under Wrens Nest Hill and Dudley Castle Hill being very well known), and in the neighbourhood of Tipton, Dudley Port, Wednesbury, Darlaston, central Walsall and Aldridge. Most of the mining took place during the 19th century but continued on a small scale at Hay Head NE of Walsall until the 1930s.

The workings in Dudley, Walsall and Aldridge are relatively shallow - often at only 30m to 50m - and therefore prone to collapse and causing surface crown holes. The deeper mines under the middle of the Black Country in the Wednesbury and Darlaston areas, at a depth of 150m to 200m, were thought to be too deep to pose a threat to surface stability but in 1978 and again in 1988, two major collapses in the Cowpasture Mine near Wednesbury caused by pillar failure resulted in severe surface subsidence. In each case the basin of subsidence was several hundred metres wide and up to 1.2m to 1.5m deep and caused severe structural damage to surface properties. A steel rolling mill and numerous houses had to be demolished and major repairs were required to many industrial premises.

Finally, it is appropriate to mention two mundane but important minerals, **Brick Clay** and **Red Sandstone**.

The Etruria and Halesowen formations of the Upper Coal Measures were a source of superior quality brick clay which made very strong, dense engineering bricks and moulded blocks, red or blue depending on how they were fired. Factories, colliery buildings and many engineering structures as well as upper class houses were made from such bricks.

Red sandstones of the Hopwas, Kidderminster, Wildmoor and Bromsgrove formations - all members of the Sherwood Sandstone Group of Triassic and possibly Upper Permian age - were won from quarries at the east and west flanks of the coalfield and a few miles south in the direction of Bromsgrove. The sandstone was crushed to liberate the sand grains but not washed to retain the clayey matrix. The slightly clayey 'soft' sand, i.e. sand having rounded grains, was ideal for making moulds for ferrous, brass and other metal castings ... a myriad of industrial, domestic and transport products, including items as large as the anchor of the *Titanic*.

---

11 October 2019

Meteorite impact on Skye

Dr Simon Drake

Birkbeck College, University of London

Report by Janet Phillips, FGS Member

This lecture was about an exciting discovery. It was also a heartening story showing how two men, working in the UK, could make an impressive discovery.

Simon was undertaking field work on the Isle of Skye, accompanied by Dr Andy Beard, a research fellow at Birkbeck College. As expected, there was plentiful evidence of a 7Ma volcanic period caused by a mantle plume. This plume is still present under the North Atlantic Igneous Province but has migrated to Iceland. Skye's expanse of basalt is well known. What they spotted was quite unexpected. An exposure with a narrow band of rare shocked minerals: minerals associated with a meteor impact. Yet they knew that there had been no impacts from space in Europe in the mid-Palaeocene.

The discovery came when they were investigating the oldest lavas on the Strathaird peninsula. They noticed two horizontal cracks. Between the cracks was Al-rich, Si-low rock, not an ejector type rock. They knew that this type of shocked mineralogy is associated with meteorites. Could there have been an impact here? Maybe one which started the volcanic eruptions of 61.5 Ma ago?

They moved to a second site near Broadford and found more evidence of impact (Fig. 1). This was followed by hard work testing their samples in the lab. They saw evidence of shearing and planar deformation in the quartz (Fig. 2). They heated zircon and tested with a laser. They found a polymorph, reidite: catho-luminescence was displayed as red lines.

Fig. 1: Dr Simon Drake (with Andy Beard in the foreground) by the meteoritic ejecta layer – Site 2

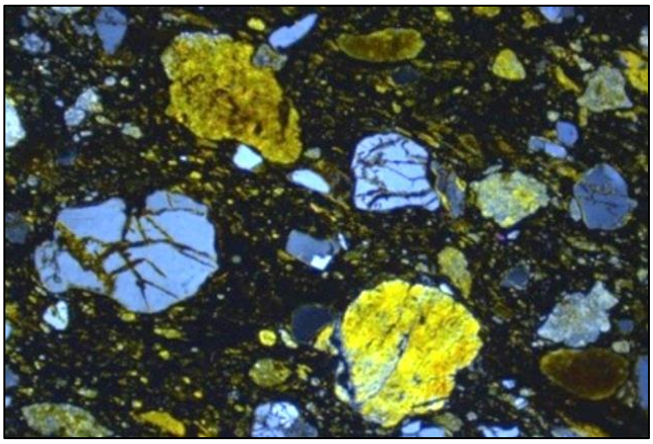


Fig. 2: Thin section of meteoritic ejecta deposit found on Skye.

