Granitoids and continental crust


Granites

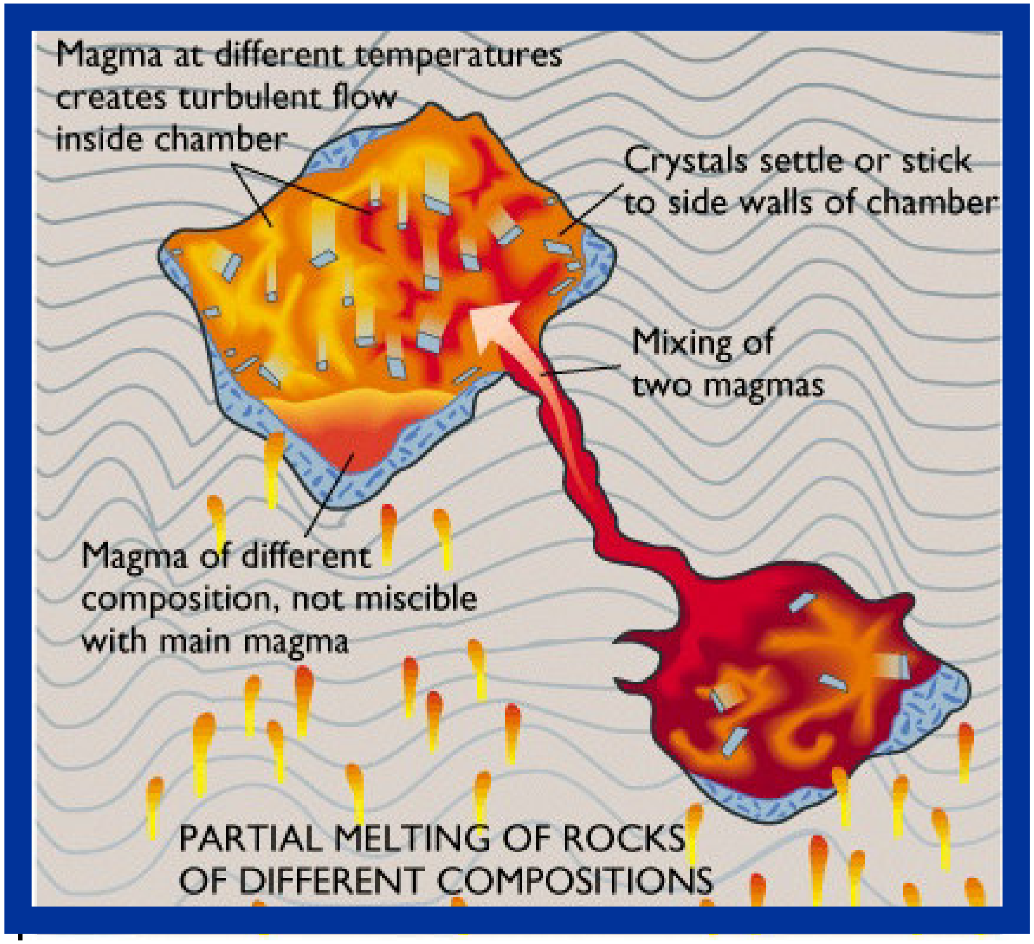
1) occur in areas where the continental crust has been thickened by orogeny, either continental arc subduction or collision of sialic masses. Many granites, however, may post-date the thickening event by tens of millions of years.

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

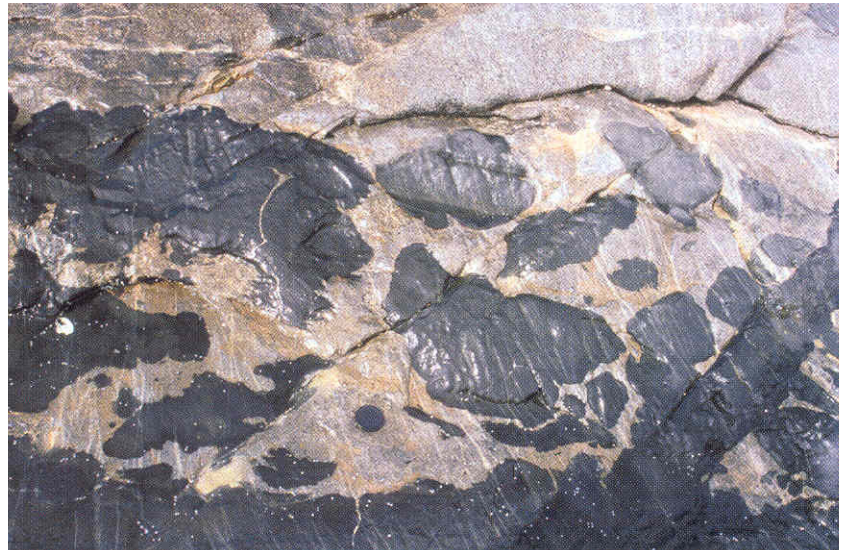
3) Most workers are of the opinion that the majority of granitoids are derived by crustal anatexis, but that the mantle may also be involved. The mantle contribution may range from that of a source of heat for crustal anatexis, or it may be the source of material as well

