AUSTRALIAN EARTH SCIENCE EDUCATION

Igneous Rocks and Processes

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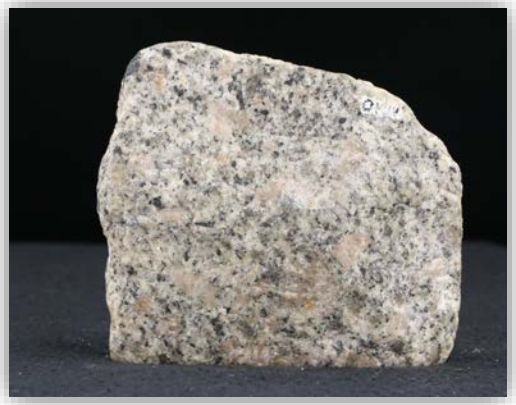
Formation

- Molten rock cools and solidifies



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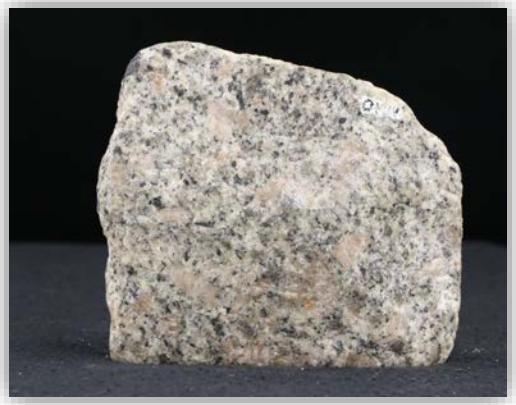

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- Interlocking crystals

Classification

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  - Size = rate of cooling

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  - Composition = amount of silica present/ chemistry, gas in magma

Terminology

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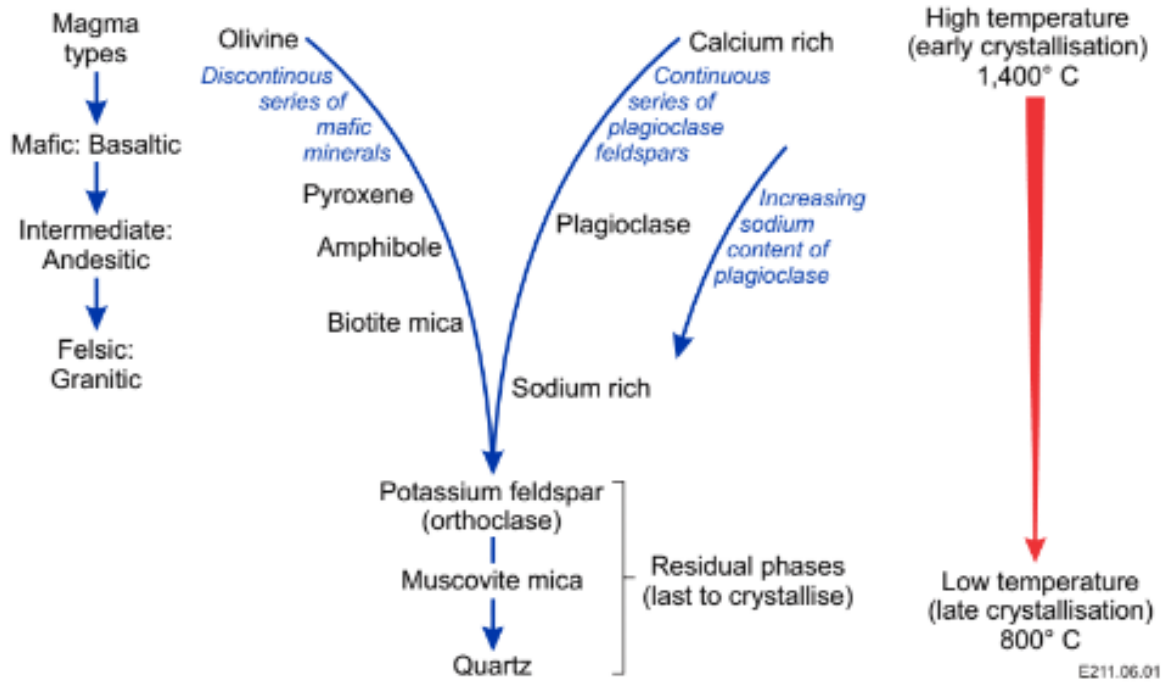
- Glassy – very rapid cooling
- Pyroclastic – rock fragments
- Pegmatic – very coarse grained

