A Tourist's Guide to the Geology of Battle Harbour, Labrador

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A Geological Tour of Battle Island

No hammers please!

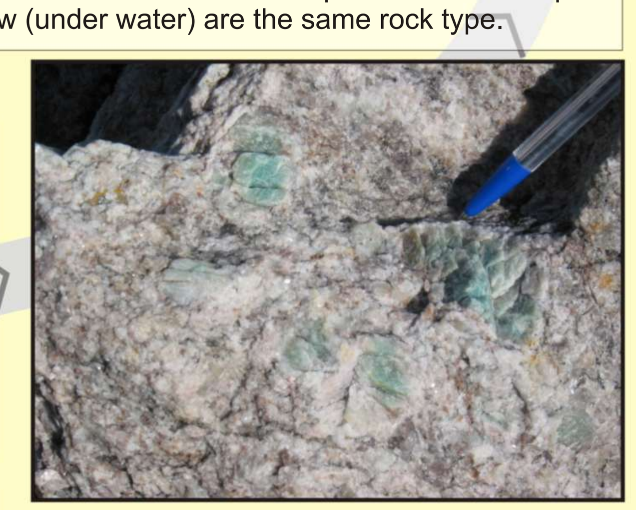
This tour may be done in three ways:
*1. The **one-stop tour** for those short of time - just go to Site 1 at the south end of Battle Island.*
*2. The **extended tour**, adding in Sites 2-7 (good weather, sturdy footwear and a guide recommended).*
*3. **Self study** using detailed report available from Battle Harbour Historic Trust (for those with some geological background).*

The one-stop tour (Site 1) ***To reach Site 1, walk south between Battle Harbour Inn and vegetable garden, following bare rock ridge, then head down to point marked on map.***

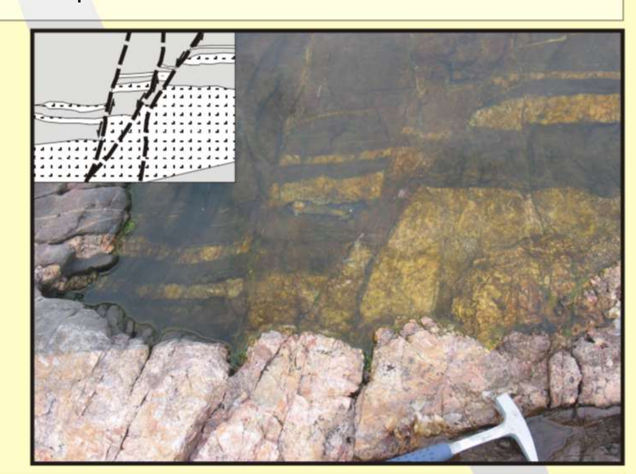
The extended tour (Sites 1- 7)

For the extended tour, return to vegetable garden and follow footpath out to aircraft crash site to get to Sites 2-7. Walk north to cairn, then down the hill past Bulldozer's grave site (not easy to find). Continue past small round deep pool, then look for pale green mineral in a pink pegmatite (see photo to right). Dangerous shoreline. Be careful!

Site 1
The key feature at this site is the brown weathering rock (see photo to left). This is a **basaltic dyke**, formed from a magma (molten rock) that was injected along a fracture. Its age is uncertain but younger than 570 million years.
The basaltic dyke cuts across two rock types, one pink and the other grey. The pink rock is **pegmatite**, which, like the basaltic dyke was injected along fractures, but, in this **case**, the magma was granitic. The pegmatites are about 1000 million years old (see Site 2), and have been bent and buckled due to deformation at that time.
The grey rocks were originally deposited as sand between 1200 and 1030 million years ago. After deposition they were buried and transformed by heat and pressure (metamorphism) into their present state (to a rock termed **psammite** by geologists - with a silent p!)



Site 2
The specific point of interest here is the green, semi-precious mineral **amazonite** (see reverse for details). The amazonite is confined to a deformed pegmatite that was intruded 1024 ± 6 million years ago (an age determined by isotopic methods). The pegmatite is one of two on Battle Island, but similar pegmatites containing amazonite are known elsewhere in southeast Labrador.

