From granulite hydration to metamorphic differentiation: Evolution of a shear zone

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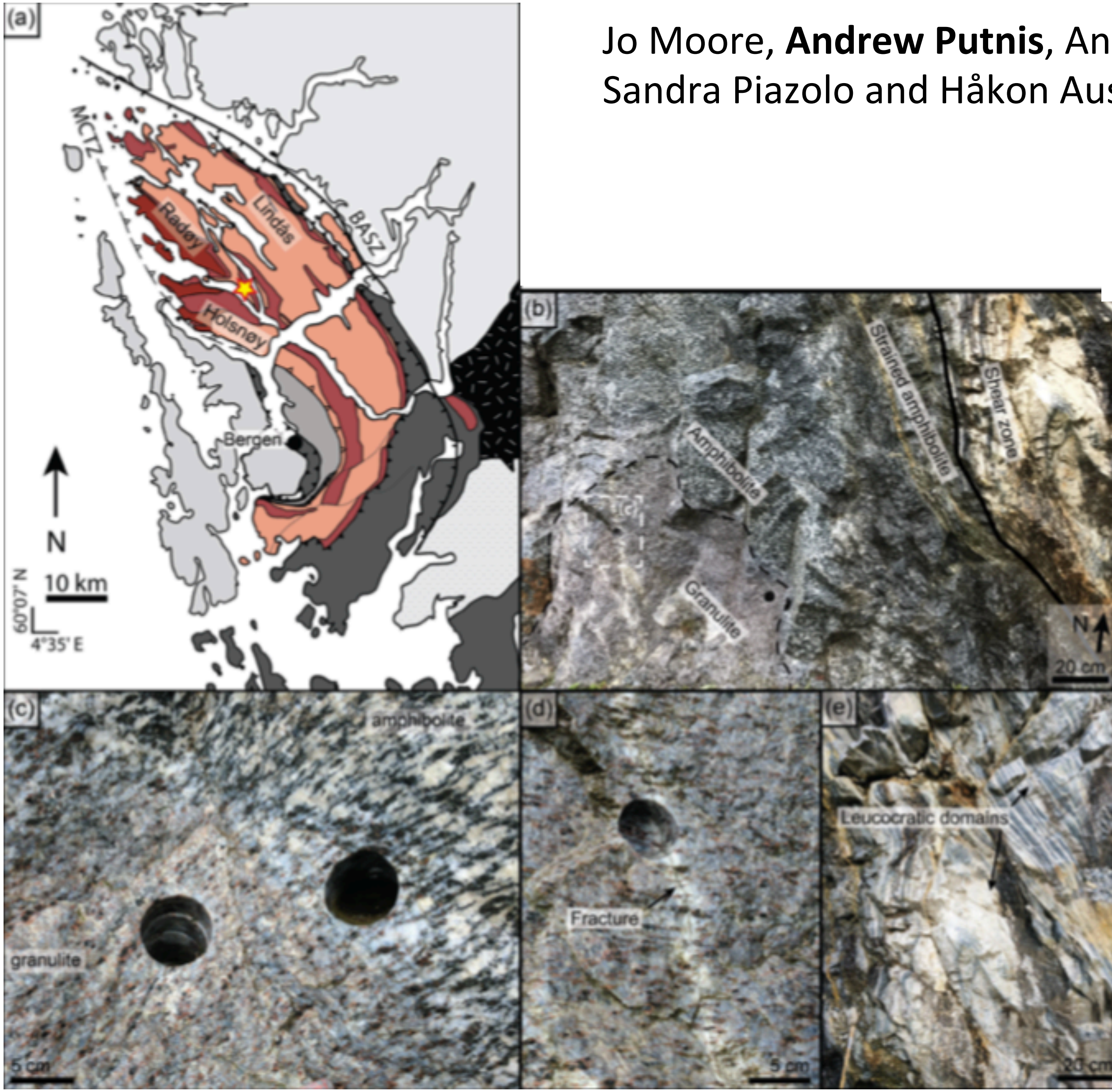