Bowen's Reaction Series



Common Igneous Rocks

	Mafic	Intermediate	Felsic
Aphanitic	Basalt	Andesite	Rhyolite
Phaneritic	Gabbro	Diorite	Granite
Dominant Minerals	Pyroxene Calcium-rich plagioclase feldspar	Amphibole Sodium & calcium-rich plagioclase feldspar	Quartz Orthoclase feldspar Sodium-rich plagioclase feldspar
Accessory minerals	Amphibole Olivine	Pyroxene Biotite	Muscovite Biotite Amphibole

Other igneous rocks to know

- Komatiite
- Pumice
- Tuff
- Obsidian

Earth resources

- Intrusive ore deposits – formed during the cooling of magma

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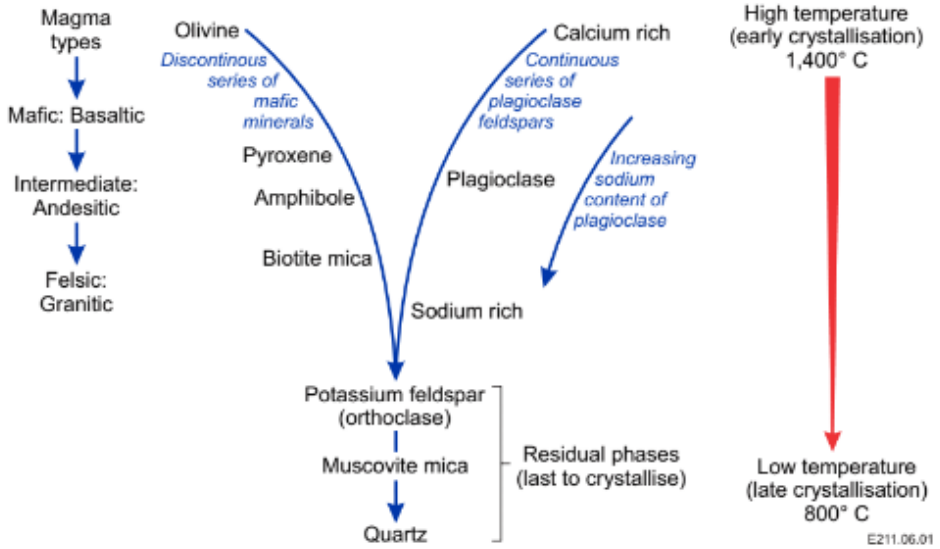
- Exhalative ore deposits – formed from volcanic materials which are extruded or ‘exhaled’ onto the Earth’s surface through hydrothermal vents

