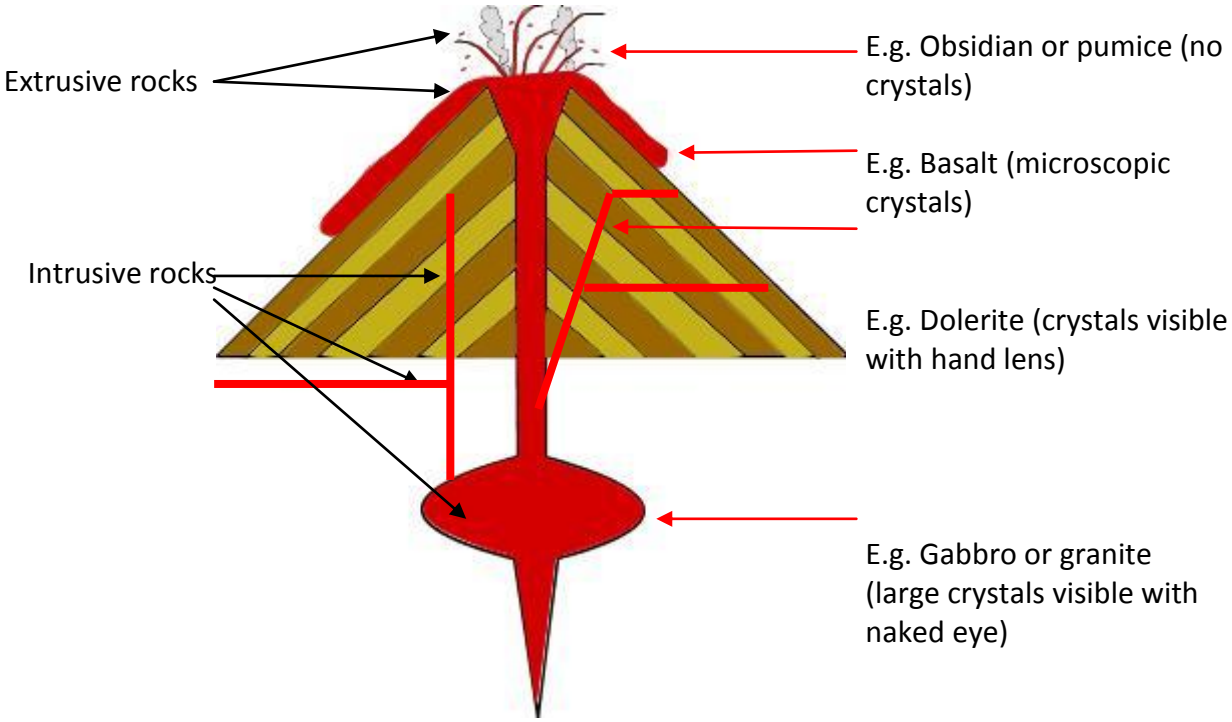
Recognising Igneous Rocks – Teacher Notes

Minerals are the building blocks of rocks
Minerals are inorganic crystals with constant structure and composition

Classification of igneous rocks

Igneous (Latin ig = fire, neous = born) rocks are formed from molten magma. They have interlocking crystals and are therefore hard. Crystal size tells us how quickly the rock cooled and chemistry tells us of possible sources for the magma.

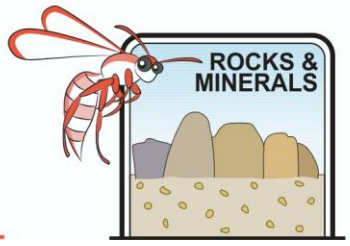


1. Extrusive or intrusive - Crystal size

The size of the crystals in a rock can tell us its history. Rocks which have been extruded from a volcano will cool rapidly and the crystals will be microscopic. Intrusive rocks solidify beneath the Earth's surface over geologically long periods of time resulting in large crystals.

Students are asked to draw a cross section through a volcano (as above) with surface lava flows, underlying sills (horizontal,) dykes (vertical,) and the magma chamber that feeds molten rock.

