3. Shelly Limestone
This yellow-coloured rock was formed by an accumulation of shells of the mollusc (bivalve) *Naiadites*, now fossilised in a limestone.

Carboniferous. 340 million years. Strathclyde Group
Randerston beach, Kingsbarns [NO 615112]

4. Andesite
This fine-grained hard black rock erupted as lava when Scotland was volcanically active. Because the lava cooled quickly, the crystals which formed are very small. It formed from a molten rock (magma) rich in iron and magnesium. When crushed andesite is used commercially for road building and railway ballast. In the past it was cut into blocks and used locally for building houses and for making paving stones for the streets of London.

Devonian. 390 million years
Arbuthnott Group, Gedinnian Stage
Clatchard Craig Quarry, Newburgh [NO 243178]

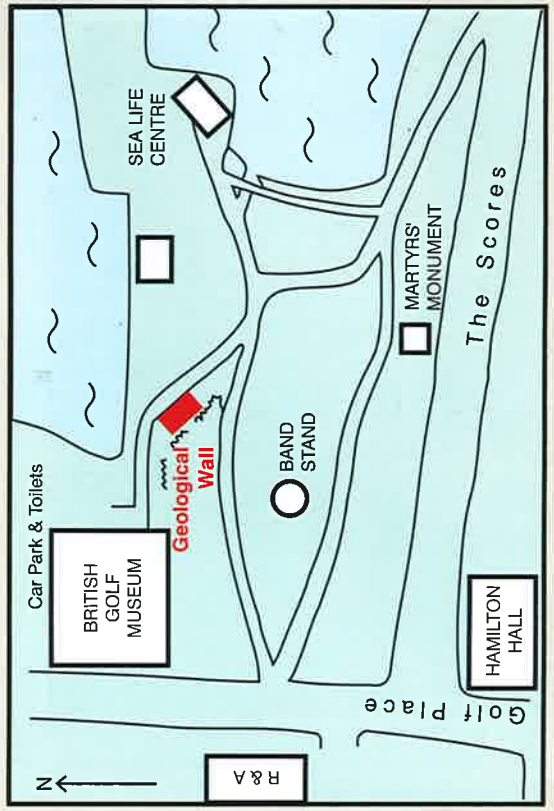
5. Crinoidal Limestone
This pale grey limestone contains disk-like segments of crinoids, relatives of the sea-lily which lived on the floor of a warm sea. This limestone was burned to make lime for the building and agricultural industries.

Carboniferous. 330 million years
Lower Limestone Group
Charlestown [NT 066838]

6. Fossil Tree Root
Britain's vast coal reserves, which fuelled the Industrial Revolution, were formed from the decayed remains of tropical forests. Among the trees in these forests were giant clubmosses, called *Lepidodendron*, which grew up to 35m high. However it is their roots which are more commonly preserved, as in this example called *Stigmaria*. The small round dimples mark where rootlets emerged from the main root. Clubmosses are represented today by the small water-loving, creeping Stag's Horn moss.

Carboniferous. 340 million years
Strathclyde Group
Crail [NO 6107]

LOCATION MAP



The St Andrews Geological Heritage Project (now geoHeritage Fife) was set up in 2000 to promote the geological heritage of St Andrews and East Fife.

If you would like to join as a Friend, or would like to receive more information:

Tel: 01334 828623

Printed by West Port Print & Design Ltd., St Andrews • Tel 01334 477135

Geology of Fife

A Geological Record in Stone

The geological wall at St. Andrews represents 400 million years of Fife's history.

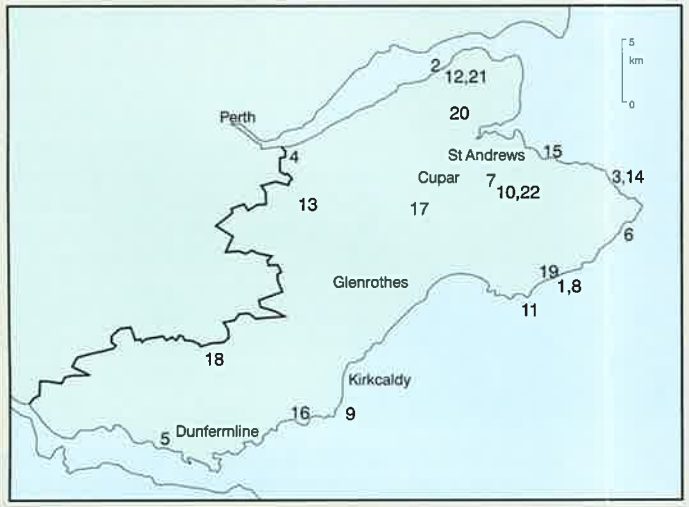
See for yourself the evidence for deserts, volcanic eruptions, coral reefs and tropical swamps.

