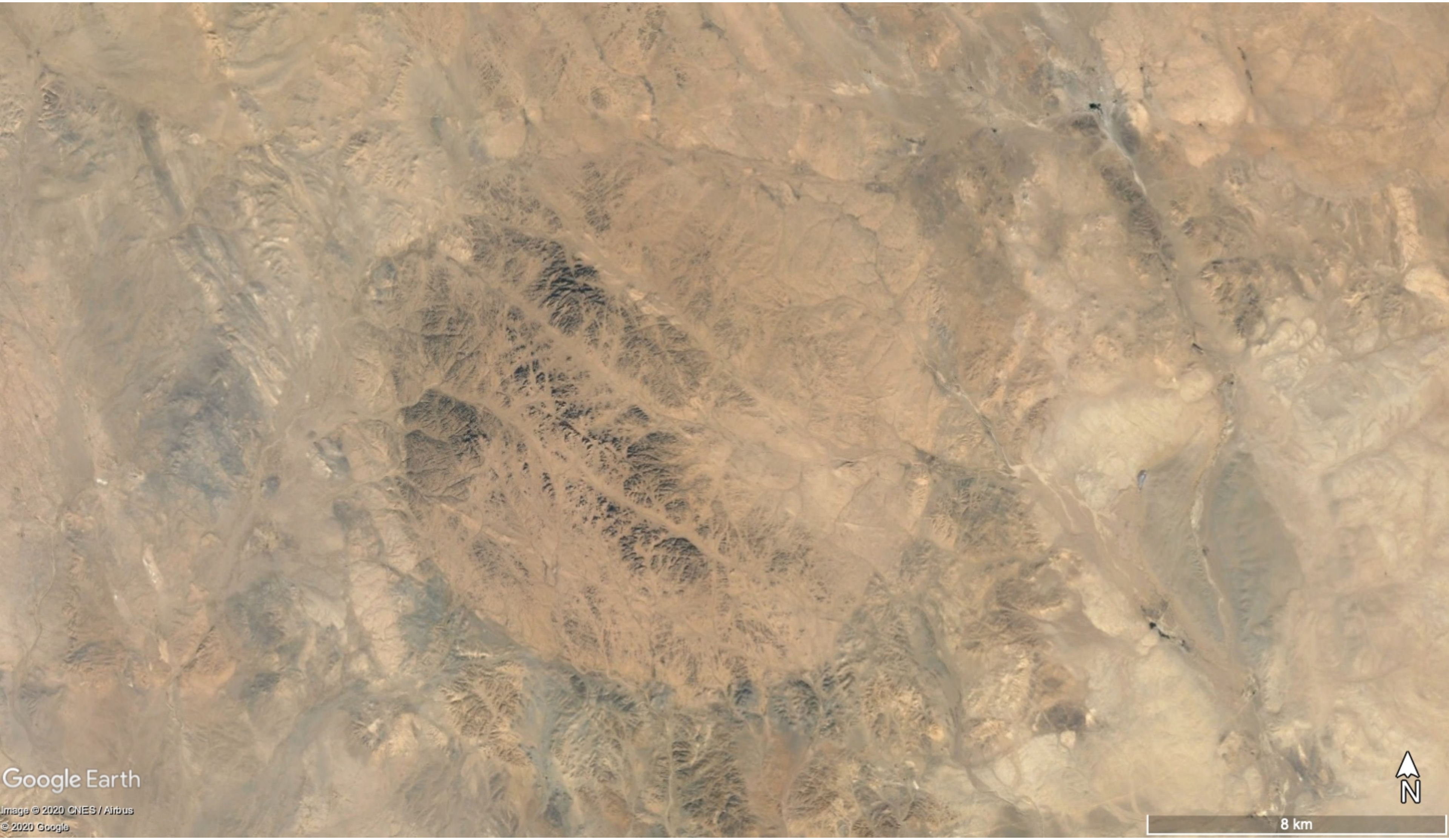
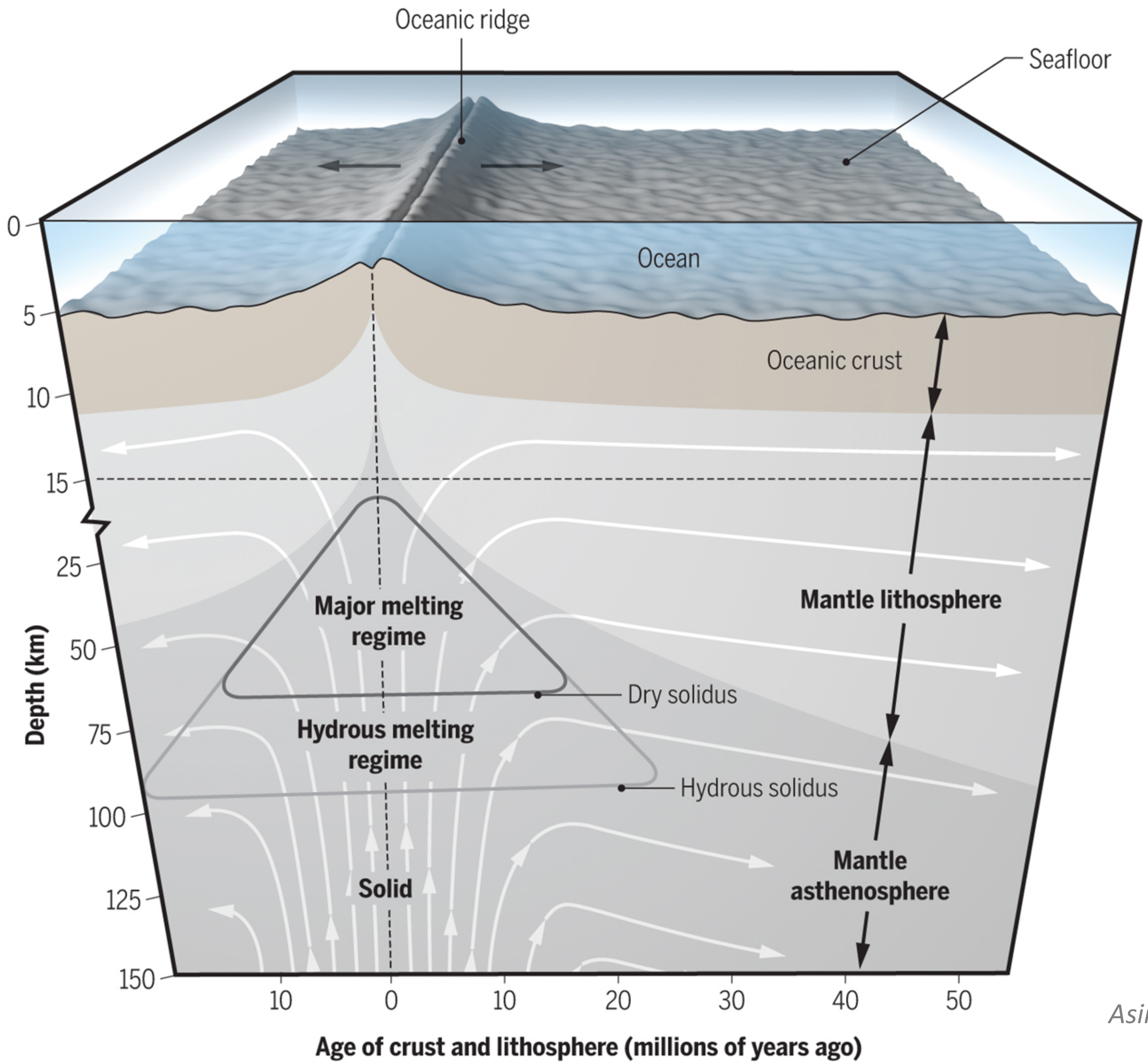
Corso di Geologia del Cristallino



La formazione e l'evoluzione dei sistemi magmatici

Generazioni di magmi

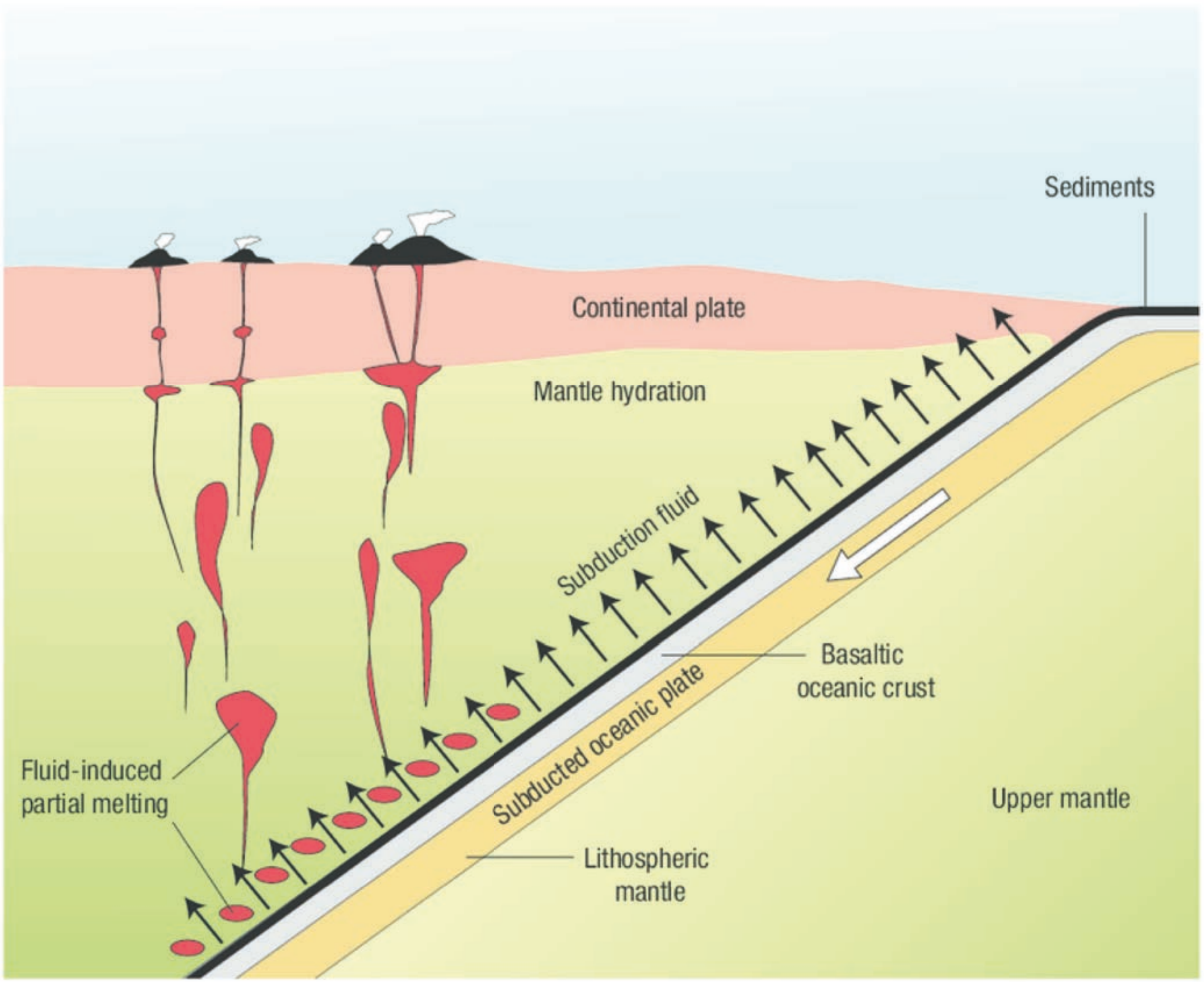
Fusione di mantello



Asimow (2017; Science)