- Obsidian, or volcanic glass is explosively ejected from volcanoes and cools instantly to glass before crystals can form. Pumice is also rapidly chilled with glass shards fused around gas bubbles. These are igneous extrusive rocks.
- Basalt lava flows can take months to cool and the crystals formed are often too fine grained to see with the naked eye. It is also extrusive.



- Dolerite has the same chemical composition as basalt but is intruded into cracks at depth within the crust to form semi vertical dykes (walls) or along bedding planes to form horizontal sills between beds. Slower cooling results in crystals that can be seen with a hand lens. It is intrusive into country rock. These rocks sometimes demonstrate chilled margins (edges) of finer crystal size.
- Gabbro also has the same chemical composition as basalt and dolerite, however it has large well formed interlocking crystals suggesting very slow cooling and crystallisation at depth. Granite also cools at depth over geological time and has large well-formed crystals. It is intrusive.

NOTE: When the rocks in the magma chamber have almost completely crystallised the last quartz rich fluids flow into cracks formed in the cooling rock. Space and time permits the formation of very large well formed crystals and are the source of some of our gem stones such as emerald and sapphire.

2. Chemical composition - felsic (Fe+Si) or mafic (Mg+Fe)

Igneous rocks are also classified by whether they are silica rich (felsic) or silica poor (mafic). Silica rich rocks such as granite have a lot of quartz and tend to be light in colour. Silica poor rocks such as basalt are richer in iron and magnesium minerals making them darker and denser.

Granite is rich in iron (Fe) and silica (Si) and is the most abundant igneous rock at the surface. It is formed from melting older crustal rocks at depths greater than 9km.

Magma from deeper in the crust or upper mantle has more magnesium (Mg) and iron (Fe) and is denser.

Molten rock is less dense than solid rock and it will slowly begin to rise up through the surrounding rock to the surface. If it reaches the surface it will form a lava flow. If it solidifies below the surface it may have to wait for the overlying rock to be eroded away to emerge.

Some igneous rocks

	Mafic	Intermediate	Felsic
Volcanic Extrusive Fine grained	**Basalt**	**Andesite** **Scoria**	**Rhyolite** **Obsidian** **Pumice**
Intermediate Intrusive Medium grained	**Dolerite**	X	X
Plutonic Intrusive Coarse grained	**Gabbro**	**Diorite**	**Granite**

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The student activity asks them to look at pictures of various igneous rocks and classify them as intrusive or extrusive and as felsic, intermediate or mafic, on their visible features. Students need not necessarily be able to name each rock. This should be followed up with classification of school specimens.

Picture	Comment	Classification Extrusive or intrusive Felsic or mafic
	Light white to cream rock. Porous Crystals cannot be seen by naked eye. Floats on water. From Mt Tarawera New Zealand.	**Pumice. Igneous felsic extrusive** Pumice has very small (cryptocrystalline) crystals. It is really shards of volcanic glass. Silica rich rock with gassy bubbles. Floats on water. White to cream. Used to make light weight concrete, in polishes and to remove dead skin. The ancient Greeks used it to remove hair from the body (ouch!)
	Light grey rock Porous Crystals cannot be seen by naked eye. Does not float on water From New Zealand and Iceland	**Scoria. Igneous intermediate extrusive.** Scoria can be both felsic and mafic. It is a gassy layer which forms at the top of lava flows. Its stickiness forms cinder cones and explosive eruptions as the gas trying to escape has to push the cooled solid scoria out of the way. Pompeii was covered with scoria when Vesuvius erupted. It was mined to make the distinctive top knots on the head of Easter Island sculptures.
	Speckled grey rock with obvious white, grey and black crystals. From Mundaring WA	**Granite. Igneous intrusive felsic** Large obvious crystals of quartz, feldspar and horneblende indicate granite crystallised slowly at great depth. Granite is the most common rock of the Earth's continental crust. It has been intruded throughout Earth's history but was more common in Archaean times. It forms the Pilbara and Yilgarn cratons of WA. Polished granite is used for gravestones, memorials and kitchen tops.

