
Four Good Eyes
Raised Beaches and Dropped Stones

Four Good Eyes

Raised Beaches and Dropped Stones

An Art & Geology Project on Fogo Island

More than a Hammer

or: How the project came into being

by Rona Rangsch

The idea of combining art and geology on Fogo isn't very far-fetched given the nature of the island. Other artists visiting the island have included geological aspects in their work. The Shorefast Foundation's *Geology at the Edge* programme may have triggered earlier geology-inspired artwork; it definitely has triggered the work presented here.

I was busy on Fogo Island with a different project when I first learned about the local geology programme, and having a background in natural sciences I loved the idea of joining forces with a geologist to look on the island's features with not only two but four good eyes and develop a body of work at the intersection of science and art.
Geology at the Edge director Paul Dean demonstrated personal intuition when he introduced me to his friend and colleague Jack Botsford, who is not only a geologist but also an experienced printmaker. Jack and I started brainstorming on geology and art immediately, and we soon came up with a number of ideas bearing an overlap and/or a mutual inspiration of the disciplines. But we couldn't – and probably didn't want to – narrow down our spectrum to a single concept at that time. We were thus more than happy when Paul arranged for a joint stay on Fogo Island in summer 2016 which would give us the opportunity to start an actual collaboration on site.

When Jack and I arrived on Fogo Island our first approach to a joint project was extended hikes all over the island where Jack introduced me to the island's geology as well as to some basic geological field methodology. That was exciting as I saw the landscape I had previously walked over with new eyes, and soon we started to have our first geological discussions in the field.

Then came the day when Jack asked me to stand in the photo he was going to take of a geological feature. At first I didn't realize that he didn't need me as an attractive accessory to the setting but as a scale instead. When he asked me again I thought that I could actually be more than the hammer, book or backpack he usually uses to add a scale to his geological images and started to play with my limbs. The next step was to try and express some of the geological information the image was meant to illustrate by means of my body. This is when I really overcame the status of a hammer or a backpack and when we started to develop a body-based geological sign language for a variety of geological formations specific for Fogo Island.

An Introduction to Fogo Island Geology

The geological setting of the project

by Jack Botsford

Fogo Island is situated off the northeast coast of the island of Newfoundland. It was a centre of fishing activity for centuries and fishing is still the main livelihood on the island. Excellent coastal exposures of bedrock geology facilitate interpretation of the complex geology.

From a regional geological perspective, Fogo Island is situated within the northern Appalachian Mountain chain, and records one part of the closure of the ancient Iapetus Ocean. Most of the island is underlain by plutonic, or intrusive rocks that are not well dated, but have yielded U-Pb ages of between roughly 410 and 420 million years (Ma.) before present, corresponding to late Silurian to Devonian.

Along the western shore of Fogo Island these rocks clearly intrude a sedimentary sequence. This sequence extends from the southern-most part of the island and continues (on the northern side of the intrusion) to the vicinity of the village of Fogo itself. No fossil evidence of the age of these rocks has been discovered, but based upon regional relationships, they are believed to be Silurian. This sequence is capped by a volcanic formation which is most prominent on Brimstone Head, near the village of Fogo. The nature of the contact between the volcanic rocks and underlying sedimentary sequence is still under debate.