Generazioni di magmi

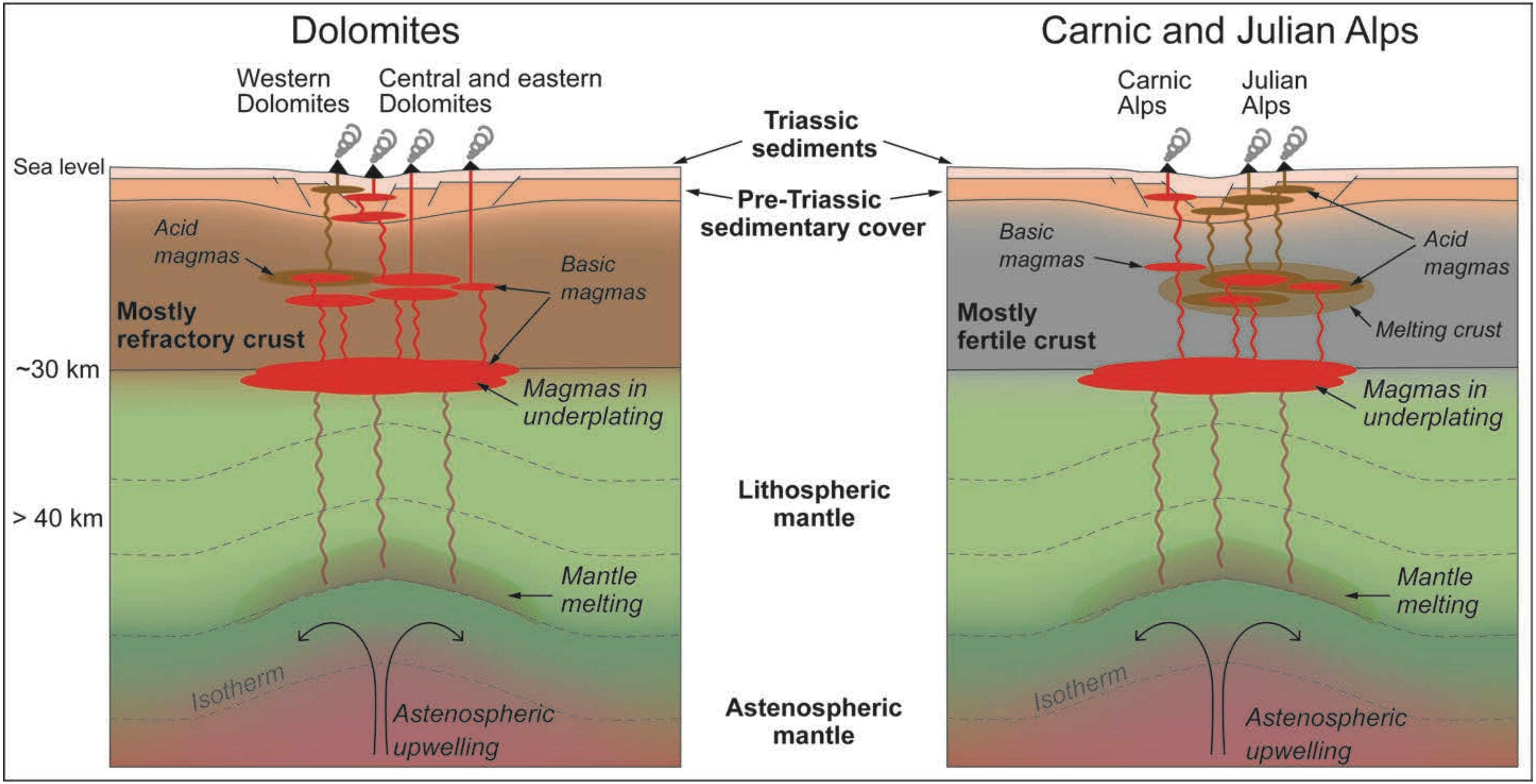
Fusione di mantello



Churikova (2008; Nature Geoscience)

Generazioni di magmi

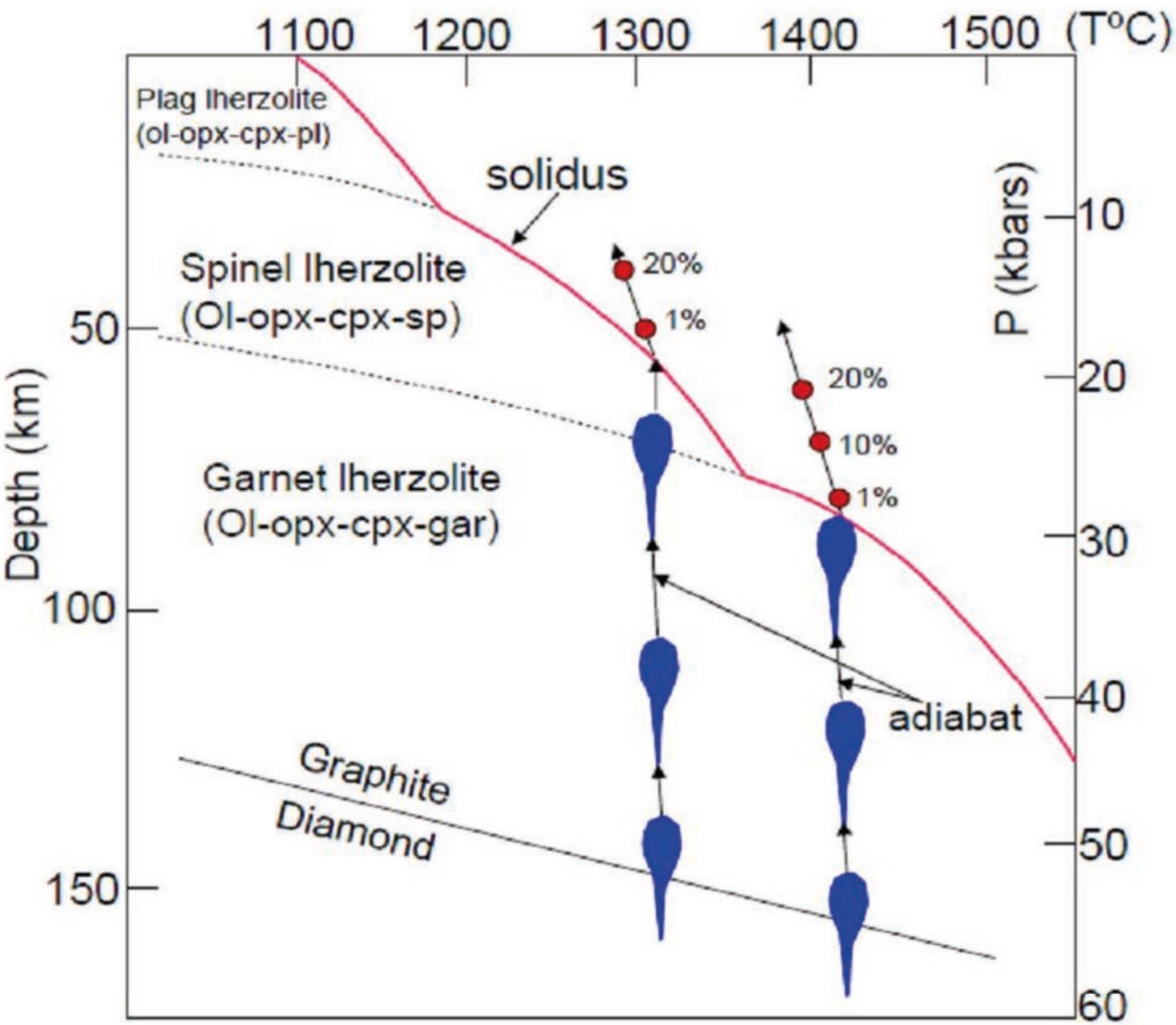
Fusione di mantello



De Min et al (2020; Geological Magazine)

Generazioni di magmi

Fusione di mantello



El-Desoky et al. (2015)

Rocce di mantello

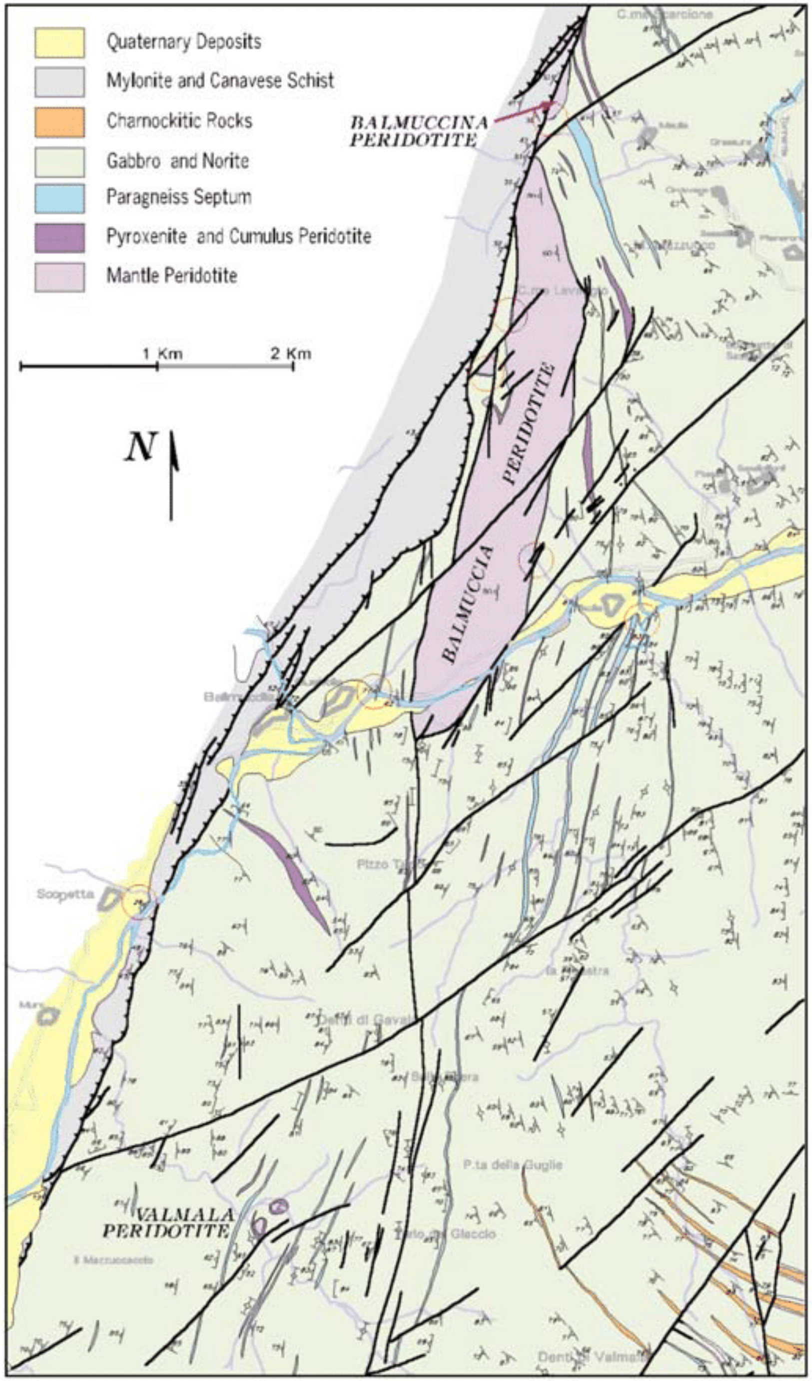
Gli affioramenti di rocce ultramafiche

Dygert et al (2016; J Pet)