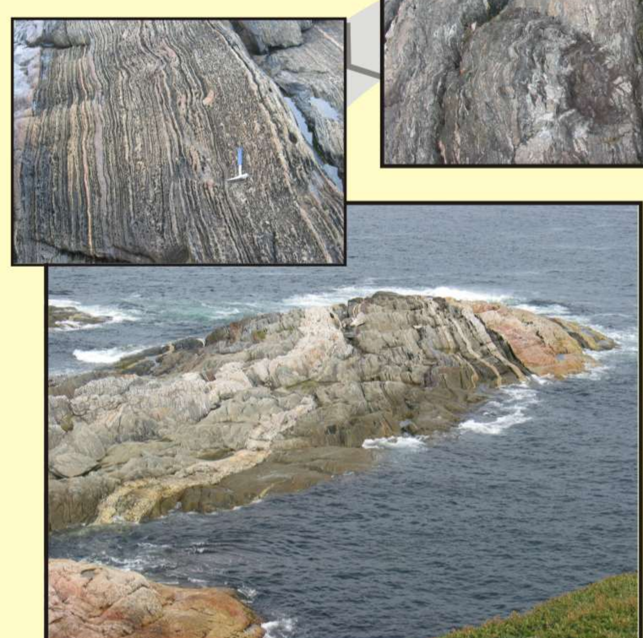


Site 3
To get to Site 3 from Site 2, proceed northwest, until you come to an L-shaped pool. Keep to the higher ground, well away from the shoreline, which can be slippery.
Surfaces across which rocks have been offset are termed **faults**. At this location the rocks have been displaced roughly 20 m from one side to the other. Fault movements take place very quickly and are the cause of earthquakes. A detail of the fault is shown in the photo above. The pink and yellow (under water) are the same rock type.

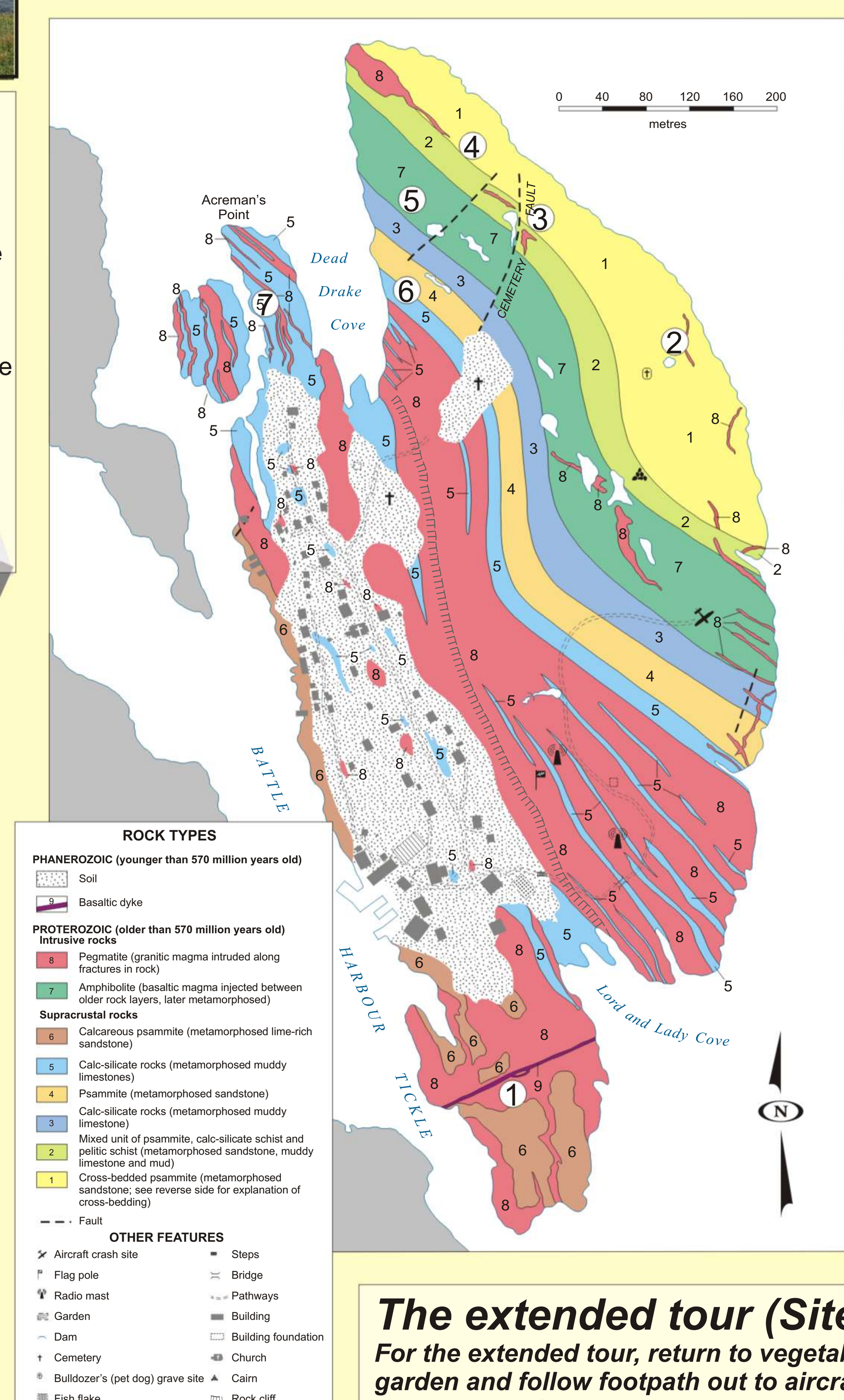
Site 4
From Site 3 continue northwest for about 100 m toward northern point , keeping on light grey rocks and staying well away from the shoreline.
The light grey rocks are termed **psammite** (silent p), which was deposited as sand, then buried, heated and deformed. The black streaky layers in the rock are concentrations of heavy minerals defining **cross-bedding**, and the black spots in the inset photo are **porphyroblasts** (see explanations on reverse). This is the only place in eastern Labrador where cross-bedding in psammite is preserved.

