Hello students, this is Malcolm Afonso, assistant Professor, Department of Geology, Parvatibai Chowgule College of Arts and Science Autonomous Margoa Goa. As part of the Distavo initiative of the Directorate of Higher Education,Government of Goa, I'm going to present a topic in igneous petrology. My topic is Ascent of magma, module 18. In this topic, we are going to cover sources of magma, factors causing rocks to melt, types of melting and magma ascent. By the end of this module,students will be able to Understand that the Asthenosphere is made up of solid rock, Be able to explain the factors responsible for the generation of magma, Understand the mechanism for magma generation in different plate tectonic setting, Be able to compare Equilibrium fusion and Partial fusion, Explain the process of ascent of Magma.

Magma refers molten or semi-molten rock below or within the Earth's crust from which lava or other igneous rocks are formed upon cooling

Magmas do not form everywhere beneath the surface of the earth. This is evident from looking at the world distribution of Volcanoes. Thus, Magmas require special circumstances in order to form.

Where do the magmas come from?

Do they come from the earth's core? Not likely, though the Outer core is the only layer of earth in a liquid state. However the material comprising the core is too dense to rise up to the surface and is at great depth.

What about oceanic crust?

In the ocean basins, magmas are not likely to come from melting of the oceanic crust, since most magmas erupted in the ocean basins are basaltic. To produce basaltic magmas by melting of the basaltic oceanic crust would require nearly 100% melting, which is not likely.

In the continents, both basaltic and rhyolitic magmas are erupted and intruded. Basaltic magmas are not likely to have come from the continental crust, since the average composition is more siliceous, but more siliceous magmas (andesitic - rhyolitic) could come from melting of the continental crust.

Thus, with the exception of the continents, Most Basaltic magmas are believed to originate from the upper part of the mantle known as the asthenosphere by partial melting of mantle rock peridotite. Asthenosphere is ductile and can flow plastically – but is still solid.

What factors cause rocks to melt?

Heat: Adding heat to a crystalline solid may cause the molecules to break away and become liquid. So simply increasing the heat may cause melting.

Decompression: Pressure holds the crystal molecules together. If we decompress it the crystal is capable of melting if it is warm enough to do so.

Adding Water and Volatiles: Adding water and volatiles to a crystal will lower the temperature at which the crystal will melt because water and volatiles increase the entropy of the system.

The source regions for magma generation often coincide with the plate margins. Very few magmas are generated within the plates (hotspots like Hawaii). Most form at convergent and divergent margins.

We know that huge quantities of eruptions take place at the mid oceanic ridges but why? Divergence of the tectonic plates is taking place here this gives rise to decompression. Diverging plate boundaries are where plates move away from each other. These include oceanic ridges or spreading centers, and rift valleys on continents. Because the lithosphere is thinned here, the asthenosphere from below which is hot and almost solid comes up to fill the gap but as it loses pressure it is then able to melt and give rise to basaltic magma forming a new oceanic crust.

In the second example we can see what happens when we increase the temperature of the mantle. This happens when there is a hotspot in the mantle for example under the Hawaiian Islands. Because the mantle temperature is hotter than usual, the rocks are able to melt. Therefore we can generate molten magma.

In the third example we can see what happens when water gets into the mantle – this is what happens at subduction zones (destructive/convergent boundaries) where one tectonic plate is thrust beneath another. as the rocks get deep down they release the water held both within the pore space of the rocks and as part of the minerals. That released water lowers the mantles melting point and therefore the hydrated mantle rocks can melt at a lower temperature giving rise to magma.

Melts are produced due to partial fusion (partial melting/anatexis) at various levels in the crust and upper mantle.

Two possible types of melting of complex silicates have been advocated.

| | |
|---|---|
| Equilibrium fusion | Fractional fusion |

| | |
|---|---|
| Occurs when the liquid continually reacts and equilibrates with the crystalline residue | Occurs when the liquid which forms is immediately isolated from the system so that there is little or no reaction with the crystalline residue. |
| Also called as Batch melting | Also called Rayleigh fusion. |
| Liquids produced by the process of equilibrium form a continuous but relatively limited compositional melt | It produces discrete melts spanning a greater compositional and temperature range. |

Once magma is generated it can begin its journey upwards towards shallow levels. The fundamental driving force causing a crystal-liquid diapir to rise upward is the buoyancy of the less dense magma. The overlying high density rocks are hydrostatically unstable and a buoyant force causes the magma to rise.

As melt forms and rise, the overlying rocks may melt into the magma. Emplacement is accompanied by engulfment of blocks of country rocks into the magma.

As the magma tries to rise itself up it will cause the overlying rocks to crack and new fractures may form. Old fractures and fault zones may also form pathways for magma intrusion and extrusion.

Thank you.