Why a stone wall?

In order to increase awareness of Fife's rich geological heritage, in 2000 a group of local people set up the **St Andrews Geological Heritage Project**.

One project was the construction of a wall in St. Andrews containing 22 rocks collected from all over Fife. Their locations are shown on the map below.

Map of Fife showing location of rocks



- Each rock has a story to tell about its origin and the environment of its formation.
- Take some time to look closely at each rock.
- You may recognise some in the buildings of St. Andrews or in your travels through Fife.

GEOLOGICAL WALL (FRONT)

1. Rootlets in Sandstone
Dark, string-like marks represent fossil plant roots which have now altered to coal. This sandstone represents a former sandy soil on which grew the lush tropical forests that gave rise to Fife's reserves of coal.

Carboniferous, 330 million years
Lower Limestone Formation
East beach, St. Monans [NO 530017]

NOTE: The figures enclosed in square brackets eg. [NO 530017] represent the UK Ordnance Survey grid reference for the source locality.

2. Vesicular Andesite
When lava erupts on the surface of the earth, it often contains gas bubbles, which tend to concentrate in the upper part of the lava flow. After the lava has solidified, the gas bubbles may become filled with minerals, occasionally forming beautiful agates. In this example silicon dioxide (silica) lined some bubbles to form red chalcedony, and some silica crystallised as amethyst.
A larger red agate can be seen in a stone below this one, just above the ground.

Devonian. 390 million years
Arbuthnott Group, Gedinnian Stage
Wormit shore [NO 3926]

7. Quartz Dolerite
This dark, coarse-grained igneous rock contains the mineral quartz. It is younger than the olivine dolerite (10) and represents a waning phase of igneous activity at the end of the Carboniferous period. This magma was intruded into the earth's crust as widespread sheets and is found in many parts of Fife where it forms the Midland Valley Sill. Note the rusty weathered surface that is typical of this rock.

Late Carboniferous. 296 million years
Stephanian
Blebo, near Pitscottie [NO 423137]

8. Dolomitised Limestone
An original band of limestone has been altered by magnesium-rich fluids which caused the minerals to re-crystallise as dolomite. The rock is now yellow (due to traces of iron) and is very hard.

Carboniferous. 330 million years
Kinniny Limestone, Lower Limestone Formation
East beach, St. Monans [NO 52950165]

9. Coral Limestone
This grey limestone contains fossil colonies of the coral *Siphonodendron*. Since we know that most corals today live in warm seas, we infer that this rock was formed when this part of Scotland lay close to the equator. This and other local limestones were burned in a nearby kiln during the 19th Century to produce lime for the building and agricultural industries.

Carboniferous. 330 million years
Blackhall Limestone, Lower Limestone Formation
Kinghorn [NT 276877]

10. Olivine Dolerite
This dark rock, rich in iron and magnesium minerals, is also a product of magma which cooled and solidified underground to form a sheet or sill. Being buried, the magma cooled more slowly than lava erupted on the earth's surface, and consequently larger crystals grew. If you look very closely at this rock you may spot small greenish-yellow crystals of the magnesium and iron silicate mineral olivine, which in the jewellery trade is known as peridot.

Late Carboniferous. ca. 300 million years
Stephanian
Drumcarrow Craig, Denhead [NO 46001312]

11. Volcanic Ash (Tuff)
There are over 100 volcanic vents in East Fife and this rock is an example of volcanic ash which was thrown out of an erupting volcano. Traces of rare minerals (zircon and garnet) indicate that some of this material originated from about 30km deep and was ejected rapidly as a gas-rich slurry. Some of the ash deposits around Elie are layered, showing that the volcanoes erupted in or near water.

late Carboniferous - early Permian. 289 million years
Elie Ness, Elie [NT 500996]

12. Volcanic Conglomerate
The mixture of coarse and fine grains indicate that this rock was formed in fast-moving water capable of moving large cobbles. These cobbles were eroded from the nearby andesite lavas (2).

