What causes plate motion?

Circulation within the mantle – mantle rocks flow very slowly, over millions of years!
This flow allows the Earth to lose heat – primary heat loss mechanism – the cooling from the nebula continues today.
Three ways to melt

1. **Decompression**
   - Decompression melting as rock is moved towards surface

2. **Flux melting**
   - Flux melting as water is added to rock

3. **Heat them** → stove-top

Transfer of heat by this mechanism may be responsible for generating some magmas in continental rift valleys, hot spots, and subduction-related environments.
Plate tectonics and magma plumbing systems Ch 7 VIPS

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Figure 7.1 Plate tectonics and magma production. Conceptual figure showing the Earth's plate tectonic system, with the principal magma generation, transport and storage systems.

Figure 7.3 Two examples of continental rift plumbing systems. (A) The example of a deep rift with low tectonic stress (equivalent to a slow spreading ridge). Here volcanism starts only after large degrees of extension and is concentrated on the rift margin as the rift deepens. (B) The example of a mature rift with higher tectonic stress, where extension and magmatism are concentrated in the centre of the rift. Here the stretching is mostly accommodated by dyking and superficial faulting, although sills may also have a major role in weakening and stretching the lithosphere. A sedimentary basin within the rift also provides local lithological control on the type of plumbing.

(A) Volcanic and igneous plumbing systems

- **Process**
  - Flow
  - Transport
  - Injection

- **Object**
  - Magma storage
  - Magma chamber

- **Tectonic controls**
  - Influences output rates and volumes
  - Influences size, shape and orientation of body
  - Controls type of plumbing through stress, faults and shear zones
  - Creates conditions for melt accumulation, created conditions for melting controls volume and rates of magma prod
Figure 7.10. System diagram for the links between tectonics and volcanic and igneous plumbing systems. (A) A simplified system showing the main features of magma production (melting), magma collection and transport, magma migration (note flow within an intrusion is not the same as an intrusion migrating) and then magma evolution in different tectonic and lithospheric environments. (B) More full systems diagram, showing some of the many interactions within the tectonic and magmatic plumbing system.
Average composition of the continental crust:

Melting a mixture -- like a rock, which is a mixture of different minerals, is very complex. A binary mixture is a good place to start:

Equilibrium Melting

Fractional Melting

Back to mantle melting

Melting of garnet lherzolite begins at spinel-garnet triple junctions (solidus) in response to a reduction in pressure. Olivine is not involved in melting at early stages. As the extent of melting (β) increases, melt migrates along grain boundaries forming an interconnected network that allows the melt to segregate from the unmelted crystal residue.

Trace elements in mantle melting

• Incompatible elements: preferentially partition into the melt phase (D_in = 1)
• Compatible elements: preferentially partition into the solid phase (D_out = 1)
• Partition or distribution coefficient (D) = C_melt/C_sol