Granitoids and continental crust
Granites

1) occur in areas where the continental crust has been thickened by orogeny, either continental arc subduction or collision of sialic masses. Many granites, however, may post-date the thickening event by tens of millions of years.

2) Because the crust is solid in its normal state, some thermal disturbance is required to form granitoids.

3) Most workers are of the opinion that the majority of granitoids are derived by crustal anatexis, but that the mantle may also be involved. The mantle contribution may range from that of a source of heat for crustal anatexis, or it may be the source of material as well.
Conditions during magma formation

- Magma mixing
- Magma mingling
Magma mingling
Classification of granitic rocks according to the ASI of Shand (1927)

ASI = molar \([\text{Al}_2\text{O}_3/(\text{CaO} + \text{Na}_2\text{O} + \text{K}_2\text{O})]\]
Classification of granitic rocks according to the ASI of Shand (1927)
Granitoid Rocks

Table 18-4. A classification of granitoid rocks based on tectonic setting
Granitoid Rocks

Himalayan leucogranites
Himalayan leucogranites U-Th-Pb ages

- Lhagoi Kangri
  - 15.1 Ma
  - Schärer et al. 1986

- Manaslu
  - 22.9 Ma & 19.3 Ma
  - Harrison et al. 1999

- Shisha Pangma
  - ~20 Ma & 17.3 Ma
  - Searle et al. 1997

- Lhagai Kangri
  - 16.8 Ma
  - Schärer et al. 1986

- Maja
  - 9-10 Ma
  - Schärer et al. 1986

- Rongbuk
  - 16-17 Ma
  - Murphy & Harrison 1999

- Everest
  - 20-21 Ma
  - Simpson et al. 2000
  - 14.3 Ma
  - Schärer et al. 1986

- Wagye La
  - 11.9 Ma
  - Wu et al. 1998

- Kula Kangri
  - 12.5 Ma
  - Edwards & Harrison 1997

- Nyalam
  - 16.8 Ma
  - Schärer et al. 1986
Himalayan Crystalline

Extrusion of a wedge, channel flow model

Grujic et al. (1996)
Himalaya leucogranites

Fluid induced anatexis of Higher Himalayan rocks, triggered by devolatilization of overthrust footwall rocks in concert with shear heating

Himalaya leucogranites

Dehydration melting induced during decompression caused by slip on the STD

Harris et al. 1993,
Guillot & LeFort 1995
A-type Granitoids
Geochemical features

- Major elements: high Si, Na + K, Fe/(Fe + Mg); relatively low Al, very low levels of Ca, and Mg

- Minor, trace elements: high levels of F, Zr, Nb, Ga, Sn, Y and REE (except Eu); relatively poor in Ba, Sr, P

- Isotopic indicators of a source in the mantle, in the crust, or a mixture; anything is possible

- Peralkaline, metaluminous, and peraluminous variants; anything is possible, commonly in the same complex!
Mineralogical features: mafic minerals

- Annite – fluorannite series
  \[ K^{[VI]}Fe^{2+}_3 [^{[IV]}AlSi_3O_{10}] (OH,F)_2 \]
- Arfvedsonite
  \[ Na Na_2 (Fe^{2+}_4Fe^{3+}) Si_8 O_{22} (OH,F)_2 \]
- Aegirine
  \[ NaFe^{3+}Si_2 O_6 \]
- Fayalite
  \[ (Fe, Mn)_2 SiO_4 \]

Mafic minerals are generally late in the sequence of crystallization. They form interstitial grains or clots.

The feldspar is mainly alkali feldspar (almost no Ca in the system)
A-type granites and rhyolites are products of a second-stage regional anatexis in the granulite-grade middle to lower crust, earlier dehydrated during an earlier episode of anatexis.
A-type granites are ultimately linked with mantle-derived melts and fluids, which have caused alkali metasomatism (i.e., fenitization) of crustal rocks in a period of extension prior to regional melting.

The distinctive mineralogy and geochemistry are thus a direct result of the extensional tectonic environment of formation.
Figure 28. Hypothetical lithosphere section through southern Malawi to illustrate a postulated zone of metasomatized mantle extending upward into the lower crust, and the doming and rifting of the crust. The horizontal dashed ornament indicates areas of partial melting. The dot pattern indicates area of metasomatism. N nepheline/ijolite; C carbonatite; SG granite, syenite/trachyte; Ph phonolite/nepheline syenite (from Woolley 1991).