Rheological properties of the shallow subduction interface: insights from the Chugach Complex, Alaska

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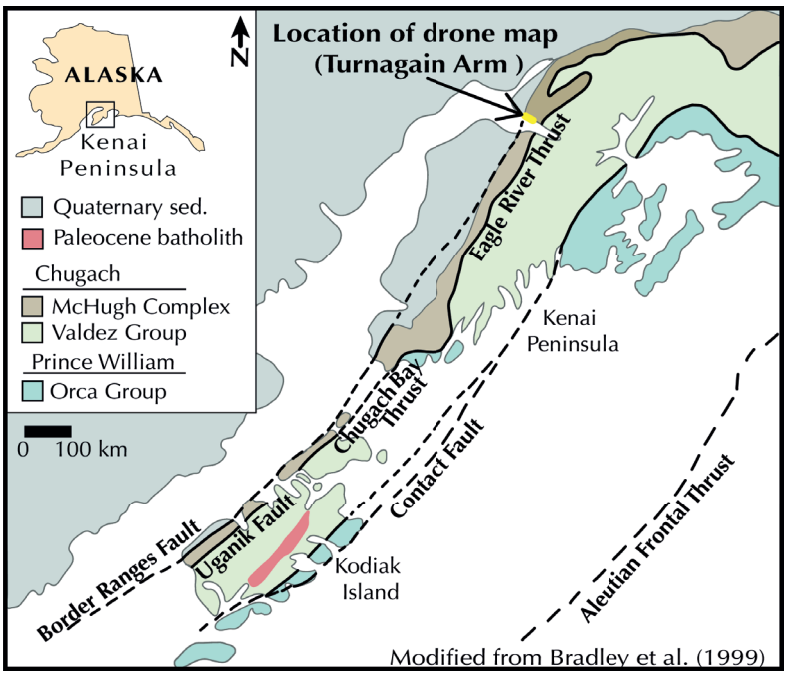
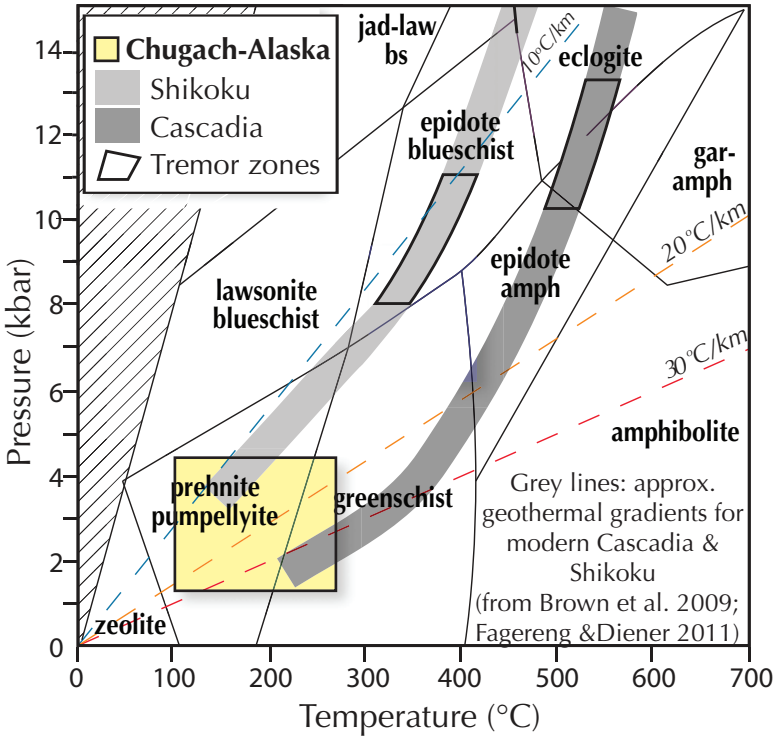
- Plate interface in subduction zones accommodates a range of seismic styles over different depths as a function of:
  - pressure-temperature conditions,
  - deformation mechanisms &
  - compositional & fluid-pressure heterogeneities,
  - degrees of strain localisation.