Conditions during magma formation

- Magma mixing
- Magma mingling



Magma mingling

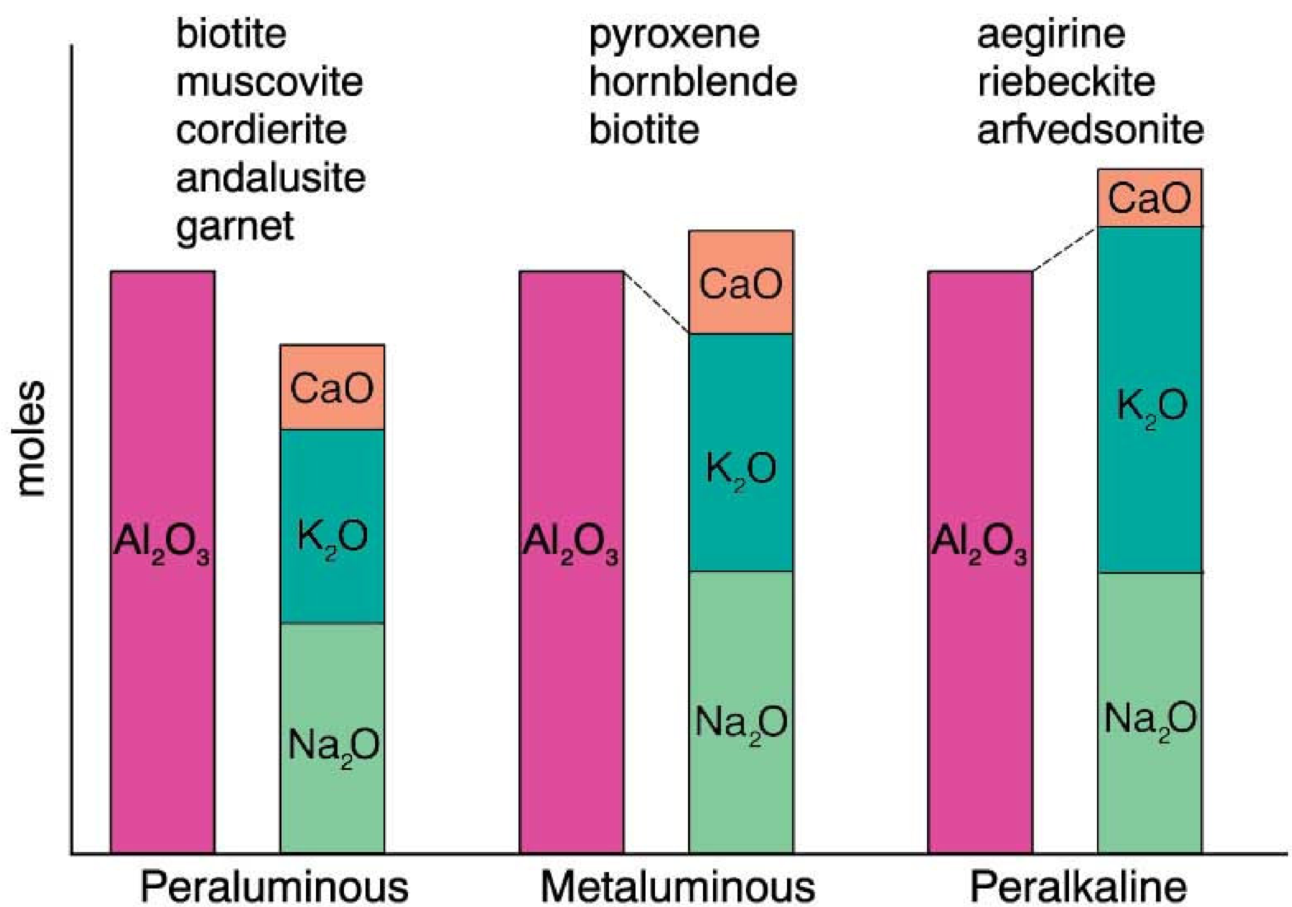


Classification of granitic rocks according to the ASI of Shand (1927)