Corpo peridotitico di

Balmuccia

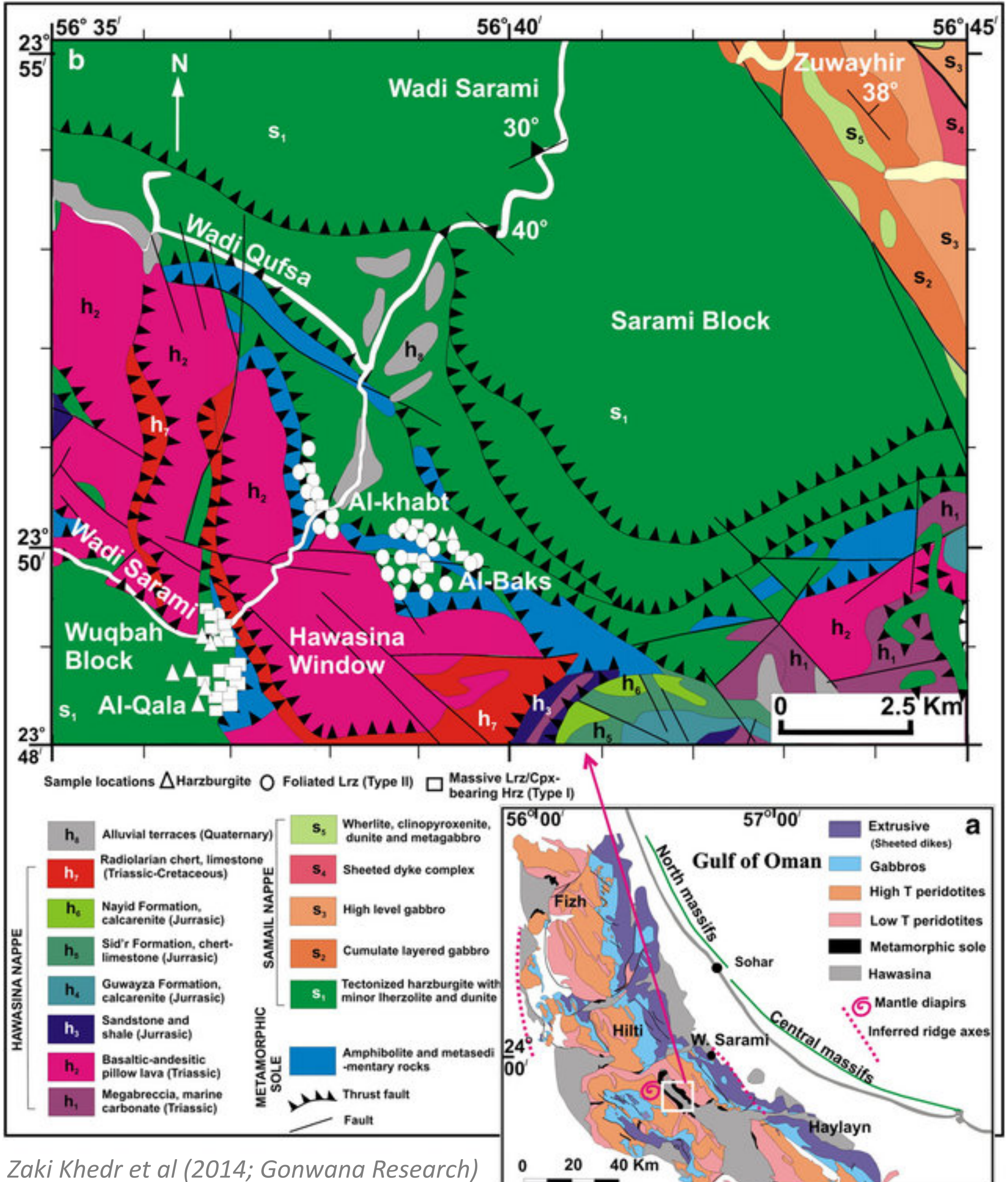
(Ivrea-Verbano)



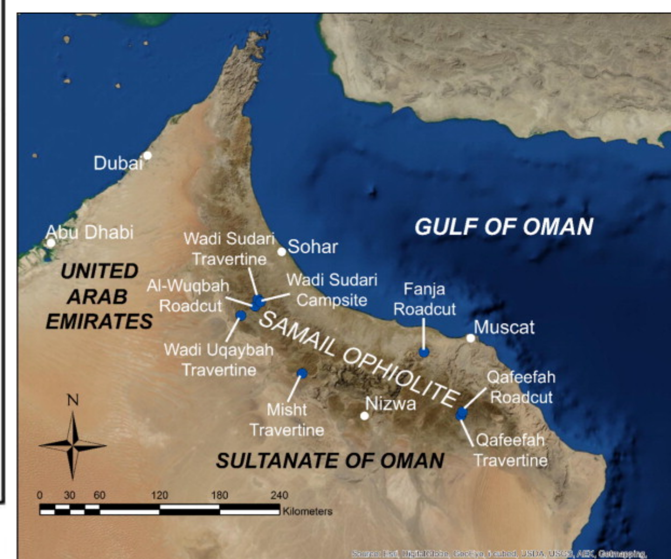
Sinigoi et al (2010)

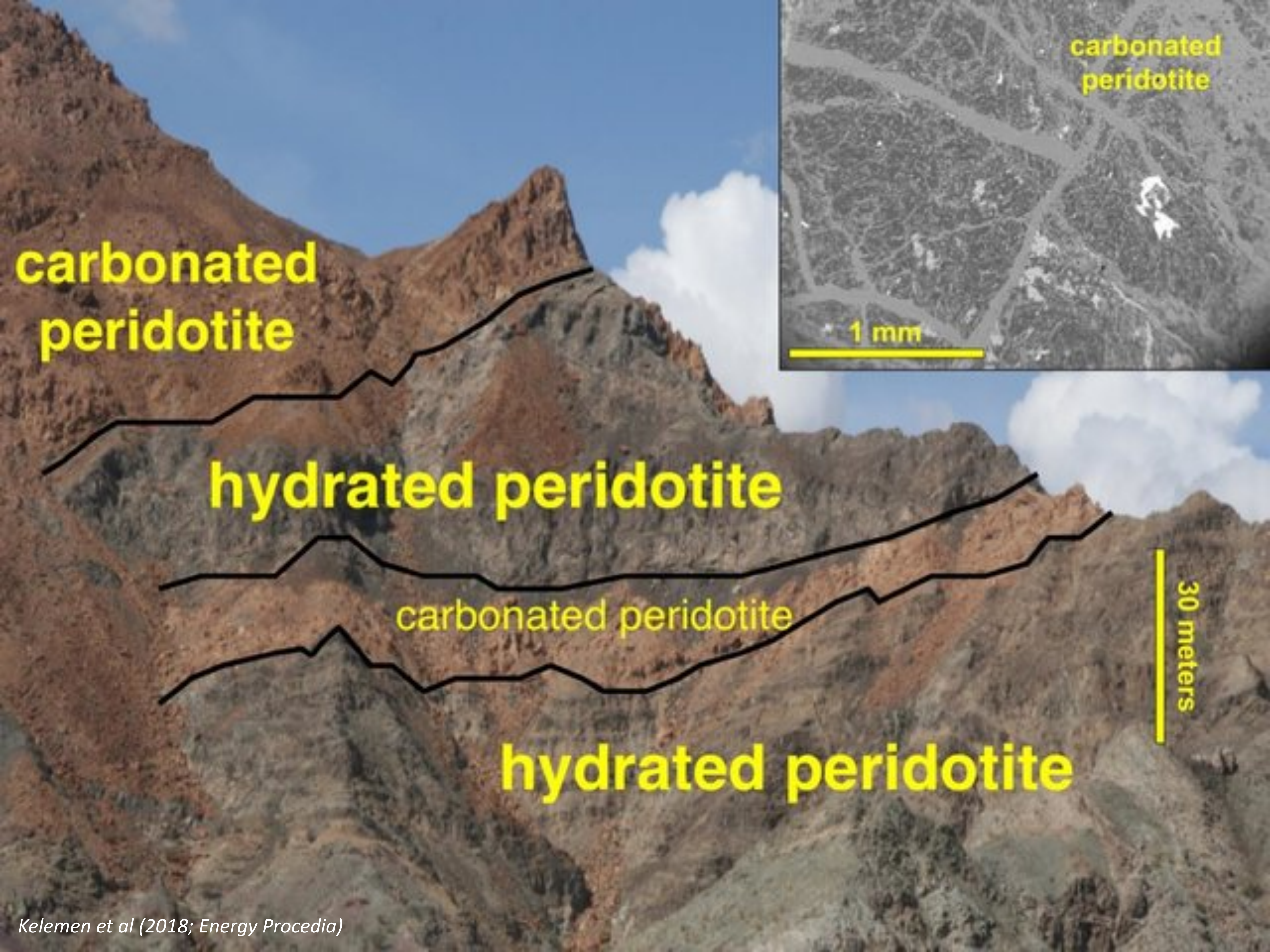

WARNING WEAR
SAFETY GOGGLES

Peridotiti nelle ofioliti dell'Oman

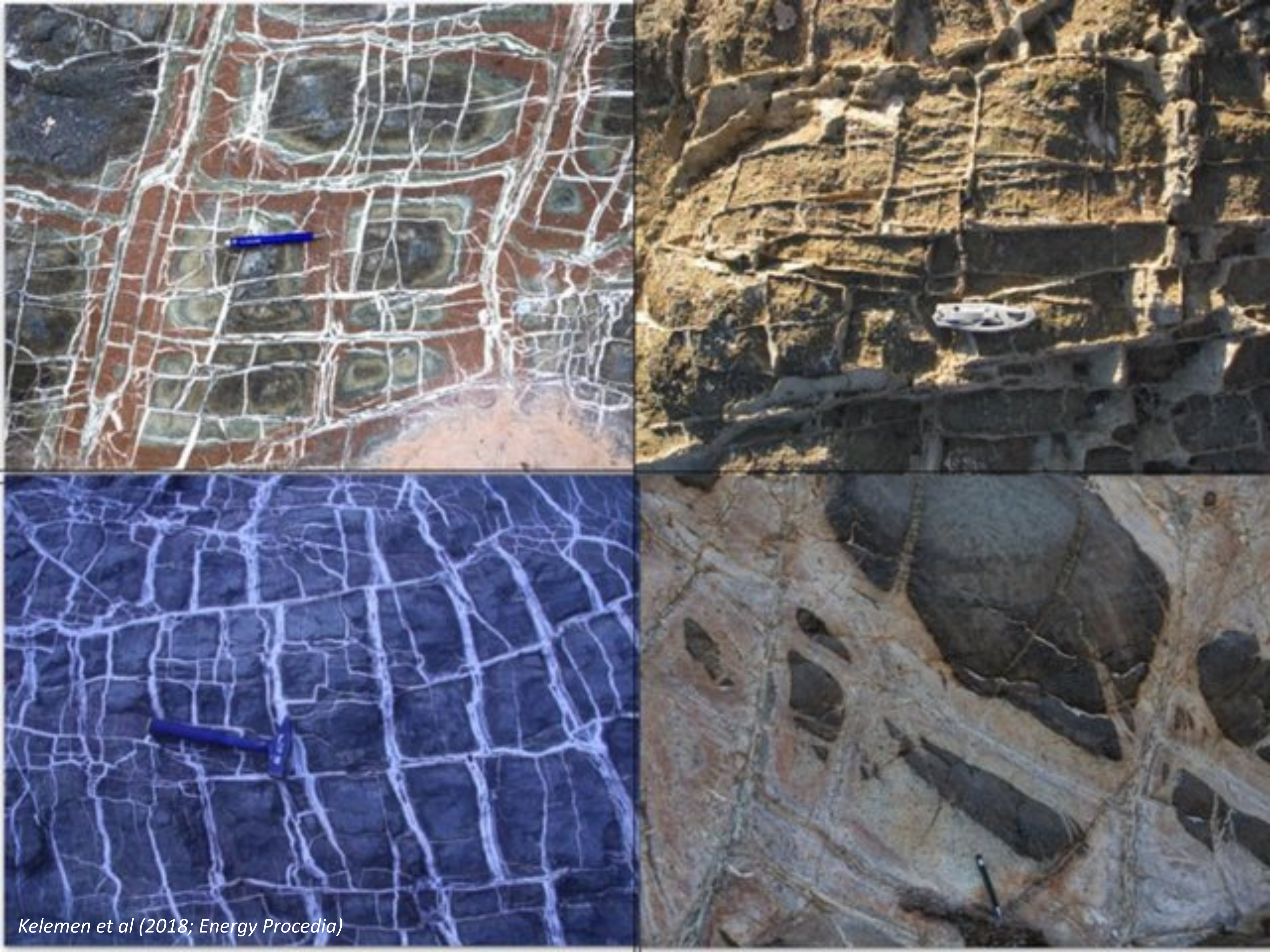


Zaki Khedr et al (2014; Gonwana Research)