Devonian. 390 million years
Arbuthnott Group, Gedinnian Stage
Wormit shore [NO 395264]

13. Red Devonian Sandstone
This red sandstone is made from rounded grains of sand which were shaped by the action of wind. The red colour is caused by a thin layer of iron oxide (the mineral haematite) on the sand grain. The conclusion is that this sandstone was formed in a desert environment before the later Carboniferous swamps developed.

Devonian. 370 million years
Fammenian Stage (Stratheden Group)
Gateside, nr. Auchtermuchty [NO 1909]

14. Algal Limestone (Stromatolite)
This unusual rock contains spherical structures formed by mats of algae trapping sediment and being rolled around on an ancient beach. Similar structures form today in very salty waters on the coast of Australia, where living forms of blue-green algae (cyanobacteria) trap sand and form hummocks called *stromatolites*.

Carboniferous. 340 million years
Strathclyde Group
Randerston beach, Kingsbarns [NO 615112]

15. Rippled Sandstone
The rippled surface on this sandstone was created by the action of waves on sand. Ripples form today on sandy beaches so this rock probably represents the rippled surface of an ancient beach.

Carboniferous. 340 million years
Strathclyde Group
Kinkell shore, St. Andrews [NO 523158]

16. Oil Shale
This dark-brown shale was formed from mud that accumulated at the bottom of a lake or lagoon. The mud was rich in algae which eventually broke down to form hydrocarbons. In the 19th Century oil shale was distilled at the Binnend Works at Burntisland, to produce oil, paraffins and waxes for industrial and domestic use. It could yield between 70 and 200 litres of oil per tonne of shale.

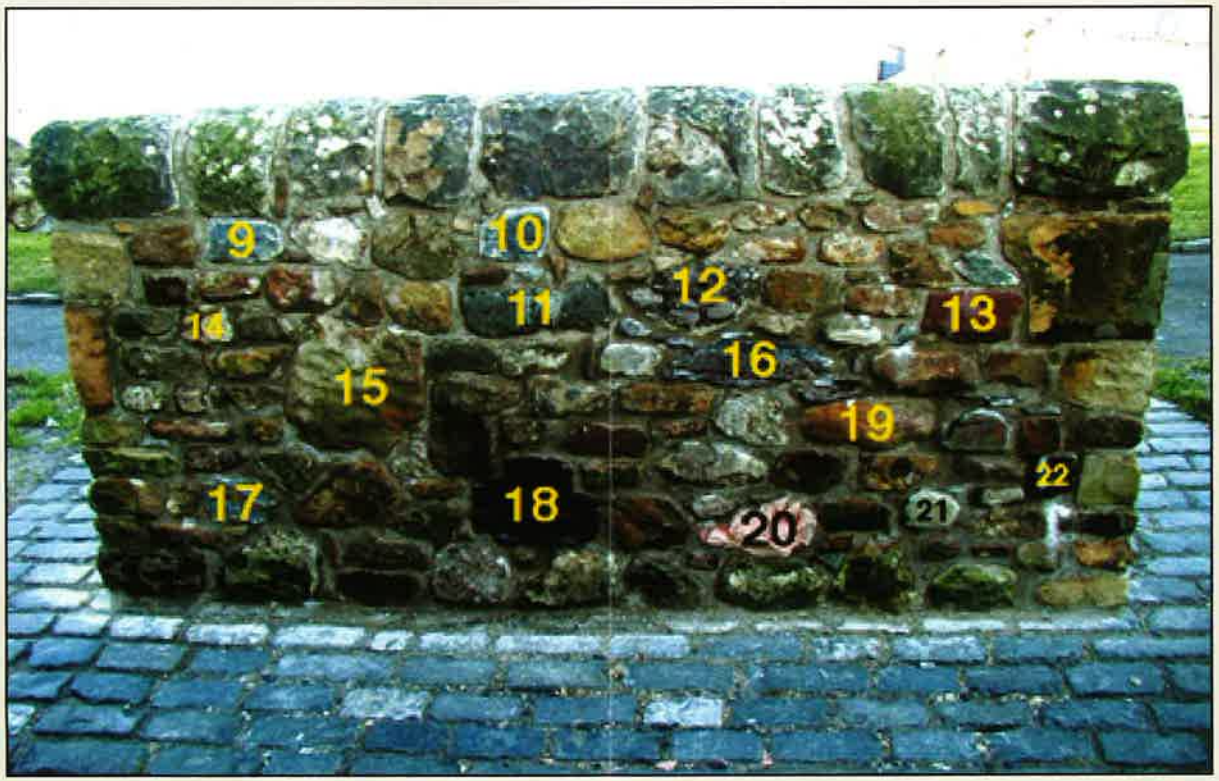
Carboniferous. 335 million years
Strathclyde Group
The Binn, Burntisland [NT 24158705]