Site 5
Leaving Site 4 and heading west you will cross a 25-m-thick unit of mixed psammite, calc-silicate rock and pelitic schist (metamorphosed sand, lime-rich sand and mud), then reach a black rock (photo left).
The black rock is **amphibolite** (metamorphosed basalt) forming a **sill** about 75 m thick. Sills form when magma (in this case basaltic) is injected along layers in its host rock and wedges them apart (whereas dykes form when magma fills fractures that cut across layering). The basaltic sill was intruded after 1200 million years ago and before 1030 ± 4 million years ago, when it was metamorphosed - at the same time as the pegmatites were emplaced (some of which also intrude the amphibolite).

Site 6
Carrying on west across the amphibolite you will reach Site 6.
Site 6 shows the boundary between **psammite** and **calc-silicate** rocks (photo above, left), derived from sand and muddy or sandy limestone. These were originally deposited on top of similar rocks seen at Site 4 east of the amphibolite, probably in a shallow-water river or marine environment. The basaltic sill was injected into the sequence after the sediments had been buried and metamorphosed. Rare examples fluorite and garnet occur in this area (see reverse).

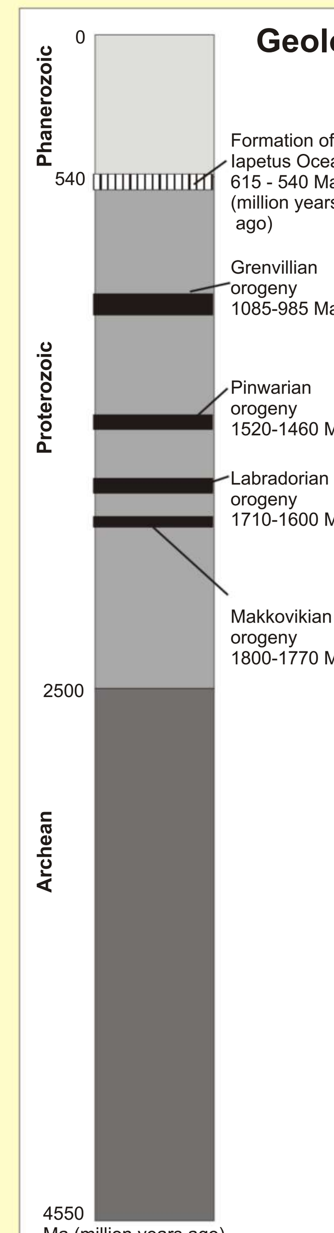


Site 7
From Site 6, leave shoreline and head toward the cemetery in the hollow. Pick up the path that takes you back toward the church. Head north to Acreman's Point.
At Acreman's Point a sequence of **calc-silicate rocks**, intruded by abundant pegmatite, is superbly exposed. The calc-silicate rocks were derived from muddy limestone and the ribbed appearance reflects original bedding layers. The bedding layers have been deformed into **tight folds**, providing evidence of the severe deformation these rocks have experienced. Note rusty-looking pods, which get their colour from the weathering of pyrite (iron sulphide - also known as fool's gold).