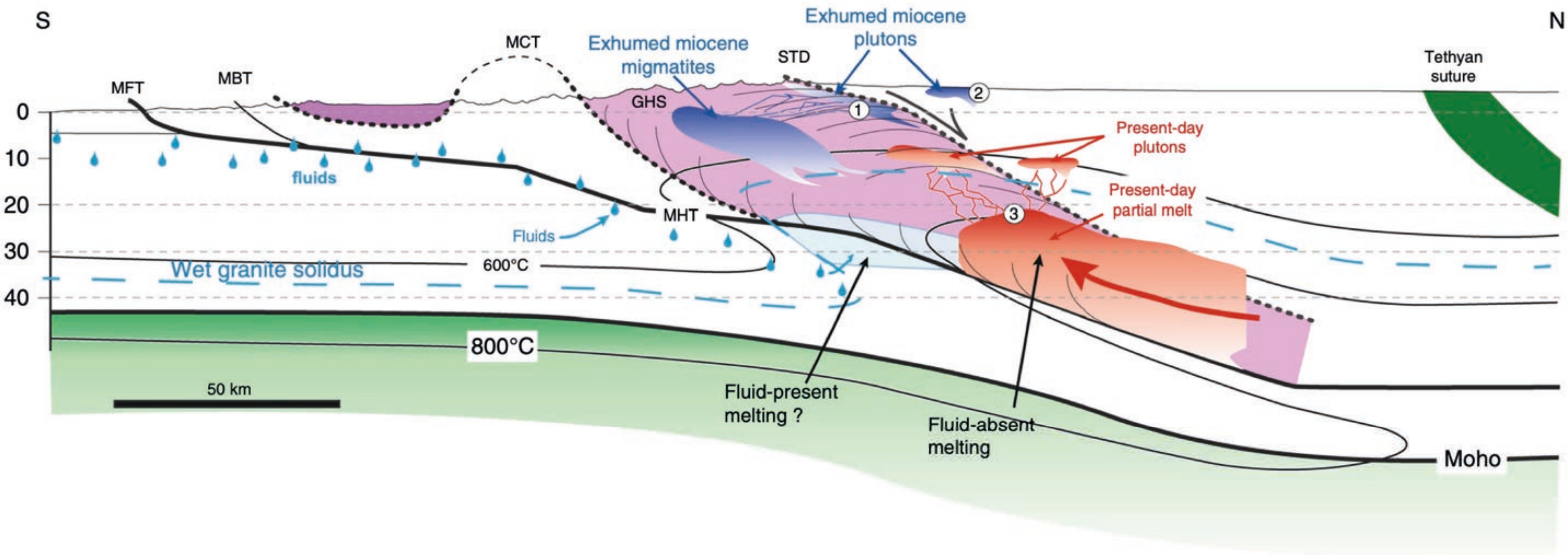
Kelemen et al (2018; Energy Procedia)



Kelemen et al (2018; Energy Procedia)

Generazioni di magmi

Fusione di crosta

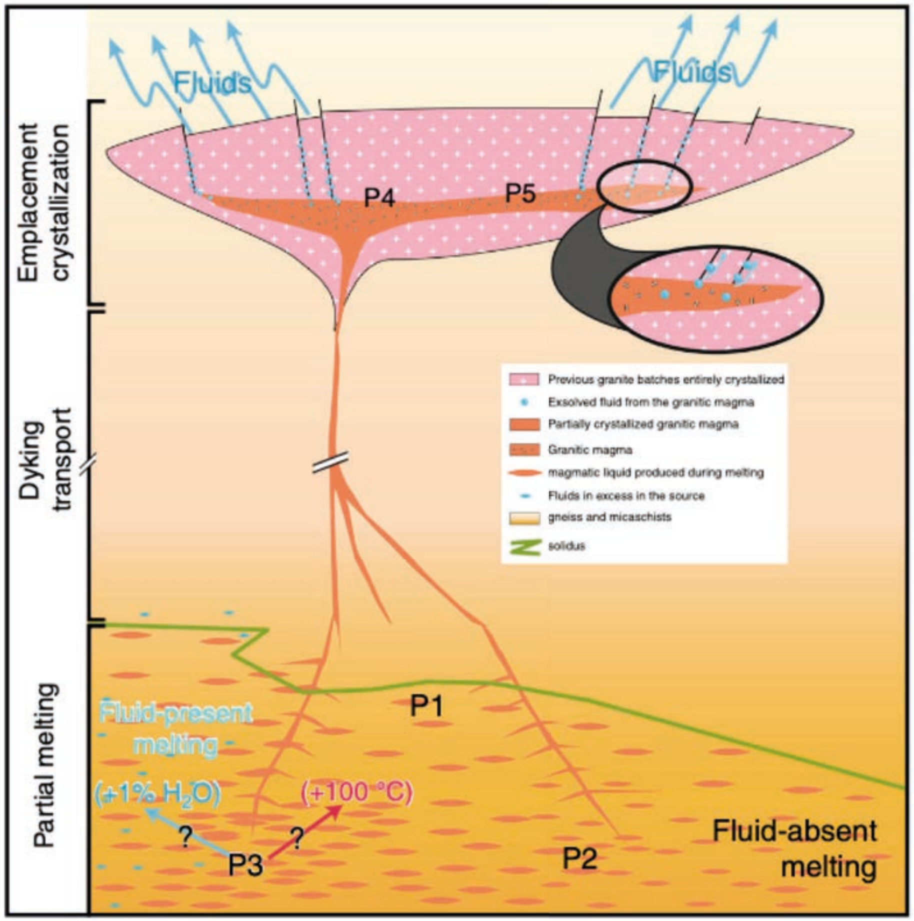


Chen et al (2018; Nature Communications)

Fig. 7 Schematic diagram of granitic magma production, migration, and emplacement in a schematic cross-section of the Himalaya. The inactive shear zones (i.e., STD and MCT) are shown with bold dotted lines, while the active shear zones (i.e., MBT, MFT, and MHT) are shown as bold straight lines. The red regions identify the present-day location of partial melting plus melt ponding (present-day leucogranite plutons) while the blue areas are exhumed and solidified granitic rocks (migmatites and plutons). The numbers illustrate the emplacement of granitic plutons (1) below the STD or (2) above the STD while (3) refers to the top of the partial melting region from where the present-day dykes feeding the growing plutons are nucleating. The fluid identified by Rawat et al.[40] is delineated by the blue droplets, south of the Main Frontal Thrust, and located within the Indian basement. Melting is obviously not occurring in the cold regions of the Indian basement, but this must represent a fluid-enriched zone that is buried beneath the chain. What happens to these fluids is not the kernel of this study but they may well contribute to the process of melting beneath Tibet

Generazioni di magmi

Fusione di crosta

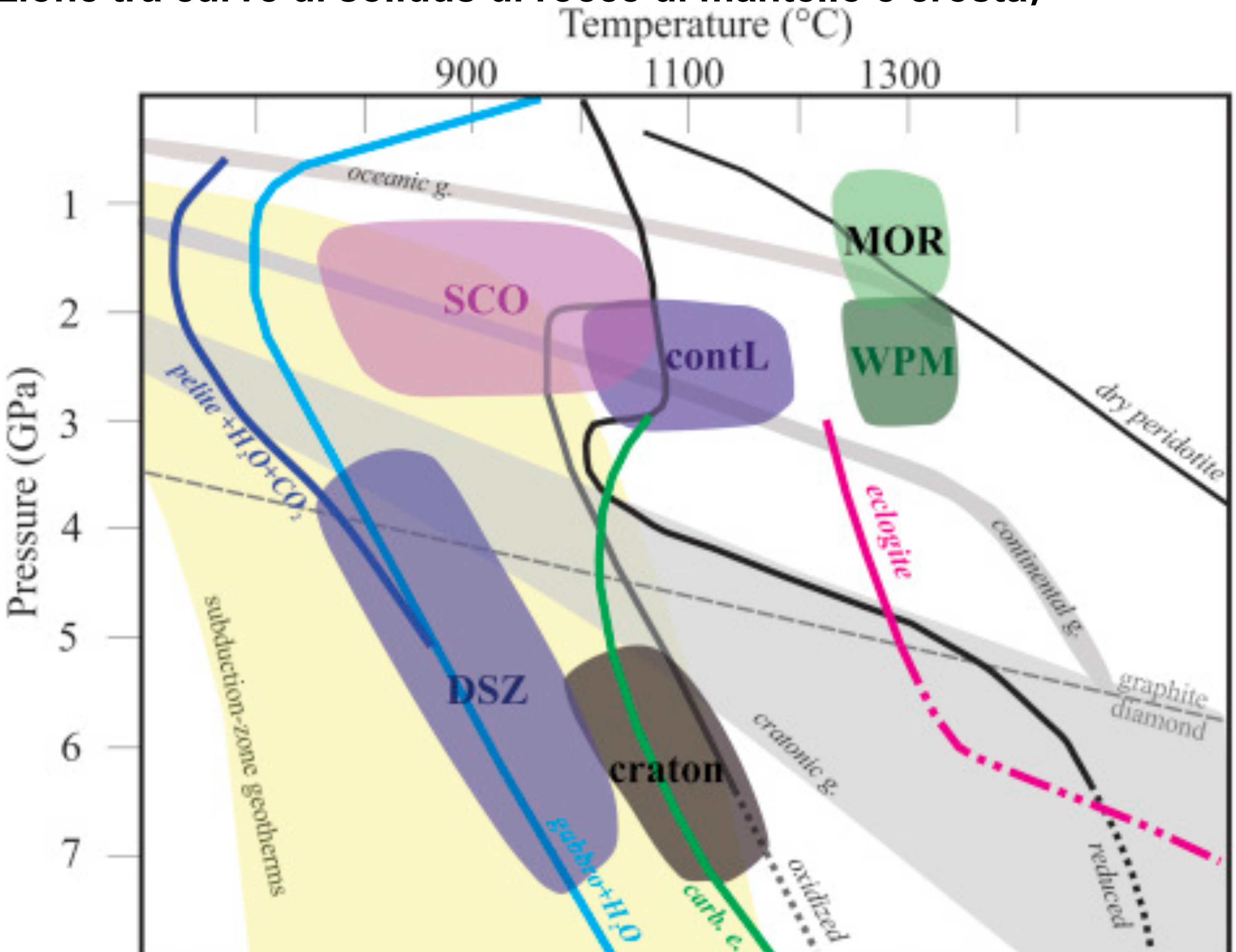


Chen et al (2018; Nature Communications)

Fig. 6 Illustration linking P1–P5 MT anomalies to magmatic processes and crustal-scale transfer of water. The magmatic conditions at the P1–P5 electrical anomalies are given in Table 3. By these magmatic processes, water is transferred from the lower crust (depth >20 km), where partial melting occurs, to the emplacement/crystallization zone of granites (depth = ca. 10–12 km). Aqueous fluids released from solidifying granites may well significantly contribute to the numerous hot springs suggested from their geochemical features[47]. Fluid-absent melting under conditions similar to the G1 *P*–*T* path can explain the Northwestern Tibet, while beneath the Southern Tibet, either fluid-present melting or a warmer crust is required

Generazioni di magmi

Comparazione tra curve di solidus di rocce di mantello e crosta)