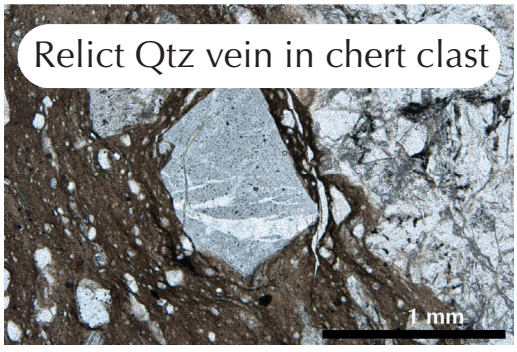
- Shallow subduction interface (i.e. ~2-10 km subduction depths) can exhibit either slow slip events (e.g. Hikurangi) or megathrust earthquakes (e.g. Tohoku).

- Chugach Complex exhibits progressive variations in subducted rock types through time, minimal post-subduction overprinting, & extensive along-strike exposure (~250 km).

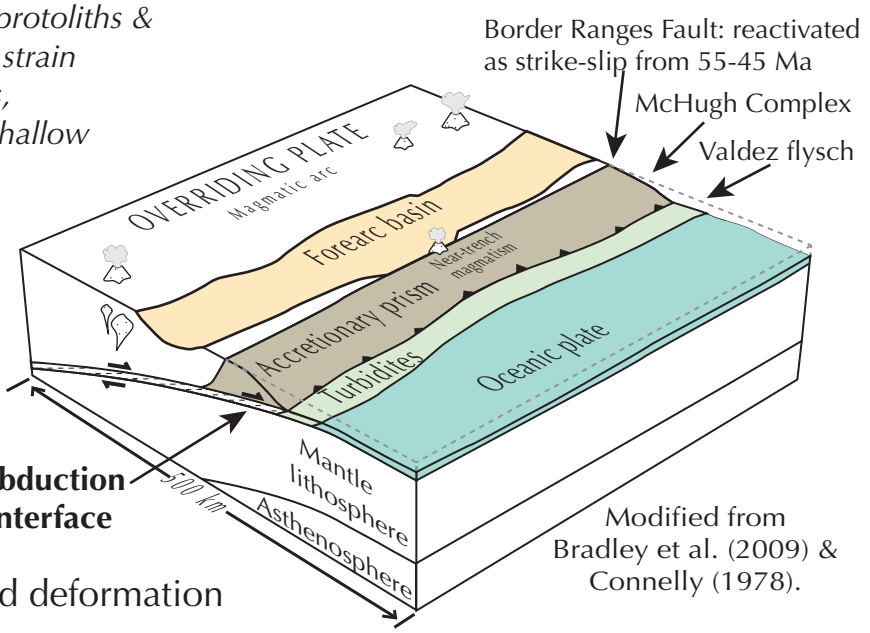




We aim to examine:
a) how strain is localised in different subducted protoliths &
b) the deformation processes, role of fluids, and strain localisation mechanisms within high strain zones,
in order to place rheological constraints on the shallow interface exposed in the Chugach



Solidifed rocks prior to subduction-related deformation



Modified from Bradley et al. (2009) & Connelly (1978).