A draft brochure on the geological features of Battle Island has been designed for use by visitors to this now well-known tourist destination (see below). The final version will measure 43 x 28 cm (17 x 11 inches), folding down to a standard brochure size of 22 x 9 cm (8.5 x 3.6 inches). In response to user feedback, minor modifications will be carried out before the final version is printed during the coming winter. Adjacent islands show similar geology with sequence of metamorphosed supracrustal rocks injected by mafic intrusions and pegmatite. Several new amazonite-bearing pegmatites were located.

Geological time and eastern Labrador



The Earth is believed by geologists to be about 4550 million years old.

Earth scientists have traditionally recognized three main divisions of geological time, namely **Archean**, **Proterozoic** and **Phanerozoic**. Almost all the rocks in southeastern Labrador are Proterozoic in age. They formed during relatively short (geologically speaking), but very active, mountain-building events termed **orogenies**.

The oldest recognized rocks were formed between 1800 and 1770 million years ago. These are more common farther north, in the Makkovik region, hence the name **Makkovikian orogeny**.

The next period of activity, for which evidence is found across southern Labrador, occurred between 1710 and 1600 million years ago. It is known as the Labradorian orogeny.

After another (relatively short) break in geological upheavals, the region was again in turmoil, between 1520 and 1460 million years ago, during the **Pinwarian orogeny**, which takes its name from southeasternmost Labrador.

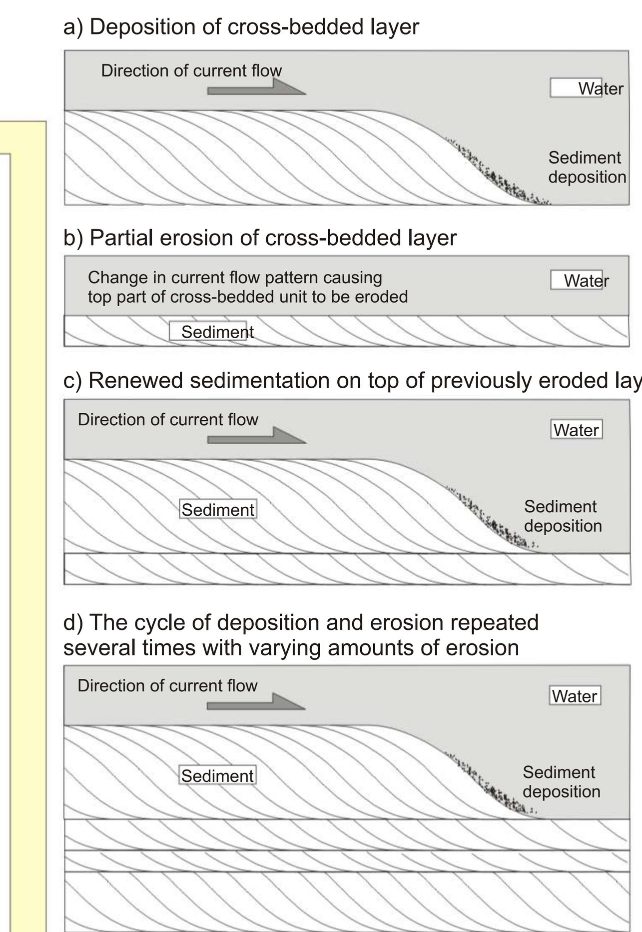
The final major and most cataclysmic event occurred between 1850 and 985 million years ago, and is termed the **Grenvillian orogeny**. This event is recognized throughout the southern part of the Canadian Shield**.** Time-equivalent orogenic events are known throughout the world resulting in one of the biggest re-organizing of crustal plates the Earth has ever known.