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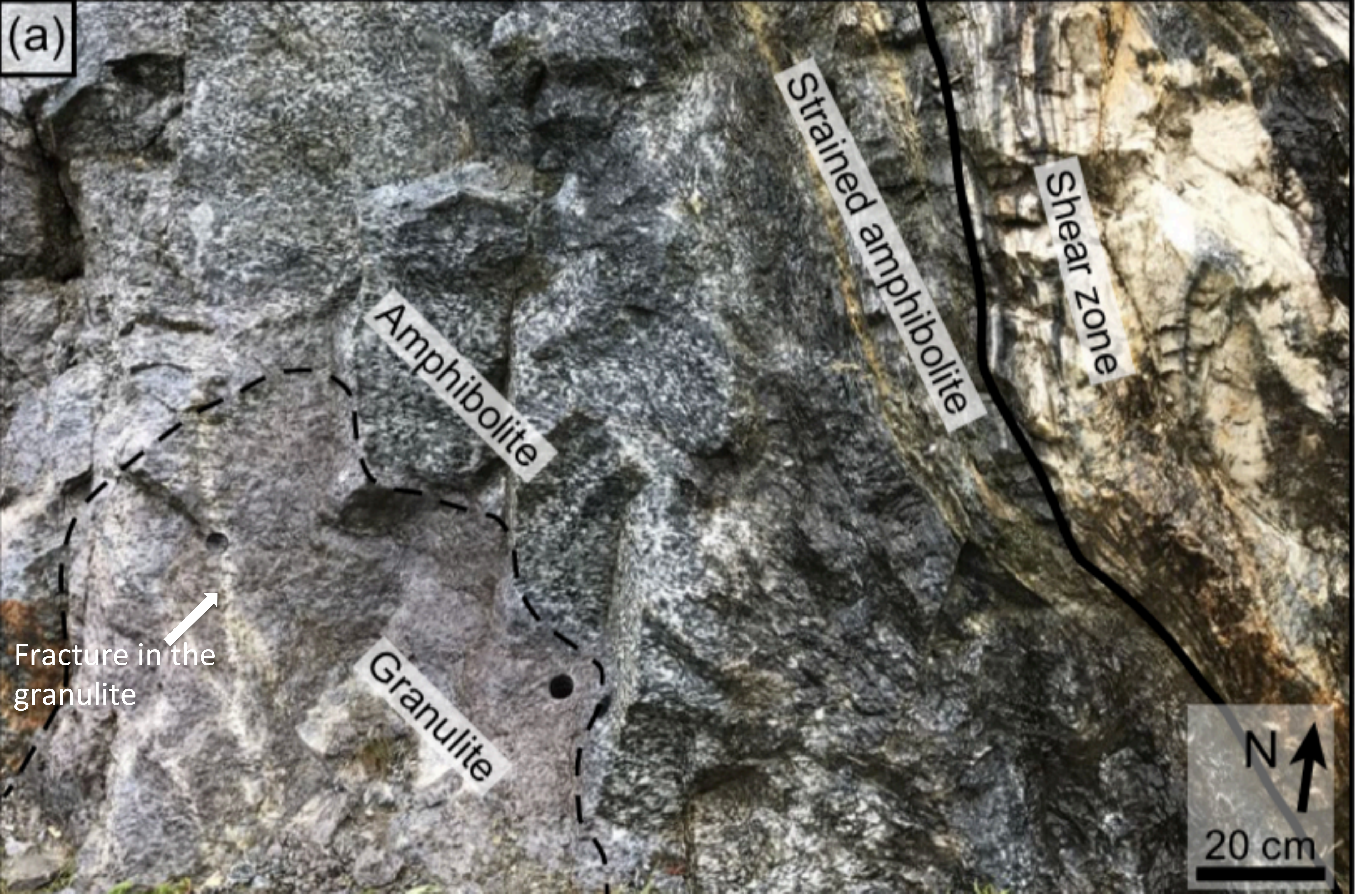


