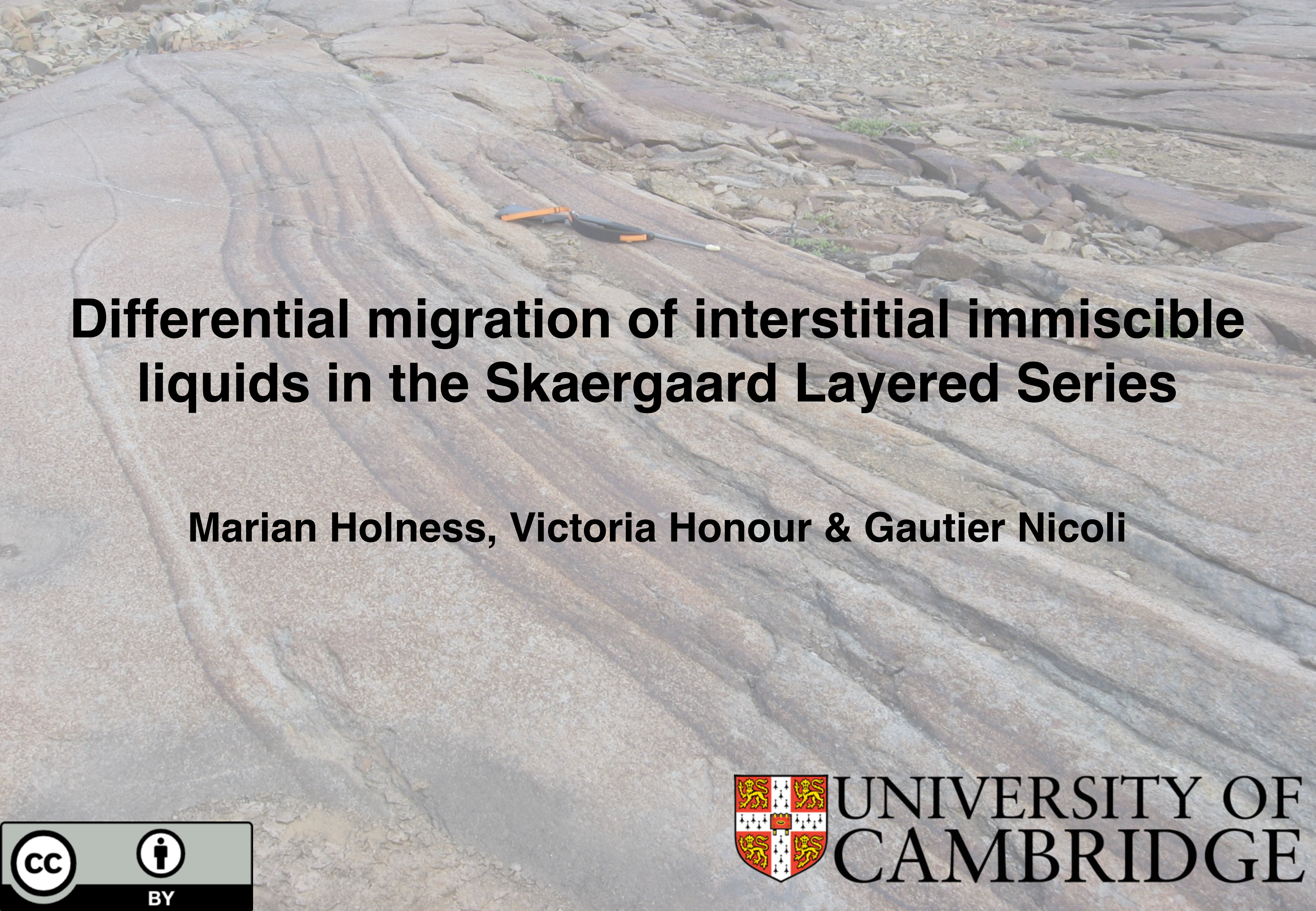

Differential migration of interstitial immiscible liquids in the Skaergaard Layered Series

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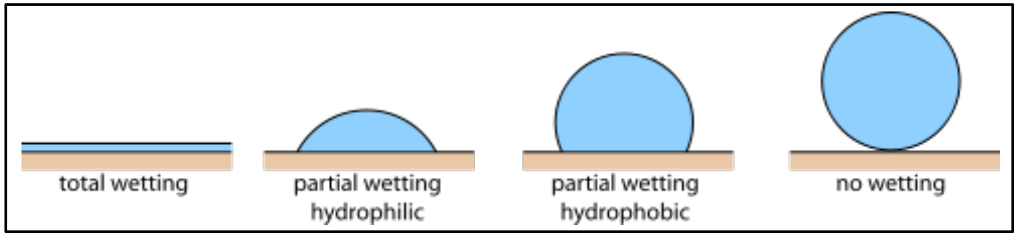
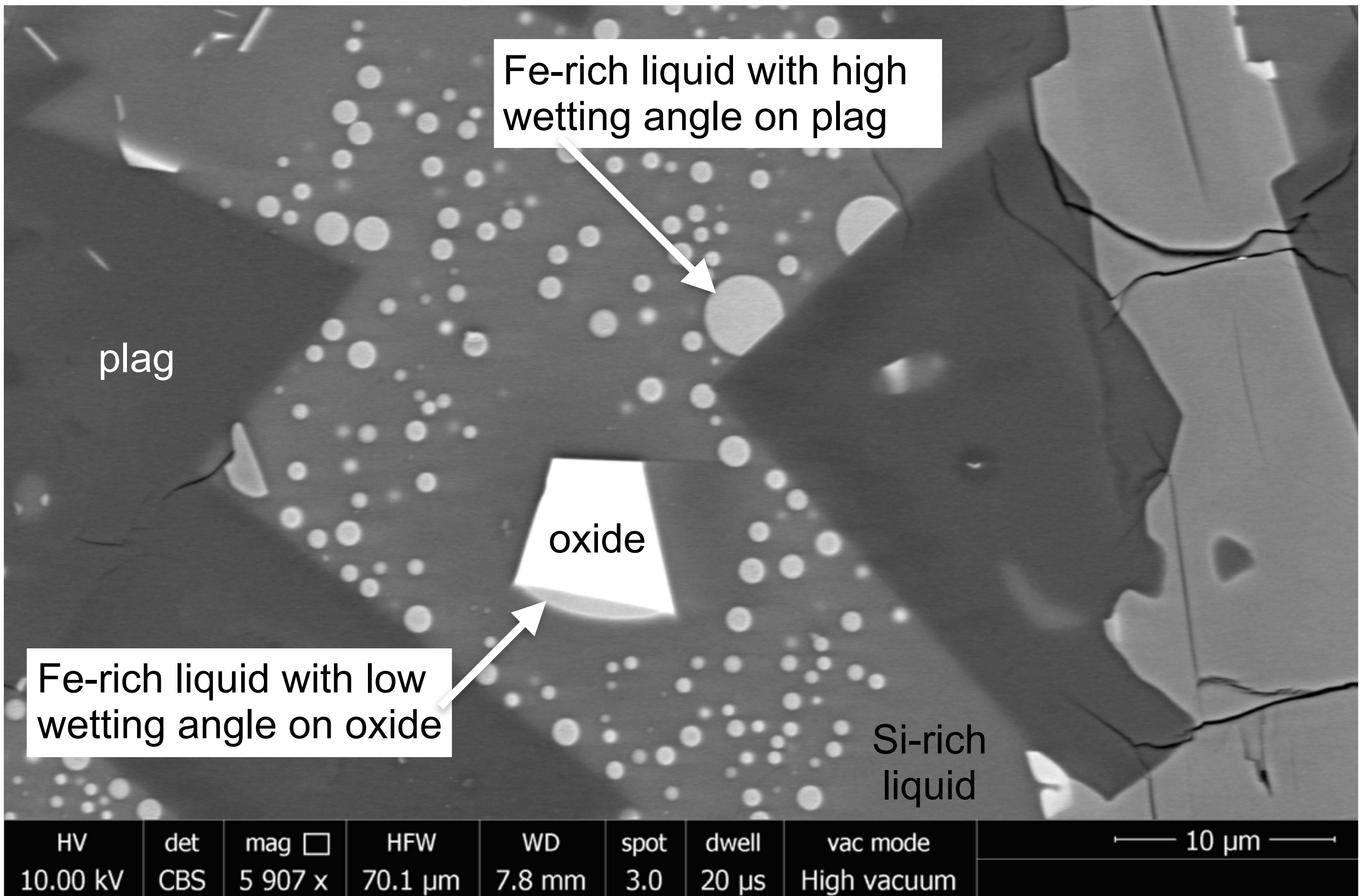
The liquid line of descent of the Skaergaard magma intersects a binodal creating an immiscible conjugate pair comprising an Fe-rich liquid and a Si-rich liquid.