17. Massive Limestone
This grey limestone has few visible fossils in it. It has been mined and quarried in the Cults area for the production of lime for over 300 years. An early record exists of Cults lime being used in the late 17th Century when the chapel of St Salvator's College at St. Andrews was being renovated.

The then provost, Dr. Alexander Skene, wrote:
"In 1685, 3 bolls of whitening limne from Pitlessie; £3".
"Pay'd to James Jafrey in Kirktown of Quhilts, for limne-stone from Pitlessie in the year 1687; £19-16s 0d".
These prices are in pounds SCOTS, where £1 SCOTS = 1s 8d ENGLISH sterling.

Carboniferous. 330 million years
Blackhall Limestone, Lower Limestone Formation
Cults Hill, Cults, near Cupar [NO 345085]

GEOLOGICAL WALL
(REAR)



18. Coal
No collection of Fife's rocks would be complete without a piece of coal. The earliest record of coal mining in Fife tells of the monks of Dunfermline Abbey digging coal from Pittencrieff Glen in the 12th century.

It was coal which fuelled the Industrial Revolution in Britain, and powered Fife's economy in the 19th and 20th centuries. Coal formed from the decayed remains of tropical forests and swamps which flourished in the Carboniferous period when this part of the country lay close to the equator.

Carboniferous. 320 million years
Limestone Coal Formation
Blairenbathie, Kelty [NT 123940]

19. Cross-bedded Sandstone
This is a cross-section of a rippled, brownish sandstone. The criss-cross patterns are caused by the accumulations of ripples on ripples over many years. Since they were not removed by later wave action, the ancient beach on which they formed was probably slowly subsiding.

Carboniferous. 330 million years
Lower Limestone Formation
East beach, St Monans [NO 529017]

20. Felsite
This salmon-pink coloured rock contains less iron and magnesium, and more silicon and potassium than andesite (4). It forced its way up through the earth's crust in molten form and punched a hole through the previously erupted andesite. Because of its distinctive colour, the crushed rock is used for footpaths and special lanes on roads. It is also used for railway ballast and some buildings in Balmullo have been built with it.

Devonian. 390 million years.
Arbuthnott Group, Gedinnian Stage
Lucklaw Hill Quarry, Balmullo [NO 419213]

21. Highland schist
This rock is the odd-one-out.

It didn't form originally within the area of Fife, but hitched a ride on a glacier from the Scottish Highlands down the Tay valley between 26000 and 14000 years ago. When the ice melted, this boulder fell out near Wormit. It has many tight, crinkly bands in it, suggesting that it has been deformed. It is called a schist, which is a metamorphic rock.
("Metamorphosis" means "change of form").

? Dalradian. ca. 470 million years
Wormit shore [NO 3926]

22. Columnar basalt
When a magma cools in shallow sheets close to the earth's surface, it contracts slightly and often develops cracks perpendicular to the cooling surface.These forces tend to produce 4-, 5- or 6-sided polygonal columns. This column has five sides. It is part of the same intrusion as rock 10 and has the same chemical composition but because it cooled relatively quickly, it has very small crystals and is called a basalt.

Late Carboniferous. ca. 300 million years
Stephanian
Drumcarrow Craig, Denhead [NO 460131]