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Picture	Comment	Classification Extrusive or intrusive Felsic or mafic
	Dark, heavy very fine grained rock. Crystals only just visible with a hand lens. Massive	**Basalt. Igneous mafic extrusive** Basalt commonly forms massive lava flows from volcanoes. It weathers to a rusty brown colour because of its high iron content. Because it is massive (homogenous) it breaks into uneven clasts which are useful for road ballast being both porous and permeable.
	Grey crystalline rock with obvious white and grey crystals. Medium density. Found in New Zealand, Scotland and the Andes Mountains.	**Diorite. Igneous intermediate intrusive** It has been described as intermediate between granite and gabbro. I t forms the roots of mountain chains in New Zealand, the Andes and Scotland. It is used for cobblestones, pavements and kitchen tops. It can be mistakenly called black granite.
	Curved glassy fragments of rock. Very sharp edges. No crystals visible even under a microscope. New Zealand	**Obsidian. Igneous extrusive felsic.** This volcanic rock degassed as it left the volcano and chilled instantly to glass before crystals could form. Early man used it to make knives and sickles. This allowed them to hunt and butcher game more effectively.

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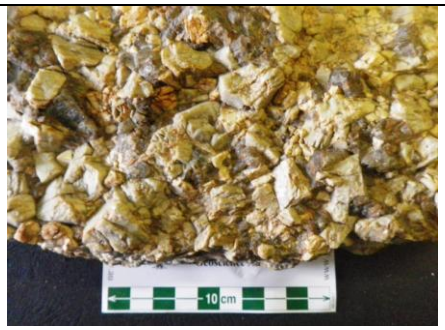
Picture	Comment	Classification Extrusive or intrusive Felsic or mafic?
	Black heavy, massive fine grained rock. Crystals only just visible under a hand lens. Beach and hill in Bunbury WA	**Basalt. Igneous extrusive mafic.** This was part of a massive outpouring of flood basalts during an eruption near Bunbury about 130 million years ago when the Australian continent separated from Gondwanaland.
	Pink silica rich rock. Light Fine crystals just visible Rotor New Zealand	**Rhyolite. Igneous extrusive felsic** Rhyolite is a thick sticky lava that builds up domes (stratovolcanoes). From the Rotorua-Taupo volcanic zone in New Zealand. Light and abrasive. Pumice has been described as rhyolite "froth".
	Very, very large well formed crystals. A light bright rock found in veins within other rocks in the ancient Yilgarn craton in WA.	**Pegmatite. Igneous intrusive felsic** When rocks such as granite cool they shrink and crack. The final fluids enter these cracks and slowly cool to form large crystals. Can contain rare earth minerals such as lithium and spodumene. Gems such as amethyst, emerald and rubies and lithium ore are found in pegmatite.

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Picture	Comment	Classification Extrusive or intrusive Felsic or mafic?
	Dark medium density rock whose crystals can only be seen with a hand lens. It forms a wall like structure cutting through other country rock. Exposed in road metal quarry in Darling Ranges.	**Dolerite. Igneous intrusive mafic** Dolerites form dykes and sills intruded into country rock. Their interlocking crystals make them hard and they are used as ballast to lay under railways and as "blue metal" for road surfaces.

Why is the Geoscience Australia card included in each picture? To provide scale for estimating rock and crystal size.

If you had to carry a bucket of rock, which rock type above would you choose? Explain your answer. Pumice is the least dense. A bucket of pumice would lightest.

If you were being attacked and had to quickly pick a rock to throw, which would you choose? Explain your answer. A small gabbro rock would be densest and have the greatest impact (Pressure = Mass X Acceleration)

You are going to design the front of a new art gallery. Which igneous rock would you choose for the front of the building? Most igneous rocks have interlocking crystals and are hard. Granite and gabbro have large crystals which would polish well. Gabbro might be a little dark and sombre (which is why it is used in mausoleums).

You have been asked to demonstrate how to make a stone knife. Which rock would you select. Explain your answer. Obsidian. Since Obsidian is quartz it is relatively hard and will break into curved sharp edged clasts which can be hafted onto wood.