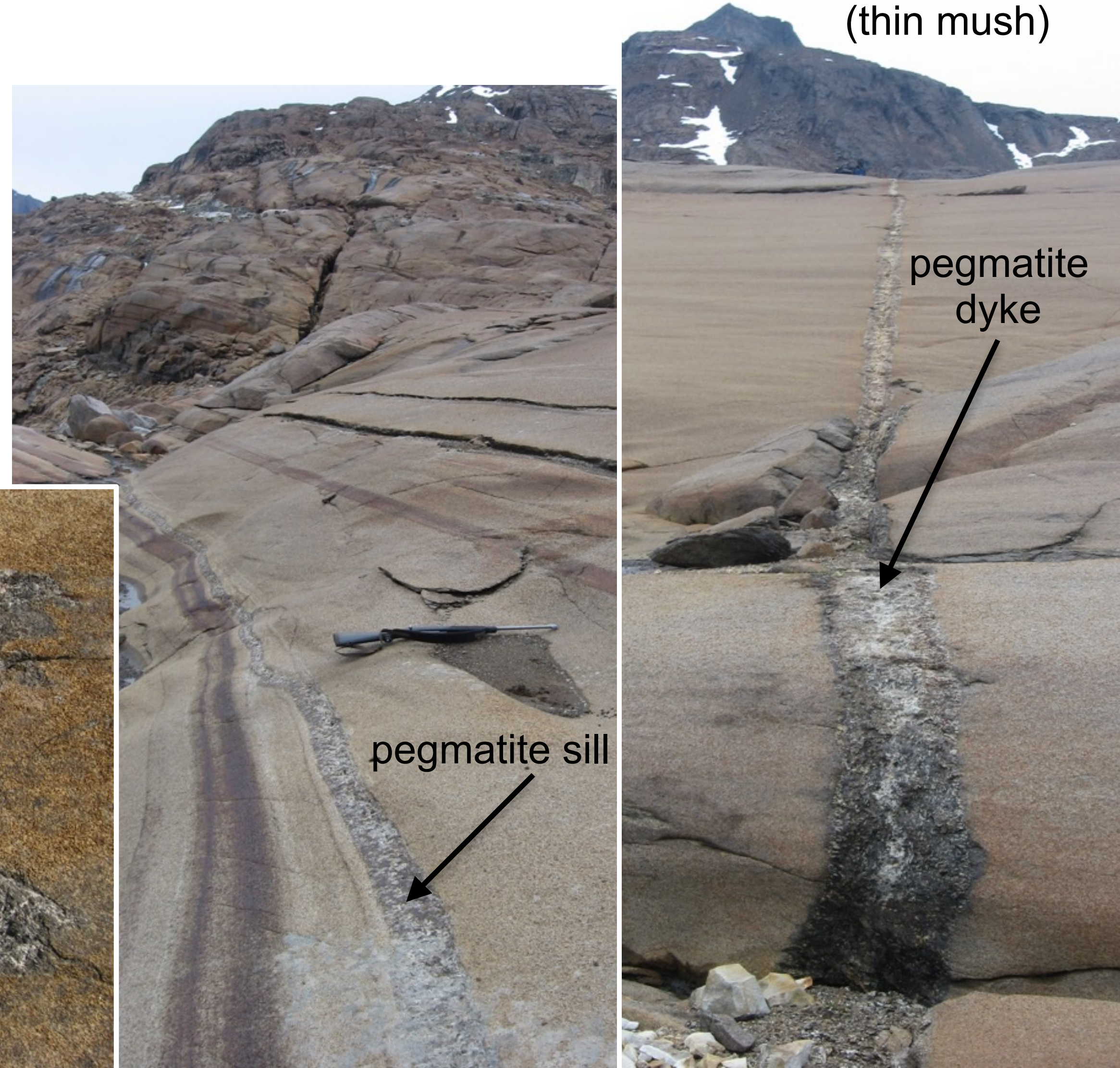
These two liquids have different physical properties: the Fe-rich liquid is dense and wets oxides, pyroxene and olivine; the Si-rich liquid is buoyant and wets plagioclase.





Gabbroic pegmatites are a common feature of the Skaergaard cumulates, representing segregations of late-stage interstitial liquid. They are irregular and rounded in the lower parts of the intrusion, where the mush is thick, but form sharply-bounded sills and dykes in the upper part of the floor series, where the mush was thin (Larsen & Brooks, 1984; Holness *et al*., 2017).

