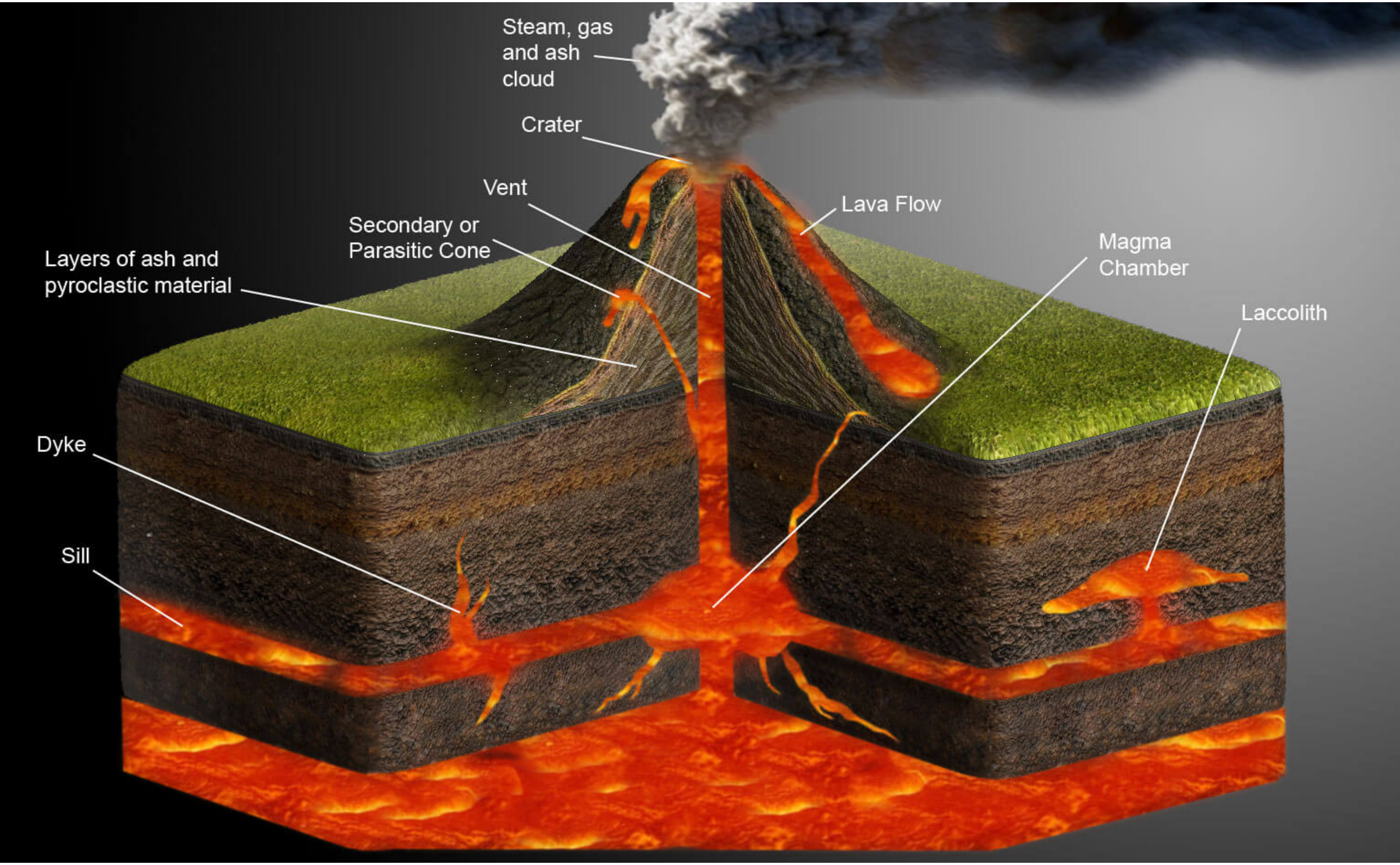
Geometrie e orientazioni delle intrusioni tabulari



https://www.911metallurgist.com/blog/volcanic-rock-formations

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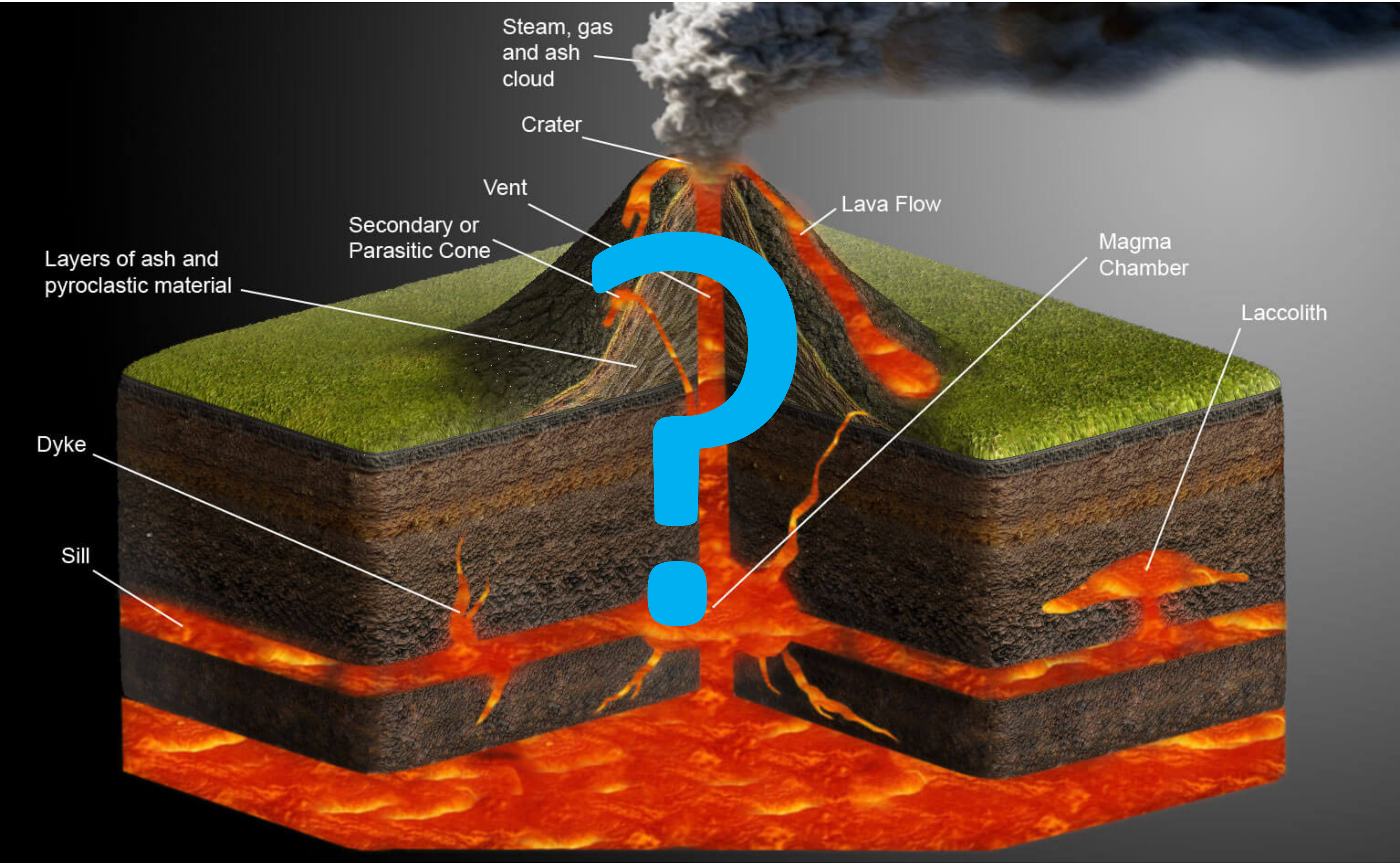