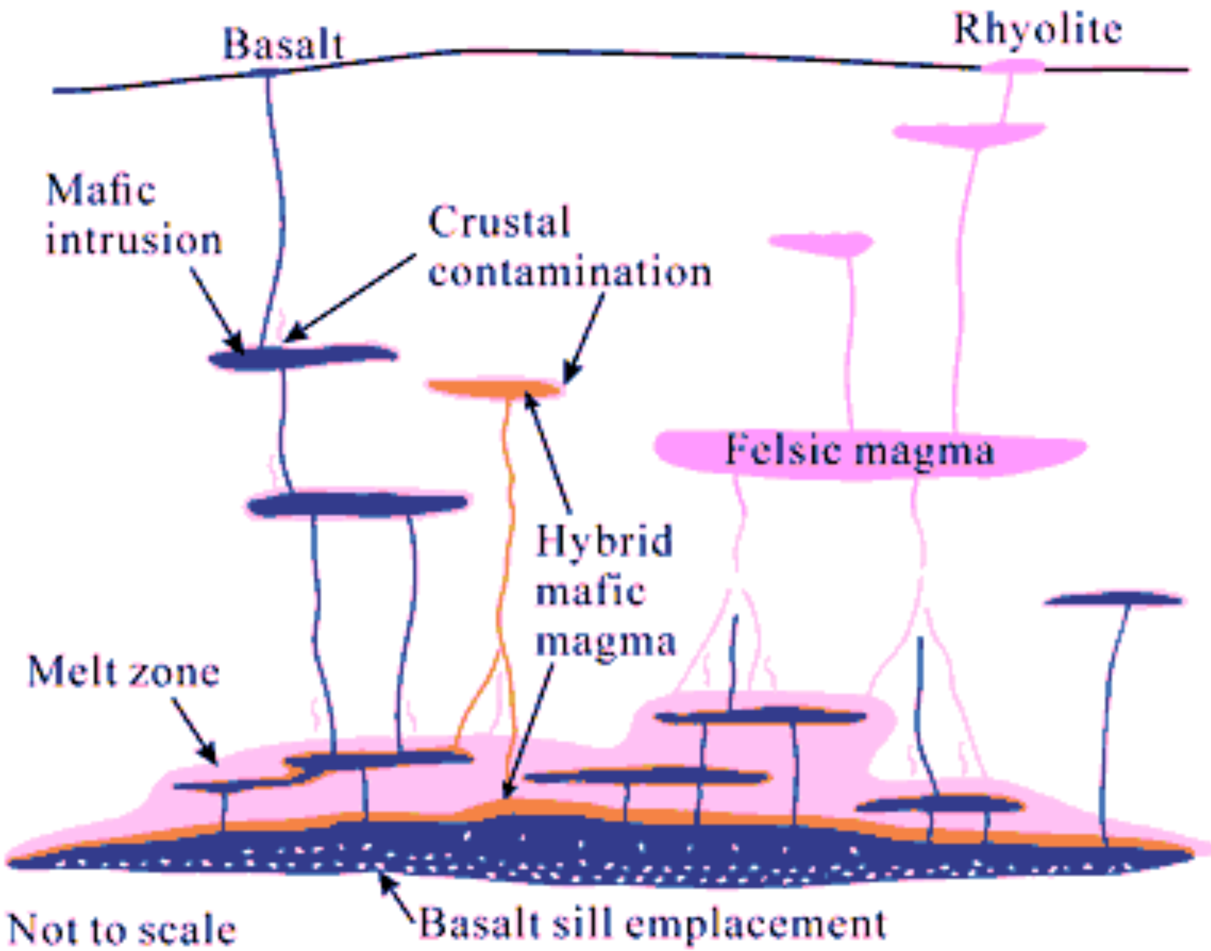
https://www.sciencedirect.com/topics/earth-and-planetary-sciences/solidus

Didascalia della figura precedente:

Figure 1.10. Pressure–temperature melting conditions for various geodynamic environments (*colored/shaded areas*) compared to melting curves for mantle rocks and components of subducting lithospheric slabs and to example geothermal gradients (*thick gray lines*). Midocean ridge (MOR) and within-plate magmatism (WPM) regions are determined by upwelling asthenospheric mantle and lie above the melting points of recycled eclogite blocks. Continental lithosphere (contL) lies close to the solidus shelf and is controlled by the stability of calcic amphibole and carbonatite melts, which therefore feature prominently in noncratonic continental mantle rocks. Melting beneath the cratons is limited to high pressures and favored in oxidizing conditions. Subduction environments are divided into (1) deep subduction zones (DSZ) in which peridotite cannot melt but both igneous and sedimentary components of the subducting slab may melt, and (2) shallow collisional orogens (SCO), in which slab components may melt followed by peridotite as mantle heat accesses the new lithosphere in the postcollisional environment. See Fig. 1.3 for sources of melting curves; pelite + H_2O + CO_2 from Mann and Schmidt (2015); gabbro + H_2O from Lambert and Wyllie (1978); eclogite from Spandler et al. (2008); and carbonated eclogite from Dasgupta et al. (2004).

http://users.monash.edu.au/~weinberg/Pages/Reru_valley/Reru_migmatite.htm

http://users.monash.edu.au/~weinberg/Pages/Reru_valley/Reru_migmatite.htm



http://www.mantleplumes.org/CrustalContamination.html

Quali sono i fattori principali che determinano la risalita dei magmi?

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- Densità

- Viscosità

- Fattori tettonici/geologici

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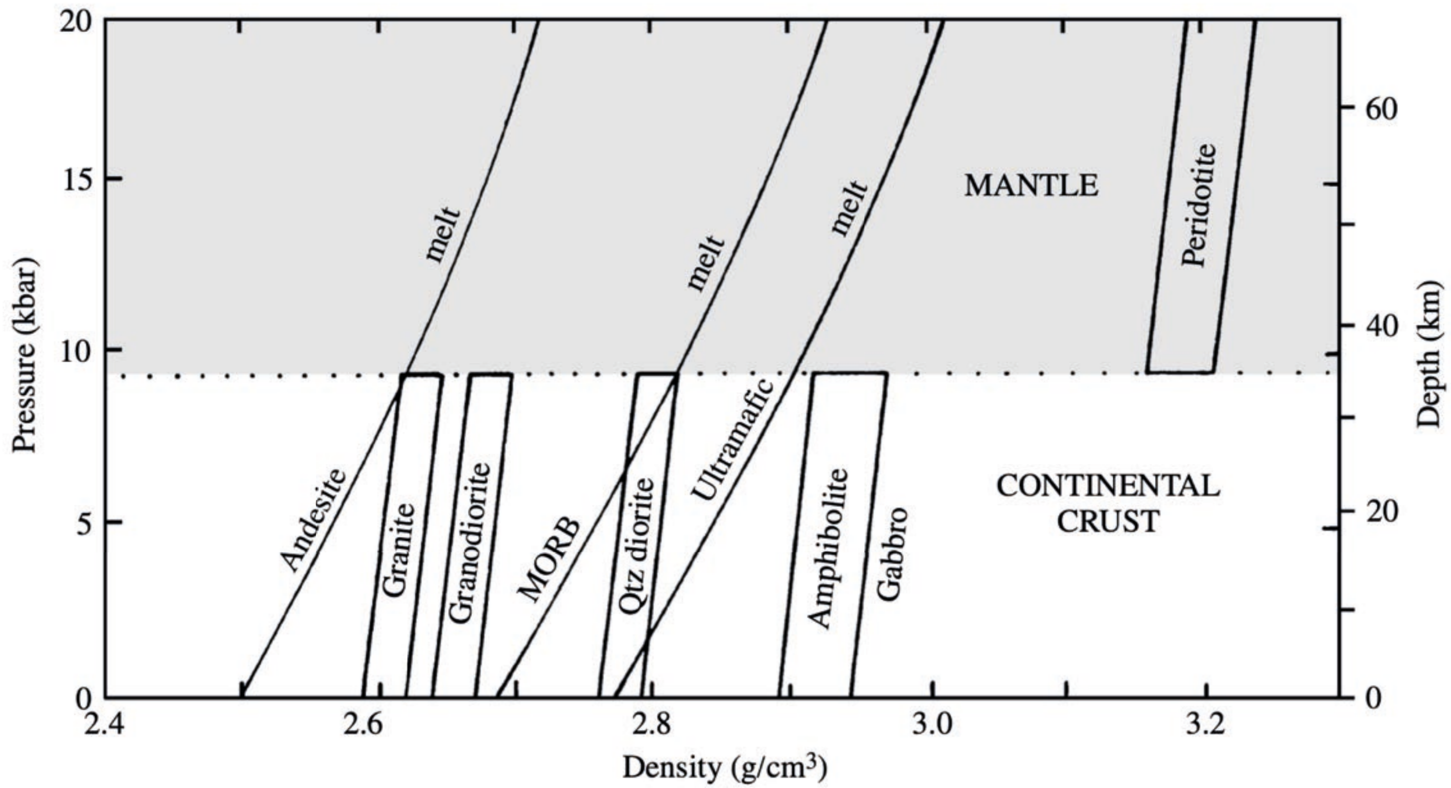
- Densità
- Viscosità
- Fattori tettonici/geologici

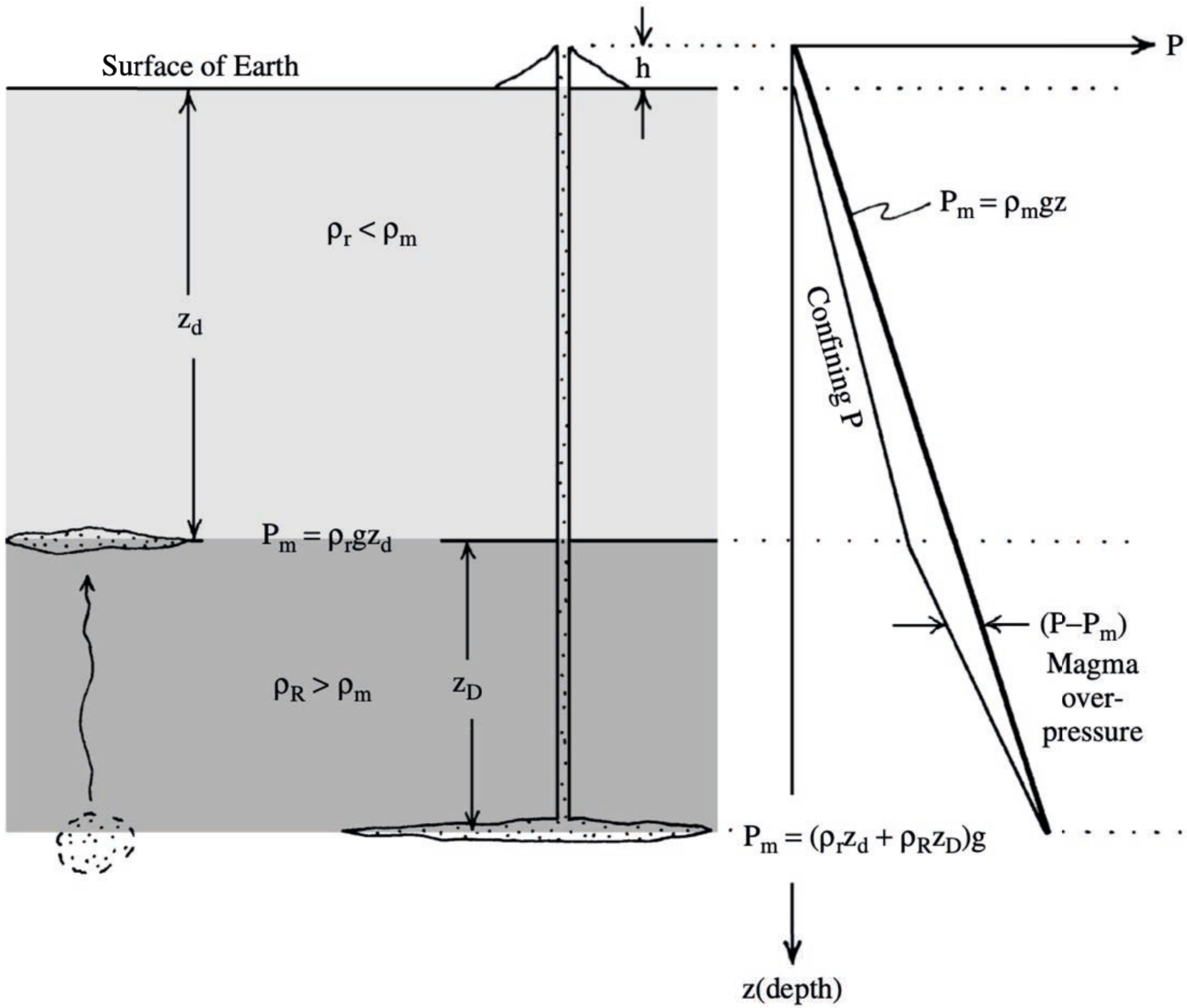
Da cosa dipendono?