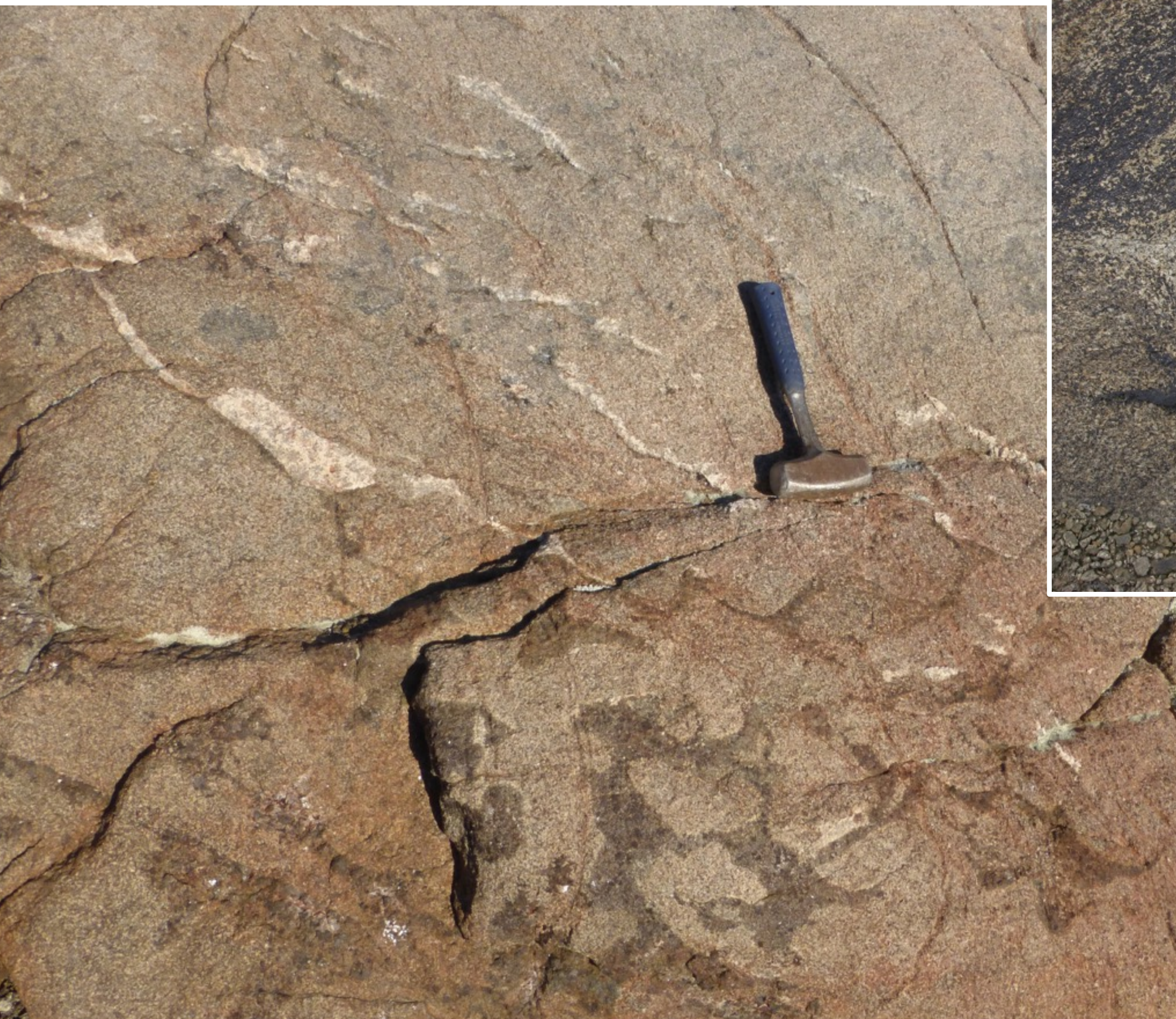
Gabbroic pegmatites seen high in stratigraphy (thin mush)

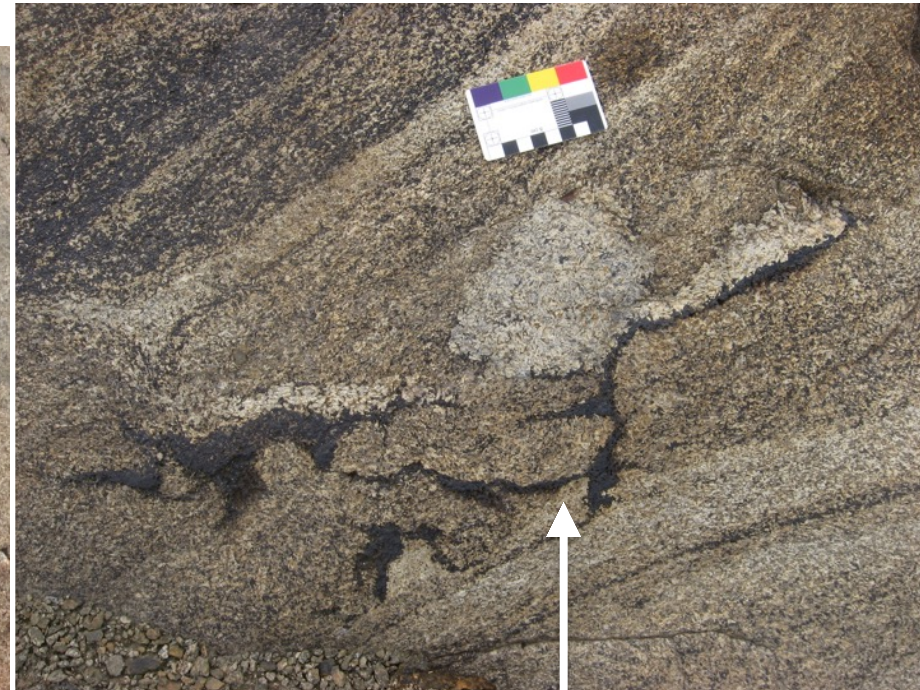


Gabbroic pegmatites seen low in stratigraphy (thick mush)

Paired felsic and mafic lenses are abundant stratigraphically above many pegmatite bodies, and represent small batches of highly-evolved liquids that rose into the overlying mush, and then separated into immiscible conjugates.

The paired lenses form irregular, approximately layer-parallel, clusters in thick mush. The Fe-rich component comprises oxide-rich olivine pyroxenite. Its greater density means it invariably underlies the Si-rich component, which is formed of plagioclase and granophyre.