$$ASI = \text{molar } [Al_2O_3/(CaO + Na_2O + K_2O)]$$

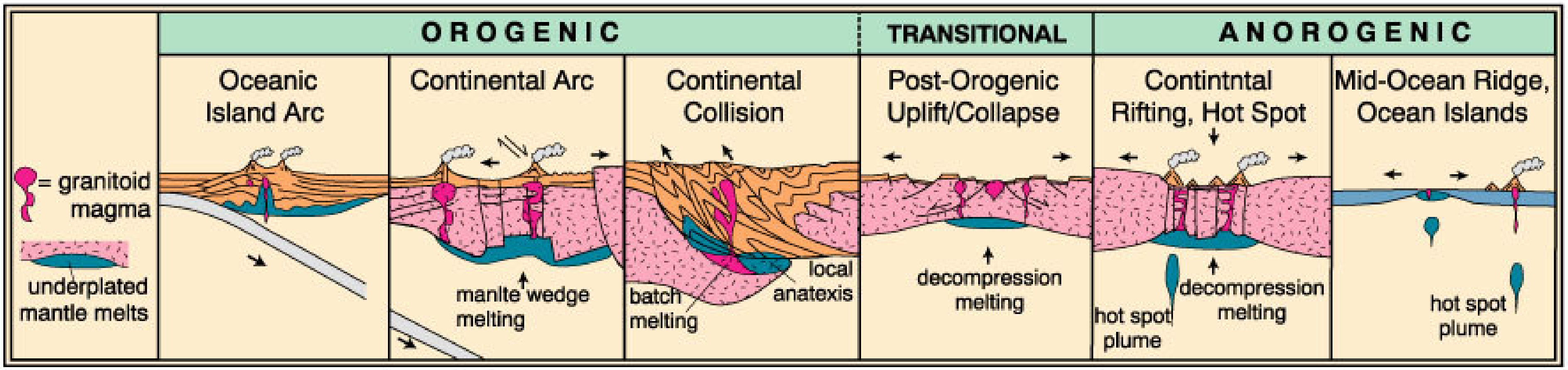
Category	*Chemical definition*	*Diagnostic minerals*
Peraluminous	ASI > 1.0	biotite, muscovite, cordierite
Metaluminous	ASI < 1.0	biotite, hornblende
Peralkaline	ASI << 1.0 Al/(Na + K) < 1	aegirine, riebeckite

Classification of granitic rocks according to the ASI of Shand (1927)