9.1 Density relations between some rock compositions and volatile-free melts in the continental crust and uppermost mantle. Range of densities for rock types is indicated in rectangular boxes. Note the smaller compressibilities of rocks compared to melts as *P* (depth) increases. MORB, mid-ocean ridge basalt. Amphibolite is a metamorphic rock composed of hornblende and plagioclase that is formed by recrystallization of mafic igneous rocks (basalt, gabbro) under hydrous conditions. (Redrawn from Herzberg et al., 1983.)

Best (2003)

Magma overpressure



Best (2003)

La risalita dei magmi verso la superficie si manifesta in due modi principali:

Diapiri

Sono corpi magmatici che risalgono lentamente attraverso le rocce ospitanti tendenzialmente duttili e altamente viscose nella crosta e nel mantello.

Dicchi

Sono corpi magmatici che risalgono attraverso fratturazioni subverticali in rocce fragili.

Best (2003)

Table 9.1 Comparison of Sheet Intrusion (Diking) and Diapirism in the Continental Crust

Aspect	Sheet Intrusion	Diapirism
Most common magma composition	Basalt	Granitic
Rheologic behavior of country rock	Brittle (elastic)	Ductile or viscoplastic
Viscosity contrast between country rock and magma	Many orders of magnitude	A few orders of magnitude
Ascent velocity	0.1–1 m/s	0.1–50 m/y
Time for magma ascent	Hours to days	10^4–10^5 y
Factors controlling ascent velocity	Magma viscosity and density contrast with country rock; dike thickness	Country rock ductile strength and thickness of boundary layer around diapir
Effect of state of stress on path of magma transport	Sheet perpendicular to least principal stress, σ_3	Probably slight
Country rock deformation	Nil	Substantial penetrative ductile, chiefly in boundary layer
Nonmagmatic example	Hydrothermal quartz vein	Salt dome

Best (2003)

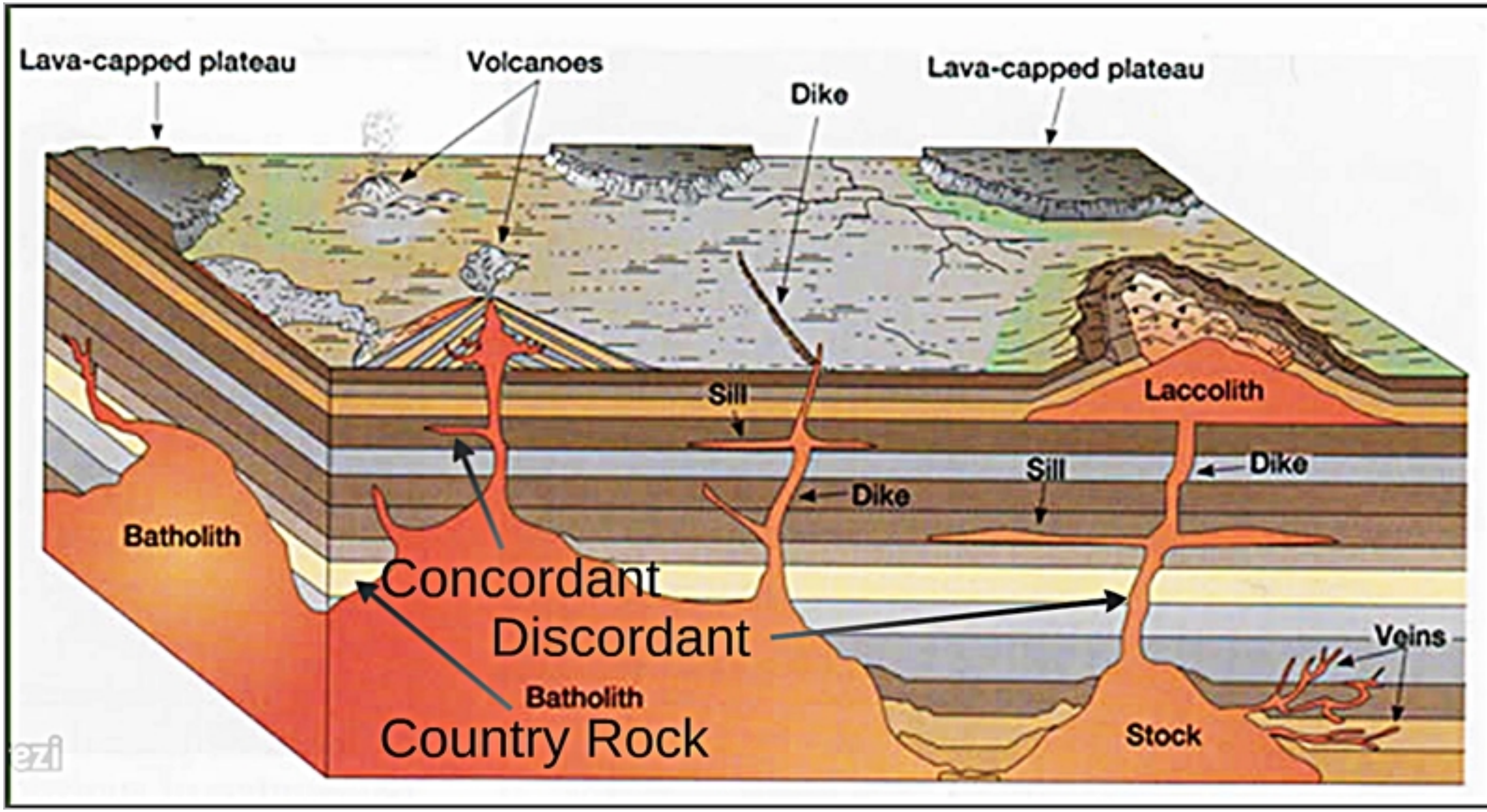
Intrusioni tabulari

Le intrusioni tabulari (*sheet intrusions*) si definiscono come tali se hanno dei rapporti spessore/lunghezza nell'ordine di 10^{-2} – 10^{-4}.

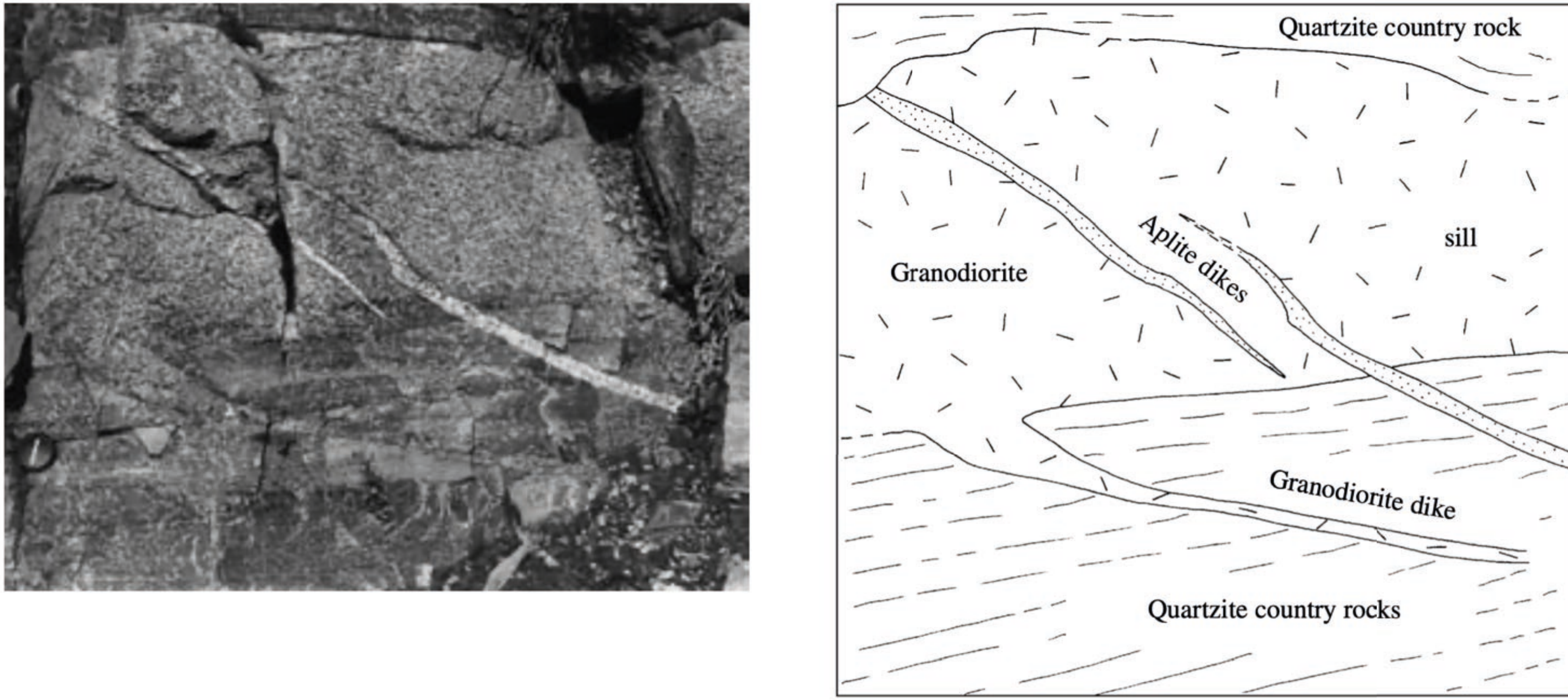
Un **dicco** è un intrusione che taglia in modo discordante le strutture planari, come la stratificazione, della roccia incassante. I dicchi sono anche le intrusioni tabulari che tagliano strutture massive e isotropiche come i graniti.

Un ***sill*** (o filone-strato), d'altra parte, è una intrusione tabulare concordante con le strutture planari della roccia incassante.