Intrusive ore deposits

Fractional crystallisation

- As magma cools, some minerals form crystals before others

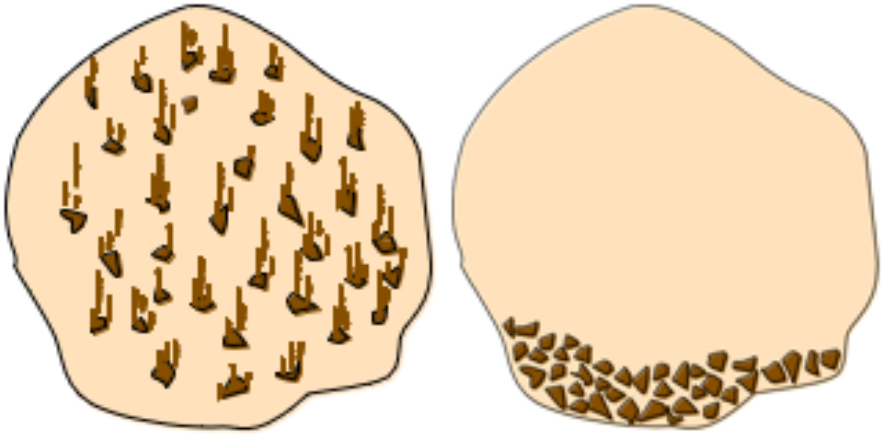


Differentiation – Pegmatite deposits

- As magma crystallises out minerals like pyroxene and calcium rich plagioclase, it becomes progressively more felsic
- Late stage magmas can be fluid rich and contain rare elements like lithium, tin and tantalum
- E.g. Greenbushes tin-tantalum-lithium deposit

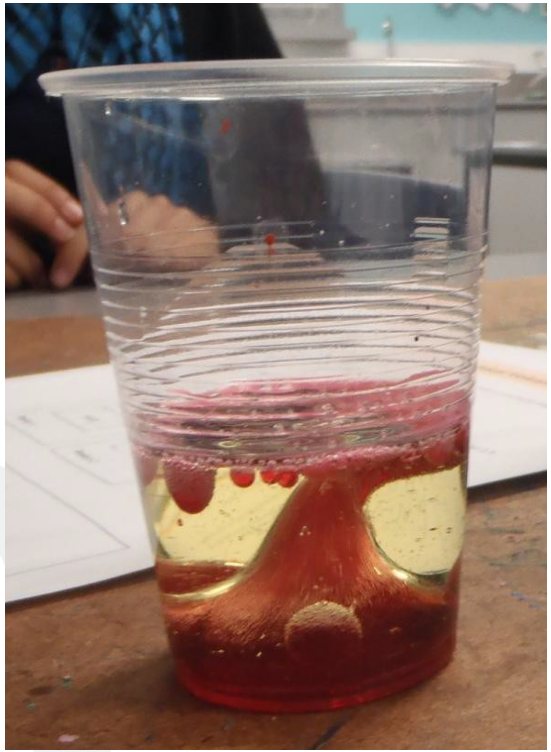
Gravitational settling

- Early formed, heavier minerals sink to the base of the magma chamber
- E.g. chromium at Coobina, near Newman



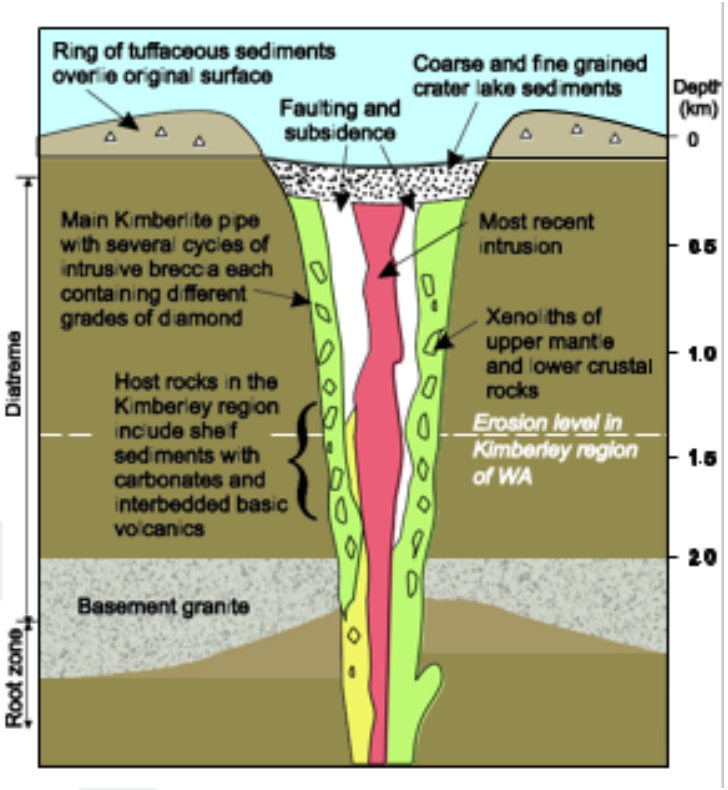
Immiscible liquid separation

- Like oil and water, some minerals don’t readily mix
- Heavy sulfur-rich liquid (high in Ni & Cu) separates from silicate-rich liquid and sinks. E.g. Kambalda