Drone map of subduction interface in Turnagain Arm, NW Chugach

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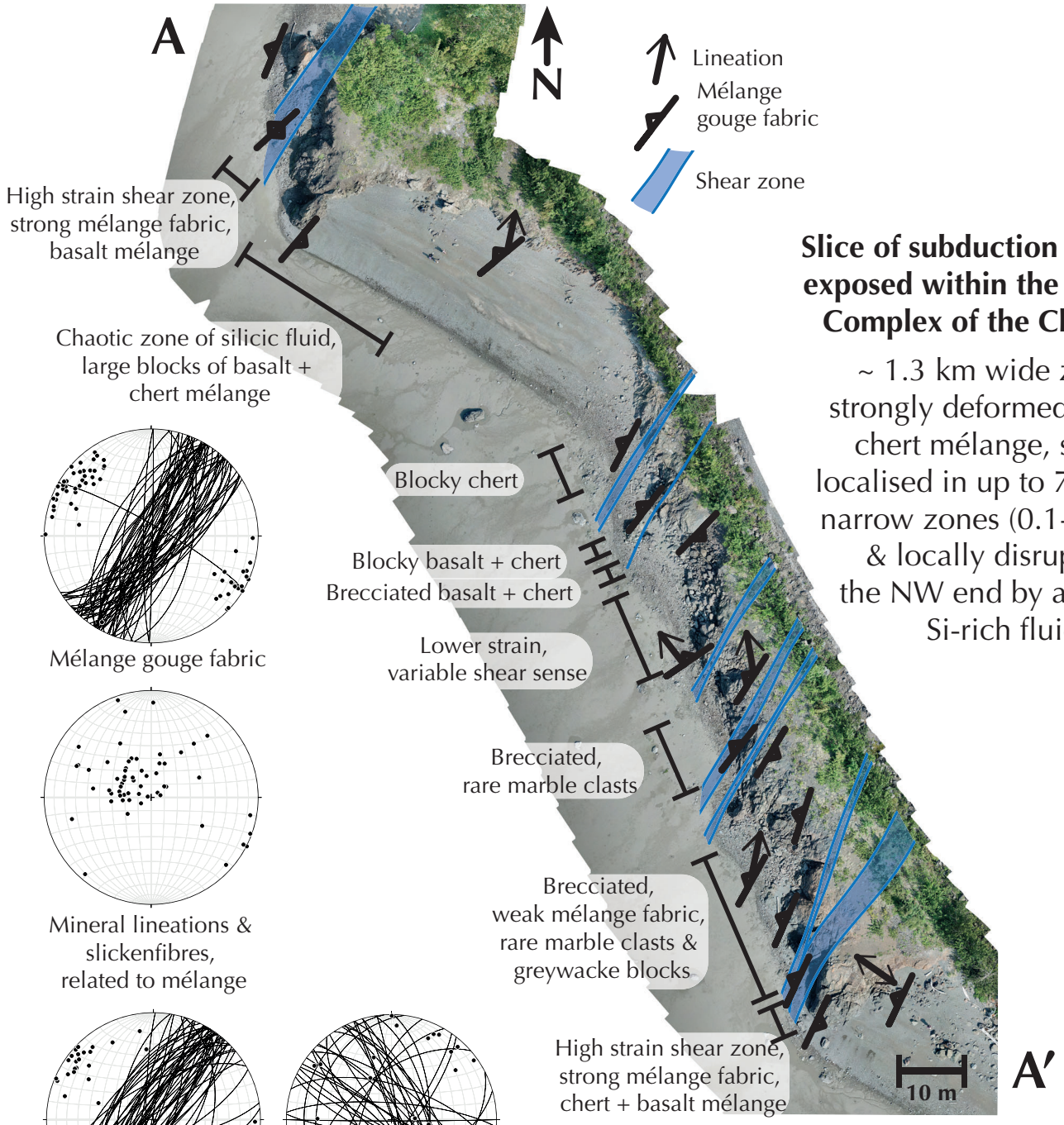


Slice of subduction interface exposed within the McHugh Complex of the Chugach:

~ 1.3 km wide zone of strongly deformed basalt & chert mélange, strain is localised in up to 7 relatively narrow zones (0.1-2m thick) & locally disrupted at the NW end by a zone of Si-rich fluid.

Mélange gouge fabric

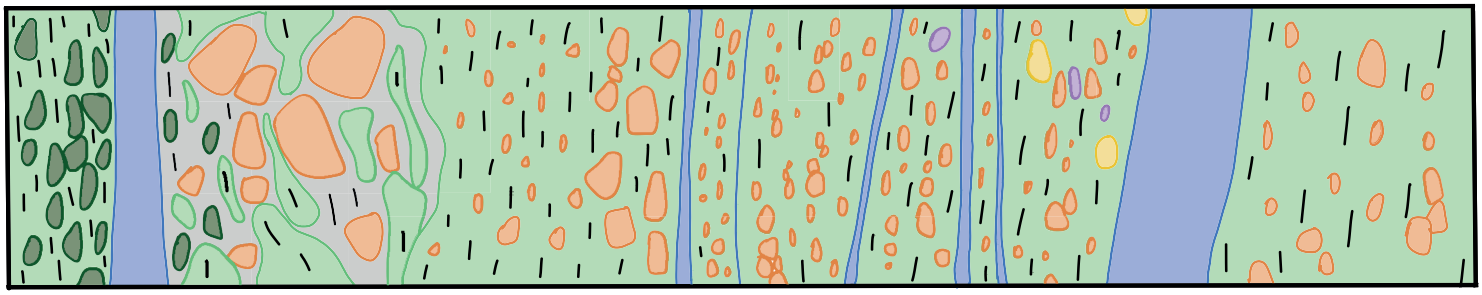
Mineral lineations & slickenfibres, related to mélange