Best (2003)

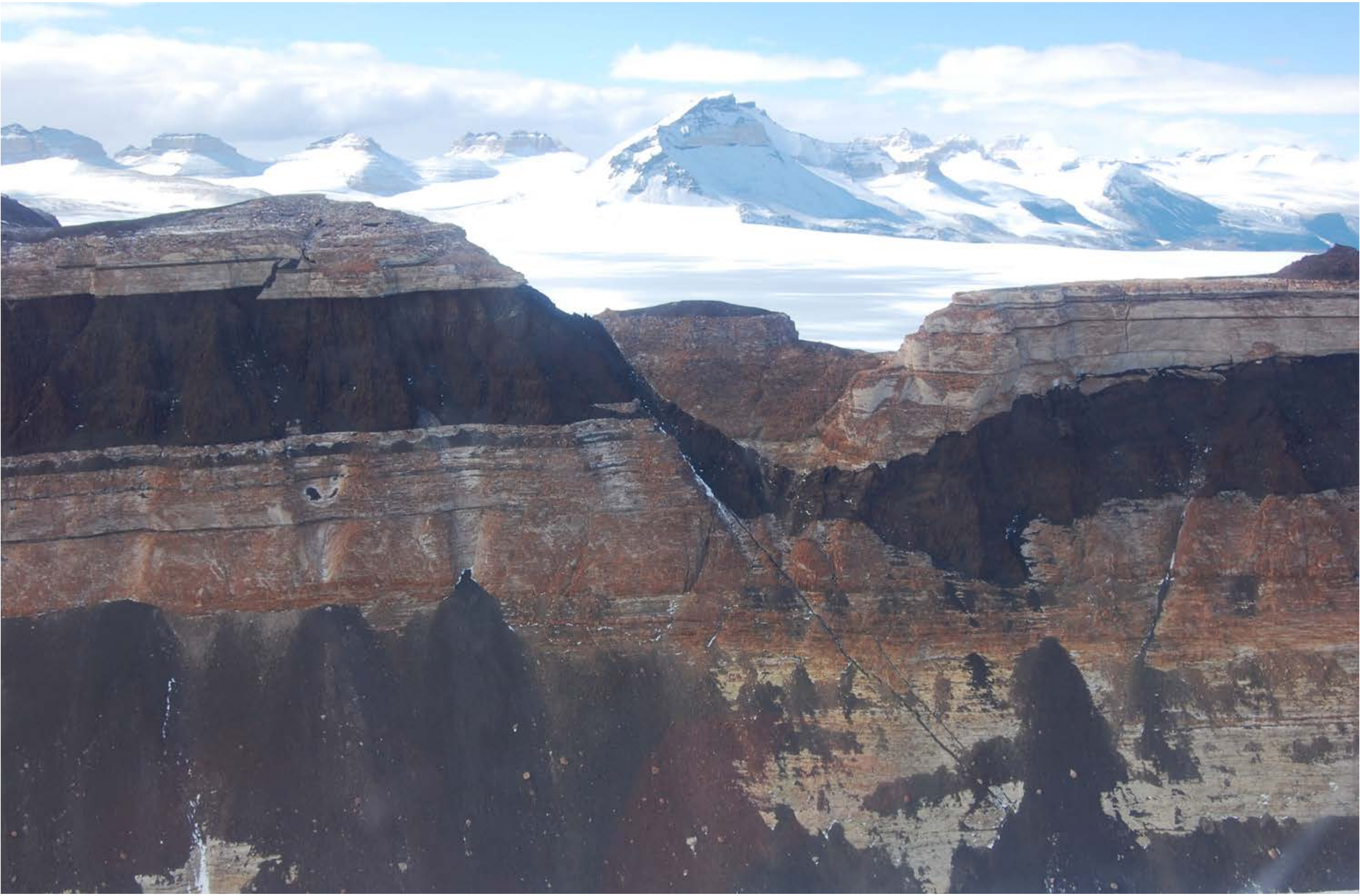


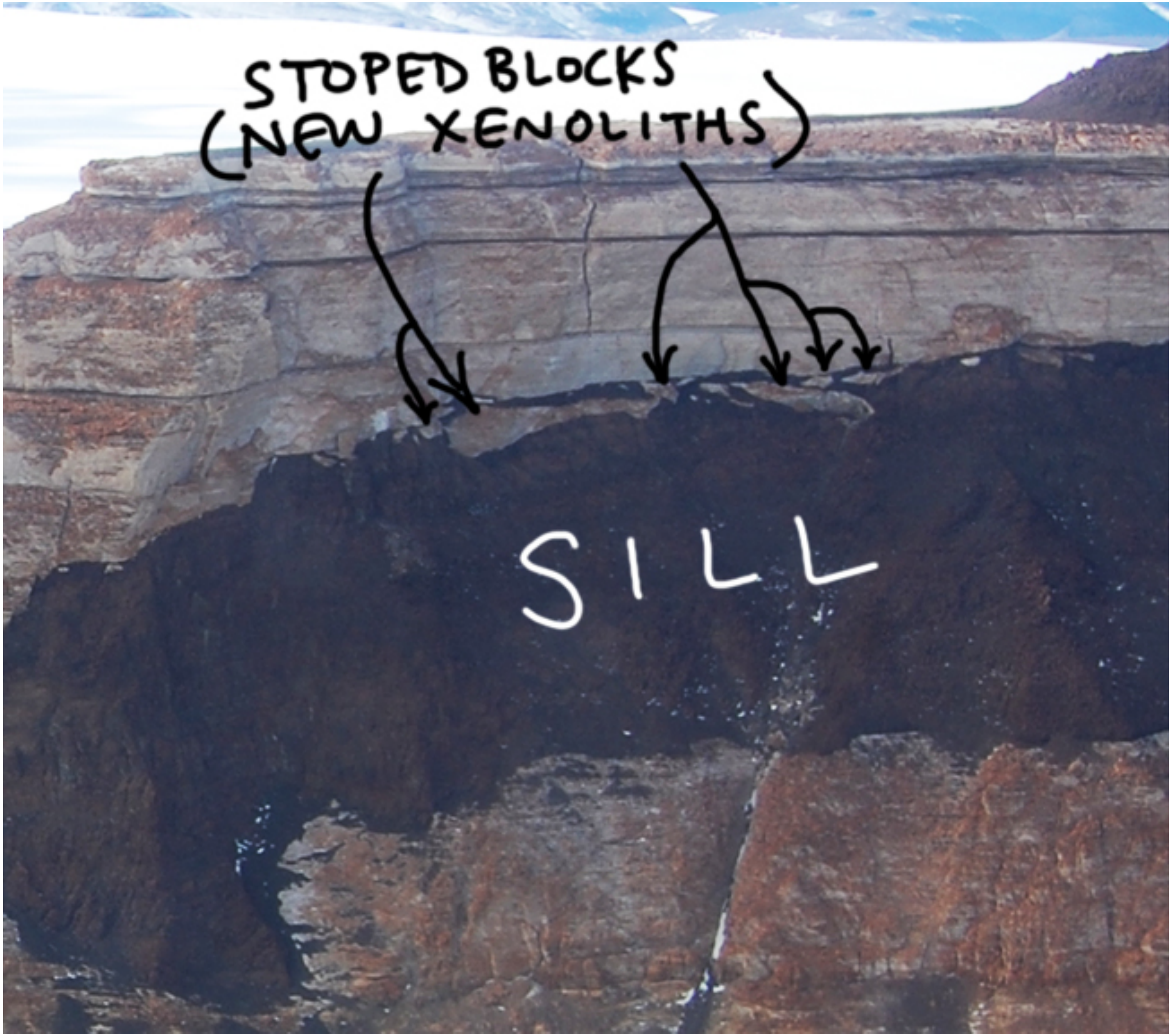
https://volcanohotspot.wordpress.com/2017/07/06/batholith-lopolith-sill-or-dike-intrusions-2/comment-page-1/



9.3 Sill and dikes. A **sill** of granodiorite intruded concordantly with layering in quartzite host rock and a smaller offshoot **dike** penetrating discordantly across layering. Thin subparallel dikes of leucocratic granite aplite cut across more mafic granodiorite and layered country rock. Note sharp contacts. Camera lens cap in lower left for scale. (a) Photograph. (b) Annotated sketch.

Best (2003)


https://blogs.agu.org/mountainbeltway/files/2015/01/DSC_0893.jpg



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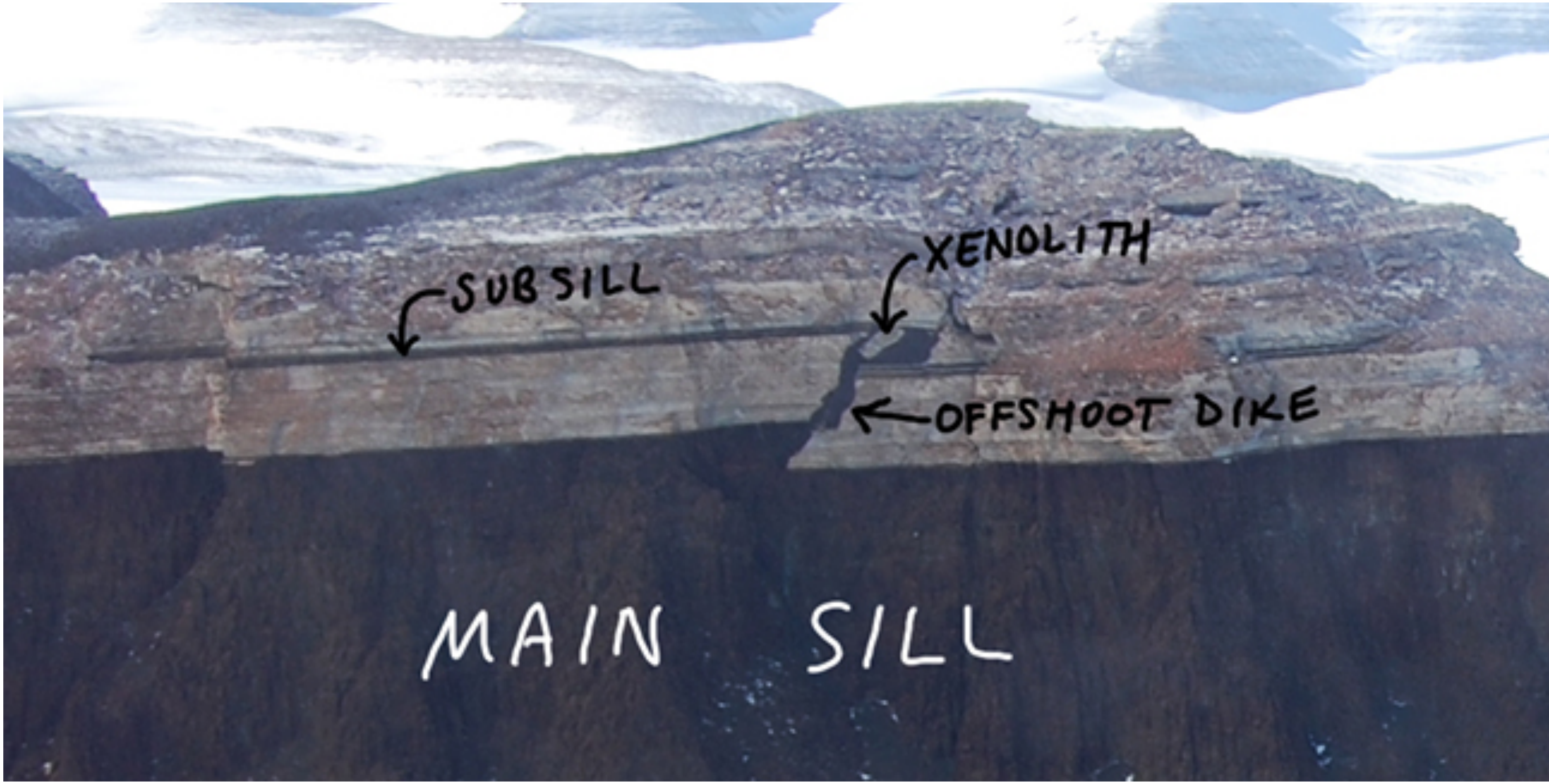


https://blogs.agu.org/mountainbeltway/files/2015/01/DSC_0893.jpg

Intrusioni tabulari

Uno **sciame di dicchi** (*dyke swarm*) consiste in una decina fino a un centinaio di dicchi messi in posto più o meno contemporaneamente durante un episodio intrusivo individuale. I dicchi in uno sciame possono avere orientazioni irregolari, essere più o meno paralleli o radiali. Gli sciami di dicchi radiali giganti sono ipotizzati essere relazionati a mantle plumes associati ad estensione continentali.