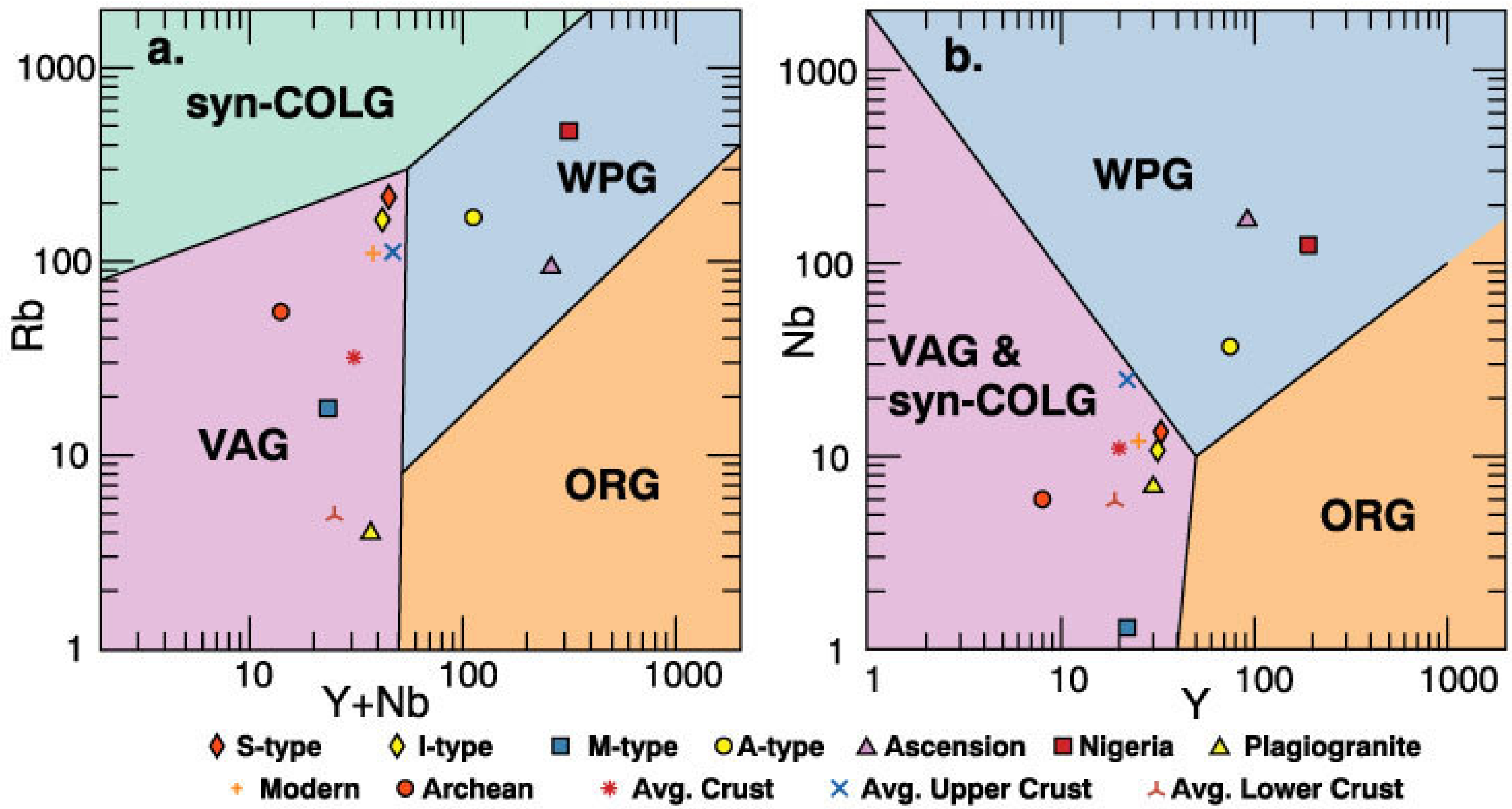


Granitoid Rocks

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



Granitoid Rocks



Himalayan leucogranites

