GRAVITY SETTLING

GRAVITY SETTLING OF MAGNETITE

Ore deposits formed by **gravity settling** are due to **magmatic differentiation** in **mafic and ultramafic igneous intrusions.**

- **The cumulate layer** is the layer of dense minerals formed by gravity settling at the base of an intrusion.
- **Magmatic segregation** occurs when **ore minerals** become **separated and concentrated** during **cooling and crystallisation** of magma, a type of **differentiation.**
- **Immiscible** describes two liquids that do not mix (form an emulsion)

Gravity settling of early formed, dense ore minerals forms a concentrated layer at the base of an intrusion (a cumulate layer). Gravity settling occurs early in the cooling history and is affected by:

A. **Metallic ore minerals**, such as **magnetite (Fe_3O_4)**, **chromite ($FeCr_2O_4$)** and **ilmenite ($FeTiO_3$),** crystallise out at **high temperatures and are dense**.
B. **Mafic and ultramafic** magma has a **low viscosity** so allows for gravity settling.
C. **Slow rates of cooling and crystallisation**, so that gravity settling has **time to take place** (plutonic/medium depth of burial).

Mineral	Formula/description	Density (g/cm^3)	Melting point (^0C)
Augite/pyroxene	Silicate mineral	3.3	1150
Olivine	Silicate mineral (Ferro magnesium)	3.4	1450
Plagioclase feldspar	**Silicate mineral**	**2.7**	1100
Magnetite	**Fe_3O_4**	**5.2**	1600
Chromite	**$FeCr_2O_4$**	4.6	1500

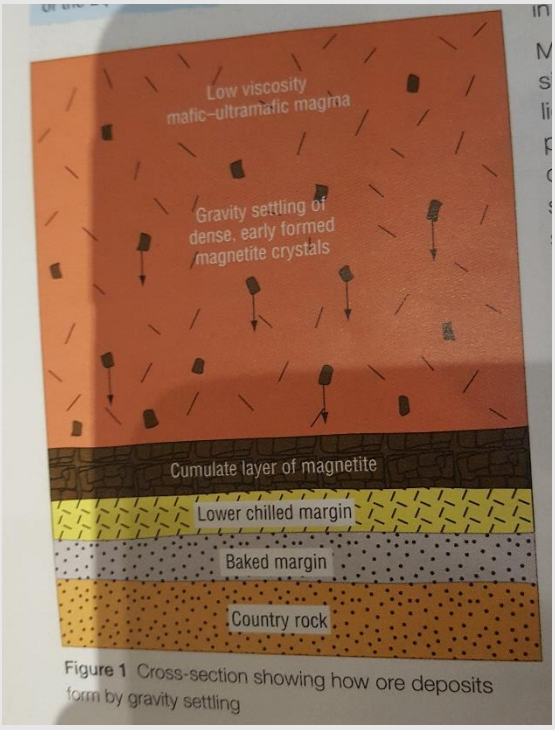

Figure 1 Cross-section showing how ore deposits form by gravity settling

Magnetite (iron ore) has a **high melting point** and is one of the first minerals to crystallise out of the magma as it cools. As magnetite **is very dense and the magma is a fluid**, the magnetite crystals will **sink due to gravity**. A **cumulate layer** forms at the intrusion base, **just above the chilled margin**, by **magmatic segregation** since this magnetite layer is i**mmiscible with remainin**g **silicate mineral**s in the fluid magma.

Ore deposits formed by gravity settling can be **very high grade** as all the metals in the original magma are **concentrated in the cumulate layer**. The **chilled margins** will have the **same composition as the original** magma as they cool faster than **magmatic differentiation** may occur. The rest of the magma intrusion remains **depleted in metals** which are now in the cumulate layer.

Magmatic segregation can also result from the separation of **sulphide and silicate liquids.**
Sulfide and silicate liquids are **immiscible** so don't mix (like oil & water). **Immiscible droplets of iron, copper, nickel and platinum sulphides** form within the **mafic-ultramafic** magmas as they cool. These **droplets join** and sink to the floor of the intrusion by gravity settling as they are **denser** than the silicate magma. They form a **cumulate layer.**

Sometimes, **immiscible metal sulphide** liquids can be **injected into fractures** in the surrounding country rocks.

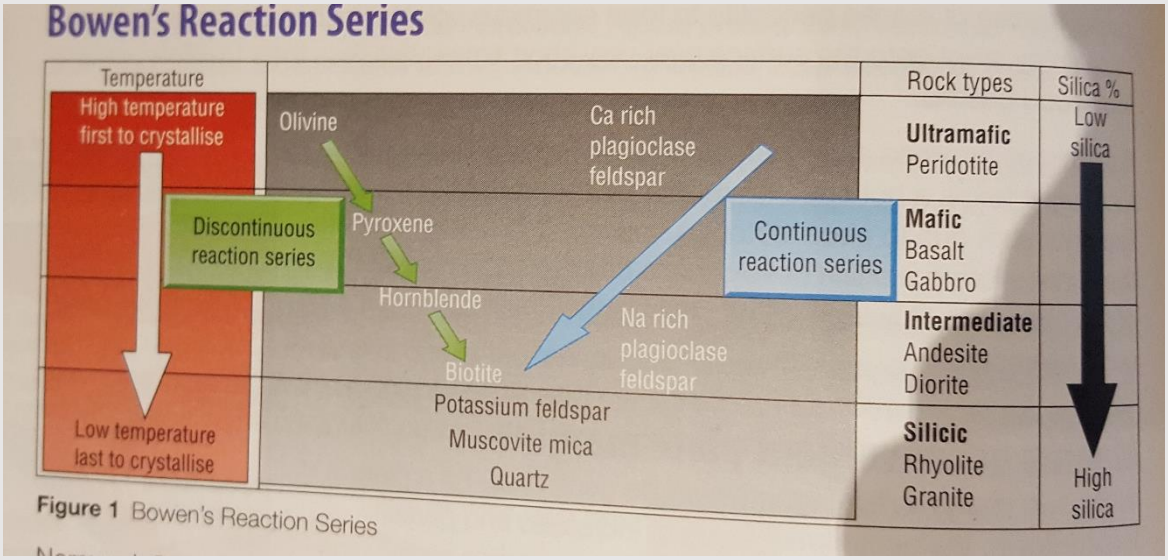

Figure 1 Bowen's Reaction Series