1) Igneous Intrusives

In general, igneous rocks have crystallized at some depth below the earth's surface from molten magma. One of the most familiar igneous rocks is granite, which is commonly composed of the minerals quartz, feldspar and mica. Granites are commonly light in colour (felsic) and may be shades of pink or grey. Compositionally, from granite at one end, there is a spectrum of igneous rocks containing higher percentages of darker and heavier minerals, often more magnesium and iron-rich, that make the resulting rock types progressively more mafic. This spectrum, progressively darker, ranges through diorite, which contains sodium-rich feldspars and amphibole minerals, but little quartz, through gabbro, which is dominated by dark minerals of the pyroxene group, to peridotite which comprises pyroxenes and olivine. The darkest and heaviest of these rock types are believed to have formed deep in the Earth's crust, and are often termed ultramafic.
On Fogo Island, there is a complex relationship among these rock types often providing conflicting evidence about intrusive relationships, timing and age. The igneous rocks of Fogo Island intruded into the sedimentary sequence, forming intrusive dykes and often tearing off and incorporating pieces of the sedimentary sequence into the then-molten magma. These range in size from boulder-size pieces to huge rafts, many tens of meters in size. As the granite cooled these were subsequently frozen in place as xenoliths. Locally, this intrusion of the granite was accompanied by folding of the sedimentary host rock.

2) Sedimentary sequence and overlying volcanics

This sequence, on the western side of the island has been termed the Fogo Harbour Formation. It is tilted at about 40 degrees northnorthwestward and may represent as much as 1.5 km of accumulated sedimentary rock. While no fossils have yet been found, it is currently regarded as Silurian because of the intrusive relationship with the granite. The sequence comprises sedimentary rock types such as shale, siltstone, sandstone, conglomerate and volcanic tuff. Many sedimentary features suggest that these rocks were deposited in a shallow marine environment. Volcanic tuffs within the sequence indicate that this deposition was going on during episodes of nearby volcanic activity. This may well relate to emplacement of the overlying Brimstone Head volcanic unit.

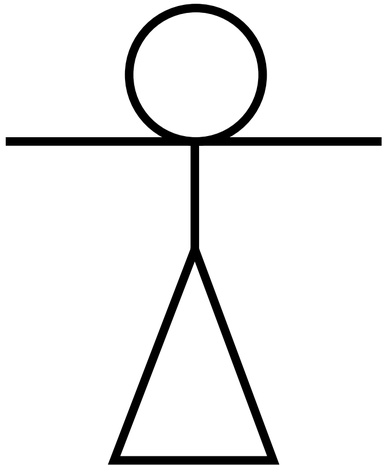
3) Glacial and post-glacial history

During the last glacial period, peaking at approximately 15 thousand years before present, the area comprising Newfoundland (and Fogo Island) was covered by the Laurentide Ice Sheet. As the glaciers retreated and the area became ice-free, by about 12 thousand years before present, numerous post-glacial shoreline features were deposited. Continental margins began to progressively "rebound" because they were no longer depressed by thick and heavy ice cover. Around the shoreline of Newfoundland this resulted in numerous raised beaches reflecting the progressive change of relative sea level. On Fogo Island, these range in elevation from 2 m to 60 m above current mean sea level.

Also, boulders sourced from much farther north (Labrador or Greenland) travelled to Fogo Island as passengers on icebergs. When sea level was relatively much higher, these passengers were deposited by melting, grounded bergs and are now found as exotic visitors, often well above modern sea level.

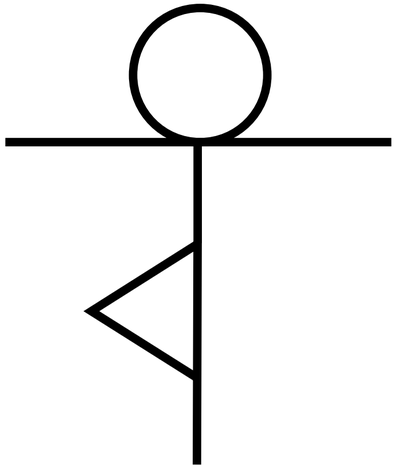
A Body-Based Geological Sign Language for Fogo Island

Granitic Dyke in Sedimentary Rock



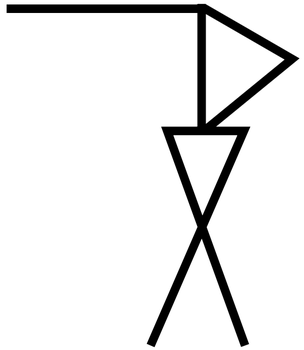
A pinkish granitic dyke
vertically intrudes into grey sandstone and siltstone
of the sedimentary sequence in outer Seal Cove.