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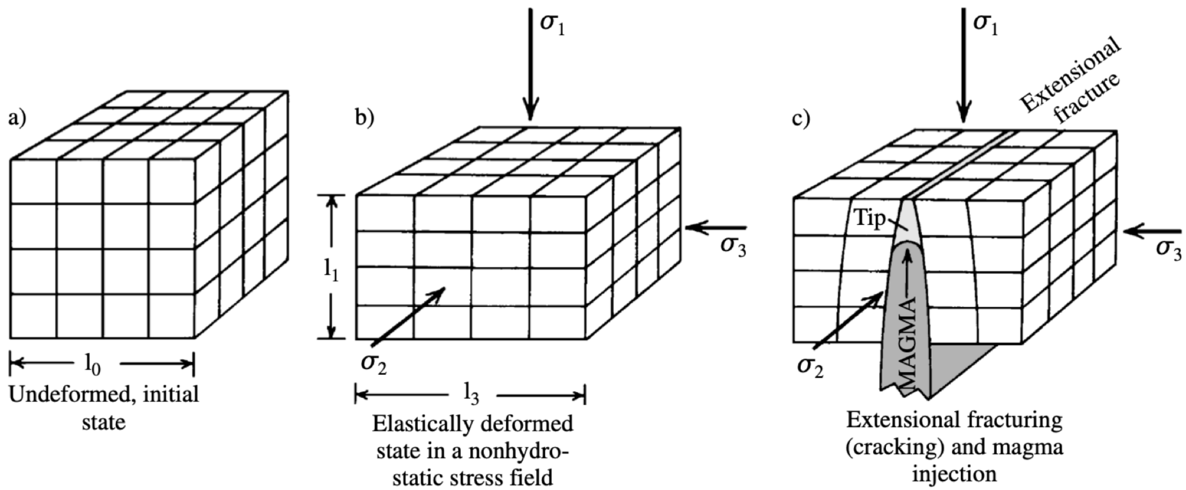
Le orientazioni dei corpi magmatici intrusi nella crosta sono governate dallo stato di stress.
La fratturazione da parte di magmi in sovrapressione crea delle fratture parallele a σ_1 e σ_2, che si aprano in direzione dello stress principale minore, σ_3 . Quindi, queste fratture in dilatazione riempite da magma, servono anche come indicatrici di paleo-stress.



8.2 Deformation of a body under a nonhydrostatic state of stress, $\sigma_1 > \sigma_2 > \sigma_3$. (a) Undeformed body represented by a cubical stack of smaller cubes. (b) Principal stresses of unequal magnitude cause a change in shape—a **strain.** Actual recoverable elastic strain produces only a small percentage of strain, far less than is represented here for illustrative purposes. However, the relative amounts of strain are as expected, that is, flattening perpendicular to the maximal principal compressive stress, σ_1, and elongation, or extension, parallel to the least principal compressive stress, σ_3. Strain parallel to σ_2 can be either elongation or flattening or nil. (c) Nonhydrostatic stresses may exceed the brittle (essentially elastic) strength of a rock so that an **extensional fracture** forms perpendicular to the least principal compressive stress, σ_3. These open cracks may be subsequently filled with magma or fluid. The pressure exerted by the magma or fluid itself may be sufficient to create an extensional fracture by **hydraulic fracturing.** Just beyond the injecting fluid or magma that wedges apart the walls of rock is a tip cavity where transient low pressure can suck out volatiles dissolved in the magma or pore fluids lodged in the wall rock.

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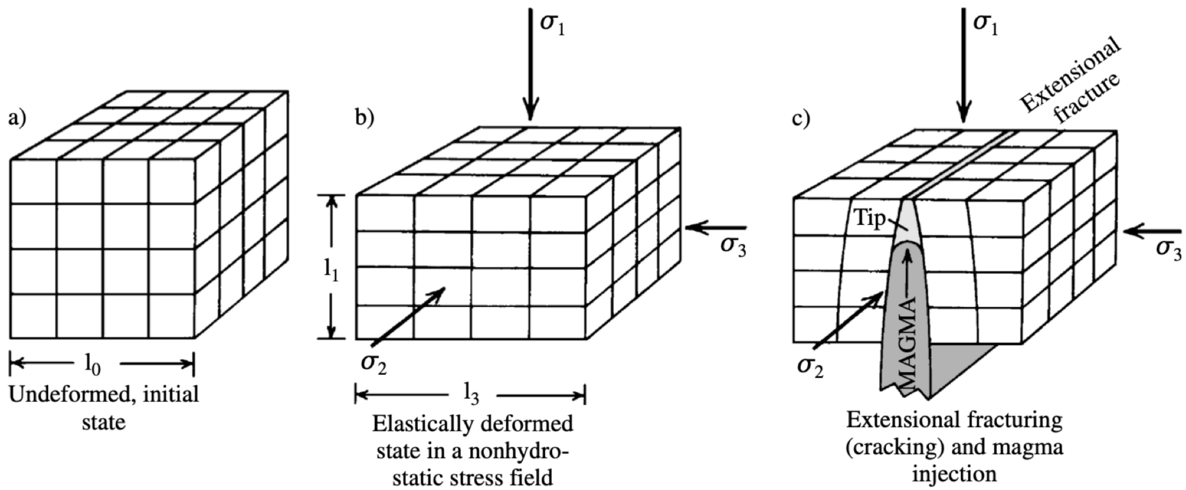
I magmi in risalita da sorgenti profonde, come magmi basaltici formati nel mantello e intrusi in dicchi sub-verticali nella crosta, implicano che σ_3 sia orizzontale, cioè la tipica orientazione sopra i *mantle plumes* e in altri regimi estensionali. Sciami di dicchi subparalleli e subverticali esposti in aree molto grandi indicano uno stato uniforme di estensione della crosta al tempo dell'intrusione.



