Other countries where fluorite may be found include Italy Switzerland, Norway, the USA, Canada and Eastern Europe. It is a veritably international mineral.

Fluorite exhibits the phenomenon of fluorescence – the flow of visible light – on exposure to ultraviolet light, but relatively weakly. It also has a number of important uses in industry, notably bauxite treatment, glass production, foundry work and the production of hydrofluoric acid (used for etching glass).

Fluorite is a most rewarding subject for collecting as it is readily available, and comes in a huge variety of forms. Most mineral dealers carry large stocks. Rare and choice specimens can fetch hundreds or even thousands of pounds, but most are reasonably priced placing this fascinating, beguiling mineral easily within the reach of most of us.

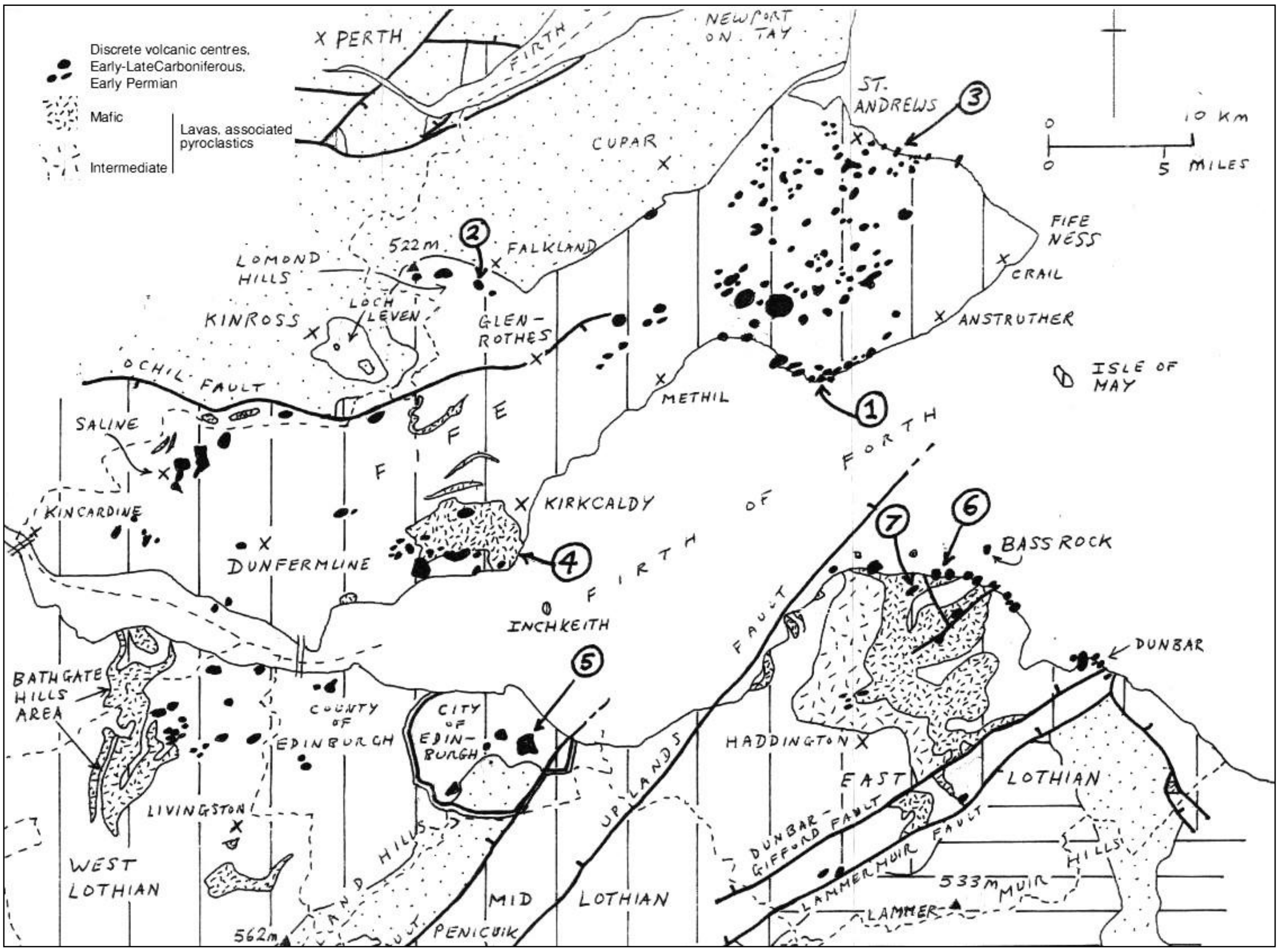
OVER ONE HUNDRED VOLCANIC VENTS: FIFE and LOTHIAN, SCOTLAND

Elizabeth Devon

This four-day field trip was expertly led by Dr. Nicholas Chidlaw in March of this year.