Himalayan leucogranites U-Th-Pb ages

Dolpo-Mugo
17.6 Ma
Harrison et al. 1986

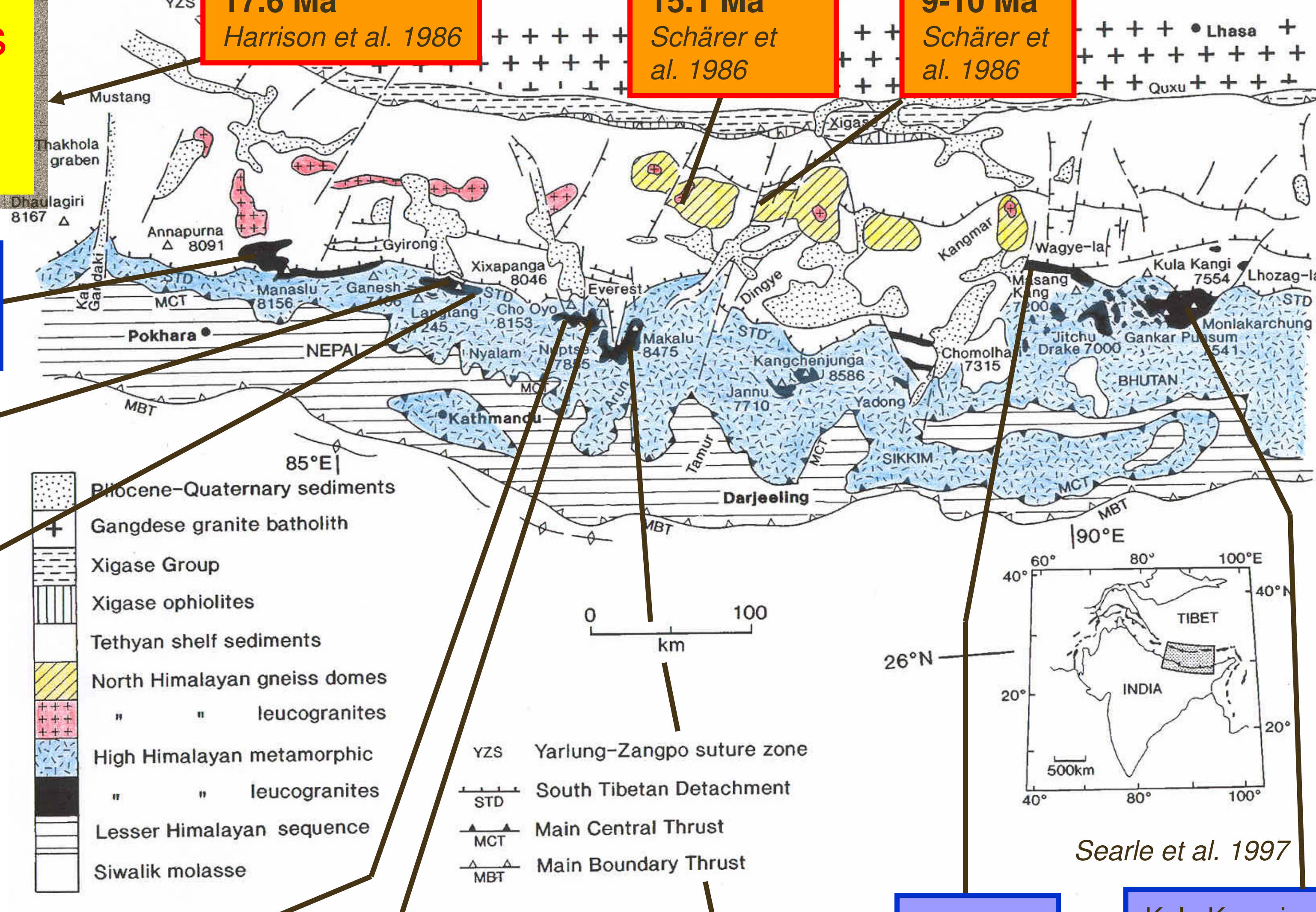
Lhagoi Kangri
15.1 Ma
Schärer et al. 1986