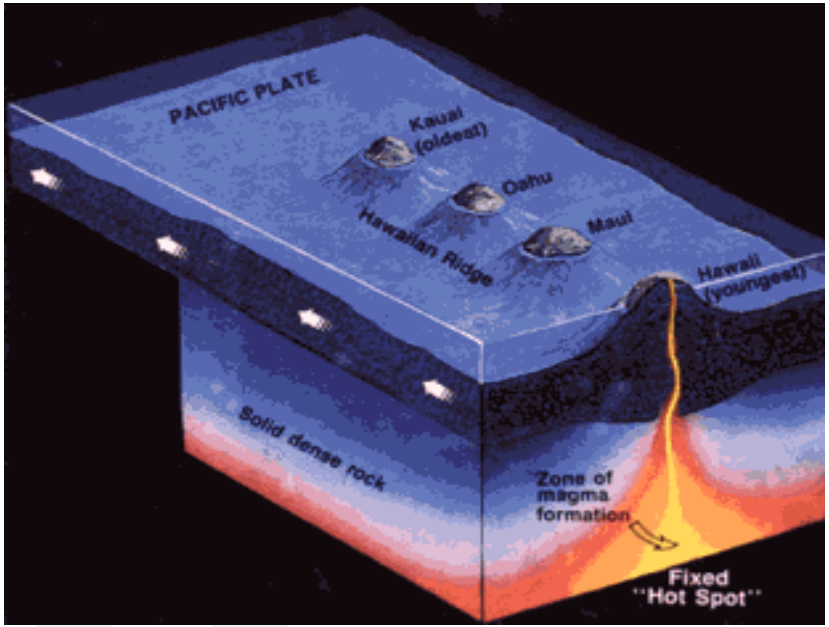
Lamproite/Kimberlite Pipes

- Diamond-bearing igneous rocks (fine-grained ultramafic)
- ‘Punch up’ from depth of ~600km
- Usually vertical, pipe-like bodies
- Rise rapidly and cool rapidly



Mantle hot spots

- Hot spots are thought to be abnormally hot sections of the mantle
- The material is thought to originate at the core-mantle boundary

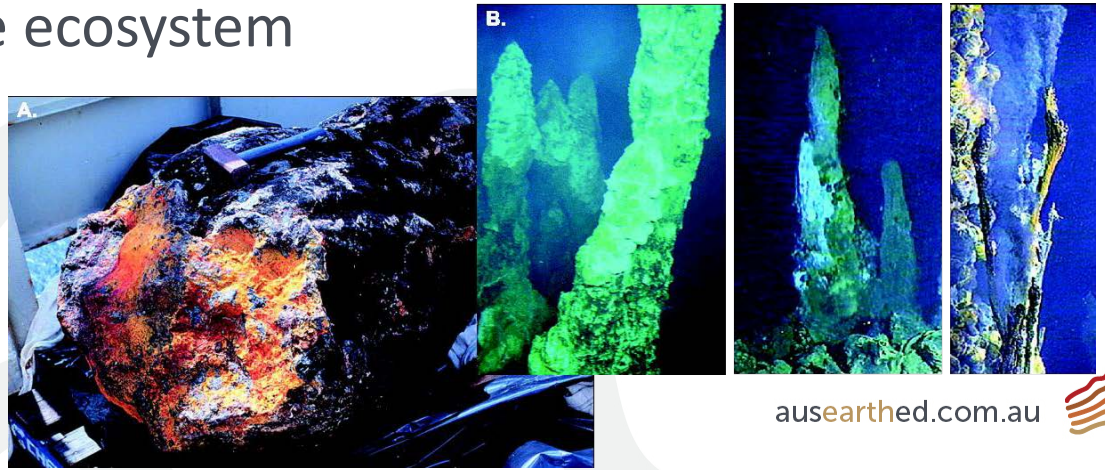


(USGS 1999, public domain)