Y-shears, boundary of shear zones

Faults, all

Basalt-derived matrix
Chert
High strain zones

A NW — A′ SE



Predominantly basalt (90%) mélange

Fluid-injection zone

Basalt (70%) & chert (30%) mélange with rare blocks of marble and greywacke

Strain Localisation in Basalt & Chert Tectonic Mélange

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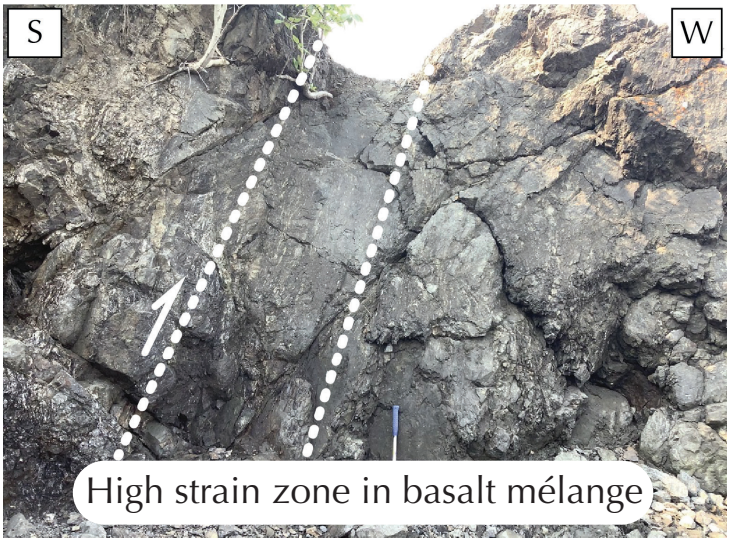
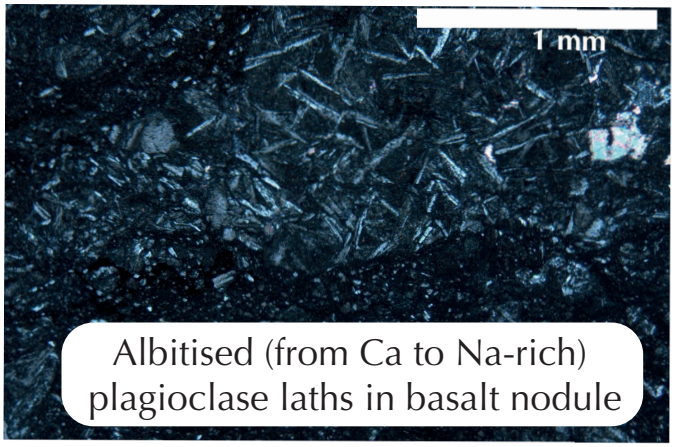
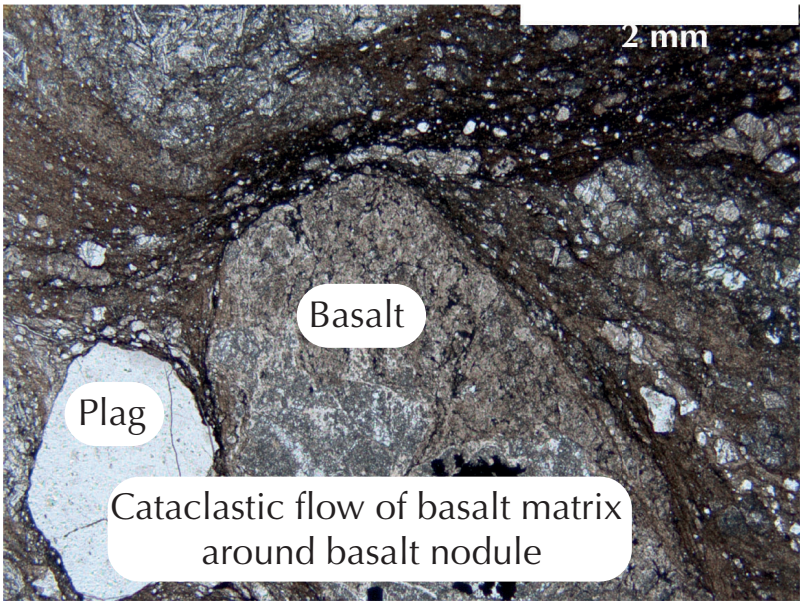