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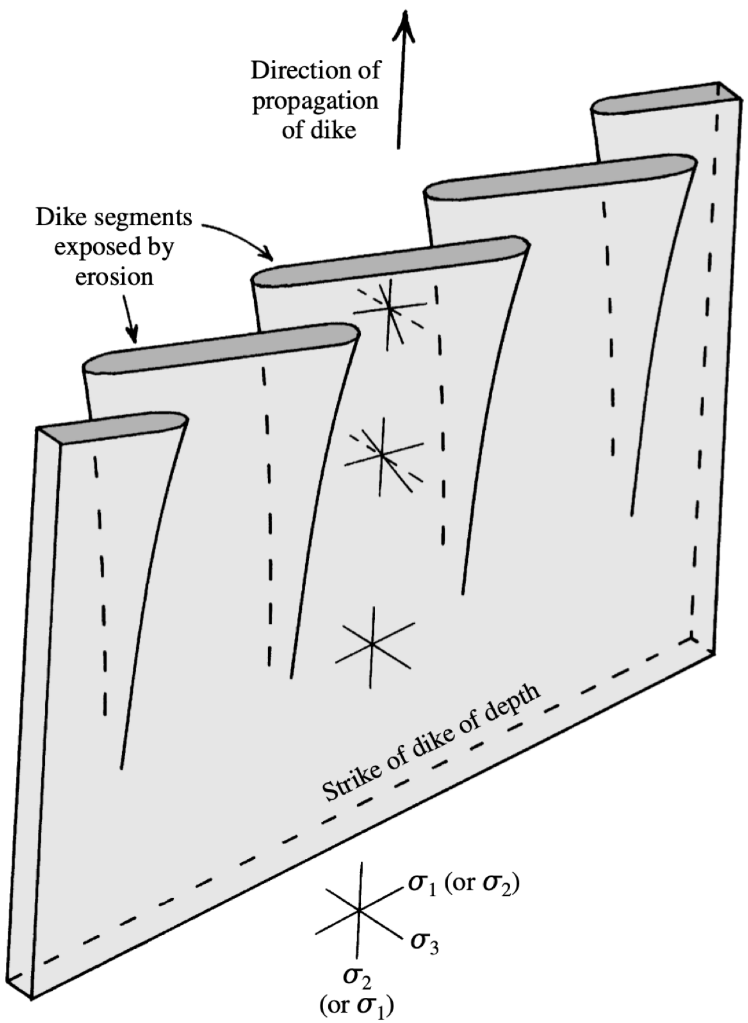
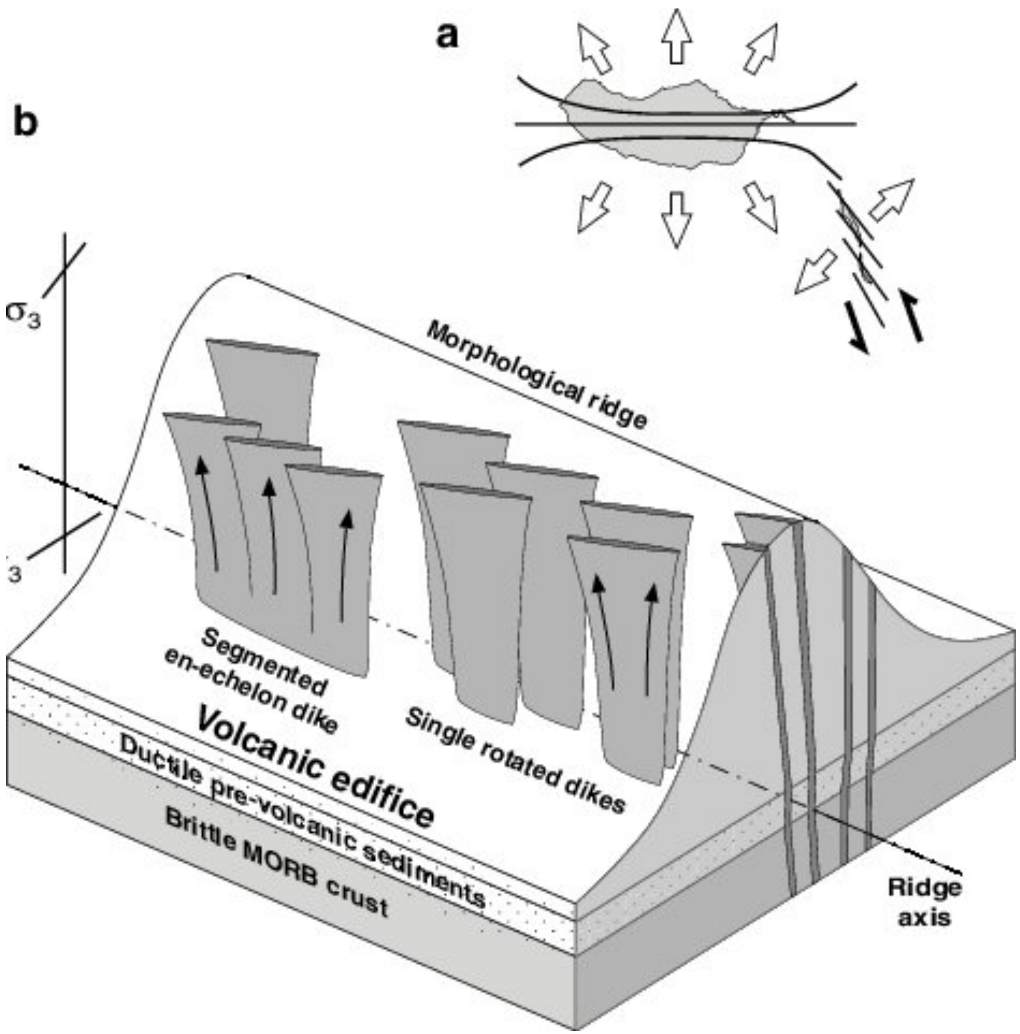
I dicchi si presentano spesso come segmenti disposti ad *en-echelon*. Questa disposizione può essere legata ad un cambiamento di direzione di σ_3 con la profondità.