Exhalative ore deposits

Black smokers

- Hot vents spewing clouds of black sulfur-bearing compounds
- Rich in copper, iron, zinc, etc.
- Supports a unique ecosystem



Volcanogenic Massive Sulfide (VMS) Deposit

Or volcanic hosted massive sulfide (VHMS)

- Hot, saline, metal-rich fluids are exhaled from hydrothermal seafloor vents or fumaroles
- Zinc, copper, lead, silver, gold, etc.
- E.g. The DeGrussa copper-gold deposit, 150 km NE of Meekarhara, hosted in what may have been a back arc basin

Image courtesy of Sandfire Resources NL

Hot spring deposits

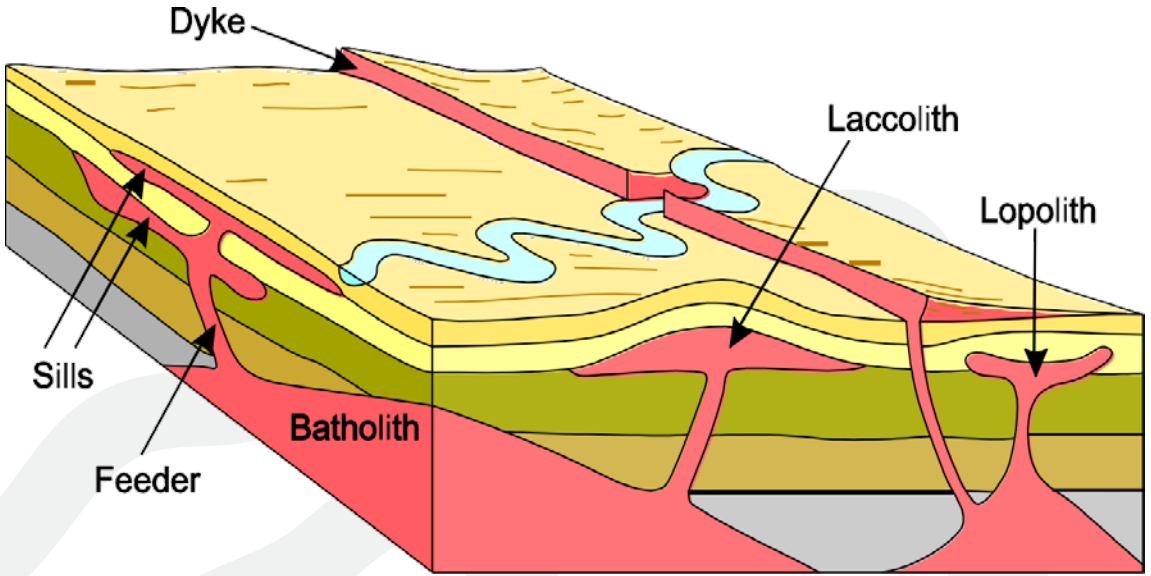
- Hydrothermal solutions reach the surface
- Superheated water overflows and precipitates out very fine silica (sinter)
- May contain lead, zinc, mercury, etc.

Volcanic fumarole deposits

- Hot volcanic gases condense and precipitate out hematite, sulfur and gypsum minerals
- Bacteria may also precipitate sulfur

Igneous intrusions

- Massive or tabular
- Discordant or concordant



References

•USGS, 1999, “Hotspots”: Mantle thermal plumes, accessed 15 May 2012 from http://pubs.usgs.gov/gip/dynamic/hotspots.html

Unless otherwise stated all information and graphics are from:

- Tompkins, DE (Ed) 2011, Epxloring Earth and Environmental Science Stages 1, 2 and 3, Earth Science Western Australia
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