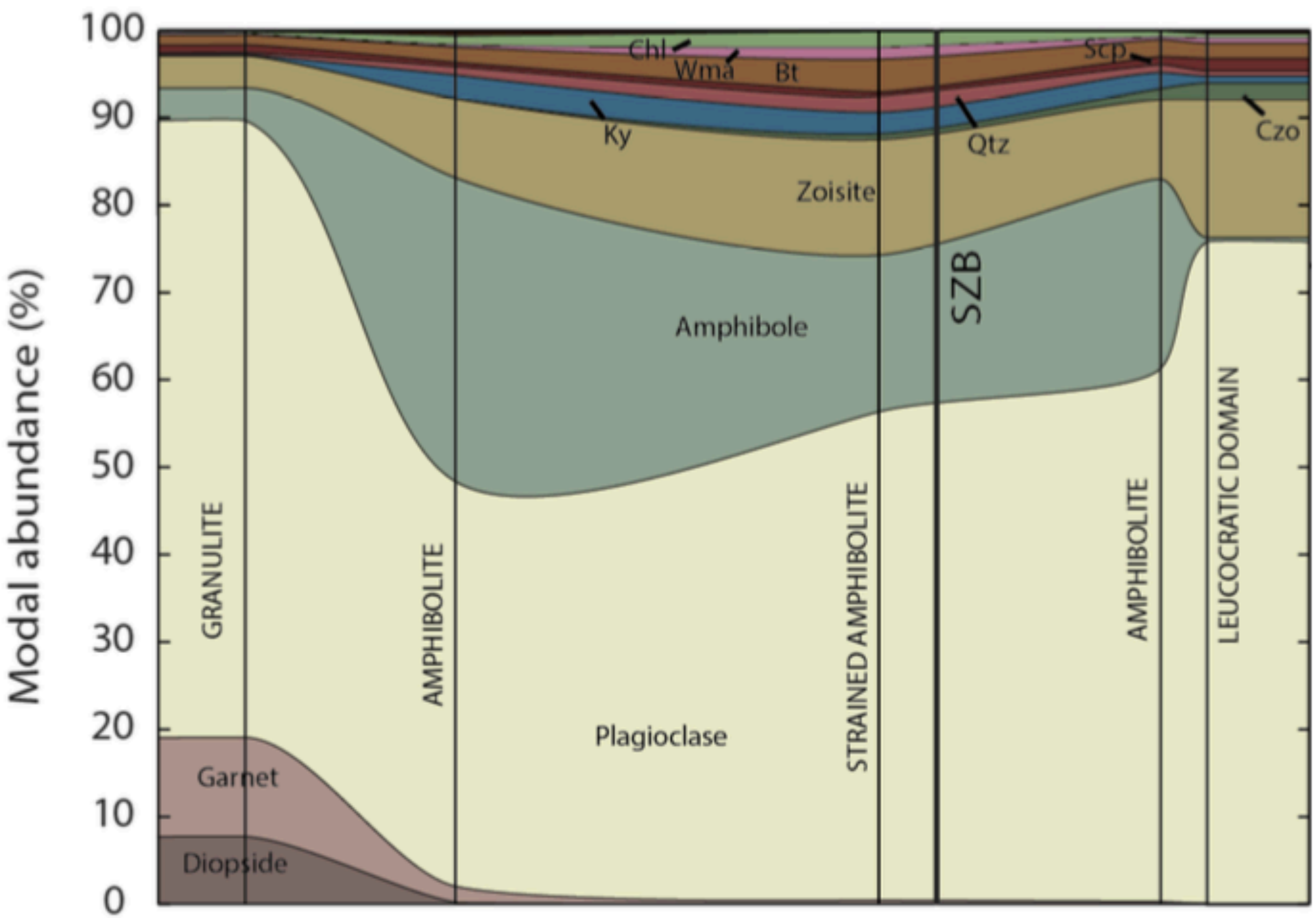
Metamorphic differentiation: Coupling between….