Best (2003)

9.9 Schematic three-dimensional form and origin of subvertical **en echelon dike** segments. At some depth the dike is an unsegmented sheet intrusion whose orientation is controlled by the nonhydrostatic state of stress indicated by the thin-line orthogonal principal stresses below the dike. At progressively shallower depths the orientation of the least principal horizontal stress, σ_3, rotates progressively counterclockwise, as shown in the upper part of the dikes. Consequently, the least-work dike configuration there is an *en echelon* system of dike segments. Note that the other horizontal principal stress must also rotate. (Redrawn from Delaney and Pollard, 1981.)

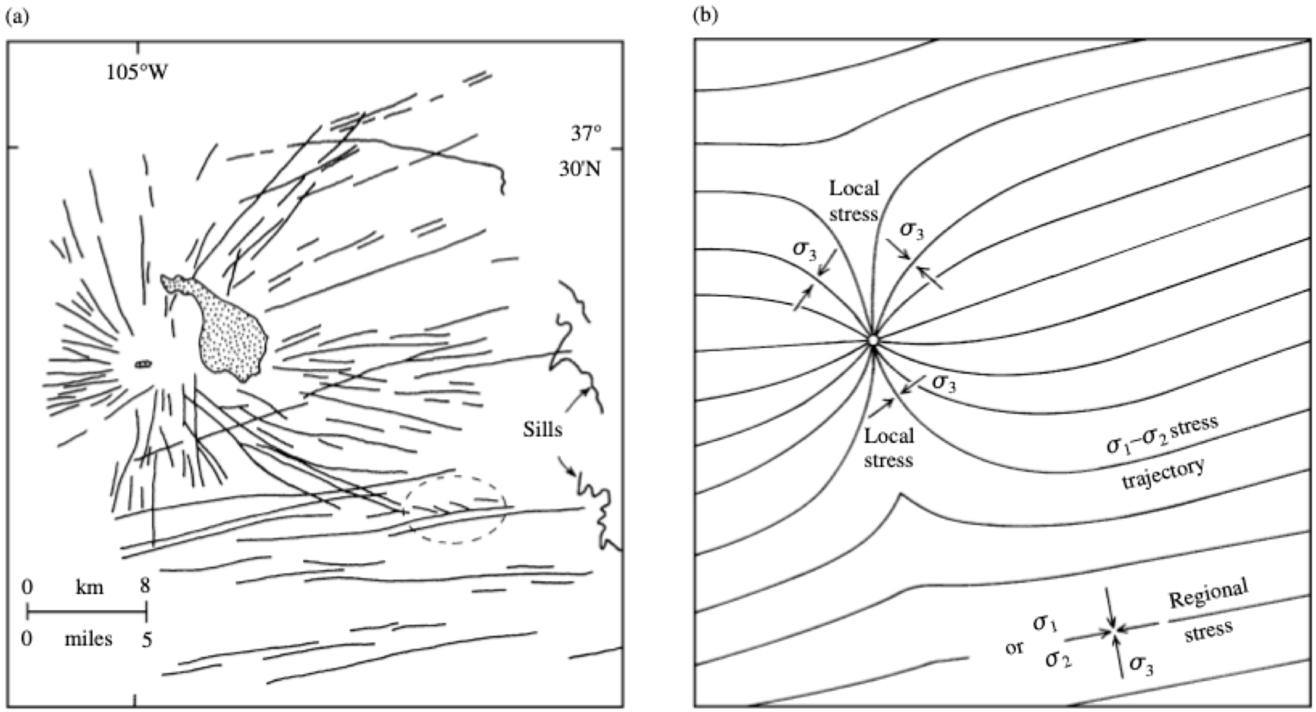


Klügel et al (2005; Bull Volc)

Fig. 8 (**a**) Simple sketch of potential dike directions indicates how spreading of Madeira (*open arrows*) causes a sinistral stress component and dike rotation at the Desertas Islands (*solid arrows*). (**b**) Sketch of dike rotation and en-echelon arrangement within the Desertas ridge (not to scale). Because of changing orientation of the principal stress axis σ_3, ascending dikes rotate counterclockwise around a vertical axis or become segmented. Both scenarios result in en-echelon arrangements of the dikes at the ridge surface.

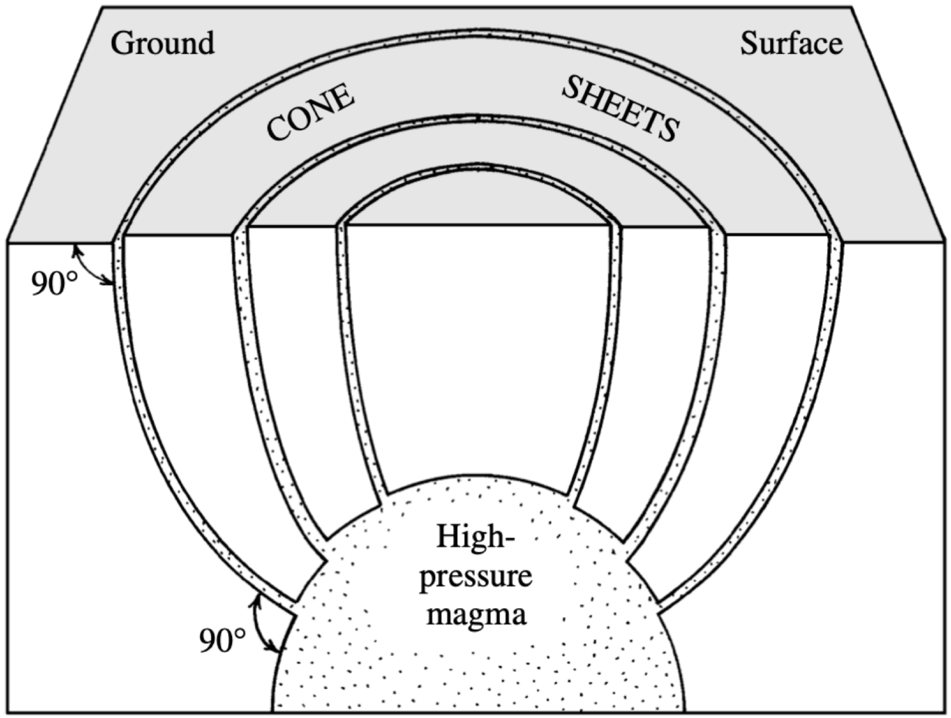
https://it.m.wikipedia.org/wiki/File:En-echelon_Dyke_Apophyses_Kosterhavet_Sweden.jpg

Le intrusioni tabulari sono comuni nella crosta superiore, dove circondano e si dispongono al di sopra delle intrusioni massive principali.
Queste intrusioni intrusioni principali (di varia forma, cilindrica o a bottiglia) possono perturbare lo stress regionale presente nella zona.
Lo stress totale risultante sarà variabile nella sua orientazione attorno all'intrusione. In questo regime di stress, le intrusioni create dal magma alimentato dall'intrusione centrale avranno varie forma, come dicchi radiali, conici o ad anello.