Granite/Sedimentary Rock Contact



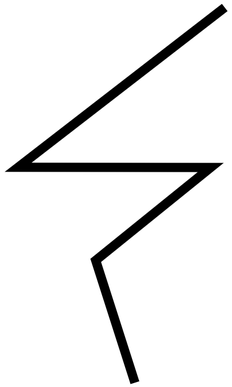
The intrusive, but sharp and planar contact between pink granite and sedimentary rock at Seal Cove southeast.

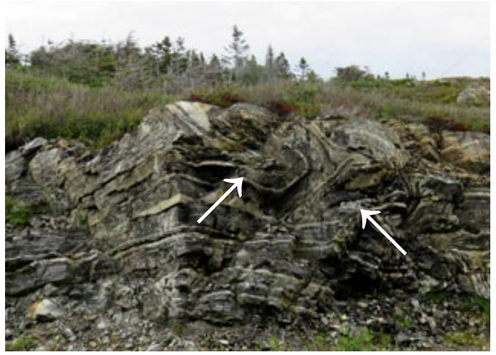
Sedimentary Xenolith within Mafic Rocks



At Sandy Cove, layered sedimentary xenoliths occur within the mafic rocks (gabbro) of the Tilting Complex. These sedimentary rafts range from less than a meter to several tens of meters and tend to be vertically inclined within the igneous rock. The sedimentary rock has been altered locally by the heat of the intrusive rock.

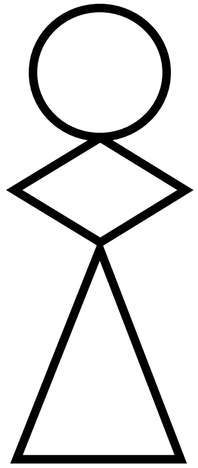
Intrusion and Folding





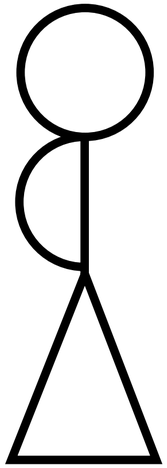
Near Paynes Harbour the Fogo Granite has intruded laterally into the beds of the sedimentary sequence, which here are predominantly black shale and siltstone. The power of this intrusion has dramatically folded the sedimentary rocks.

Granitic Dyke in Ultramafic Rock



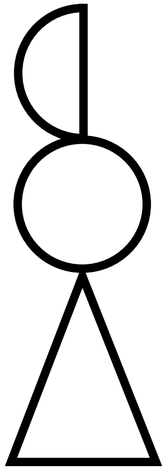
Very pink, felsic dykes such as this one are often steeply inclined and seem to be rather late in the story. They crosscut a variety of rock types, including this dark ultramafic rock southeast of Tilting.

Granitic Dyke in Diorite



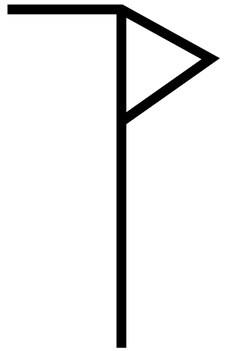
This dyke is very similar to the one shown in the previous photo, and is here crosscutting diorite in the vicinity of Greene's Point in Tilting.

Diabase Dyke in Granite



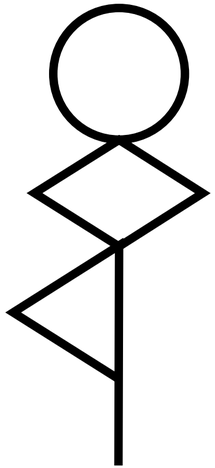
This dark diabase dyke in granite occurs near the start of the Joe Batt's Point walk. It is nearly vertical and approximately 6 meters thick. Diabase is a dark rock, compositionally equivalent to a gabbro, that generally occurs in shallow intrusions and in this case, contains crystals (phenocrysts) of feldspar.