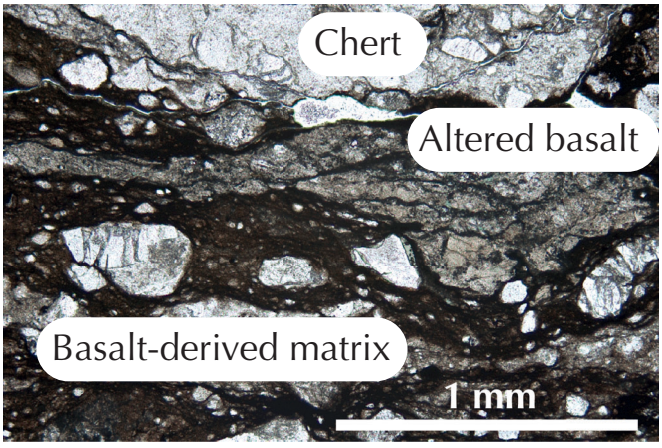
Strong tectonic fabric in mélange; green & black are different degrees of alteration of basalt

• *Matrix, from XRD:* Chl + Smectite + Mica (white mica/illite, undifferentiable) + Amorphous material

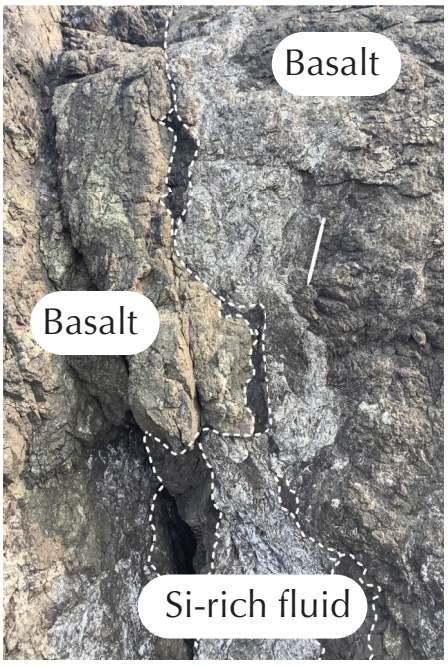
• Progressive granulation of basalt and chert creates fine-grained matrix through cataclasis



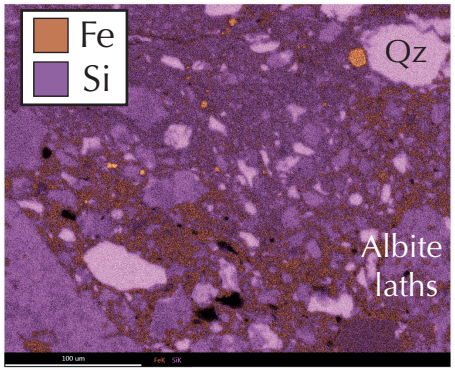




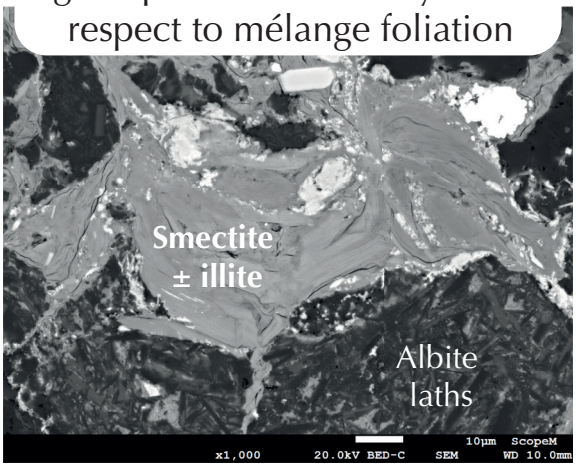
Strain Localisation in Fluid Injection Zone