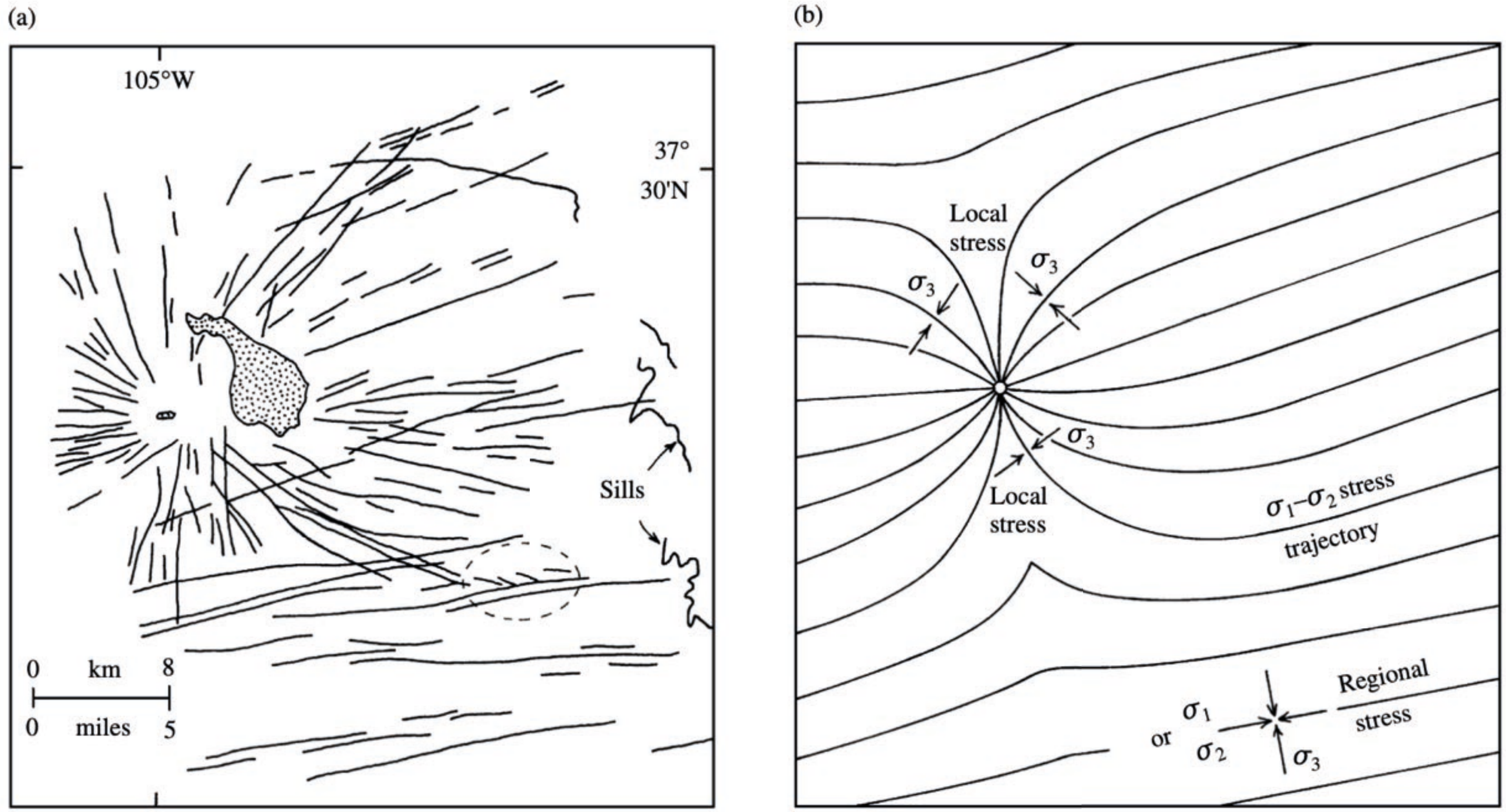
Lo spessore dei dicchi può variare da qualche cm al centinaio di metri (tipicamente sono nell'ordine del metro). Nel caso di sciami giganti, la loro estensione può arrivare fino ai 2000 km.

I dicchi di alimentazione (*feeder dykes*) sono quelli che alimentano i sills e le altre intrusioni magmatiche. Ad esempio, i dicchi basaltici sono spesso le strutture che permettono la crescita di vulcani contintentali, oceanici e dello stesso fondale oceanico.

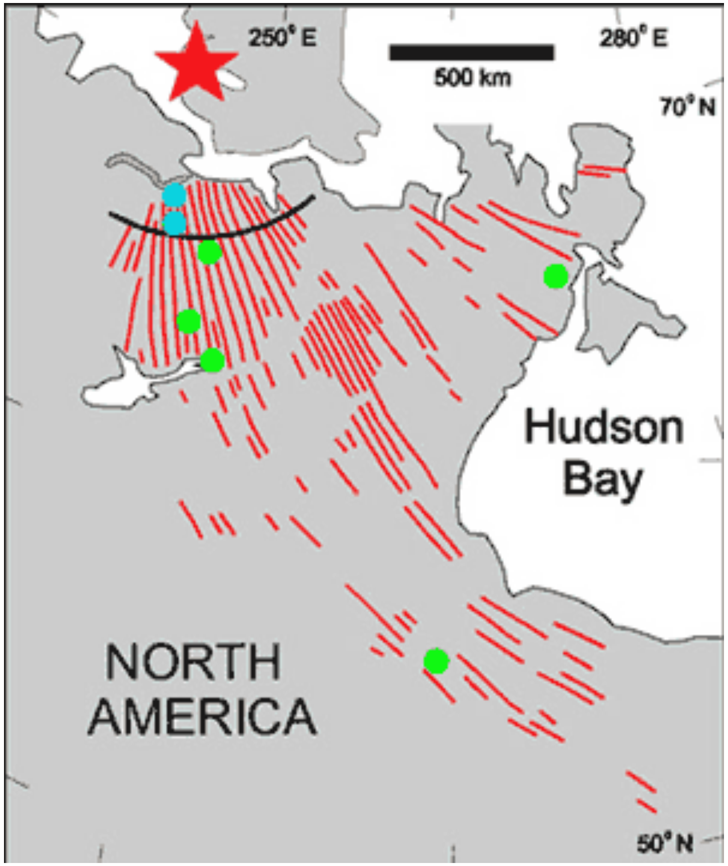
Best (2003)

http://earthwise.bgs.ac.uk/index.php/Dykes,_dyke_swarms_and_volcanic_plugs,_Palaeogene_volcanic_districts_of_Scotland#/media/File:P580470.jpg

Best (2003)



9.6 **Radial** and **parallel dike swarms.** (a) Subvertical dikes were emplaced at 28 to 20 Ma around **central intrusions** of the Spanish Peaks (stippled) in south central Colorado. Flow markers (aligned tabular phenocrysts, elongate vesicles) in the dikes indicate the central intrusions as the source of the radially diking magma. Most dikes consist of segments a few meters to several kilometers long; many segments are *en echelon* but cannot be shown on this small-scale map except some unusually well-expressed ones enclosed by the dashed-line ellipse. An origin for *en echelon* dikes is shown in Figure 9.9. (Redrawn from Smith, 1987.) (b) Theoretical stress analysis. Central intrusion (open circle) is responsible for a *local stress* field that allows for radial diking. The central intrusion perturbed a *regional stress* field that controlled emplacement of the mostly older swarm of subparallel east-northeast-striking dikes mainly of more mafic magma. Trajectory lines are traces (intersections) in the horizontal plane of vertical surfaces parallel to σ_1 and σ_2. Because these surfaces are perpendicular to σ_3, they are potential avenues for magma intrusion. Note that most radial dikes are oriented nearly parallel to the regional $\sigma_1 = \sigma_2$ trajectory. (Redrawn from Odé, 1957.)



http://www.mantleplumes.org/GiantRadDykeSwarms.html

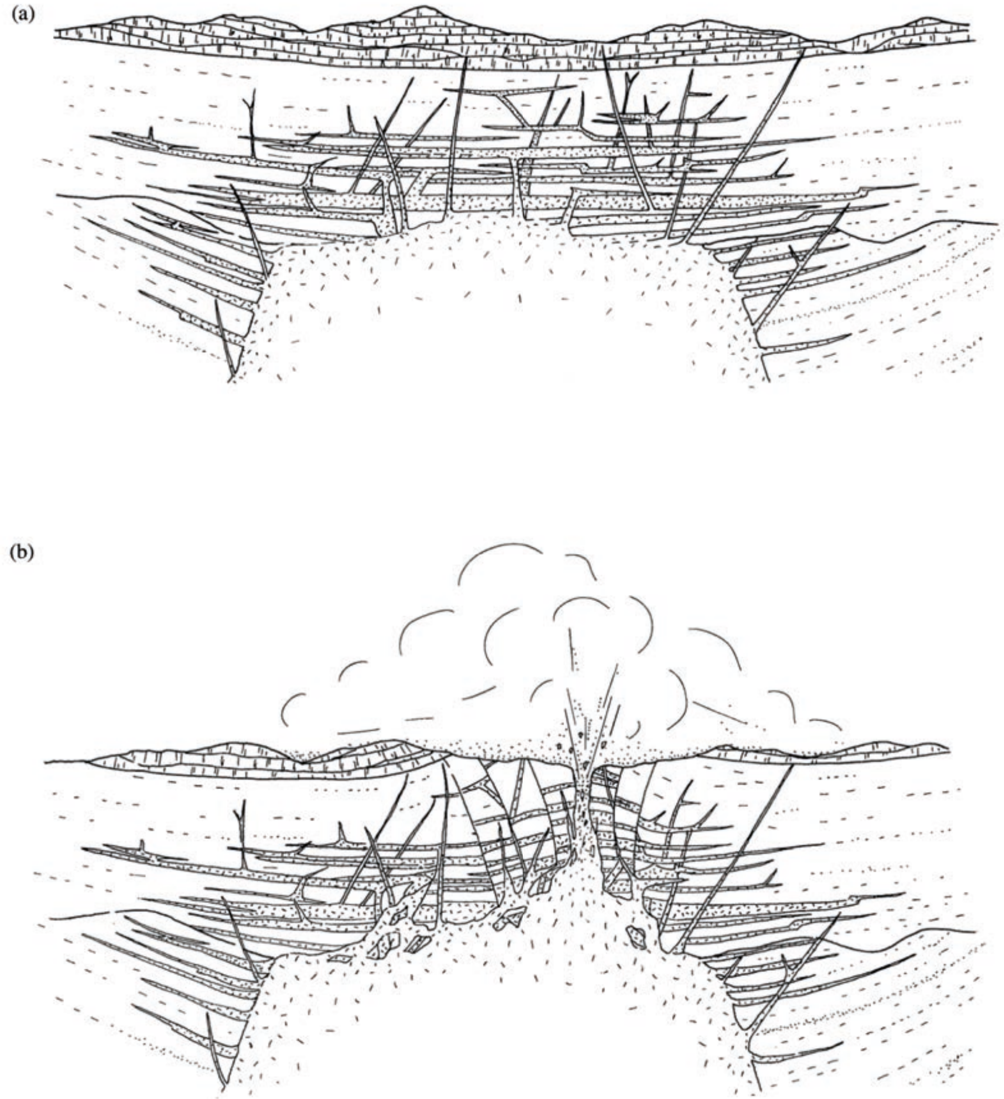
Intrusioni tabulari

Alcuni dicchi possono anche non raggiungere la superficie o altre intrusioni magmatiche. Esse possono essere chiamate intrusioni «cieche» (?) (*blind intrusions*)

Anche gli **sciami di sills** hanno estensioni variabili come gli sciami di dicchi.

Nei casi estremi, come in alcuni sciami presenti in Antartide, Sud Africa e Tasmania, i singoli sills possono avere spessori fino a 300 m e occupare aree più grandi di 15,000 km^2.

Best (2003)



Best (2003)

9.5 Schematic cross sections illustrating inferred relations among main intrusion, overlying dike-sill swarm, and layered volcanic rocks in the Miocene-Pliocene Tatoosh complex in Mount Rainier National Park, Washington. (a) In an early stage in the rise and emplacement of the intrusion, magma is lodged in an overlying dike-sill complex, advectively heating the roof of older volcaniclastic rocks. (b) In a later stage, the main mass of magma has continued to rise by **stoping** into its dike-sill complex and by **doming** the sills, their older host rock, and overlying volcanic rock layers. Note stoped blocks of roof rock in the main intrusion. Magma has broken through to the surface in an explosive eruption. A still later stage can be envisaged in which the still ascending magma intrudes its own volcanic cover. (Redrawn from Fiske et al., 1963.)

Link all’affioramento 3D