Maja
9-10 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

Nyalam
16.8 Ma
Schärer et al. 1986



Searle et al. 1997

Rongbuk
16-17 Ma
Murphy & Harrison 1999

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

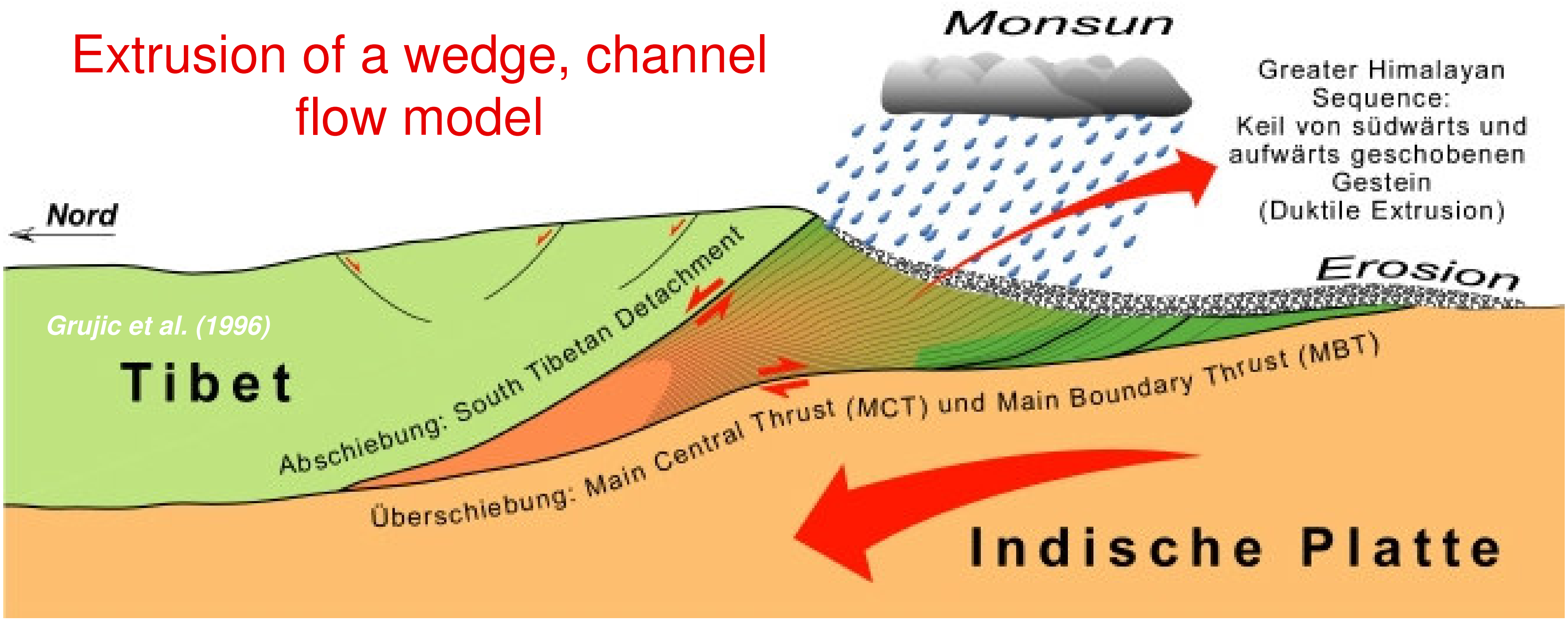
Makalu
22-24 Ma
Schärer 1984

Wagye La
11.9 Ma
Wu et al. 1998

Kula Kangri
12.5 Ma