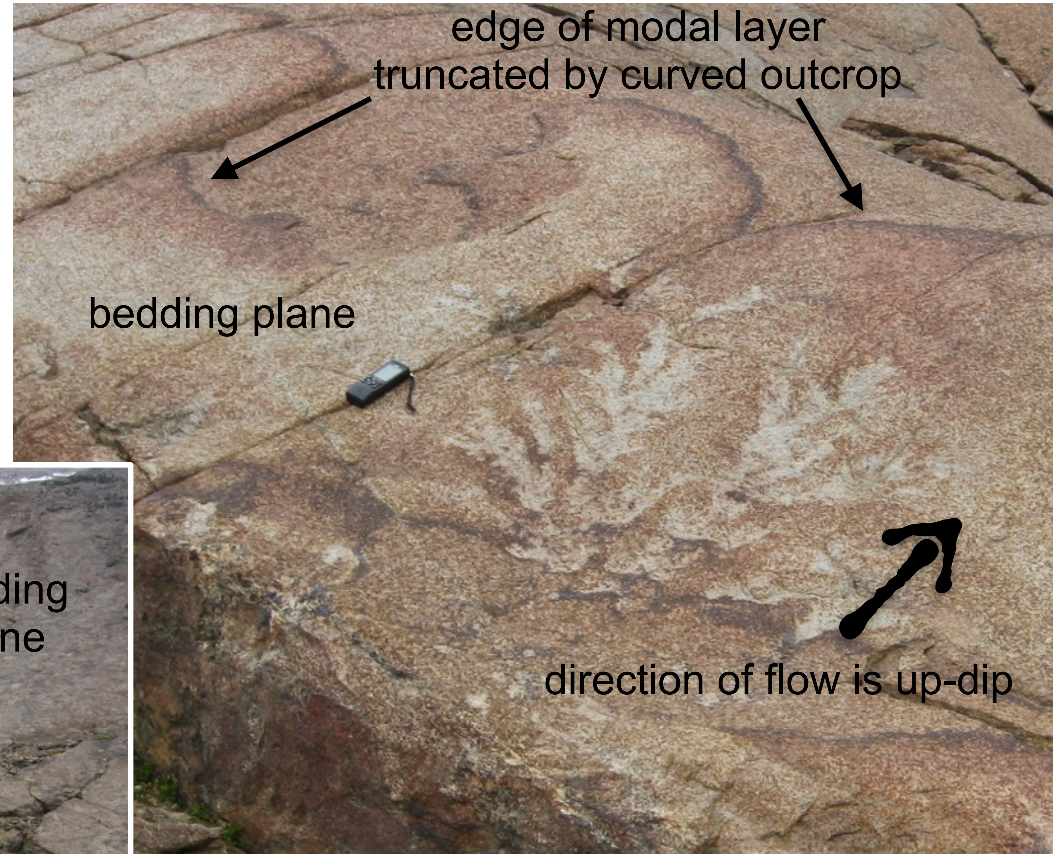




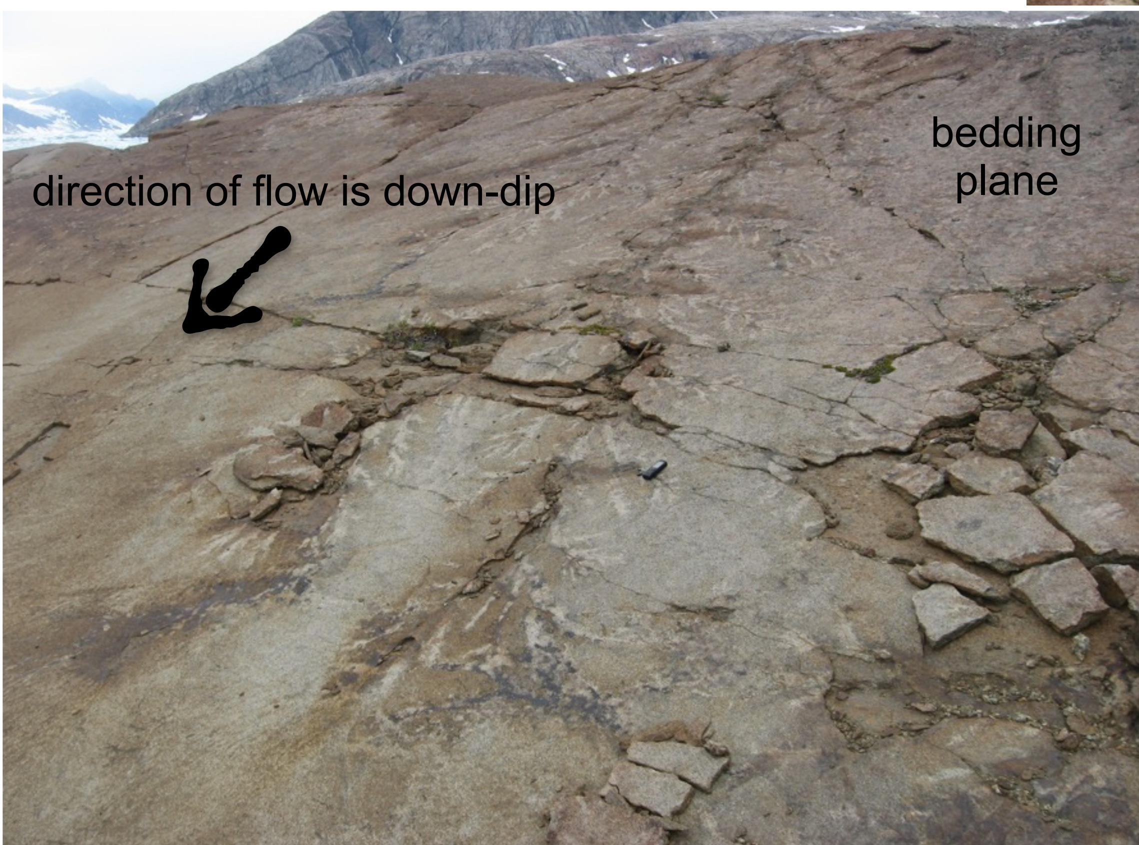
The dense Fe-rich liquid sinks to the bottom of a pocket of late-stage liquid, and infiltrates the underlying mush

The paired segregations form concordant dendritic structures on bedding planes in thin, low-porosity, mush. We interpret this to be an example of Hele-Shaw flow of a coarse emulsion, with segregation of the two components.

Invariably the dense melanocratic component lies down-dip, regardless of the flow direction.