They used Raman microscopy test with an EMP electron probe. Reidite shock lamellae taken with the correct Raman spectra is evidence of instantaneous shock pressures found only in impact sites.

Further evidence was gathered by the discovery of vanadium-rich osbornite (TiVN) which had been detected only once before: in dust from comet Wild 2. Niobium-rich osbornite, (TiNbN) was also present. This was new: it had never been seen before. The bands are between 25cm and 2.1m in depth.

These compounds are un-melted impact minerals. Only at Chicxulub have such un-melted minerals been recorded. Notably, barringerite $(FeNi)_2P$, a rare phosphide reported from meteorites. There were carbon-bearing native iron spherules, also alabandite (MnS). U-Pb and Ar-Ar radiometric dating was used. All the evidence pointed to a meteor strike.

Site 2 yielded accretionary lapilli, also schreibersite plus silicides. Suevite was found at a third site. In summary, they had found an ejector layer, with shocked zircons and osbonite with no oxygen.

Simon and Andy have continued their investigation in Northern Ireland at Donalds Hill where there is stretched out chert. Reidite was found here, thought at present to be 62.6 Ma. Their findings indicate that the impact area reached Northern Ireland and we are left wondering how much further the area extends.

Postscript: Simon told us a sad tale. His team published their findings and, as required, gave the exact location of the sites. Then an advertisement was spotted online (*see Newspaper article above*) selling rock from the sites - some for £10 a piece, another for £60. The sites on Skye are now much depleted of these rocks.

Photos: Dr Simon Drake.

Reference:

https://pubs.geoscienceworld.org/gsa/geology/article/46/2/171/525169/Discovery-of-a-meteoritic-ejecta-layer-containing

---

24 May 2019

Windfarms as renewable energy

David Shilston

Technical Director for Engineering Geology and Fellow at Atkins*, where he manages and contributes to a wide range of geotechnical and environmental projects.*

Report by Janet Phillips, FGS Member

David surprised us by commenting that 33% of electricity in the UK comes from renewables; in Scotland it is 100%.

Amongst renewables, offshore wind turbines have proved the most productive. His map of England showed the various locations of these 'turbine farms' - a large field off the coast of North Wales, Rampion, off Worthing in the south but the majority of wind farms lie off the east coast of England.

Their placement depends on various considerations, proximity to large populations and industry being important. Existing National Grid infrastructure can reduce the cost.

The geotechnical problems in planning a new field are complex. These massive turbines have to be about 1km apart, are mounted at height on masts which have to be fixed to a robust rock base using a well-designed base. Finding suitable sites requires surveying.

The succession of rocks visible at Whitecliff Bay, Isle of Wight, gave the same succession as existed in the Rampion field. Rampion was further complicated by the remains of the Channel River System; the large river system that had run between UK and France, and was fed by various French and English rivers and which was finally overwhelmed at the end of the last ice age when the London Brabant ridge was cut and the English Channel was formed. Rampion now supplies 1/3 million users with electricity.

Boreholes are expensive and hence ship mounted surveys are used, the resulting information displayed on a map for engineers to utilise. A clever map has been designed showing the stable areas.

This was a most interesting talk sparking many and varied questions from an appreciative audience.

---

14 December 2018

Jungle Volcano – The descent into Nyiragongo

Professor Chris Jackson

Imperial College London

Summarised by Yvonne Brett on behalf of OUGS (London) (reprinted with kind permission), with figures added by Liz Aston, mainly taken from ***Wikipedia****,* **Nyiragongo.com**
http://nyiragongo.com/2002.html and
Volcanic Discovery
https://www.volcanodiscovery.com/nyiragongo.html.

Chris Jackson, who is Professor of Basin Analysis in the Department of Earth Science and Engineering at Imperial college started his lecture with the trailer of the 2017 BBC programme about an expedition to try to aid in the prediction of an eruption of the Nyiragongo volcano (Fig. 1), thus saving lives. There are few places on Earth where a volcano threatens so many people.

Volcanoes though they kill, also give life through the fertility of the lava when it breaks down to soil and hence their slopes are frequently the location of dense farming communities. The less siliceous the lava, the more basaltic and iron-rich it is and the further it flows; hence these low-silica lavas usually flow for miles and thus the farms and communities will be dense and spread out.

Situated in the Virunga National Park, located in the Western branch of the East African Rift Valley near Lake Kivu and the Congolese-Rwandese border, Nyiragongo lies 20km north of the town of Goma which has more than one million inhabitants. It has a permanent lava lake, which has at times been the most voluminous known lava lake (of the 6 known worldwide) in recent history.