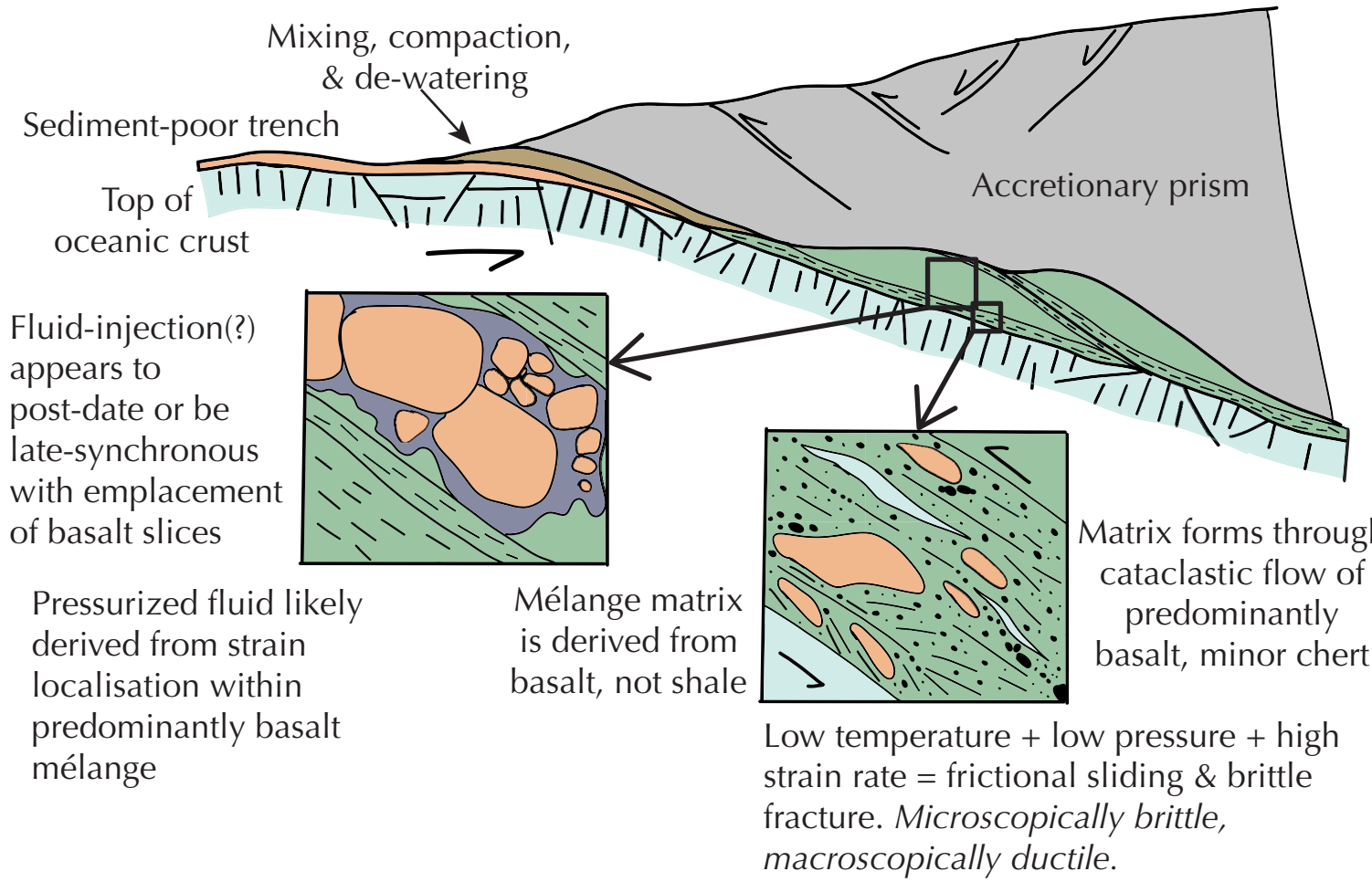


• Silicic fluid chaotically disrupts foliation
• Black rock bordering basalt blocks: clay, Fe-, T-, Ba-oxides, amorphous unkn.



Randomly oriented clay surrounded by nodules of albite, grew post-kinematically with respect to mélange foliation





Summary

• *High strain is localised in basalt*. Pillow basalt shows progressive flattening of pillows parallel to high strain zone boundaries. Within high strain zone, mélange gouge fabric is fine grained, strongly aligned and derived almost entirely from altered basalt.

• *Fluid and alteration types can be used to determine a relative sequence of events*. Glassy amorphous material is a relict of original basalt formation. Albitisation of plagioclase (Ca replaced by Na) occurred on the seafloor during interaction between fresh basalt and seawater. Chlorite and fine smectite with minor illite are a result of syn-subduction alteration. Randomly-oriented smectite (also with very minor illite) occured after the main subduction-related deformation and is associated with the siliceous fluid injection zone. We hypthesize that the Si-fluid was pressurized during shearing and emplacement of basalt slices and injected into material directly above these basalt high strain zones.

• *Subduction interface shear zone deforms primarily the lower plate*. Trench is starved of clastic sediment and subduction interface shear zone cuts down into lower plate and underplates top of oceanic crust.

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