(i) an imposed differential stress

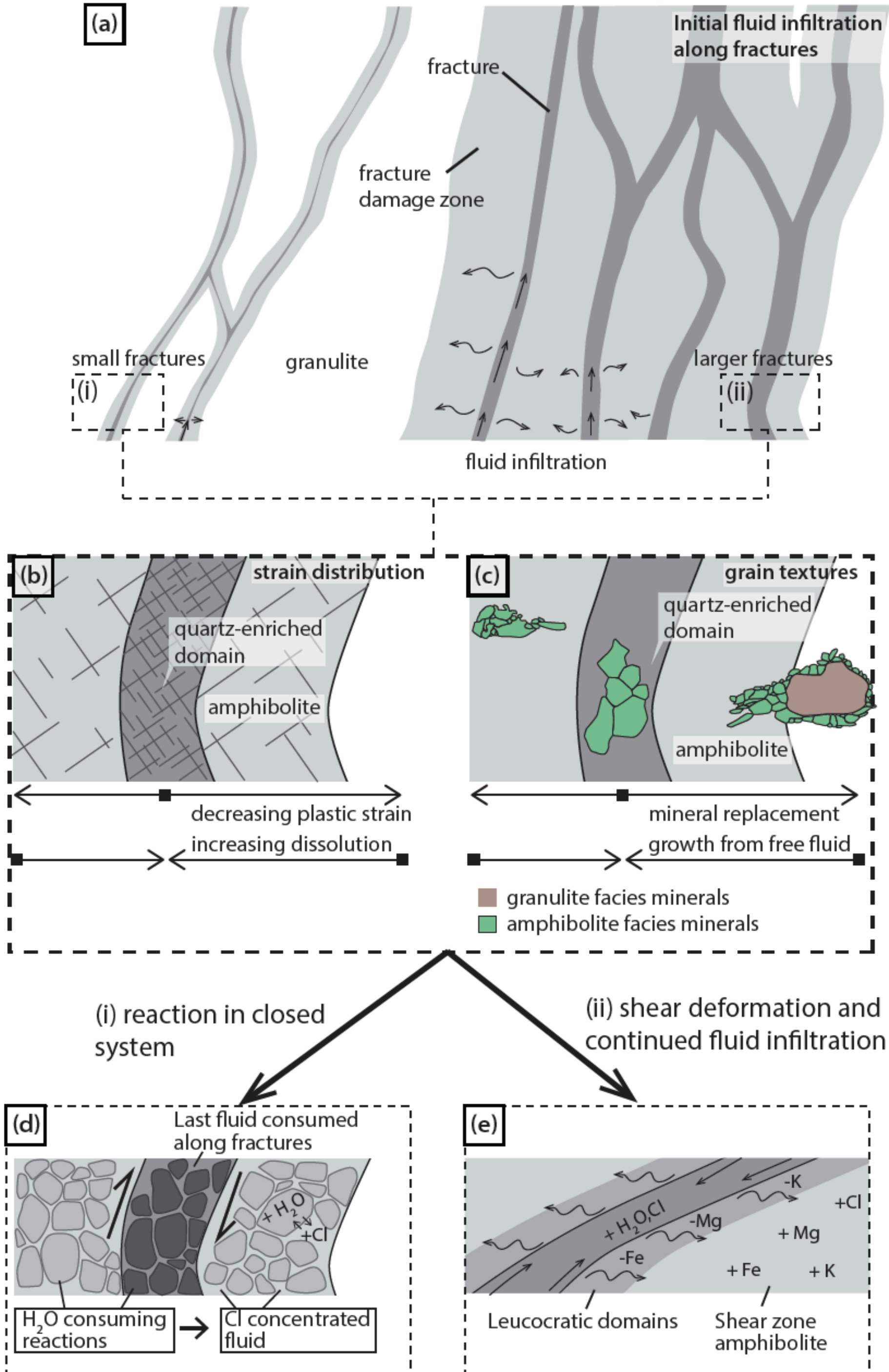
(ii) mass transport along a chemical potential gradient

Moore et al. :

- A detailed study of the petrography, quantitative mineral chemistry and bulk rock analyses applied to investigate compositional variations and assemblage microstructure.
- Thermodynamic modeling applied to provide additional constraints on the P-T-X_{H2O} conditions of assemblage formation and mass transfer.