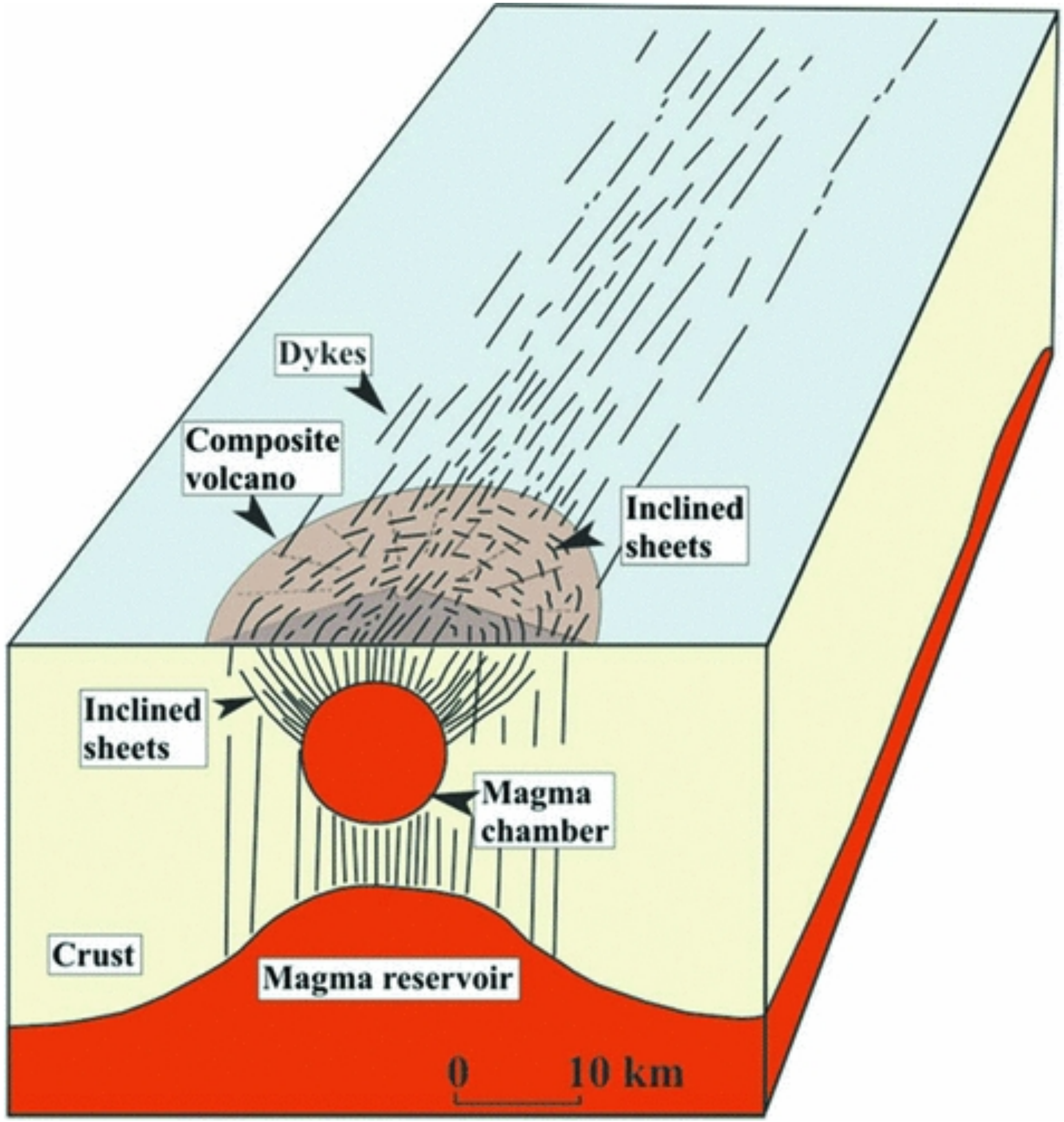
Best (2003)

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.)



Best (2003)

9.10 Idealized geometry of **cone sheets** above a shallow, forcefully intruded **central magma intrusion.** Inward-dipping cone sheets develop as high-pressure magma in the central intrusion invades conical extensional fractures that follow $\sigma_1 = \sigma_2$ trajectories above the apex of the intrusion. This geometry applies to situations in which the depth to the top of the intrusion is comparable to its width; in such cases, some of the magma commonly extrudes and the intrusive complex is referred to as *subvolcanic.* Many intrusions are emplaced farther beneath the surface and for this reason and other factors do not have cone sheets.



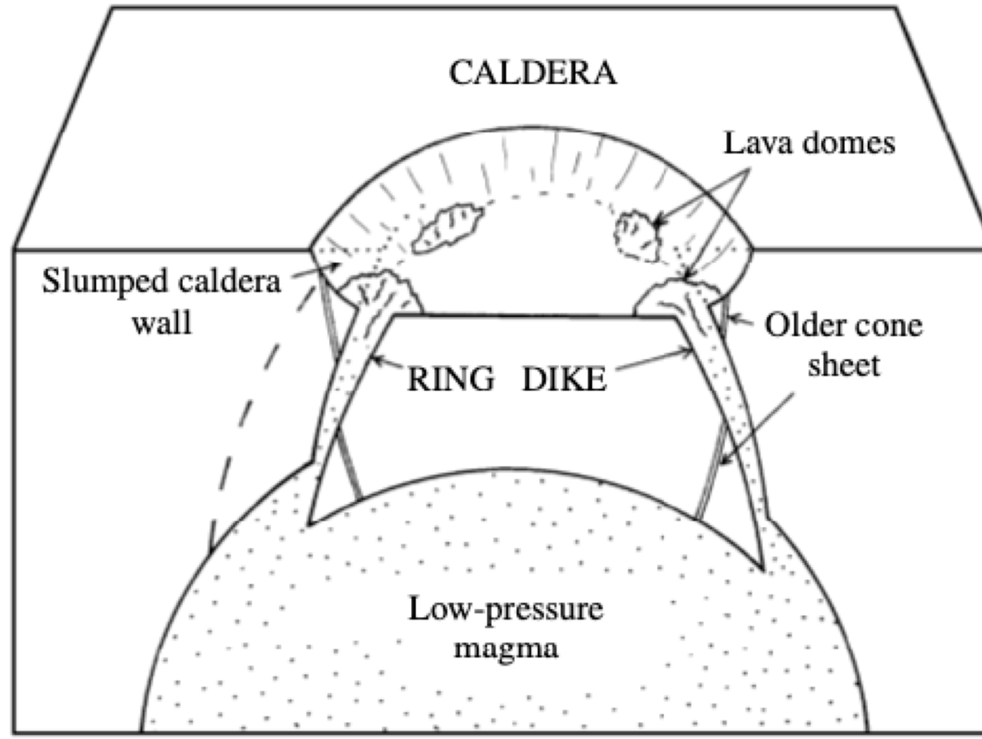
Gudmundsson et al (2014)

Dopo uno stato iniziale di sovrappressione di una certa intrusione magmatica massiva, i.e., una camera magmatica, in seguito alle eruzioni in superficie la pressione della camera magmatica possono diminuire.