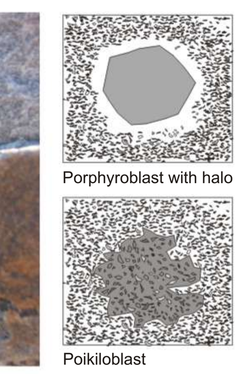
The last major event in the region was a period of crustal break-up between 615 and 540 million years ago**.** This lead to the formation of an ancient sea, to which geologists have given the name **Iapetus Ocean**.

Still younger events, minor and of uncertain exact age, have been recognized in eastern Labrador.

Cross-bedding

In some rocks, especially sandstones, it is common to see certain bedding layers oblique to the general 'lie' of the geological formation. In the photo to the left, these are the dark streaks, rich in heavy minerals. These are truncated by the lighter layer to its left. This structure, formed during sediment deposition, is called **cross-bedding**. It is created when there is a decrease in current velocity, thus allowing the sediment to be deposited, creating the sigmoidal curved structures shown in the diagrams below. A good analogy is repeatedly emptying a wheelbarrow down a slope.





Porphyroblasts and poikiloblasts

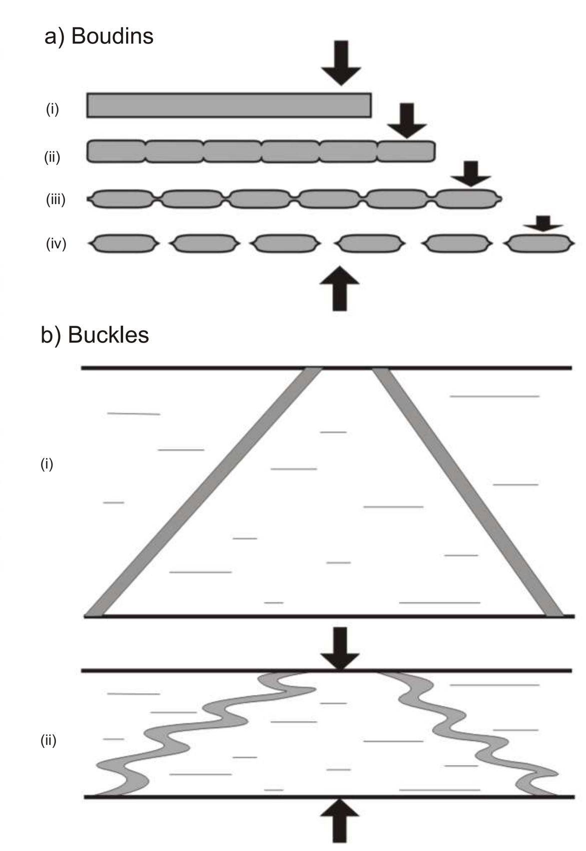
A porphyroblast is a large mineral crystal in a metamorphic rock that has grown within a finer-grained matrix as a result of chemical reactions that took place when the rock was hot (say 400-700°C). Commonly, porphyroblasts are surrounded by haloes, which result from material that the prophyroblast needed to grow being 'sucked' out of the matrix.

If the porphyroblast doesn't require the surrounding minerals for growth it shoulders them aside, or simply grows around them. The unwanted material ends up as inclusions in the porphyroblast. A porphyroblast with lots of inclusions is known as a poikiloblast.

The word porphyroblast has obscure roots. The 'porphyr' part comes from a related Greek word meaning purple, the colour of an attractive rock containing large crystals and used for ornamental purposes. The 'blast' part comes from a Greek word meaning germ, reaching geology through medical terminology for tumours.

