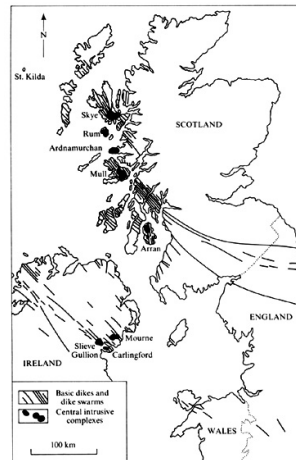


## Continental Arcs Shallow Processes

Reading:  
Winter Chapter 17

### Dike Swarms

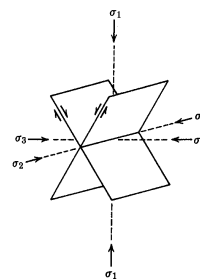
- Hundreds of contemporaneous dikes
- May be radial
- Large radial swarms associated with mantle plumes



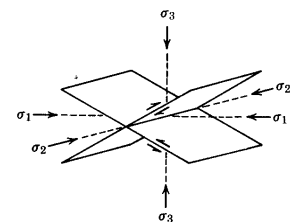
### Stress for Dikes

- Dikes are hydraulic tensile fractures
- They lie in the plane of  $\sigma_1$  and  $\sigma_2$
- They open in the direction of  $\sigma_3$
- They are good paleostress indicators

$\sigma_1$  vertical



$\sigma_3$  vertical



## Dikes

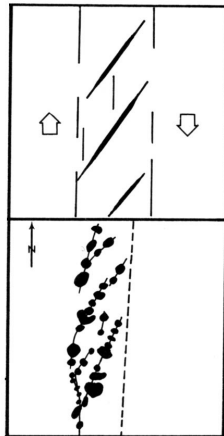
- Intrusions with very small aspect ratio
- Aspect: width/length =  $10^{-2}$  to  $10^{-4}$
- Near vertical orientation
- Generally 1 - 2 meters thick

### Intrusion into Dikes

- Stress perpendicular to the fracture is less than magma pressure
- Pressure must overcome resistance to viscous flow
- Magma can hydrofracture to rock and propagate itself

## Orientation

- Near-vertical dikes imply horizontal  $\sigma_3$
- Typical in areas of tectonic extension
- Can be used to interpret past stress fields

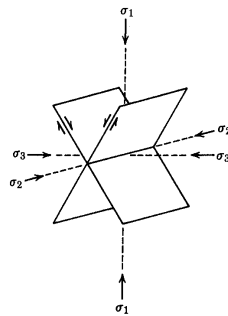


## Tectonic Regime

- Extensional regime
  - Basalts common
- Compressional regime
  - Andesites common

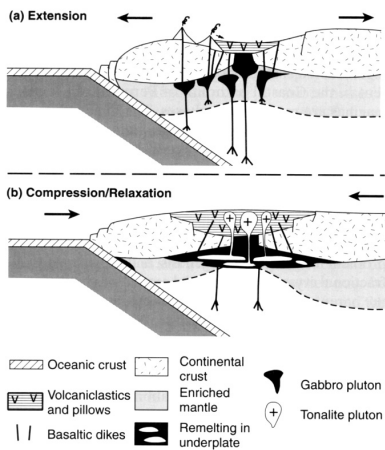
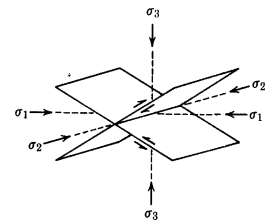
## Extensional Regime

- $\sigma_1$  is vertical
- $\sigma_2$  and  $\sigma_3$  are horizontal
- $P_m > \sigma_3$
- Vertical basaltic dikes rise to surface



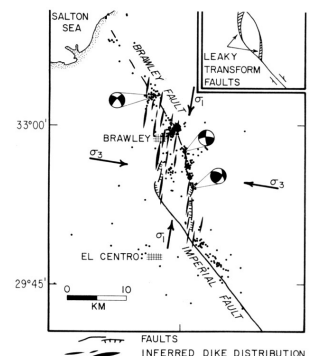
## Compressional Regime

- $\sigma_3$  is vertical
- $\sigma_1$  and  $\sigma_2$  are horizontal
- $P_m < \sigma_2$
- Basalt rise limited by neutral buoyancy



## Tectonic Room

- Dilatant faults zones
- Bends in a fault zone
- Hinge zones of folds
- Domains of extension in a compressive regime



## The Intrusion

- Contacts
  - Record length and type of effects
- Border zone
  - May be permeated with changes due to thermal, chemical, and deformational effects

## Composite Intrusions

- Compositionally or texturally different
- Chilled, fine-grained inner contact
- Variable time intervals (and cooling histories) between intrusions

## Batholiths

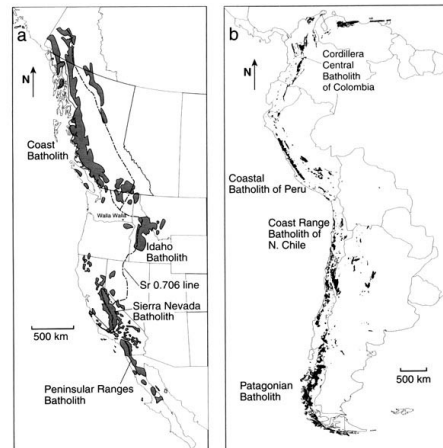
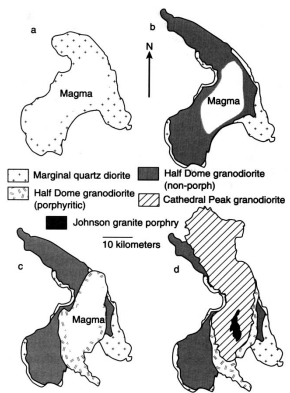
- An example: the Sierra Nevada Batholith, CA
- A group or groups of separately intruded plutons with a composite volume of  $10^6 \text{ km}^3$
- Age extends through the Mesozoic (>130 my)
- Average pluton volume is  $\sim 30 \text{ km}^3$

## Granite Plutons

- Generally inhomogeneous in composition
- Composite intrusions
  - Emplacement of two different magmas
- Zoned intrusions
  - Concentric gradations

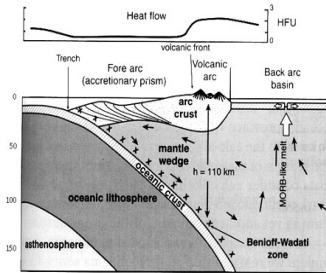
## Zoned Intrusions

- Concentric parts
- Successively less mafic inward
- Gradational contacts
- Assimilation of country rock?



## Emplacement Process

- Stopping
- Brecciation
- Doming
- Ballooning
- Void zones



Gill, 1981