Queste eruzioni o anche le intrusioni nelle vicine rocce incassanti possono creare dei vuoti in alcune porzioni della camera magmatica. Questo può causare una subsidenza della camera magmatica, creando una depressione topografica chiamata **caldera**.

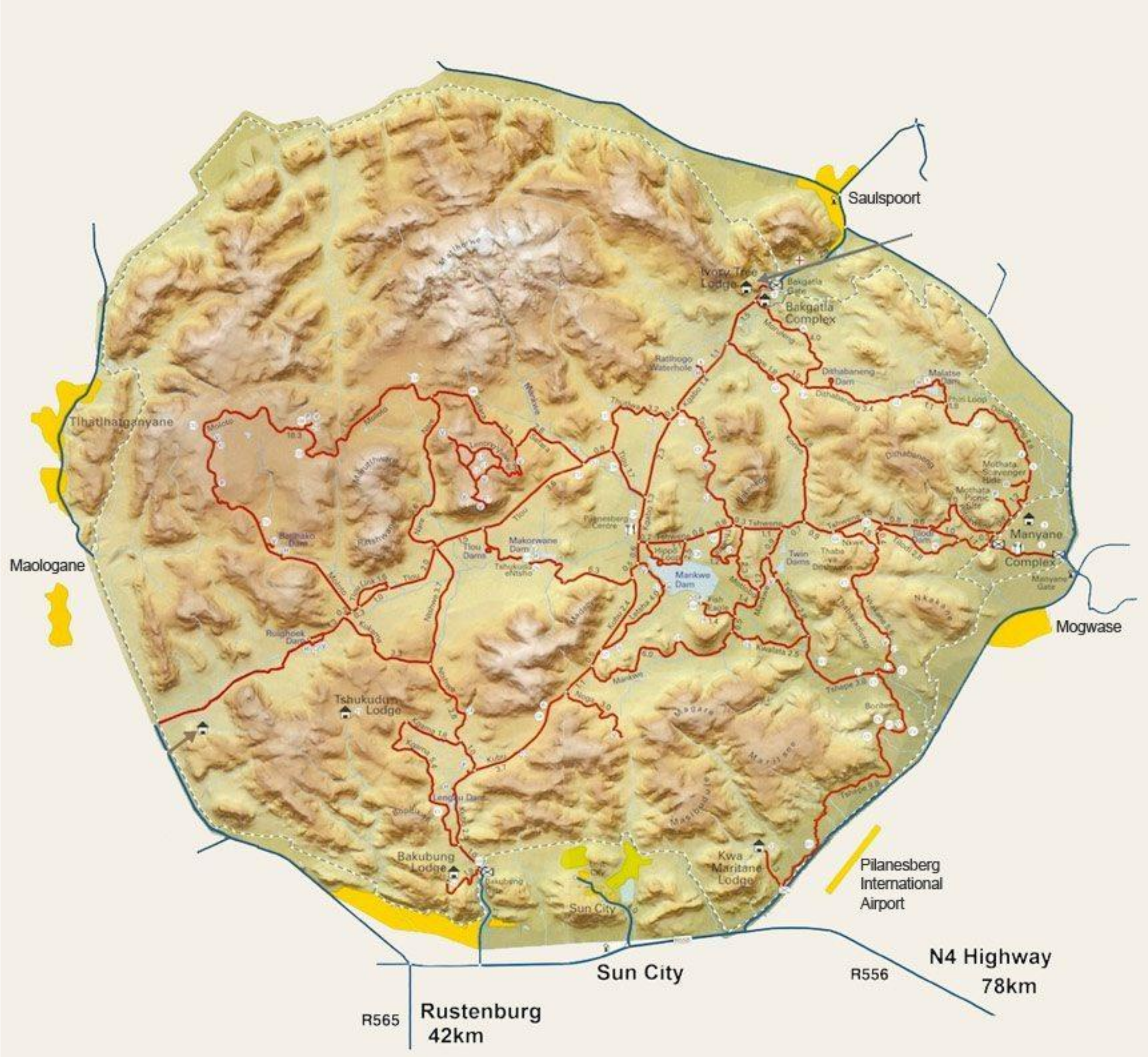
La fratturazione ad anello che fa da confine al tetto che va in subsidenza segue all'incirca la forma della camera magmatica. Durante questi processi, del magma può risalire in questa frattura ad anello, formando quello che viene chiamato **dicco ad anello**.

Best (2003)



9.11 Hypothetical **ring dike** and **caldera** above a shallow magma chamber. Postcollapse caldera fill consists of landslide debris that is produced by slumping of the unstable caldera wall and epiclastic (sedimentary) deposits shed off the eroding caldera wall. Magma rising in the ring dike locally extrudes to form lava domes or flows; their vents mark the position of the usually concealed underlying ring dike and the ring fault it followed.