Chris showed maps of the area and of the volcano showing that some eruptions come from the summit but others from the flanks. The eruption in January 2002 had pyroclastic flows and lava flows that ran through the middle of Goma killing many people and leaving 200,000 people homeless, with 400,000 people evacuated. It covered the airport runway, destroyed the business centre and went into Lake Kivu. The lava has a very low silica content and thus is very viscous, flowing like water.

Fig. 1: An aerial view of the towering volcanic peak of Mount Nyiragongo. (Photo: MONUSCO/Neil Wetmore, ex Wikipedia)

The volcano is 3,470m high and the team had to abseil down into the crater with all their equipment carrying tents, etc. to place them on the second tier inside. Chris showed films of them doing this despite the obvious difficulty of filming with gas reducing visibility.

The magma is very strange - with only 40% SiO_2, it is the world's largest natural source of CO_2. The lava contains leucites, nephelinites, carbonic acid and volcanic glass. The smell in the crater is like that of an ocean with CO_2 and methane (CH_4) degassing from the lava lake, so that CO_2 monitors were active all the time.

We were left with admiration for the courage and skill of the team, especially in the knowledge that they or others like them would return.

Additional Information by Liz Aston

Nyiragongo is one of the world's most active volcanoes; it is a large stratovolcano with a 1.2 km diameter summit caldera containing the world's most active and largest lava lake. It typically has large effusive eruptions with a persistent lava lake in the summit crater. The lava is extremely fluid and runs like water when the lava lake drains. In 2002, the lava lake drained from fissures on its western flanks. A similar eruption in 1977 exited through openings in its outer flanks, a huge lava flow poured out and killed hundreds of people.

Terraces inside the steep-walled, 1.2-km-wide summit crater mark levels of former lava lakes, which have been observed since the late-19th century.

Nyiragongo volcano eruptions: 1884, 1894, 1898, 1899, 1900, 1901, 1902, 1905, 1906, 1908(?), 1911, 1918, 1920-21, 1927-77, 1977, 1982, 1994-96, 2002 (17 Jan.), 2002-ongoing (lava lake)

Fig. 2: Deep within the lava lake, gas collects into bubbles that rise to its surface where they explode, tearing apart the overlying thin crust and splashing around drops of hot lava. (Photo: Ingrid Smet).

The eruption was preceded months beforehand by increased fracturing and fumarole activity on the upper slopes on the south side of the volcano. There was also an increasing level of seismicity, especially during the first half of January 2002. New fumarole activity was observed in Shaheru crater and from new cracks in the inner walls of the Nyiragongo crater following the 7 October 2001 earthquake.

People fled Goma when lava vents were seen to develop within the city in advance of the main lava flow. The vents were located at two roundabouts, 500m from the end of the airport runway. Lava flows created fires in the commercial centre and there were audible explosions, possibly as cars and petrol stations exploded.

In January 2002, the opening of fissures lower down and directed towards Goma may reflect a new evolution for the volcano with eruptions caused by rifting.

The future hazard for Goma and Lake Kivu is for lava to be erupted from a magma chamber or deep conduit in an extension of the rifting. This type of eruption would be more dangerous than either the 1977 or January 2002 events. Large fissures have developed along the slopes of Mount Nyiragongo, prompting fears that lava and toxic gases could be released and cause even more damage than the last eruption. In 1977, the eruption produced a lava flow which covered 20 km^2, killed 2,000 people, and destroyed 400 houses and a 10-km section of road.

Fig. 3: Image from Google Earth Pro, information from USGS. Image approx. 850 km N-S; 500 km E-W. Yellow lines are political boundaries; long green dashed line is a plate boundary.

Publications:

Allard P., Baxter P., Halbwachs M., Kasareka M., Komorowski J.C., Joron J.L. (2003), The most destructive effusive eruption in modern history: Nyiragongo 2003, Geophysical Research Abstracts, v. 5, 11970

Verhoogen, Jean: Les volcans Virunga et l'éruption du Nyamlagira de 1938 / par J. Verhoogen, S. 326 - 353. (Frankfurt University Library, Germany)

Meyer, André: Study of the Volcano Nyiragongo: a progress report / by Thure G. Sahama and André Meyer. - Bruxelles: Hayez, 1958 (Frankfurt University Library)

Seach, John, Nyiragongo Volcano Eruption 2002; nyiragongo.com