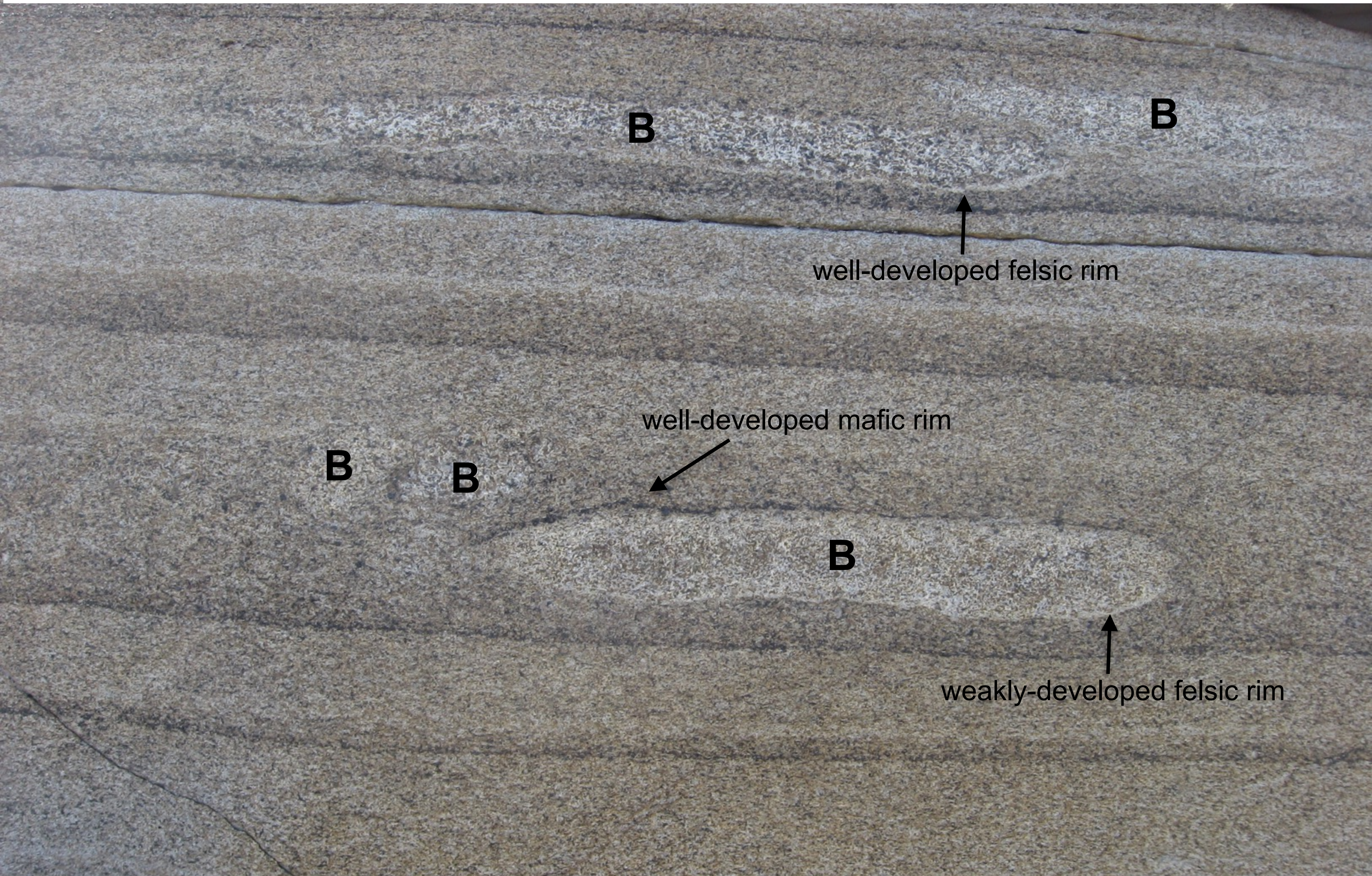


Melanocratic component near the injection point, with flow up-dip



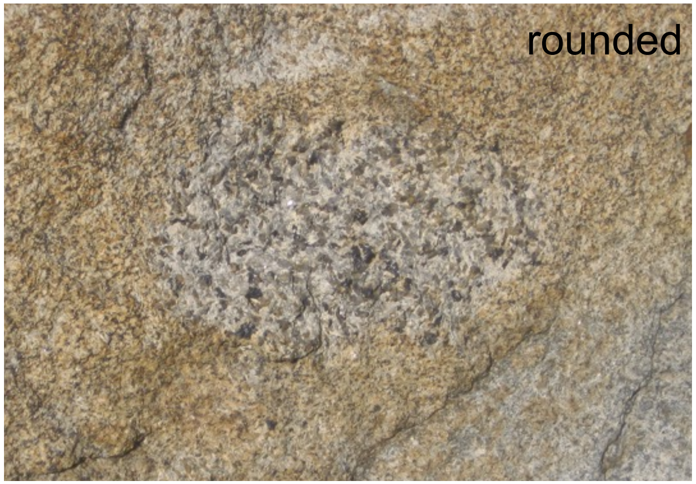
Melanocratic component at the dendrite tips, with flow down-dip

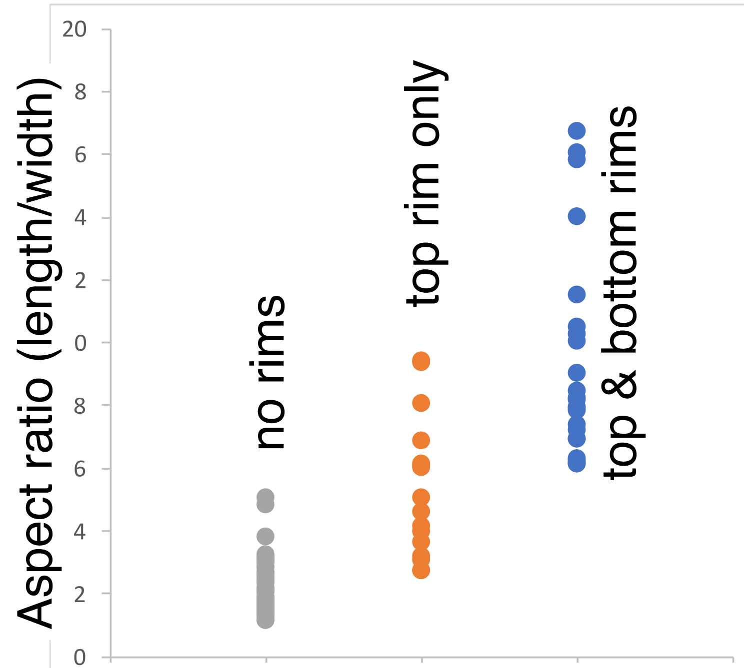
Differential migration within the floor cumulates is also recorded by mm-scale mafic and felsic rims developed on the top and bottom margins of anorthositic blocks (denoted B) derived from the roof.