All the black dots you can see on the map are discrete volcanic centres of Early and Late Carboniferous and Early Permian in age. We investigated all the sites numbered 1 to 7 on the map. This article would be very long indeed if I wrote about everything we saw, so I have restricted it to a bit of background and some sites of special interest that show the various stages of the development of tuff-rings. It was hard to decide which to include as the whole trip was fantastic and extremely interesting, made particularly good by Nick's excellent hand-outs, meticulous planning and attention to detail and inexhaustible enthusiasm and patience.

In Early Carboniferous times 359 - 318 Ma (million years ago), crustal stretching began to affect southern Scotland and a developing NE-SW trending fault system released pressure in the Earth's interior, causing numerous eruptions of mafic magma along this line. This was the beginning of volcanism and associated intrusions that continued in Scotland for the next 100 million years,



producing over 6,600 km3 of lavas. Added to this, crustal compression (Variscan Orogeny) took place in Scotland towards the end of the Carboniferous period. A striking number of discrete volcanic centres across East Fife (over 100 recognised), as well as some others elsewhere (e.g. North Berwick in East Lothian) cut through the fold structures in the Carboniferous strata, and are therefore evidently of very Late Carboniferous - Early Permian age (c.299 Ma); they often contain small mafic intrusions that have been dated from around this time. The cluster of vents along a NE-SW line at and near Elie (see map) strongly suggests eruptions along a fault line.

Some of the volcanic areas we were studying are 'tuff rings' (also called 'maars').

The following summarises the 6-stage development of these tuff-rings:-

Stage 1: Crustal stretching caused pressure to be released and hot magma to rise up rapidly and locally into the crust. These discrete areas of hot magma caused thermal arching of the overlying strata. The sedimentary layers were heated and cracked; this could occur up to 1 km depth. Hot pressurised gases mixed with some magma rose upwards into these cracks and created spaces. Some of the bedrock was brecciated and disintegrated during this process, especially soft shales. The mixture of magma and breccia consolidated to form a rock called 'Tuffisite'. The cracks and spaces were known as 'cryptovents' and may be up to a metre or so in width. Photo 1 shows a cryptovent containing a lot of dark shaley material intruding the pre-volcanic, domed sandstone strata.

Photo 1: Cryptovent near Elie Ness Neck

This photo is Nick's from 2009. The cryptovent was covered in seaweed when we were there!

Stage 2: The arched strata collapsed into the hot rising magma. Lake and swamp water on the surface drained into the collapse, and groundwater in the strata was drawn towards the magma.

Stage 3: This collapse caused a violent explosion of Surtseyan-type - a phreato-magmatic eruption occurred when the water hit the magma. This produced an enormous amount of pyroclastics *(Photo 2).*

This photo shows a large block of tuff with cross bedding which must have formed when the volcanic material was deposited. It was then blown out of the volcano again and incorporated in another tuff deposit. The tuff here contains xenocrysts of pyrope garnets known locally as 'Elie Rubies', and zircons. These date at about 317 Ma. Xenoliths of ultramafic rocks and gneiss can also be found in the Elie Ness Neck. Some pre-volcanic sedimentary rock has become re-deposited in the tuff; shaley material giving dark layers, quartz sand, limestone pebbles and wood fragments which now form calcite-veined coal.

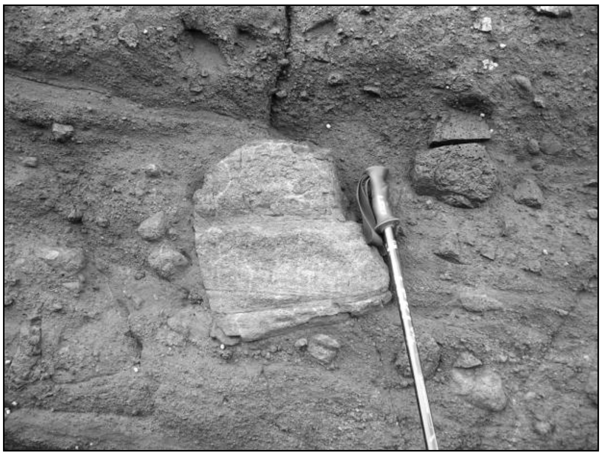


Photo 2: Pyroclastics, Elie Ness Neck

Stage 4: The tuff-ring was formed when the pyroclastics landed. They were shallow in height and could be several km wide. There may have been repeated eruptions and there may have been debris flows (landslides) on the sides of the cone *(Photo 3).*

Photo 3: Debris flow, Partan Craig Vent, North Berwick

Stage 5: This is the extinction stage, when the pipe filled with lava or brecciated lava. In the crater a freshwater lake may have formed, in which sediments accumulated.