Boudins and Buckles

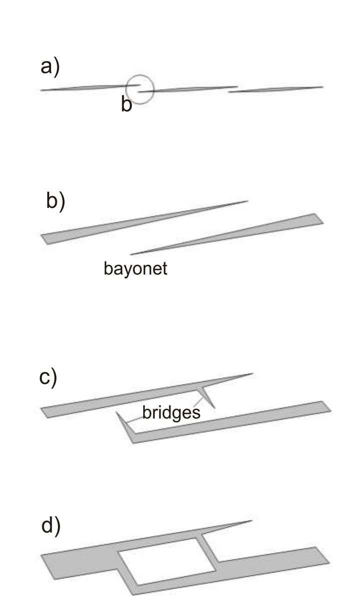
When thin sheets of rock, such as dykes, are deformed, they experience either **boudinage** or **buckling**, depending on their original orientation relative to how they are being squashed. Remember that the rocks, although not molten, were hot at the time and capable of flowage (ductile).



If the sheet of rock is oriented at right angles to the direction of squashing, it will either break or stretch depending on its ability to flow relative to its host rock. If ductile, it will start to thin at points of weakness (necking) and eventually break into pods (photo, top left). These pods are called boudins, a word which has it origin in French, meaning sausage

If the sheet of rock is in a plane at an oblique angle to the direction of a squashing, it will shorten by buckling. If the sheet of rock is inclined to the right it will shorten into a series of S shapes (photo, middle left). If inclined to the left it will shorten into Z shapes (photo, bottom left). These 'snake rocks' are found all over Battle Island, making it a veritable geological serpents' nest.

Bayonets and Bridges



a) An igneous dyke is a tabular body of rock formed when molten rock (magma) is injected into a pre-existing fracture. Although dykes are typically drawn as continuous linear features on geological maps, commonly they form *en echelon*, as shown to the right (a and, in detail, b)

b) As magma continues to be injected into the fracture, separate en echelon segments will join. The process starts by the fractures lengthening and getting wider, resulting in the ends (**bayonets**) of fractures overlapping.

c) The next stage in development is cross fractures (**bridges**) between two bayonets. The bridges can form at the tip of the bayonet, or at several points along its side. The bridges are filled with magma as they develop (photo, top left).

d) Eventually the bridges will extend completely across the gap and link up two bayonets. If only one bridge forms, the dyke will simply have a stepped appearance, with or without bayonets preserved. If two or more bridges develop, blocks of the host rock will get trapped within the now-joined dyke (photo, bottom left).

Minerals

All these occurrences are on Battle Island. If you find them, please do not damage, instead leaving the minerals for others to see.

Amazonite
The pale green mineral in the pegmatitic pod is amazonite, a lead-bearing feldspar. The amazonite here is not very high quality, but where it has a deeper, richer blue-green colour it is considered semi-precious. Amazonite was regarded as sacred by the ancient Egyptians. It is reputed to cool and sooth the mental state, to inspire hope and confidence, make your married life happier, and to be useful in activating lazy teenagers.

Microcline and Hornblende
The pink mineral is microcline and the black mineral is hornblende. Microcline (a potassium feldspar) is the major mineral in pegmatites on Battle Island. Feldspar is used in the ceramics and glass industries. Hornblende is a member of a complex group of iron-magnesium aluminum silicates. It does not have major ornamental or industrial use. It is credited with improving wisdom, communication and balance.

Quartz
The pod in the centre of the photo is made of quartz (silicon dioxide). Quartz is abundant in most rocks on Battle Island and can easily be seen in the pegmatites. It is used in ceramics, glass, optical instruments, electronics, and abrasives. Quartz is favoured by mystics, who recommend it for aligning one's consciousness with electromagnetic forces of the universe.

Fluorite
Fluorite (calcium fluoride) is the purple mineral in the centre of the pod. This is the only known example of fluorite on Battle Island, but, in general, fluorite is not uncommon in pegmatite. Fluorite is used as a flux in steel making (a flux reduces the melting temperature of materials to which it is added), and in the glass, ceramics and optical industries. It is known as a 'brain' stone, aiding concentration, objectivity, truth and the intellect.

Garnet
Garnet comes in various varieties, depending mainly on its iron, magnesium, calcium or manganese content. It is the red-brown mineral in the photo - probably an iron- and calcium-rich variety. Because of its hardness, garnet is prized as a gemstone and used extensively as an abrasive (e.g. sandpaper). It is claimed to combat lethargy and depression, blood deficiency diseases, and to be good for sexual desire.