

## **CASE STUDY: The Impact of Igneous Intrusions on the Landscape**

### **ISLE OF ARRAN**

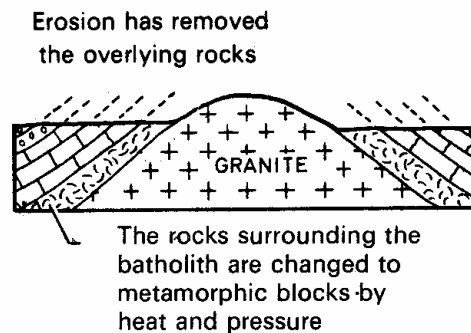
Almost half of Arran is made up of igneous rocks, including granites and lavas. These rocks are 60 million years old and date back to a period when the coast of NW Britain was joined to North America and Greenland. Along the west coast of Scotland the continental crust was stretched and thinned and magma exploited points of weakness, forcing magma to the surface. As well as volcanic extrusions, some magma did not reach the surface and was injected in to the crust as igneous intrusions.

#### **North Arran – Batholith formation**

The hills of Northern Arran are made up of two intrusions of granite (earlier coarse grained granite and a later finer grained granite).

##### **Formation of Granite Intrusion**

Around 55 million years ago (during the tertiary era) an up thrust of magma pushed its way into the sedimentary rocks of Arran forming the Northern Granite. The forces of the intrusion caused the sedimentary rocks into which the magma was intruded to arch up some 3000 metres. As the magma and solidified it formed a large shaped batholith. The layer of sedimentary rocks surrounding batholith was metamorphosed by and pressure of intrusion into Over time weathering and erosion have removed the overlying rocks the granite batholith below.



cooled dome-  
the heat schists. processes to expose

Source:

Bunnett: Physical Geography in Diagrams (1973)

##### **Impact on Arran's Landscape**

As the granite is harder and more resistant to erosion than the surrounding sedimentary rocks, it stands up as higher ground forming Arran's northern hills and mountains. Further erosion and chemical weathering of joints in the granite (cracks formed during the cooling and shrinking of the rock) has given rise to Arran's rugged highland scenery. (Note: this has led to the formation of distinctive granite features such as tors – see notes on impact of weathering on the landscape).

#### **Southern Arran: Sills and the Landscape**

##### **Formation of Arran's sills**

Sills are formed when igneous rock is intruded between the bedding planes of sedimentary rocks. As the magmatic intrusion cools and shrinks it forms vertical joints (columnar jointing). In southern Arran, many sills, (some dolerite rock, some felsite) were formed in the red sandstones.

##### **Impact of Sills on Arran's Landscape**

### ***The Hills of Southern Arran***

The sills in Southern Arran are normally inclined rather than horizontal due to tilting of Arran's rock by earth movements. As the sills are usually harder than the rocks into which they have been intruded, they have been exposed as the weaker sedimentary rocks have been weathered and eroded. These now dominate much of the landscape and most of the hills in Southern Arran are formed of the harder sill rocks.

### ***Coastal Cliffs***

The exposure of sills has also created coastal cliffs (e.g. Drumadoon Point) and the columnar characteristics of the joints can clearly be seen.

### ***Waterfalls***

Where rivers have crossed sills, as the harder rock is not eroded as rapidly as the sedimentary rock, a step in the landscape is formed over which the water will flow as a waterfall. (Glen Ashdale has a staircase of waterfalls formed where a stream has crossed a sequence of sills.)

## **Southern Arran: Dykes and the Landscape**

### **Formation of Dykes**

During the opening of the Atlantic Ocean, the land, including Arran was stretched which resulted in cracks running North-South through which magma was intruded into the crust. The magma solidified underground in the vertical cracks, forming Dykes which cut across the sedimentary rocks. In contrast to sills, as dykes are vertical intrusions, as the rock cooled and shrank horizontal joints were formed. Many of Arran's dykes radiate from the batholith intrusion.

### **Impact of Dykes on Arran's Landscape**

#### ***Southern Coastline***

As the dykes are formed of rocks that in most cases are harder than the surrounding sandstone, along the south coast of Arran, where they have been worn down by erosion they stand a little above the surrounding sandstones. Some form natural breakwaters, trapping sand and forming little beaches between them (separated by the line of the dyke) e.g. Kildonan Shore, Arran.

#### ***Northern Landscape***

Where dykes cut through the granite intrusion, it is the dykes that have been worn away to form lower ground as the granite is the more resistant rock. Small gorges have formed where rivers have worn the dyke away and waterfalls and pools result. Where a dyke has cut across the mountain ridge on the north side of Glen Sannox, a v-shaped gash has been formed as the dyke has been eroded, this is known as the Witch's Step.

### **Sources:**

- An Introduction to the Isle of Arran (Mike Lewis)  
<http://www.brixworth.demon.co.uk/geography/arran.html>)
- Arran and the Clyde Islands (Scottish Natural Heritage BGS)
- Waugh, D. Geography: An Integrated Approach.