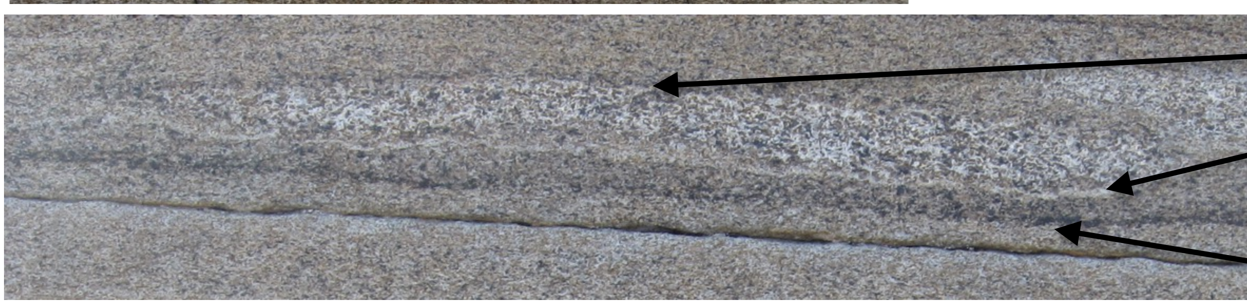
Highly tabular blocks have an upper mafic rim and a lower leucocratic rim. As the block aspect ratio decreases, the rims disappear, with the mafic rim retained at lower aspect ratios than the leucocratic rim.

We interpret this as a consequence of trapping migrating interstitial liquid against the relatively impermeable blocks: upwards-migrating Si-rich liquid is trapped at the lower margin of blocks, while Fe-rich liquid moves downwards and is trapped at the top of blocks. Tabular blocks are most effective at trapping these liquids.