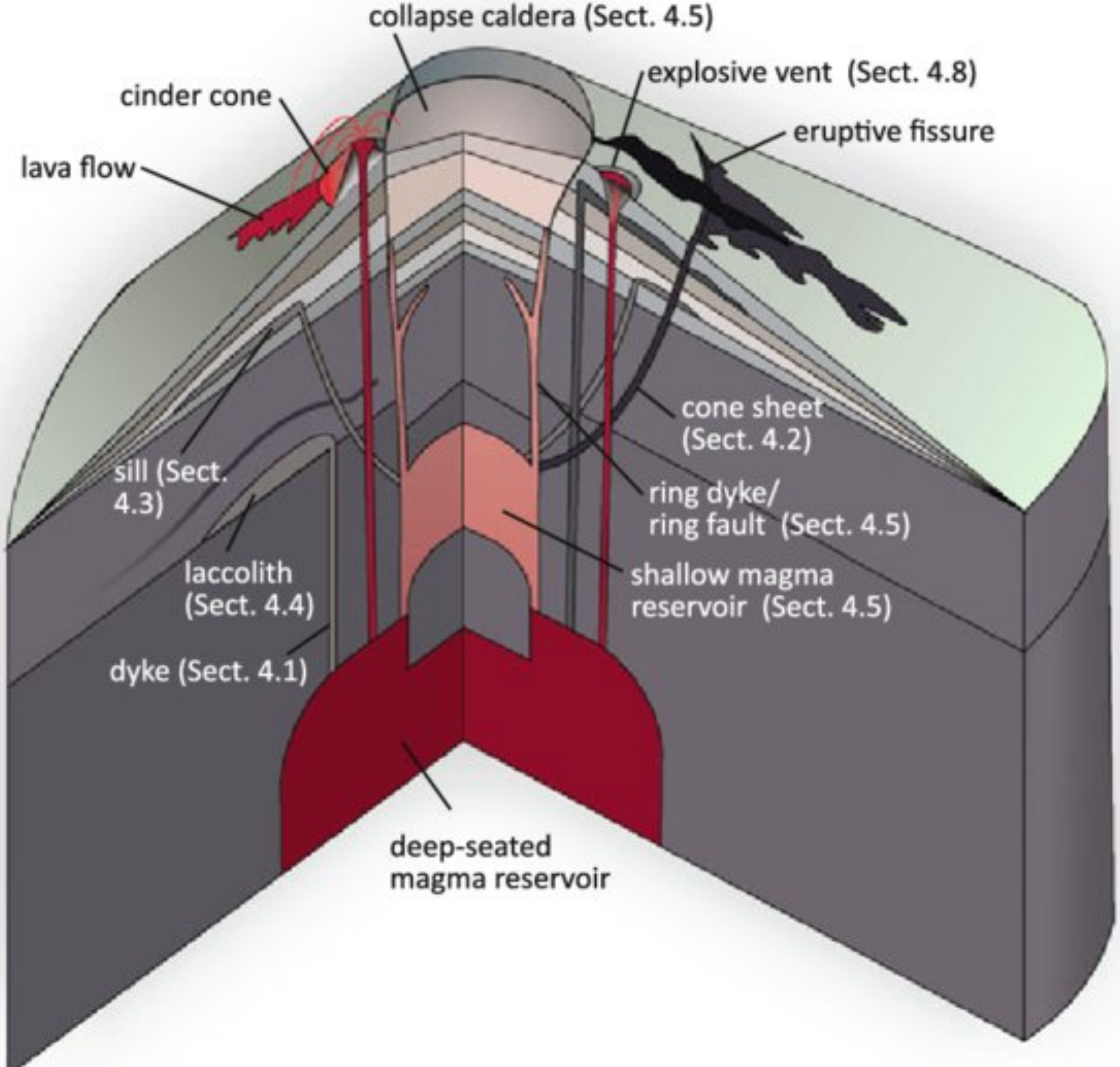
Pilanesberg National Park



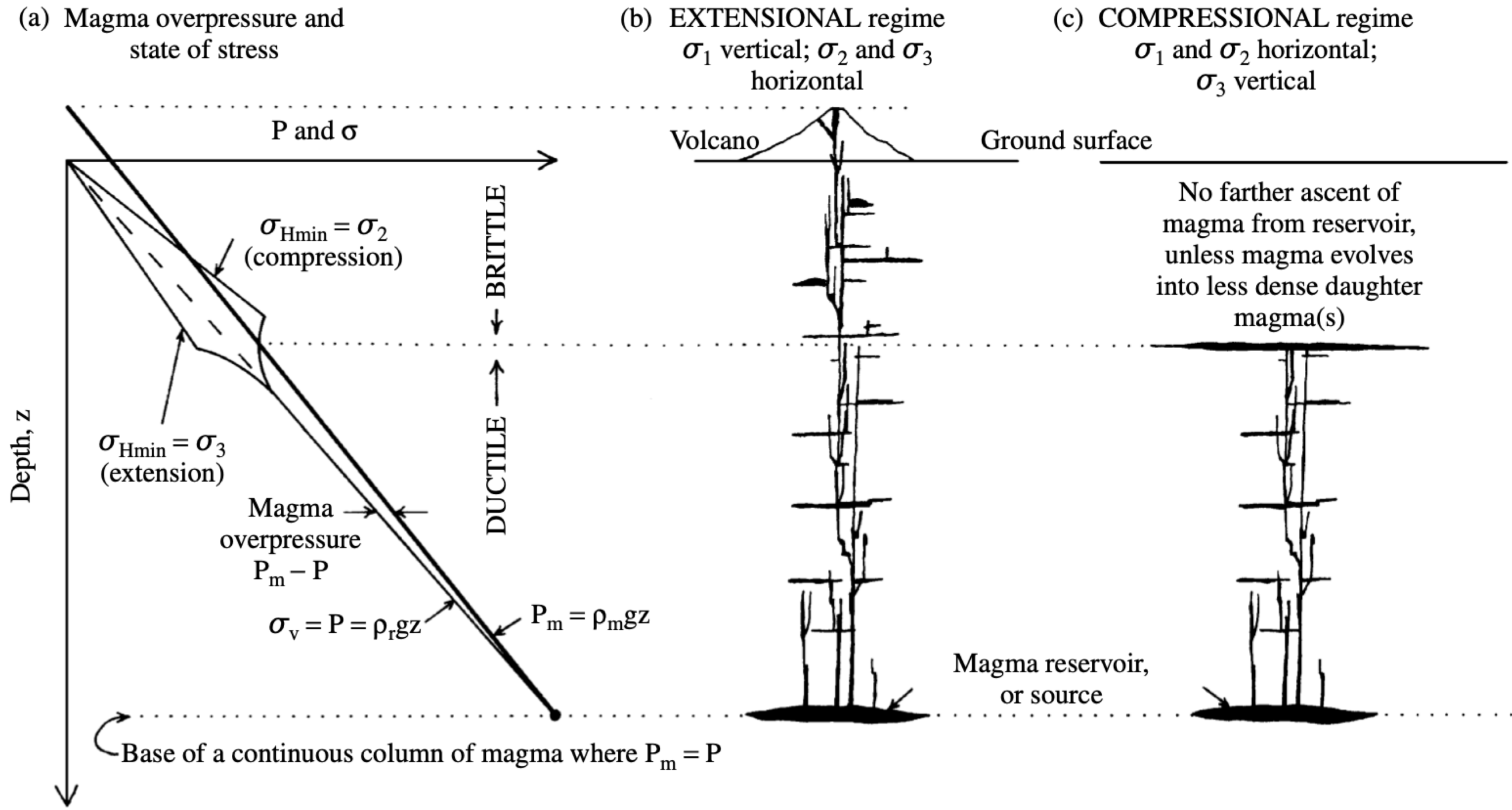
https://pilanesberggamereserve.com/geology.html