Edwards & Harrison 1997

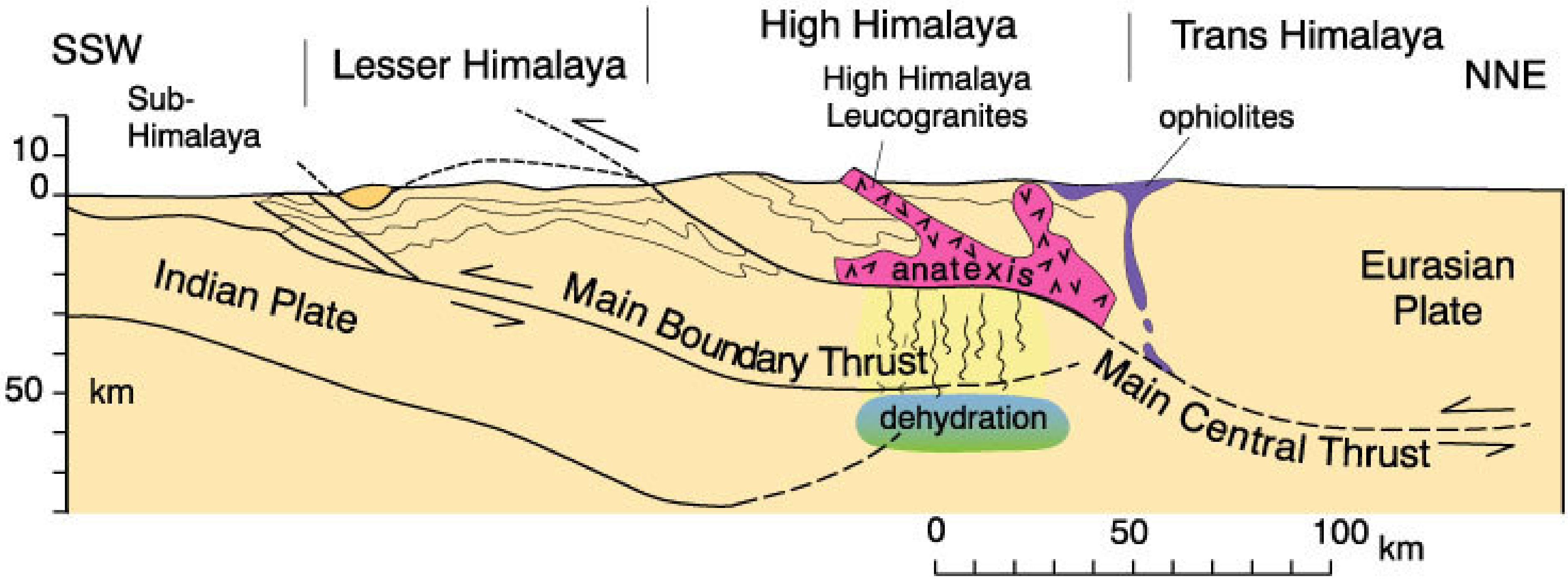
Himalayan Crystalline

Extrusion of a wedge, channel flow model



Himalaya leucogranites

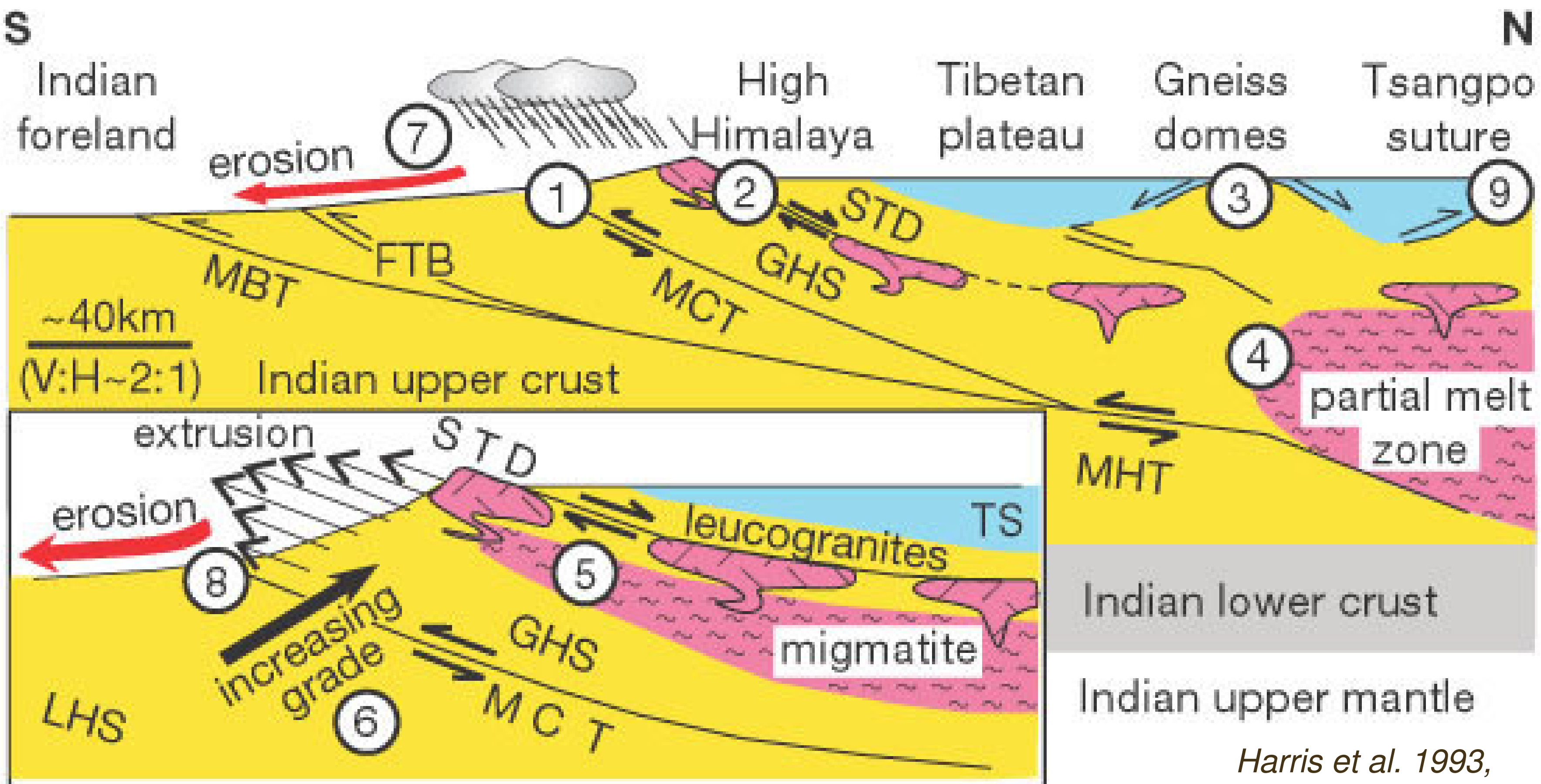
Fluid induced anatexis of Higher Himalayan rocks, triggered by devolatilization of overthrust footwall rocks in concert with shear heating