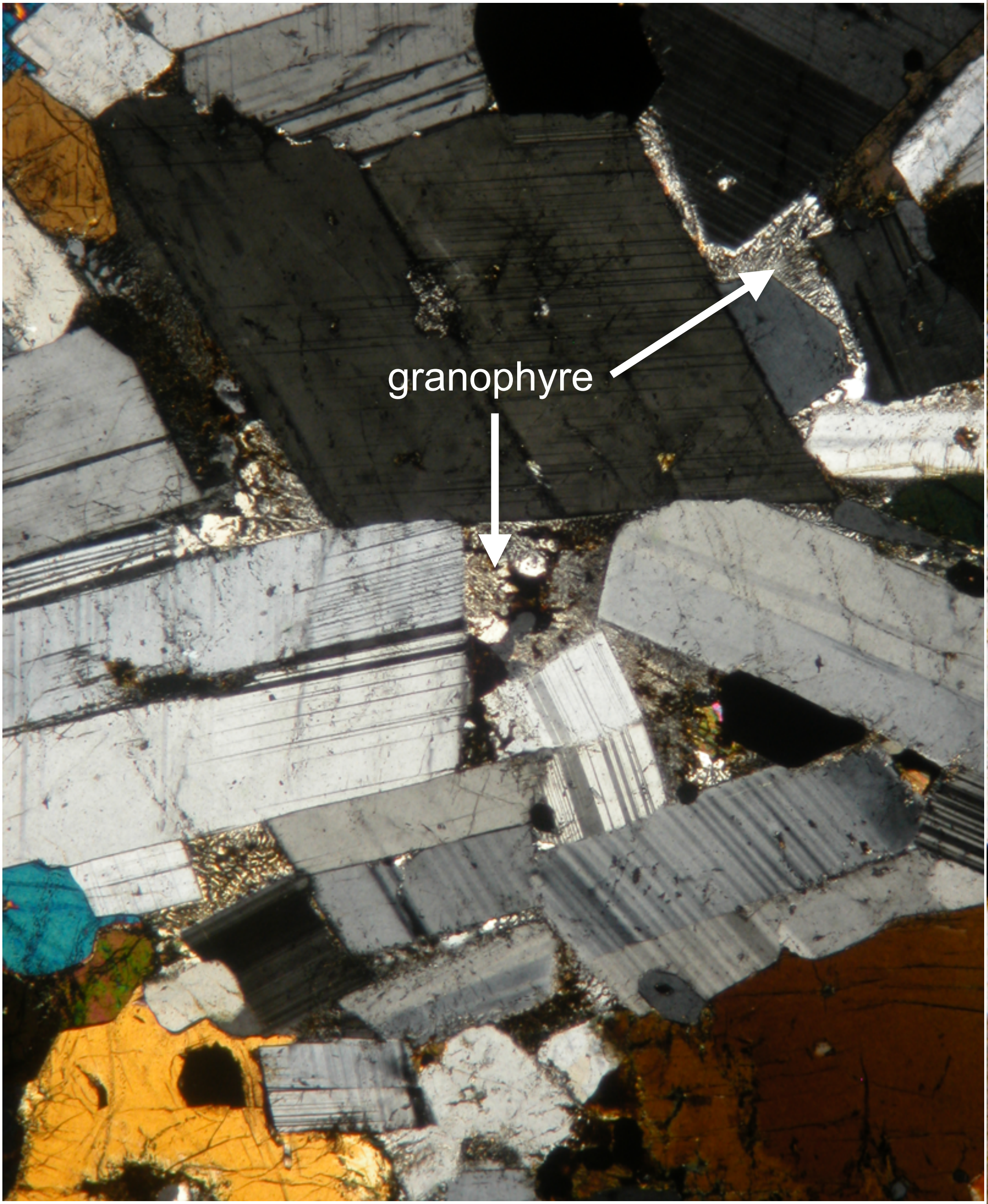




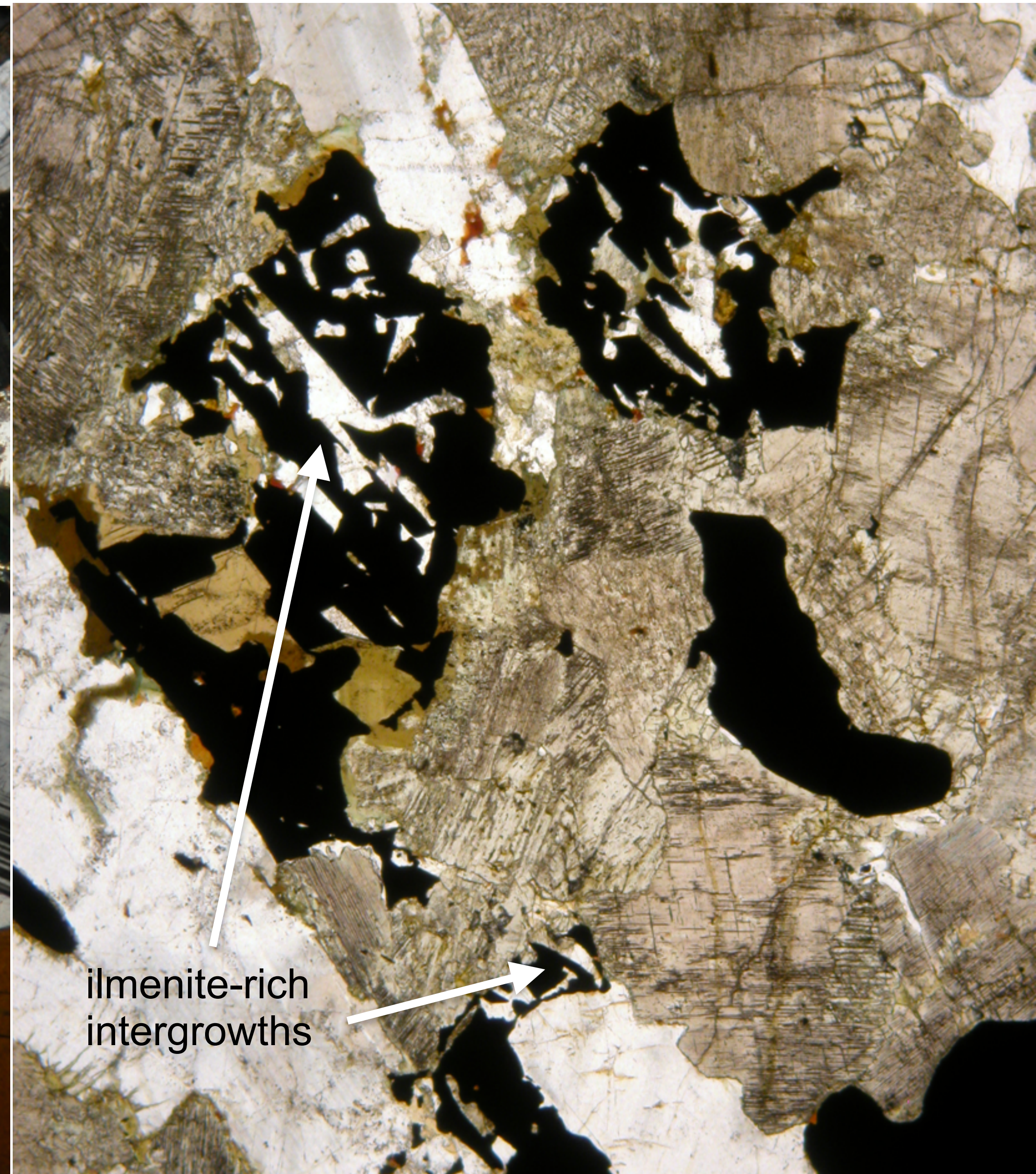
data from 2D intersections of blocks on glacially-polished outcrops. Each dot represents a single block. True 3D shape of blocks is not known



The different wetting properties of the two immiscible conjugates drive differential migration within the mush

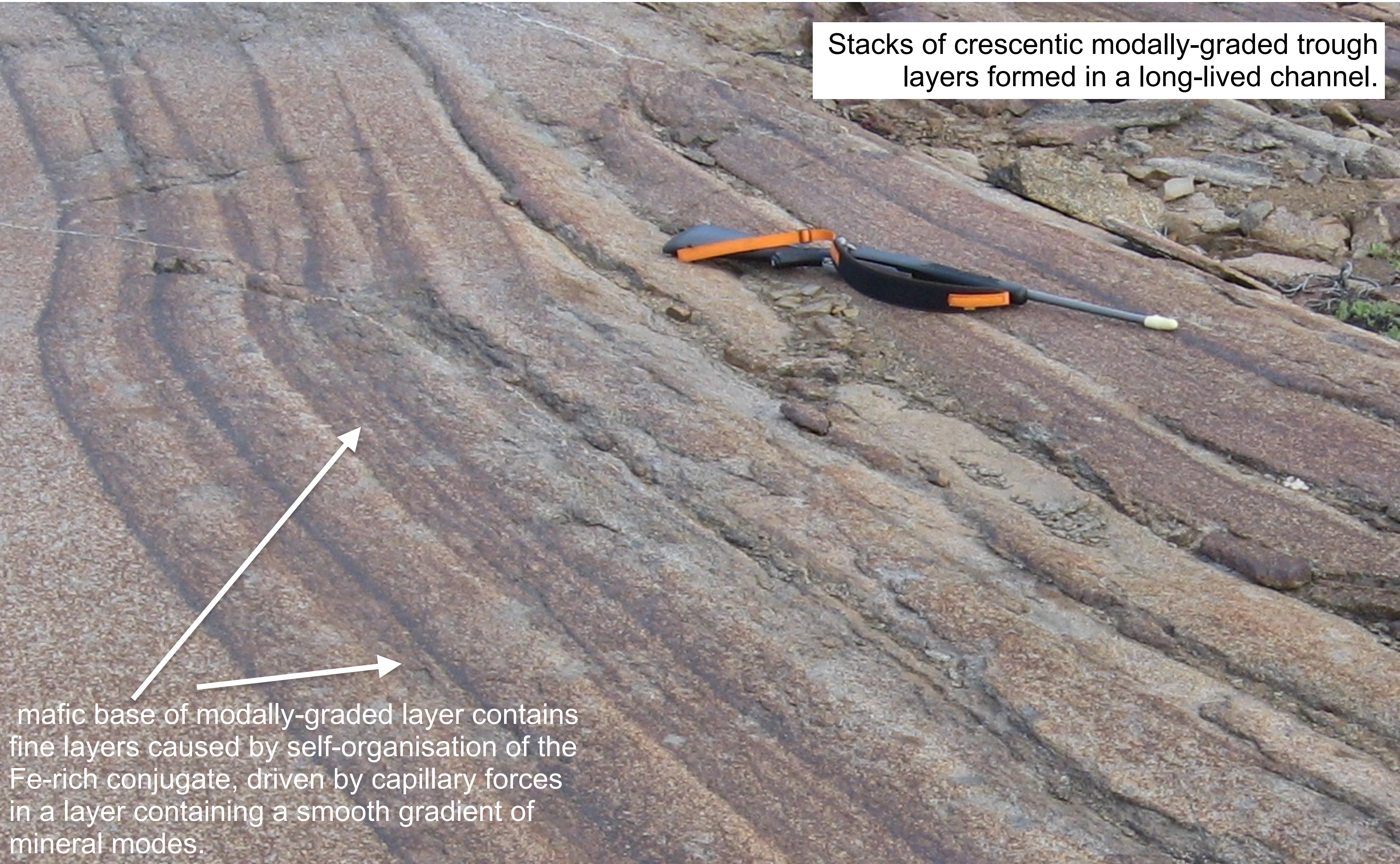


The Si-rich liquid segregates into pores bounded by plagioclase, and crystallises to form granophyre.