Pilanesberg Caldera

Pilanesberg Caldera

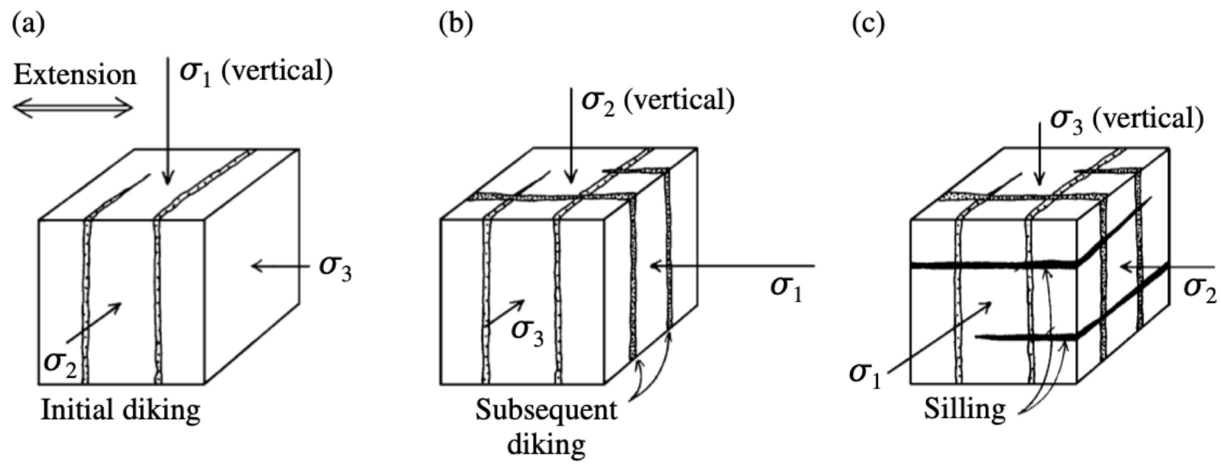


Galland et al (2015)



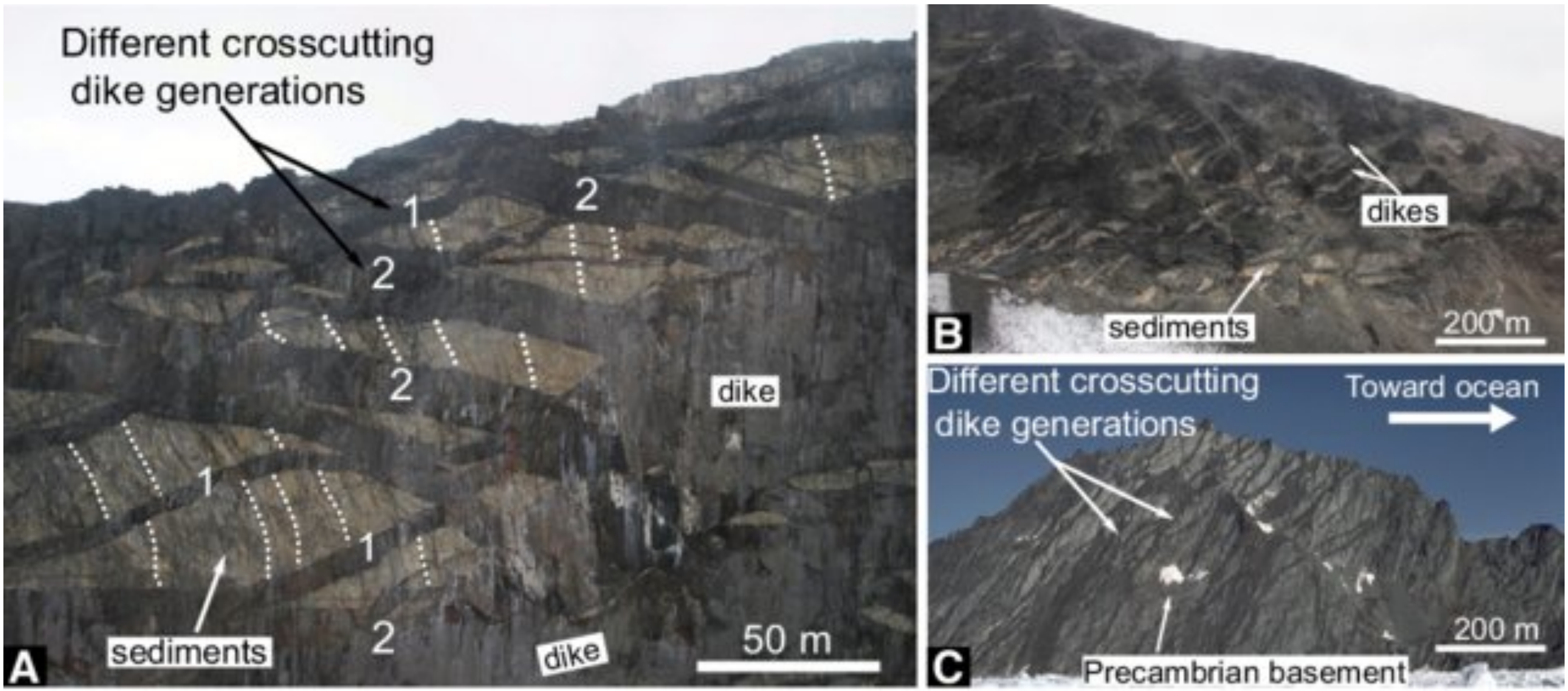
9.12 Schematic relations between static magma pressure and state of stress in the lithosphere that govern magma ascent and stagnation. See also Marrett and Emerman (1992). It is assumed for simplicity that there is no reduction in magma pressure due to viscous loss that occurs during upward flow in a dynamic system and that the tensile strength of rock is nil.

Best (2003)



Best (2003)

9.13 Intrusion of horizontal sills in an extensional tectonic setting after vertical diking. (a) Initial intrusions are vertical dikes perpendicular to horizontal least compressive principal stress, σ_3. Wedging of magma reinforced by thermal expansion of heated wall rocks increases the stress perpendicular to dikes so that σ_3 becomes σ_1 in (b). Relative magnitude of other two principal stresses remains the same: Vertical σ_1 becomes σ_2 and horizontal σ_2 becomes σ_3. In this new state of stress, additional magma is emplaced in vertical dikes perpendicular to initial ones. After this subsequent diking, magnitudes of principal stresses are again interchanged to yield a third state of stress in (c) where σ_3 is now vertical, allowing horizontal sills to develop as more magma is introduced. The sills lift the overlying crust against gravity. (Redrawn from McCarthy and Thompson, 1988.)



Abdelmalak et al (2015; Geology)

Varie risorse online

https://app.visiblegeology.com/profile.html

(Modelli geologici in 3D)