Stage 6: Finally, thermal collapse occurred when magma had gone from the area - many faults formed and all dips became inwards towards the centre. We could work out where the edges of some of the vents were by studying the varying dip angles. Photo 4 shows the view south from the Fife coastal path within the Elie Ness Neck. The curve of the bedded tuffs dipping inwards towards the

Photo 4: Bedded tuffs dipping towards the centre of the Elie Ness Neck

centre of the neck can be seen clearly, about 35° to the west (right). There are often huge blocks of sedimentary rocks caught in these collapses. They were there before the eruption happened. A good example is the large block of sandstone in the Elie Harbour Neck.

We looked at lots of features associated with this volcanism, including feeder pipes, dykes and sills. South of the Kinkell Ness Vent you can find the Rock and Spindle *(Photo 5).* Both are parts of a local feeder pipe within the Kinkell Ness volcano. The Spindle shows wonderful radiating columnar jointing in the basalt lava.

Photo 5: Rock and Spindle, within the southern part of Kinkell Ness Vent

At Kinghorn, we studied the lavas along the coast. Photo 6 shows weathered pillow lavas picked out by calcite. Also at this site, you can find pillow lavas at the top with hyaloclastite beneath. This unit is 35-40m thick and the pillows are up to 1m across with paler green chilled margins. Hyaloclastite is a hydrated tuff-like breccia rich in volcanic glass formed during volcanic eruptions under water. The fragments are angular and flat - 1mm to a few cm. Fragmentation occurs by the force of volcanic explosion or by thermal shock due to rapid cooling. The top of the pillow/hyaloclastite unit is gradational (5-10m) into an overlying basalt lava c20m thick; lenses and sheets of amygdaloidal basalt appear at the base of this transition zone, increasing in number upwards.

Photo 6: weathered pillow lavas picked out by calcite, Kinghorn coast lavas

I shall have to save the details from the day we spent investigating the Arthur’s Seat Volcanic Formation in Holyrood Park in Edinburgh for another occasion. We clambered over much of the area and wondered what it must have been like here in Early Carboniferous times. There are at least three volcanic vents here and thirteen lava flows have been identified. The area was active for millions and millions of years. You can identify laterite soils which developed during periods of quiescence and it is believed that the Arthur's Seat Volcano, represented now by a dolerite/basalt plug surrounded by volcanic agglomerate, was at least 5km in diameter and at least 1000m high.

This field trip was fantastic. If you have a chance to join any of Nick's trips, then do so! I have taken GPS co-ordinates of all the sites so please ask me if you would like them. I have also finally finished writing up the notes and incorporating all the photos - 3 months later. All this is available on request.

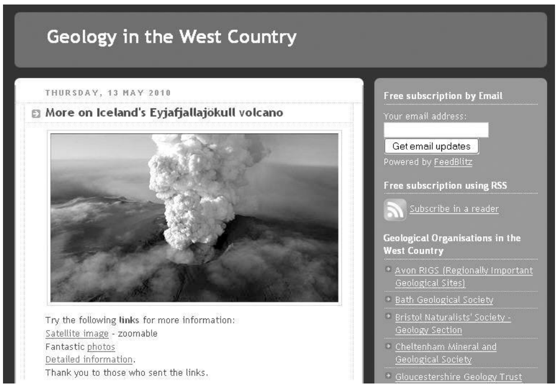
Acknowledgements:
Considerable help from Nick Chidlaw

Field trip area - Fife and Lothian

1. Volcanic Necks at Elie
2. East Lomond sub-volcanic plug
3. Kinkell Ness Vent
4. Kinghorn coast lavas
5. Arthur's Seat Volcano
6. North Berwick volcanic vents
7. North Berwick Law sub-volcanic plug

INTERESTED IN OUR LOCAL ROCKS AND LANDSCAPES?

Click on to
http://geologywestcountry.blogspot.com



There are links to

- all local geological organisations,
- museums with geological displays
- geology in education

THE DINOS THAT 'LIVED LIKE A COUCH POTATO'

From the METRO free newspaper

By Ross McGuiness

Some dinosaurs grew to such a huge size because they were the 'couch potatoes' of the prehistoric world, a zoologist has claimed.

Far from the gnashing teeth and rampages seen in films such as Jurassic Park, many apparently enjoyed a sedentary lifestyle.

That, combined with a plentiful supply of food, helped them to grow to such a scale, said Dr Brian McNab.

Dr McNab's finding emerged after he developed a model to explain the body size of existing and extinct mammals, ranging from baleen whales and elephants to an ancient rhinoceros.

'Some dinosaurs reached masses that were at least eight times those of the largest, ecologically equivalent terrestrial mammals,' he said.

The model also shed light on the creatures' body temperature, according to the report published in Proceedings of the National Academy of Sciences.

Dinosaurs were neither cold nor warm-blooded, said Dr McNab, but 'maintained an intermediate temperature' instead.