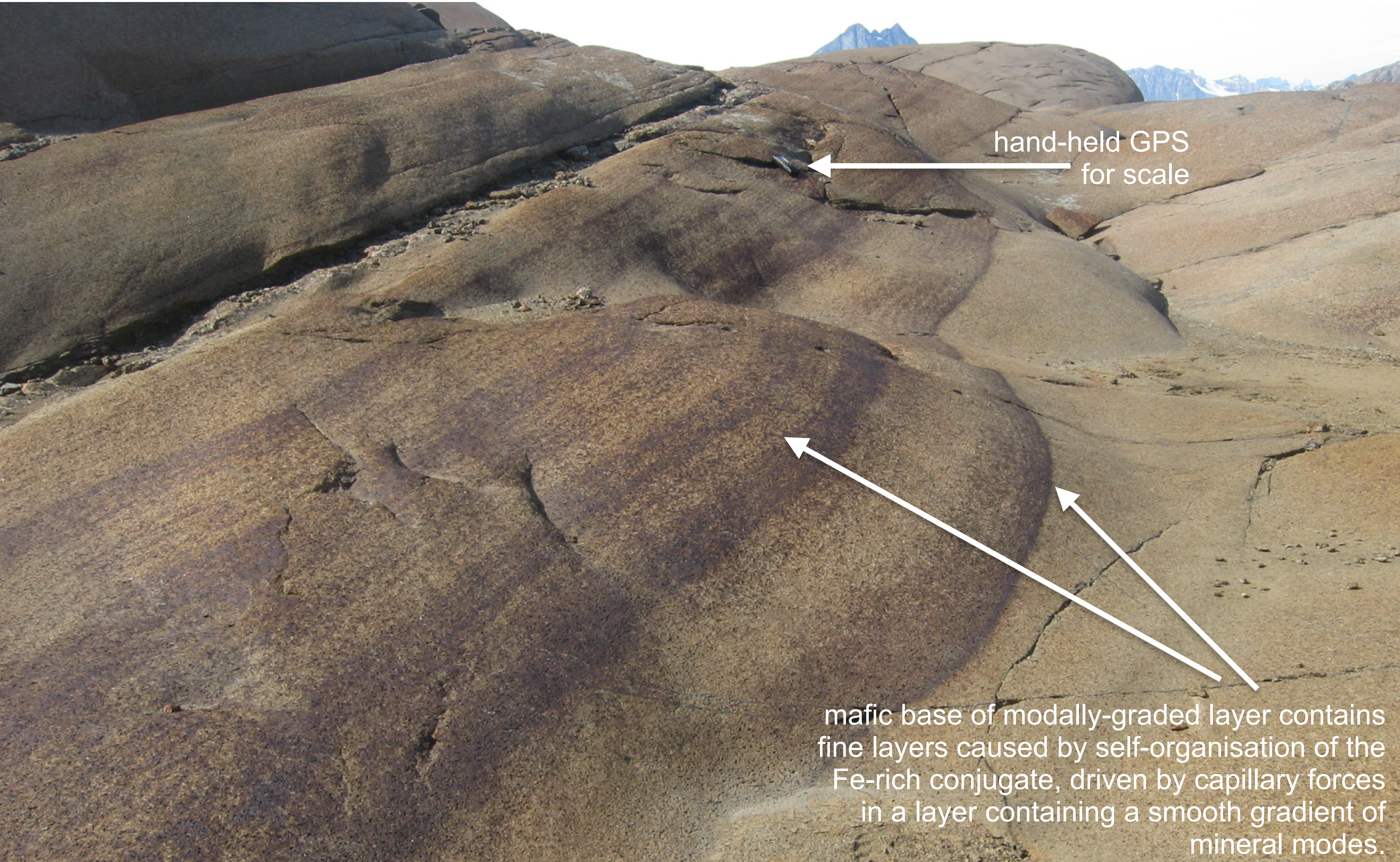


The Fe-rich liquid segregates into pores bounded by mafic phases or oxides, and crystallises to form complex intergrowths dominated by ilmenite.

The different wetting properties of the two immiscible conjugates result in post-accumulation self-organisation of the interstitial liquid in rapidly deposited, modally graded, layers, with the felsic conjugate segregating into the tops of the layers and the mafic conjugate ponding at the base.



The different wetting properties of the two immiscible conjugates result in post-accumulation self-organisation of the interstitial liquid in rapidly deposited, modally graded, layers, with the felsic conjugate segregating into the tops of the layers and the mafic conjugate ponding at the base.



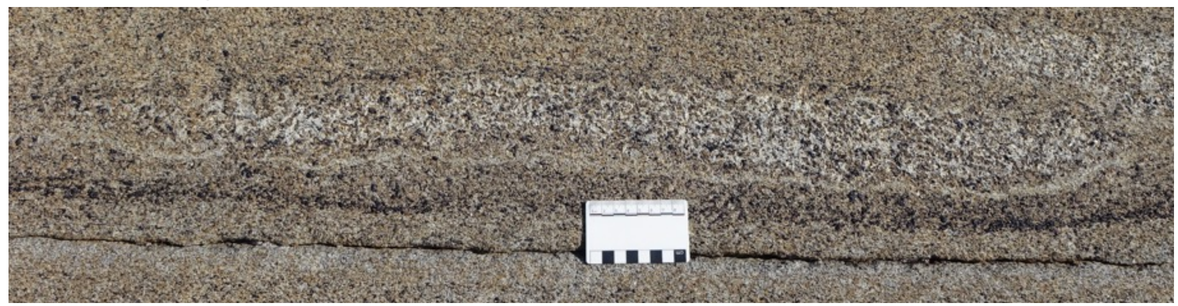
The tops of the modally-graded layers may also develop felsic flame-like structures.

These are a consequence of upwards-migration of the immiscible Si-rich component of the interstitial liquid from high-porosity rapidly deposited layers into the overlying cumulates.

Differential migration of interstitial immiscible liquids in the Skaergaard Layered Series

localised migration of large bodies of emulsion that then separate into their conjugate components.

pervasive differential migration of the separated emulsion through the crystal mush



Understanding mass transport in a crystal mush containing a two-phase interstitial liquid depends not only on mush thickness and permeability, but also on cm-scale distribution of constituent mineral phases.

References:

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Larsen, R.B. & Brooks, C.K. (1984) Origin and evolution of gabbroic pegmatites in the Skaergaard Intrusion, East Greenland. *Journal of Petrology*, **35**: 1651-1679.