Crystalline Vein in Ultramafic Rock



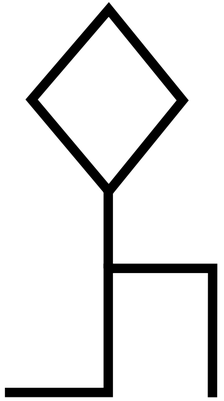
This near-vertical vein is 10 to 20 cm thick
and comprises crystalline feldspar and hornblende.
It intruded at some pressure, well below the earth's surface
as the mafic host rock was cooling.

Granite/Mafic Contact



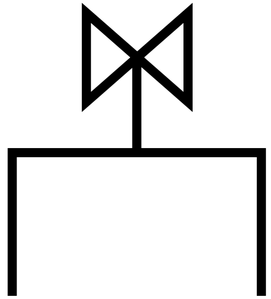
On the Olivers Cove trail, southeast of Tilting, light coloured granite or possibly diorite is in irregular, steeply-inclined contact with the dark rocks of the ultramafic complex. It appears that the felsic rock is younger, and intruding into the darker rock.

Intrusion Breccia



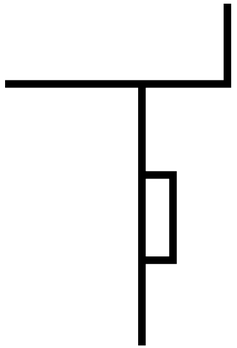
At several localities, including the Olivers Cove trail, Wild Cove, and here near the "Squish Studio" at Tilting, dark rocks of the ultramafic complex have been broken into angular fragments of various sizes by the violent intrusion of more felsic rock.

Sedimentary Mudcracks



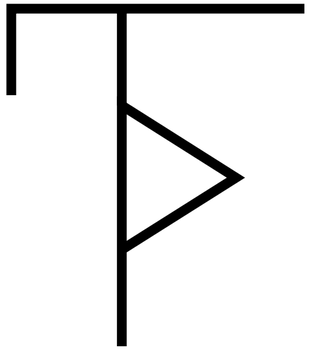
The Fogo Harbour Formation is interpreted to have generally been deposited in a shallow marine setting and locally displays very shallow water or intertidal features such as ripple marks, or polygonal mud cracks.

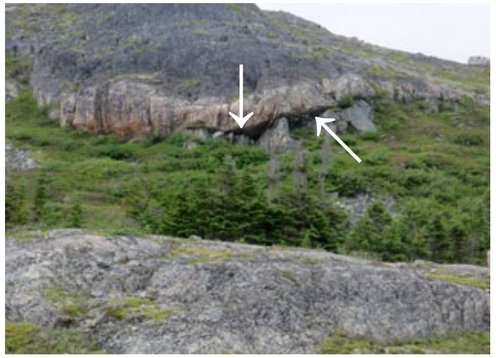
Volcanic Tuff



Volcanic tuffs are bedded deposits of volcanic ash. They are interbedded with the sandstones, siltstones and shales of the Fogo Harbour Formation, indicating frequent volcanic activity during the deposition of the shallow water sedimentary sequence. The tuff beds are up to several meters thick, are finely layered and very silica-rich. They often form resistant ridges.