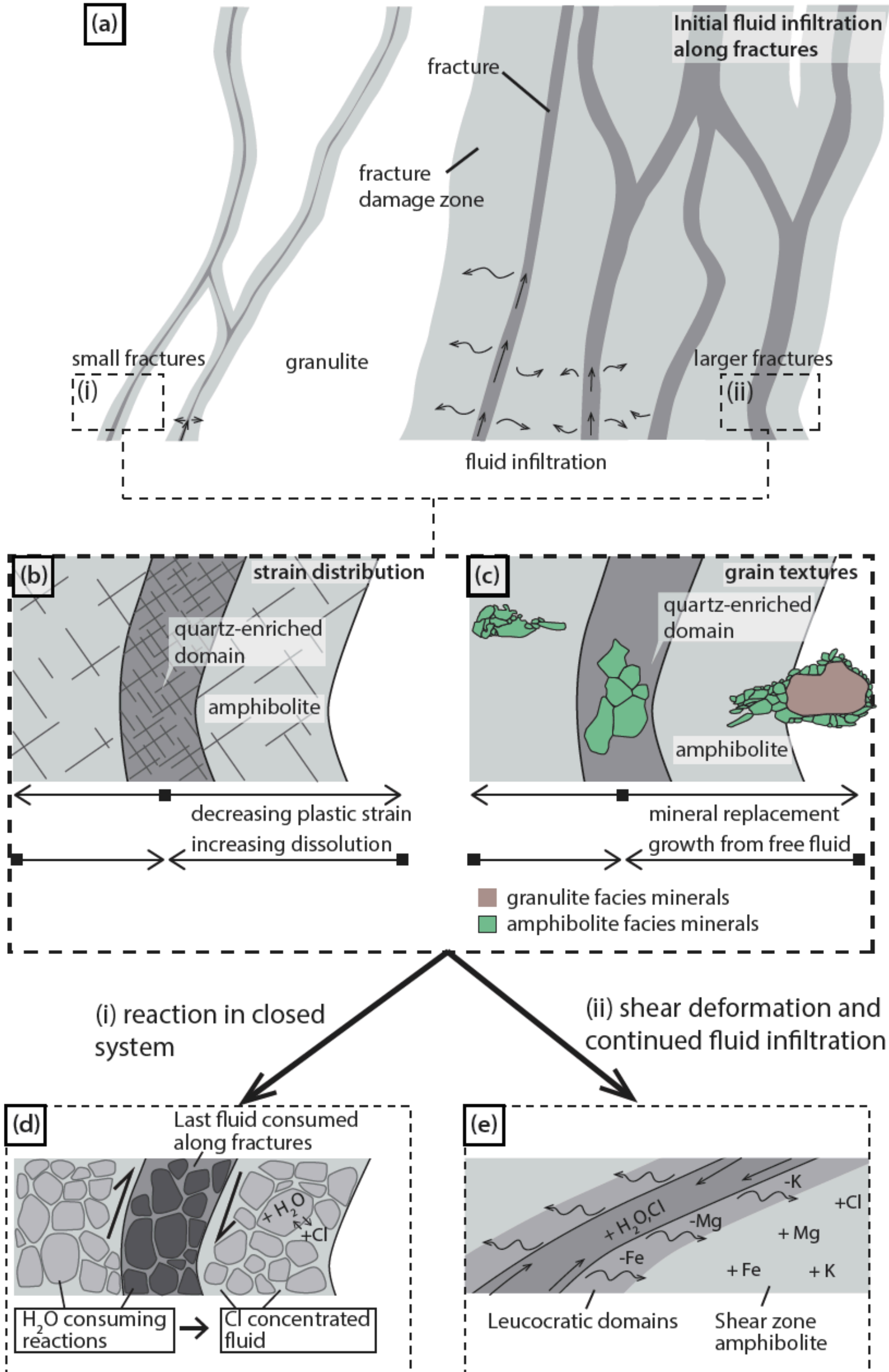


SZB :
Shear Zone Boundary



Conceptual model:

(a) Initial fluid infiltrates granulite along pre-existing fractures of varying size.
The stages illustrated in (b) and (c) are simultaneous. (b) Illustration of the strain distribution resulting from fracturing. The concentration of strain on a central plane enhances both fluid availability and dissolution within that zone. (c) Due to the heterogenous strain and fluid distribution the minerals grown in each domain have different characteristic textures. Minerals grown in the central fracture - quartz-enriched domains- have a microstructure characteristic of crystal growth in a free fluid. Minerals grown in the outer fracture damage zones - the amphibolite - are characteristic of interface-coupled dissolution and precipitation, leading to pseudomorphic replacement of granulite facies minerals.
(d) In areas where fracture damage zones are relatively small the system is closed off to further fluid infiltration. Here H_2O consuming reactions leave a final fluid that is concentrated in Cl, precipitating Cl-enriched minerals along fractures.
(e) In areas where fracture damage zones are sufficiently large and the localisation of shear is facilitated deformation enables continued fluid infiltration. The combined continued fluid infiltration and deformation results in the leaching of elements (Mg, Fe, and K) from the leucocratic domains, transporting them into the shear zone amphibolite.



CONCLUSIONS

1. Fracturing in the granulite: The reaction fracture assemblage in the fracture is identical to that occurring within leucocratic domains of the shear zone i.e. compositional layering in the shear zone is linked to fracturing during initial fluid infiltration.
2. Mass balance calculations indicate that the compositional differentiation resulted from internal mass distribution rather than partial melting or precipitation from the externally derived fluid.
3. The process of internal fractionation within the shear zone is driven by enhanced dissolution along fracture planes, resulting in the loss of MgO Fe_2O_3 and K_2O within from domains.
4. The mass transfer causing metamorphic differentiation of the shear zone is dependent on continuous fluid flux and heterogeneous strain distribution.