Le Fort 1975, France-Lanord & Le Fort 1988, England et al. 1992

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

  $Na\ Na_2\ (Fe^{2+}{}_{4}Fe^{3+})\ Si_8\ O_{22}\ (OH,F)_2$
- 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)

The “residual source” model

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

Mantle model

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

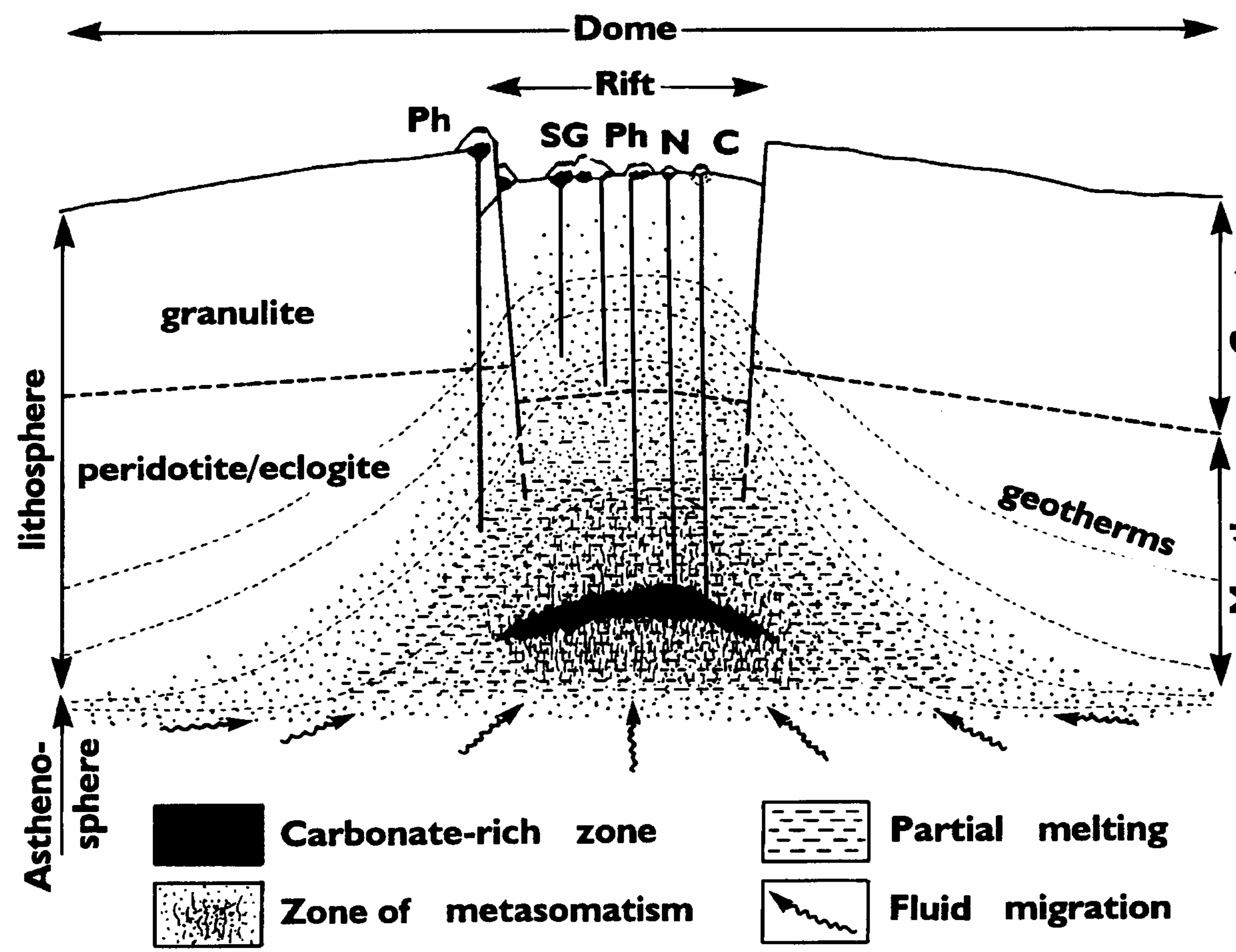


Figure 28. Hypothetical lithosphere section through southern Malawi to illustrate a postulated zone of metasomatized mantle extending upward into the lower crust, and the doming and rifting of the crust. The horizontal dashed ornament indicates areas of partial melting. The dot pattern indicates area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