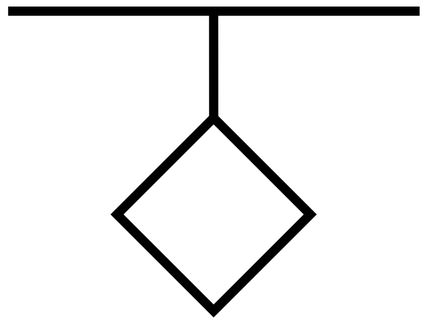
Volcanic/Sedimentary Contact





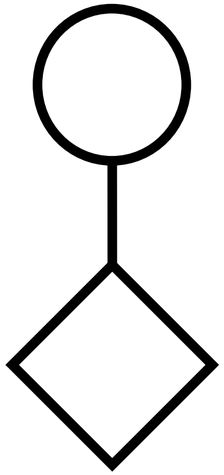
The volcanic rocks of the Brimstone Head Formation comprise a number of lithologies, including “welded tuffs” deposited as glowing hot ash and flows of volcanic lava. These often weather a distinctive orange-brown and are found in sharp contact with the underlying sandstone of the Fogo Harbour sedimentary sequence.

Raised Beaches on Sedimentary Sequence



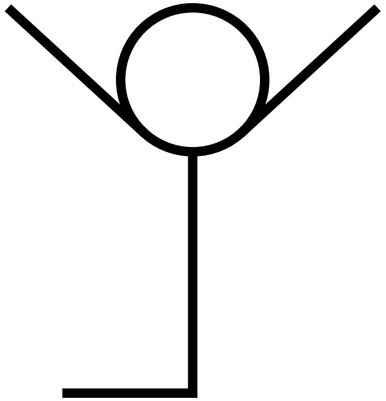
As the Laurentide icecap melted, around 12,000 years before present, the continental margin began to “rebound” and this uplift stranded a progressively younger series of “raised beaches”. These two beaches are several meters above mean sea level. They comprise cobbles composed of sedimentary rock, and lie atop the Fogo Harbour Formation.

granite Cobble Raised Beach on Sedimentary Sequence



This raised beach lies atop the sedimentary Fogo Harbour Formation, but is composed mainly of granite cobbles. The intrusive contact with the granite is some distance in the background, suggesting longshore drift during the deposition of the beach.

Granitic Gneiss Iceberg Dropstone



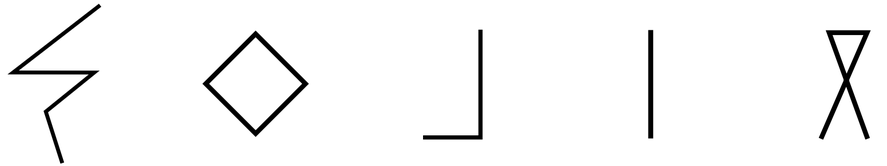
This boulder is composed of granitic gneiss, foreign to Fogo Island, and probably originated in Greenland or Labrador. It sits many meters above mean sea level, south of the village of Tilting and was dropped here by a melting iceberg thousands of years ago, when relative sea level was much higher.

Vocabulary

granitic sedimentary gabbro volcanic mafic

shale tuff gneiss

contact dyke intrusion breccia cracks



folding raised beach dropstone vein xenolith

The Authors

Four Good Eyes are Jack Botsford and Rona Rangsch

Jack Botsford is a (retired) geologist based in St. John's with a keen interest in geological education at the school level. Geology field trips, and guidebooks for teachers, were the thrust of his tenure as President of the local Chapter of the Geological Association of Canada in the early 90's. He has been a geologist-in-residence on Fogo Island in the *Geology at the Edge* programme in 2015 and 2016. His time there was divided between leading geological field trips for visitors and mapping the sedimentary sequences on the island.

Rona Rangsch is a multimedia artist from Germany who has realized a series of projects in and about Newfoundland over the past years. Having a background in physics she has been interested in linking art and natural sciences before, notably art and life sciences in her project *Nature happens*. (see www.rangsch.de/nature_happens.html) Her intention is to get a true insight into the scientific discipline under consideration and to develop audiovisual analogies of selected aspects of its specific methodology and output.

Imprint

Acknowledgments

The project was kindly supported by the *Geology At The Edge* programme of the Shorefast Foundation, Fogo Island.

The publication was funded by a grant from the Canadian Geological Foundation.


LEROY